INFORMATION VISUALIZATION FOR INTELLIGENT SYSTEMS

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Preface

The book focusses on advanced computing, or machine intelligence, the ability of a technology (a machine, device, or algorithm) to interact with its surroundings intelligently. This means that the technology can make decisions and take actions that will increase the likelihood that its objectives will be met. In contrast to the natural intelligence exhibited by people, artificial intelligence (AI), sometimes referred to as machine intelligence, is intelligence manifested by machines. The modern world is experiencing a period of paradigm shifts. New technologies have contributed to these shifts in part because they offer high-speed computing capabilities that make complicated machine intelligence systems possible. These advancements are paving the way for the creation of new cyber systems, which employ continually generated data to construct machine intelligence models that carry out specific functions inside the system. While the isolated use of cyber systems is becoming more common, the synchronic integration of these systems with other cyber systems to create a compact and intelligent structure that can interact deeply and independently with a physical system is still largely unanswered and has only been briefly discussed from a philosophical perspective in a few works.

Modern civilisation has undergone many paradigms shifts as a result of technological breakthroughs. These developments brought in immense data creation, cloud data storage systems, near-instantaneous worldwide information exchange, very quick computer capabilities, etc. Additionally, they paved the way for the development of cutting-edge cyber systems that employ systematically created data pipelines to carry out certain tasks. For instance, in certain nations, video surveillance imagery is used to detect criminals or possible criminals using machine intelligence (MI) models. Moreover, autonomous MI systems have applications in the medical field, where they enable prompt detection of infections like COVID-19. The chemical industry also uses a variety of applications.

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Analysis of Restaurant Reviews Using Novel Hybrid Approach Algorithm Over Convolutional Neural Network Algorithm with Improved Accuracy

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Abstract
The goal of this endeavor is to assess restaurant evaluations using a novel hybrid approach method in conjunction with the algorithm known as convolutional neural network (CNN). The study presents a novel hybrid approach that uses deep learning to classify restaurant evaluations as either good or negative. A collection of reviews was compiled in order to assess the efficacy of the proposed method. The hybrid approach algorithm (accuracy = 96.1%) analyzes the reviews and increases the measured accuracy over CNN (accuracy = 92.30%) with a statistically significant value of 0.004. The findings from the assessment conducted on the test dataset indicate that, in comparison to alternative methodologies currently in use, the novel hybrid approach technique yields the most precise reviews.

***Keywords*:** Sentiment analysis, novel hybrid approach, convolutional neural network, deep learning, restaurant reviews, polarity, food

Introduction

In recent years, the growth of restaurants through online platforms has been significant, with websites becoming the primary way for customers

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to provide their opinions and assess the quality of restaurants and food services. The sentiment of customers can be inferred from these online reviews, which play a crucial role in shaping the reputation of an eatery. The potential to evaluate customers' opinions and make adjustments is provided by the contact between customers and owners via Internet platforms. Training machines with labeled data provides the benefit of more accurate future analysis of customer sentiment (Young *et al.*, 2018). The significance of this study extracted features from reviews and predicted their sentiment using a mixed deep learning technique. The findings of this study will help business owners by offering insightful information for making decisions. The procedure entails removing text from the web, classifying it, and figuring out how it feels. This contribution comprises a dataset comprising one thousand reviews sourced from Bangladesh. Chinsha T.C. proposed a feature based on an analysis of restaurant reviews (Chinsha and Joseph, 2015). The applications of the analysis of restaurant reviews using the novel hybrid approach algorithm include (Sharif, Hoque, and Hossain, 2019) the following: Improving Restaurant Operations: The analysis of customer feedback can be used by restaurants to identify areas for improvement and make informed decisions about menu offerings, food services, and other aspects of their operations. Customer Segmentation: Customers can be divided into groups according to their opinions and preferences using the hybrid approach, allowing restaurants to tailor their customers (Mohammad, Kiritchenko, and Zhu, 2013).

The examination of restaurant review systems has generated a significant amount of scholarly interest in recent years. On Google Scholar, over 191 papers were published, whereas on IEEE, over 97 papers were published. This research aims to analyze individuals' perspectives about restaurants using an innovative method. By utilizing deep learning architectures, this study seeks to achieve higher accuracy in sentiment analysis of restaurant reviews. The innovative combination of a convolutional neural network (CNN) and a novel hybrid strategy is suggested to address the diversity of recent datasets. A sample of 1000 reviews was collected and preprocessed to structure the unstructured and unlabeled data, with labels assigned as positive or negative. The CNN model learns the representation of words, while the novel hybrid approach learns more nuanced representations specific to the classification task. Hyperparameters were optimized before training the model to improve accuracy. Sentiment analysis is a common approach to predict customer reviews, as shown in previous studies by authors like Gan, who assessed restaurants based on factors like the quality of the food, cost, service, or atmosphere, and its context, and Jia, who created a model for categorizing restaurant reviews (Jia, 2020). Using a set of data of 1060 reviews, author Niphat Claypo developed a sentiment analysis framework using a combination of K-means clustering and the MRF feature selection (Claypo and Jaiyen, 2015). The optimal average K-means accuracy was 71.73%. An opinion mining model with 70% accuracy was proposed by author Sun using a dependency parser and Sentiwordnet (Sun, Luo, and Chen, 2017). Author Soujanya Poria developed the CNN methodology for identifying sentiment meaning using aspect uprooting. A multilayer CNN was used for word tagging according to Young *et al.* (2018).

The research gap is to overcome these limitations, a hybrid approach combining deep learning and sentiment analysis is proposed to classify sentiment polarity as either positive or negative. However, it is important to note that the accuracy of the machine learning models is contingent upon the quality of the training data, and any biases or inaccuracies could result in incorrect predictions. Additionally, the interpretability of some machine learning models, such as deep learning networks, can be limited, making it challenging to comprehend their reasoning. This study evaluates the effectiveness of a new hybrid approach method in comparison to a CNN algorithm for improving the accuracy of emotion polarity categorization in restaurant reviews.

Related Work

In the past five years, between 2017 and 2021, there has been an analysis of restaurant review systems that have been the subject of a sizable number of research articles. There are over 191 papers published on Google Scholar and over 97 papers published in IEEE. Hossain, Sharif, and Hoque (2020) conducted an analysis utilizing 4000 Bengali movie reviews, suggested a sentiment analysis model, and achieved a precision of 88.90% for long short-term memory (LSTM) and 82.42% for SVM. Utilizing the multinomial naive Bayes system that has an accuracy rating of 84%, 2000 Bengali critiques of books were utilized to categorize sentiment opposites into positive and negative categories (Hossein, Hoque, and Sarker, 2021). Sarker (2019) offered an LSTM-based sentiment analysis with an accuracy of 55.23% to categorize 1500 tweets into positive, negative, and neutral groups. The study of Wahid, Hasan, and Alom (2019) introduces a method for sentiment analysis utilizing LSTM (long short-term memory) on a dataset of 10,000 comments on Facebook to divide Bengali content into either positive or negative groups with 95% accuracy.

An LSTM-based algorithm was used to classify attitudes from Facebook tweets, achieving an 85% accuracy on a set of 10,000 Bengali messages.

Previous studies on sentiment analysis in Bengali focused on datasets such as Twitter posts, book reviews, and movie ratings, but these datasets were generally small. There is a dearth of research on sentiment analysis of restaurant reviews in the Bengali language other than this study. A total of 6625 restaurant reviews were gathered for the current study from a variety of online sources, including restaurant pages (1763), groups (1940), and Facebook comments (2922). Furthermore, 2000 restaurant reviews were acquired using the Yelp dataset. Data obtained from February 2020 to June 2020 contained inconsistent reviews. To address this, a filter was designed to exclude duplicates, comments with a minimum of three terms, mixed language evaluations, neutral sentiment evaluations, and reviews containing punctuation, numerals, and emojis. The filter produced a refined dataset of 6435 evaluations, which had been manually annotated by three annotators with 12 to 18 months of expertise in natural language processing (NLP). The annotation process entailed preserving the labels of 2000 evaluations from the Yelp dataset. Mohammad, Kiritchenko, and Zhu (2013) employed Cohen's Kappa to assess the inter-rater agreement among annotators for evaluating the annotation quality. The data exhibit good quality, as indicated by the average Kappa value of 0.81 (Kwok & Yu, 2013).

Existing Methodology

Convolutional Neural Network Algorithm

CNNs are a deep learning technique known for their effectiveness in image identification and may also be applied to text classification tasks like sentiment evaluation of restaurant reviews. In the case of restaurant reviews, the text data are transformed into numerical data using techniques such as tokenization, padding, and one-hot encoding. The CNN model is then trained using the numerical data. During training, the model learns the patterns and relationships between the words and phrases in the reviews and the corresponding sentiment (positive, neutral, or negative). After the model has undergone training, it can be utilized to categorize fresh reviews and forecast the sentiment expressed in the review. Evaluating the model's accuracy can be done by utilizing metrics such as precision, recall, and F1-score.

Overall, using a CNN algorithm for sentiment analysis of restaurant reviews can lead to effective and efficient classification results.

Algorithm Steps

Data preprocessing
1. Load the restaurant review dataset
2. Clean and preprocess the text data
3. Tokenize the text data into sequences of words or phrases
4. Pad the sequences to a fixed length
5. One-hot encode the sequences

Model building and training
6. Define the CNN architecture (number of layers, filter size, etc.)
7. Compile the model by defining the loss function, optimizer, and metrics
8. Train the model on the preprocessed data using a suitable batch size and number of epochs

Model evaluation
9. Evaluate the trained model on a test set of reviews
10. Calculate evaluation metrics such as precision, recall, and F1-score

Model deployment
11. Save the trained model for later deployment
12. Load the saved model and use it to classify new restaurant reviews and predict their sentiment.

Proposed Methodology

The dataset used in this research work is based on the concept of restaurant reviews (Govindarajan, 2014). The dataset used in this research is collected from Kaggle. The sample size was determined through GPower software, where two groups of 10 sets were selected. Using the GPower 3.1 tool, a pre-test strength value was determined with $\alpha = 0.05$ and power = 0.80, the necessary parameters for a test of statistical significance comparing two independent means. The study employed a novel hybrid method and CNN algorithm by utilizing Technical Analysis software. Human or animal samples were not used due to the absence of ethical approval requirements. The hardware configuration comprised an Intel i5 core processor paired with 16 GB of RAM. The software utilized included HTML, Python, Java, Tomcat/Glassfish server, Jupyter Notebook, My SQL database, CSS web technologies, and J2SDK1.5 Java version.

Novel Hybrid Approach Algorithm

The novel hybrid approach algorithm for analyzing restaurant reviews combines multiple techniques from NLP to provide a comprehensive analysis of customer opinions and sentiments. The algorithm uses methods such as sentiment analysis, topic modeling, and entity recognition to identify trends and patterns in the data. The objective is to help restaurant owners and managers make informed decisions about their business and food services by understanding the strengths and weaknesses of their establishment through the analysis of customer reviews. The insights obtained from the study can be used to improve the customer experience and enhance overall satisfaction.

Pseudocode for a Hybrid Approach Algorithm for Analyzing Restaurant Reviews:

Step 1: Preprocessing
Input: Raw restaurant reviews
Output: Cleaned and preprocessed reviews
Remove irrelevant information such as punctuation, stop words, and special characters.
Tokenize the reviews into individual words.
Utilize lemmatization or stemming to simplify words to their most basic form.

Step 2: Sentiment Analysis
Input: Cleaned and preprocessed reviews
Output: Sentiment scores for each review
Utilize an analysis of sentiment tool or algorithm to categorize each review as favorable, negative, or neutral.
Calculate the sentiment score for each review based on the classification results.

Step 3: Topic Modeling
Input: Cleaned and preprocessed reviews
Output: Topics and their distributions in the reviews
Apply LDA (latent Dirichlet allocation) for topic modeling to determine the primary subjects covered in the reviews.
Calculate the distribution of topics in the reviews.

Step 4: Entity Recognition

Input: Cleaned and preprocessed reviews

Output: Entities mentioned in the reviews

Use an entity recognition tool or model to identify entities such as food items, services, ambiance, etc. mentioned in the reviews.

Store the entities and their mentions in a data structure.

Step 5: Combination of Results

Input: Sentiment scores, topic distributions, and entity mentions

Output: comprehensive analysis of the restaurant reviews

Combine the results from the sentiment analysis, topic modeling, and entity recognition steps to obtain a comprehensive analysis of the restaurant reviews.

Use the results to identify patterns and trends in the data.

Step 6: Visualization and Reporting

Input: Comprehensive analysis of the restaurant reviews

Output: Visualizations and reports

Use data visualization techniques to present the results of the analysis in an intuitive and easy-to-understand manner.

Statistical Analysis

In order to statistically analyze restaurant evaluations, SPSS software employs a special hybrid approach strategy that outperforms the naive Bayes approach in terms of accuracy. Accuracy is the dependent variable, and efficacy is the independent variable. A sample size of ten has been used for the analysis. The novel hybrid approach algorithm's accuracy is determined using the statistical T-test analysis.

Results

The hybrid approach algorithm and the CNN algorithm were run independently in Jupyter Notebook using an experiment size of 10.

Table 1.1 displays the expected accuracy and loss of the hybrid approach algorithm.

Table 1.2 represents the CNN's expected accuracy and loss. The statistical values that can be utilized for comparison are computed for each of

Table 1.1 An analysis of accuracy and loss was conducted on a novel hybrid approach algorithm using a sample size of 10. The hybrid approach algorithm achieves a precision rate of 96.10% with a corresponding error rate of 3.90%.

Iteration	Accuracy (%)	Loss (%)
1	96.63	3.37
2	97.46	2.54
3	98.25	1.75
4	94.52	5.48
5	95.66	4.34
6	95.68	4.32
7	95.25	4.75
8	96.25	3.75
9	95.20	4.80
10	96.10	3.90

the 10 data samples together with the associated loss values. According to the findings, the CNN had a mean accuracy of 92.30% and the hybrid approach algorithm had a mean accuracy of 96.1%.

Table 1.3 represents the mean accuracy scores for the CNN and the hybrid approach algorithm. When compared to the CNN, the hybrid approach algorithm's mean value is superior, with standard deviations of 2.08555 and 2.18436, respectively.

Table 1.4 shows the hybrid approach algorithm and CNN-independent sample T-test data with a statistically significant value of 0.004 ($p < 0.05$).

Table 1.5 evaluates the convolutional neural network, also known as CNN [20–25], algorithm's accuracy against that of the hybrid approach algorithm. The hybrid approach algorithm attains an efficacy of 96.10%, whereas the CNN (convolutional neural network) algorithm yields a success rate of 92.30%. In terms of accuracy, the hybrid approach algorithm performs better than the CNN model algorithm.

Table 1.2 A CNN with a sample size of 10 is used to analyze its accuracy and loss. 92.30% precision and 7.70% error rates are attained using the CNN.

Iteration	Accuracy (%)	Loss (%)
1	91.15	9.85
2	94.32	5.68
3	93.46	6.54
4	91.07	9.93
5	93.18	6.82
6	94.74	5.26
7	90.56	9.44
8	90.78	9.22
9	91.44	8.56
10	92.30	7.70

Table 1.3 The group statistics for the novel hybrid model show a mean accuracy of 96.10% with a standard deviation of 1.11. In comparison, the LSTM model has a mean accuracy of 92.30% with a standard deviation of 1.52.

	Group	N	Mean	Std. deviation	Std. error of the mean
Accuracy	Hybrid algorithm	10	96.1000	1.11427	0.35236
	CNN	10	92.3000	1.52996	0.48382

Figure 1.1 illustrates the flow chart of a distinctive hybrid methodology that integrates a CNN (convolutional neural network) to analyze the sentiments of online restaurant reviews.

Figure 1.2 shows the average accuracy difference between the hybrid approach algorithm and the CNN. With a mean of 93.3571, a standard

Table 1.4 Performing a T-test on an independent sample to establish significance and compute the standard error. A p-value of less than 0.05 is considered statistically significant, and a confidence interval of 95% was calculated. The hybrid approach algorith demonstrates superior performance compared to CNNs, with a statistically significant p-value of 0.004, meeting the criteria for significance at a two-tailed level of $p < 0.05$.

Levene's equality of variances test				**T-test for means equality**					**95% Confidence interval for the difference**	
		F	**Sig**	**t**	**df**	**Sig. (two-tailed)**	**Mean difference**	**Std. error difference**	**Lower**	**Upper**
Accuracy	**Assuming equal variance**	0.309	0.014	6.349	18	0.004	3.80000	0.59853	2.54254	5.05746
	No assumption of equal variances			6.349	16.451	0.004	3.80000	0.59853	2.53400	5.06600

Table 1.5 Comparison of Hybrid Algorithm and CNN with their accuracy. The accuracy achieved by the CNN Algorithm is 92.30%, while the Hybrid Approach Algorithm is 96.10% accurate. The Hybrid Approach Algorithm has better accuracy compared to the CNN algorithm.

Classifier	Accuracy (%)
Hybrid approach algorithm	96.10
Convolutional neural network	92.30

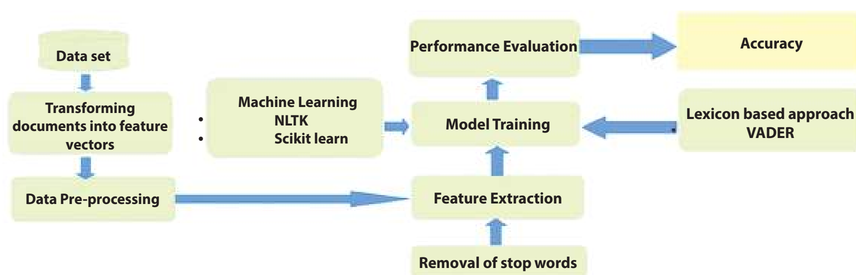

Figure 1.1 A flowchart illustrating a cutting-edge hybrid method that combines sentiment analysis for online restaurant reviews with a CNN model.

deviation of 2.08555, and a standard error of the mean of 0.78826, the hybrid approach algorithm is performing well. CNNs have averages, variability, and precisions of 89.2857, 2.18436, and 0.82561, respectively.

The group statistics number for both procedures includes the mean, standard deviation, and standard error of the mean. The categorization of the graphical juxtaposition between the hybrid approach technique and the CNN illustrates the disparity in precision between the two. The results indicate that the hybrid approach algorithm outperforms the CNN in terms of accuracy, achieving a rate of 96.1% compared to 92.30%.

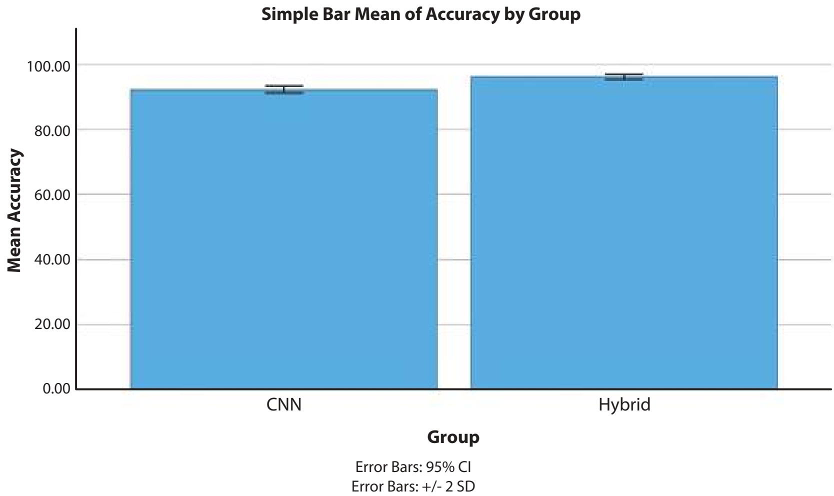

Figure 1.2 Comparative analysis of the Hybrid Approach Algorithm and CNN. The classifier is evaluated based on its mean accuracy. The average accuracy of the Hybrid Approach Algorithm surpasses that of the CNN. The X-axis represents the comparison between the Hybrid Approach Algorithm and the CNN. The Y-axis represents the mean accuracy of detection with a standard deviation of +/−2.

Discussion

This study introduces a new hybrid approach method for evaluating restaurant evaluations, with the goal of enhancing prediction accuracy in comparison to a conventional CNN method algorithm. This study investigates a new hybrid method that integrates a CNN (convolutional neural network) to analyze sentiment in online restaurant reviews. Despite not achieving 100% accuracy, this model provides close to satisfactory results and highlights new diversity in text review analysis. This methodology can be extended to encompass alternative textual viewpoints. The objective of the study titled "Improved Accuracy in Analysis of Restaurant Reviews using a Hybrid Approach Algorithm over CNN" is to evaluate and compare the effectiveness of a newly developed hybrid algorithm against a conventional CNN algorithm. The primary objective is to enhance the precision of sentiment categorization, with the goal of attaining an improvement that is statistically significant shown by a p-value of 0.004 ($p < 0.05$).

Author Hanhoon Kang experimented with a novel strategy, integrating INCB and Sentilexicon for the impression examination for patrons of restaurants. The reference is the work of Kang, Yoo, and Han (2012). The trial concluded with approximately 7000 restaurant evaluation documents.

Xing Fang proposed a sentiment analysis method for evaluating product reviews. They utilized sentiment polarity categorization to do this. The citation "Fang and Zhan 2015" is included. The data were classified using SVM, naive Bayesian, and random forest algorithms. A subjective score formula generated the feature vector representing a sentiment. Author Ganu points out that textual materials still produce superior results than star ratings presented in numerical form (Ganu, Elhadad, and Marian, 2014). Multinomial naive Bayes was used by author Hossain to create a sentiment analysis model using internet restaurant reviews (Hossain *et al.*, 2021). The model with the greatest accuracy was achieved after sixfold cross-validation. Author Trivedi created a sentiment analysis model based on vocabulary. They worked on gathering feedback from patrons regarding the caliber of a restaurant's offerings (Kumar and Singh, 2021). Author Silva devised a technique whereby new customers were helped and customer reviews and their polarity were examined using a fuzzy logic model (Sadaei *et al.*, 2019). Author Omar used multinomial naive Bayes to analyze internet restaurant reviews and create a sentiment analysis program (Hoque, Hossain, and Sharif, 2019). Author Pravalika suggested a machine learning technique to predict restaurant reviews. They have used canonicalization and lexeme labeling to their date set of roughly 1000 reviews as part of the preparation phase (Raguraman and Pravalika, 2022). A CNN model for feature extraction of reviews was introduced by author Kumar where they combined two distinct datasets using a single convolution layer (Rahman and Kumar Dey, 2018). Opinion mining, another name for sentiment analysis, depends on the analysis of text, NLP, and computational approaches (Yi *et al.*, 2003). Machine learning algorithms did well in the classification of sentiments, according to the literature review and observation of rule-based techniques. Deep learning techniques can now be used to improve prediction and accuracy. We added a combined CNN–novel hybrid method architecture to this issue set as a result of this. CNN first applied a layer using a novel hybrid method. This architecture offers improved performance in addition to an improved F1-score. The data used in machine learning projects are crucial since bad data might produce bad information (Mahardika, 2021). This is the opposing factor for this research (Mahardika, 2021; Ayem and Hamrin, 2021). The most notable aspect of this research is the creation of a pioneering hybrid approach algorithm that enhances the precision of restaurant review analysis in comparison to a conventional CNN algorithm. While the approach yields reasonable results in comparison to prior research, further enhancements are necessary to elevate this system to a production level.

Some limitations of using CNN for the analysis of restaurant reviews are the following: CNN assumes linear separability of data, which may not always be the case for text data, CNN can be sensitive to the choice of kernel and hyperparameters, requiring extensive tuning, and CNN may have difficulty handling imbalanced data, as it prioritizes accuracy over handling class imbalance. The future scope of the analysis of restaurant reviews using machine learning includes integration with other data sources. Machine learning models could be integrated with other sources of data, such as customer demographics and menu item data, to provide a more comprehensive analysis of restaurant reviews. Customers could receive personalized recommendations via machine learning algorithms based on their meal tastes, ratings, and other information.

Conclusion

This study suggests a hybrid technique for analyzing restaurant reviews. This study introduces an innovative hybrid method that combines a CNN (convolutional neural network) to analyze the sentiment of online restaurant reviews. This study will help the restaurant management to analyze customer reviews and feedback. By applying this study to reviews, the services that need to be improved can be easily identified without meeting the customers directly. Despite not achieving 100% accuracy, this model provides close to satisfactory results and highlights new diversity in text review analysis. The hybrid approach algorithm achieves a higher accuracy of 96.10% compared to the convolutional neural network, or CNN algorithm, which has an accuracy of 92.30%.

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Forecasting of Product Demand Using Hybrid Regression Model in Comparison with Autoregressive Integrated Moving Average Model

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Abstract

This research aims to predict product demand trends by employing the novel hybrid regression (NHR) machine learning model, which integrates diverse regression techniques for more accurate and robust forecasting. This will involve training the NHR model using historical sales data and subsequently comparing its predictive performance with the autoregressive integrated moving average (ARIMA) model. This comparative analysis seeks to ascertain the accuracy and effectiveness of the NHR model in generating forecasts compared to the established ARIMA model. In this study, the store item demand forecasting dataset is leveraged, dividing the analysis into two distinct groups: the NHR and the ARIMA. The sample size for each group, determined through G-power analysis with a pretest power of 80%, a significance threshold of 0.05%, and a confidence interval of 95%, is 20. The key finding reveals that the NHR model exhibited an accuracy of 84.61%, outperforming the ARIMA model, which achieved 70.53%. The statistical significance value obtained from an independent sample T-test comparing NHR and ARIMA is $p = 0.000$ ($p < 0.05$) two-tailed, signifying a noteworthy difference between the two groups. The findings from this research affirm that the NHR model demonstrates superior accuracy in predicting product demand trends when contrasted with alternative models.

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***Keywords*:** Autoregressive integrated moving average, forecasting, machine learning, novel hybrid regression model, product demand, retail industry

2.1 Introduction

Efficient supply chain management relies significantly on accurate product demand forecasting, playing a pivotal role in achieving demand-driven management for organizations and individuals in the retail industry. This study introduces an innovative hybrid regression machine learning model designed to predict product demand trends. The foundation of the model's application lies in the analysis and forecasting of store item demand, utilizing the dataset dedicated to store item demand forecasting. In the contemporary business landscape, possessing knowledge about product demand is crucial for maintaining stability in the retail industry [2]. Understanding forecasted demand trends is essential for making informed operational decisions [3, 4], contributing to financial stability and risk reduction. This insight directly influences cash flow and aids in overall expenditure management [5]. The implementation of this model promises to provide valuable foresight into future product demand [6, 7].

A multitude of research papers emphasize demand forecasting, particularly in the background of store items within the retail industry. These papers are disseminated across various platforms, with approximately 100 available on Google Scholar, over 50 on IEEE Xplore, and more than 20 on ScienceDirect. In [8], the authors presented a model that excels in forecasting, achieving an impressive 42.4% mean absolute percentage error (MAPE) score on average. Meanwhile, Smirnov and Sudakov [9] introduced a regression-based model with a demonstrated root mean square error (RMSE) score of 427.958 for demand forecasting. In [10], the proposed article employing long short-term memory yields an RMSE score of 467.958. Notably, Ren *et al.* [11] proposed a model utilizing the gradient boosting method, showcasing effective prediction and forecasting in the fashion industry. Moroff *et al.* [12] introduced a study employing a multilayer perceptron model, achieving the highest overall score of 81.9%. The second-best performance (80.8%) was attained by the triple exponential smoothing model from Holt-Winters. Lorente-Leyva *et al.* [13] put forth a model demonstrating a commendable R-squared score of 0.82, indicating accurate demand forecasting. Among all citations, this model outperforms others significantly, showcasing superior accuracy and performance.

The current body of research in this field exhibits certain shortcomings, characterized by a lack of detailed analysis, reliance on unrealistic assumptions, and inaccuracies in data analysis. Prior research has employed models that lacked a high level of precision and accuracy in predicting demand trends. Addressing these limitations, the primary objective of the present study is to introduce and employ the novel hybrid regression (NHR) model for forecasting demand trends within the retail industry. Unlike previous research, the focus is on overcoming shortcomings by utilizing a more robust and sophisticated model that has the potential to yield more precise and accurate results in forecasting product demand patterns. The overarching aim is to contribute to the advancement of forecasting methodologies, particularly in the retail sector, by introducing a model that enhances the accuracy of predictions and supports more informed decision-making processes in logistic management and related areas.

2.2 Materials and Methods

The proposed research article was implemented at the Data Science Laboratory of SIMATS School of Engineering, which is part of the Saveetha Institute of Medical and Technical Sciences in Chennai, the research investigation involved two distinct sets. Each group consisted of 20 samples, contributing to a total sample size of 40 for the research endeavor [3, 4]. The determination of the sample size was carried out using G-power, considering a pretest score of 80%, a significance threshold of 0.05%, and a confidence interval of 95%.

The testing configuration employed for this study involved utilizing a Jupyter Notebook environment in conjunction with Statistical Package for Social Sciences version 26.0.1. The computational setup consisted of a laptop equipped with an Intel 9th Gen i5 processor, 16-GB RAM, and a 4-GB graphics card. To manage the dataset effectively, a slicing technique was employed to scale it down. Subsequently, comprehensive analysis and testing procedures were conducted using Python libraries within the Jupyter Notebook code environment.

The dataset [14] seems designed for time series analysis and forecasting; the objective is forecasting upcoming sales based on historical patterns. The features include temporal information (date), store-specific data, and item-specific data, which are crucial for building accurate and effective demand forecasting models. Analyzing and understanding the relationships between these constraints can provide valuable insights for optimizing inventory management and meeting customer demand effectively.

Novel Hybrid Regression Model

The NHR model employs a multi-step approach, starting with regression modeling and exploratory data analysis (EDA). Subsequently, statistical forecasting is applied to render the data stationary. The implementation of time series forecasting involves the utilization of the XGBoost algorithm, where the XGBoost regressor employs gradient boosting to anticipate the product demand. The initial store item demand forecast dataset, initially in time series format, undergoes a transformation into a supervised data structure. Following this transformation, steps are taken to make the data stationary. What sets this model apart is its direct approach, aiming to minimize errors efficiently, achieve rapid convergence, and simplify calculations. The model leverages multiple gradient-boosted trees to predict the values of dependent variables. This involves the combination of decision trees to form a robust learner, with "gradient-boosted trees" referring to the n estimator values implemented in the model. The overall process integrates regression, EDA, statistical forecasting, and advanced machine learning techniques to improve the precision and effectiveness of predicting product demand.

Algorithm
Input: Historical demand data for retail store products
Step 1: Import the necessary libraries and packages
Step 2: Load the dataset into the code environment and assign it to a DataFrame
Step 3: Utilize statistical forecasting methods
Step 4: Apply adjustments for trend and seasonality to convert forecasted values to the original scale
Step 5: Transform the data to achieve stationarity
Step 6: Generate DataFrame for transitioning from time series to supervised learning
Step 7: Introduce a lag column
Step 8: Split the data into training and testing sets
Step 9: Scale the data using MinMaxScaler
Step 10: Return the values of x_train, y_train, x_test, and y_test
Step 11: Implement reverse scaling
Step 12: Obtain prediction values and store them in a pred DataFrame
Step 13: Employ the XGBoost regressor to forecast future demand trends
Output: Forecasted future demand trends for retail store products

Autoregressive Integrated Moving Average

The autoregressive integrated moving average (ARIMA) [1] model holds significant popularity in time series analysis, particularly in demand prediction. This is attributed to its capability to offer valuable insights into forecasting the future demand of a product. ARIMA predominantly employs differencing techniques to transform non-stationary time series data into a stationary format, allowing the model to forecast future values based on historical data. Despite its linear nature, the ARIMA model proves effective as it projects future values as linear functions of past data. This algorithm represents a regression analysis technique used to depict the relationship between a dependent variable and other varying factors. It is adaptable to non-stationary data as it facilitates the transformation of such data into a stationary form, suitable for time series analysis. Following this transformation, the algorithm reintroduces trend and seasonality constraints back into the data for further analysis.

Algorithm
Input: Historical demand data for products in a retail store
Step 1: Import the required libraries and packages
Step 2: Load the dataset into the coding environment
Step 3: Visualize the data through plots to gain insights
Step 4: If necessary, stabilize variance in the data through transformations
Step 5: Apply differencing to achieve stationarity in the data
Step 6: Utilize ACF/PACF analysis to determine the appropriate model order (p, q, d)
Step 7: Evaluate the residuals of the model
Step 8: Make predictions and generate forecasts
Output: Forecasted future demand trends for retail store products

Statistical Analysis

Utilizing IBM SPSS 26.0.1 software, a comparative statistical analysis was executed to evaluate the performance of both the proposed and reference algorithms. The dataset incorporated 'sales' and 'item' columns as dependent variables, while the independent variables encompassed 'store', 'date', and 'item'. Employing an independent sample T-test, an in-depth examination of both algorithms was conducted. Subsequent to this analysis, comprehensive documentation was carried out, detailing key statistical measures, including mean accuracy, standard deviation, and standard error.

2.3 Tables and Figures

Table 2.1 The group statistics of the data were performed for 20 iterations between NHR and ARIMA.

	Group	N	Mean	Standard deviation	Standard error of the mean
Accuracy	NHR	20	84.61	4.971	1.112
Accuracy	Arima	20	70.53	5.113	1.143

2.4 Results

Upon contrasting the NHR model with the ARIMA, the results suggest that the NHR model has demonstrated superior performance. This is evident in its ability to provide more accurate forecasts, particularly in predicting product demand.

Table 2.1 presents the statistical results derived from the analysis of all iteration variables. The outcomes highlight the superior performance of the NHR model in comparison to the ARIMA model. Notably, the mean accuracy attained by the NHR machine learning [22–26] model is 84.61%, surpassing the accuracy of the ARIMA model, which is recorded at 70.53%. The standard deviation for the NHR model is calculated at 4.971, whereas for the ARIMA model, it is recorded at 5.113. Furthermore, the standard error of the mean for the NHR model is determined to be 1.112, while it stands at 1.143 for the ARIMA model. These statistical metrics collectively highlight the superior performance and more consistent accuracy of the NHR model over the ARIMA model in this analysis.

Table 2.2 details the results derived from an independent sample T-test, aiming to compare the accuracy of the NHR model and the ARIMA model. The analysis uncovered a mean accuracy difference of 14.08 between the two models, accompanied by a similar difference in standard deviation. The 95% confidence interval calculated for the hybrid regression model indicated a range of 17.30809. However, the significance value resulting from the test was determined to be 0.926. Despite observing a significant

Table 2.2 The independent sample T-test between NHR and ARIMA.

						T-test for equality of means	T-test for equality of means	T-test for equality of means	T-test for equality of means
		f	**sig**	**t**	**df**	**Sig. (2-tailed)**	**Mean difference**	**Std.error difference**	**95% confiden interval of difference**
Accuracy	Equal variances assumed	0.009	0.926	8.830	38	0.000	14.08000	1.59460	17.30809
Accuracy	Equal not variances assumed			8.830	37.970	0.000	14.08000	1.59460	17.30818

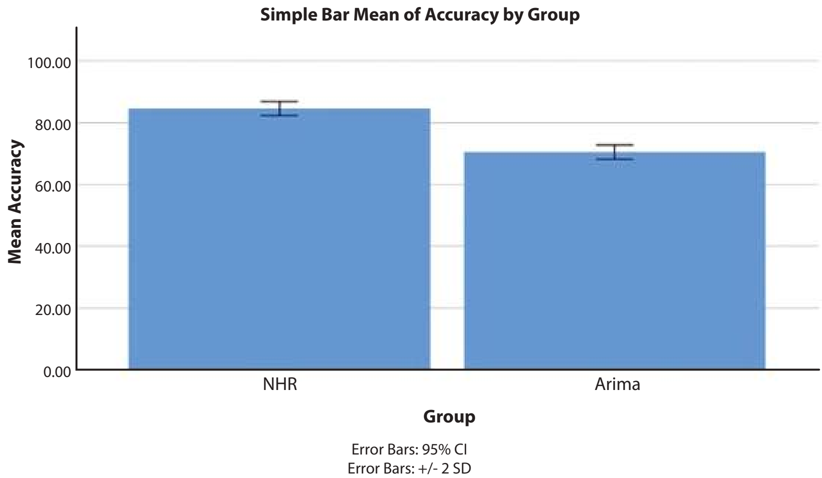

Figure 2.1 Comparison of NHR and ARIMA model. The NHR (84.61%) regression outperforms the ARIMA (70.53%) model. *X* axis: NHR vs. ARIMA, *Y* axis: Mean accuracy. Error bar +/– 2 SD.

difference in variance, it is important to note that the significance value, in this case, did not meet the threshold for statistical significance (typically below 0.05). Thus, while there might be variations in accuracy between the models, the test did not establish a statistically significant difference.

Figure 2.1 visually depicts the contrast in accuracy between the NHR model and the ARIMA model. The graphical representation unmistakably showcases the substantial and noteworthy superiority of the NHR model over the ARIMA model in terms of accuracy. The discernible and significant difference observed in accuracy underscores the superior forecasting performance of the NHR model compared to the ARIMA model. This visual evidence reinforces the robustness of the novel approach in achieving more accurate and reliable predictions in the context of forecasting.

2.5 Discussion

In this research study, the NHR model, boasting an accuracy of 84.61%, has demonstrated substantial superiority over the ARIMA model, which exhibits an accuracy of 70.53%, particularly in the realm of forecasting product demand. The p-value derived from the statistical analysis, which is $p = 0.000$ ($p < 0.05$) two-tailed, indicates a high level of statistical significance.

This value signifies that the two sample groups have demonstrated a significant difference when subjected to the sample T-test.

Several research articles support the findings of this study. In [15], the proposed model incorporating symbolic regression achieved a standard deviation of forecast error at 4.676. Kilimci *et al.* [8] introduced a model that demonstrated superior forecasting performance with an average MAPE score of 42.4%. Tsao *et al.* [16] presented a model utilizing the random forest algorithm, resulting in a mean absolute error (MAE) score of 4.074 and a mean squared error (MSE) score of 19.772. Smirnov and Sudakov [9] implemented a regression modeling approach, showcasing an RMSE score of 427.958 for demand forecasting. In [17], the proposed model achieved an MAE score of 4.374, successfully forecasting demand trends in the textile industry using a textile dataset. Pawar *et al.* [18] introduced a neural network model with commendable accuracy in predicting demand for anti-aircraft missiles. Ibrahim *et al.* [19], Guo *et al.* [20], and Punia *et al.* [21] focused on water demand forecasting, with the proposed models attaining an impressive 82% accuracy. It is noteworthy that there is currently no opposing research published, indicating a consensus in favor of the proposed algorithm and model. The collective evidence from these studies further underscores the effectiveness and versatility of the proposed approach across various domains.

The dataset under consideration is currently confined exclusively to store items within the retail industry. The product data within the dataset pertains solely to items available in retail stores, encompassing approximately 30 items. It is essential to note that products from other industries are not represented in the dataset. Consequently, the predictive and forecasting capabilities of the model are limited to the context of the retail industry. To enhance the overall scope and applicability of the model, the future scope of this study involves a comprehensive expansion of the dataset. This expansion includes the incorporation of a more extensive array of products from the retail industry and, notably, the inclusion of products from diverse industries. By diversifying the dataset, the model's prediction scope can be significantly broadened, enabling it to extrapolate trends and make forecasts not only within the retail sector but also across various industries. The envisioned expansion aims to make the model more robust, efficient, and trustworthy in forecasting product demand. A more diverse dataset will enable the model to capture a broader range of patterns and relationships, thereby enhancing its adaptability to different product types and industries. This proactive approach to dataset improvement aligns with the overarching goal of ensuring that the forecasting model remains relevant and effective across a more extensive spectrum of scenarios.

Conclusion

In the conducted research study, a thorough comparative analysis was executed to assess the efficacy of the NHR model in contrast to the ARIMA for the purpose of product demand forecasting. The outcomes revealed a conspicuous difference in accuracy, with the NHR model showcasing a substantially higher accuracy rate. Notably, the NHR model outperformed the established ARIMA model by an impressive margin of 14.08%. This substantial improvement in accuracy stands as a clear indicator of the enhanced predictive capabilities of the NHR model in the realm of product demand forecasting. The sizable difference in accuracy signifies a considerable advancement over the conventional ARIMA model, suggesting that the NHR approach is more adept at capturing the underlying patterns and nuances inherent in the dataset. This outcome underscores the potential of the NHR model to provide more reliable and precise forecasts, thereby contributing to the refinement and advancement of product demand forecasting methodologies.

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3

Identification of Stress in IT Employees by Image Processing Using Novel KNN Algorithm in Comparison of Accuracy with SVM

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Abstract

The purpose of this endorsed investigation is to analyze besides accomplish a mental illness identification among IT employees on the basis of work schedule, personal commitments, and working nature. This study is carried out with two different Machine Learning classifiers (ML), namely, K-nearest neighboring (KNN) and support vector mechanism (SVM) classifiers. This process includes choosing the gathering of data, training the data, and testing the data using advised classifiers. The size of 112 MB human face expression picture collection dataset was downloaded from the Kaggle and UCI repository site. The proposed ML classifier model is trained on 80% of the dataset volume, while 20% is used for assessment. For the SPSS examination, the output of two classifiers is split into two groups, each of which has 10 output values from various well-designed tasks for a total of 20. During the SPSS investigation, the metrics CI and alpha are valued at 0.95 and 0.292, respectively. Throughout the experimental research using the Python compiler, the accuracy improvement between the two classifiers is examined. In comparison to the SVM classifier's accuracy of 86.27%, the Novel KNN classifier's accuracy of 95.67% boosted the recognition of stress-related theft by IT workers. Two groups were found to have a p-value of 0.001 ($p < 0.05$), indicating statistical significance. Work-life balance can boost workplace performance and improve the working environment as a whole. Men and women are impacted by work stress.

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Cooperation and coordination are necessary for work-life balance at the individual, family, national, governmental, organizational, and societal levels. Prior to the Six Sigma strategy, which is production-oriented, the majority of businesses used, the employees' work-life balance became apparent. To solve this issue, both the employees and the employee should make an equal effort to prevent or reduce the things that cause stress at work.

***Keywords*:** Stress, IT employees, novel KNN, SVM classifier, machine learning (ML), mental illness, sustainable communities

Abbreviations Used

K-Nearest Neighbour	KNN
Support Vector Machine	SVM
Standard Deviation	SD

3.1 Introduction

Human resources are essential for growing a company or organization. One component that companies may easily acquire is human resources. The organization typically has requirements or criteria that have been defined and that all employees must meet in terms of performance (Kular 2017). When establishing work standards for the organization, management uses a set of criteria as a guide, including work results, work knowledge, mental agility initiatives, attitude, time management, and attendance rate. The outcome of an employee's labor in finishing the duties assigned to them according to their skills, abilities, and dedication to the work at hand is their performance (Belcher 2020). Every employee will experience stress if they are unable to control demands, and tension if they are unable to do so. Workplace stress among employees can be harmful to the firm due to the discrepancy between production and the costs connected with paying salaries, benefits, and other expenses. Stress results from prolonged exposure to emotionally challenging events, which can cause physical, emotional, and mental illnesses. Employee stress and workload increase as a result of pressure from high turnover and the need to meet these goals. The fundamental requirement of an organization is the ability to recognize workplace stress among employees and inspire them to achieve their objectives. The use of data mining is advised for this strategy (Narahari and

Koneru 2018). Some of the applications of it are wine quality prediction, spam detection, and data theft identification.

A total of 1800 publications from the years 2007 to 2022 were reviewed; 400 were selected from IEEE Xplore, 700 from Research Gate, 450 from Elsiver, and 250 through Springer. By utilizing HVR metrics, the author (Amato *et al.*, 2017) classified non-stress people and stress-affected people in a large volume. The metrics chosen for improving the prediction rate are RMSSD, AVNN, and SDNN. A wearable device is used to predict stress on drivers using conventional machine learning approaches based on the ECG-derived HVR metrics (Healey and Picard 2005). Heart rate and mental stress are related, according to (Pandey 2017). For the categorization task, which is helpful in the prediction of stress, they employ machine learning techniques like linear regression and SVM. IoT is utilized in this case to alert the user when a risky situation actually exists. On Kaggle, (Sriramprakash, Prasanna, and Ramana Murthy 2017) suggested a method that was used with the SWELL- KW dataset. They took into account the physiological signals received from ECG, galvanic skin reaction sensors, etc., and created a method for the selection of dominating features, which they combined with overlapping techniques to get better outcomes. For continuous stress monitoring, Gjoreski *et al*. (2016) suggested a technique that may be applied both in the lab and in real life. The web application was created for data collection in the lab. Throughout this app, the stress levels of a person are categorized using specific formulae.

The application of machine learning classifiers to a variety of human tasks, such as hand gesture recognition, reading handwritten alphabets, and enhancing visual security. These studies give us enough information to recognize stress in IT employers based on their routine behaviors. The purpose of this task is to mend IT employers' capability to predict stress more accurately.

3.2 Materials and Methods

This study was carried out by the Saveetha School of Engineering's Department of Computer Science Engineering at the Saveetha Institute of Medical and Technical Sciences. The dataset of human facial expression images was obtained from the Kaggle website (Stress Datasets 2019). To detect stress among IT employees due to work nature and personal reasons, the study utilized 20 samples and employed KNN and SVM classifiers. The Python compiler was utilized for the implementation of the classifiers.

Version 26 of IBM SPSS was used to conduct the statistical investigation (Dinesh Peter *et al*. 2020).

A. Research Methodology
Below is a description of the research approach that was used to carry out the analysis for this study. The foremost contribution of the paper is the use of machine learning to recognize stress. The planned study on machine learning-based stress detection is depicted in the flow diagram below.

K-Nearest Neighbor

The simplest machine learning classifier is based on the supervised learning method (Rajaguru and Prabhakar 2017). This non-parametric method's principal use is in classification. In order to identify the class of the new data, the classes of the K nearest data are compared with the known data, which is retained under the names of the chosen characteristics. The use of large datasets for training is common. This is widely utilized for making graphs (Chanal *et al*. 2022).

Pseudocode for K-Nearest Neighbor
Step 1: The network is loaded with the chosen data.
Step 2: The dataset has to be modified.
Step 3: Features required for enhancing the categorization are extracted and attributes are selected.
Step 4: Use specific features to train the model.
Step 5: Finish the classification.

Support Vector Machine

A method of supervised learning applied to regression and classification (*The Microbiome in Health and Disease* 2020). To find hyperplanes in the data space that increase the minimal distance, or margin, between objects and classes, a set of objects was trained and categorized into several classes. The maximum margin hyperplane is the name given to the hyperplane. It divides objects without using variation among class means by using objects on the margin's corners. A support vector mechanism (SVM) is a separation technique where the hyperplane is assisted by vectors closer to the margin.

Pseudocode for K-Nearest Neighbor
Step 1: Gathering the essential amount of data.
Step 2: Pre-processing is the next step.

Step 3: Any noise or empty spaces must be eliminated in order to proceed with the processing.
Step 4: The classification process model is created and tested.
Step 5: The necessary accuracy value is used for the classification.

3.3 Statistical Analysis

To analyze and enhance the prediction of stress levels among IT employees [17–21], a Python compiler was employed to obtain accuracy values from essential features. IBM SPSS version-26 software was utilized to do an analysis using statistics on the output generated by the Python compiler. The study utilized a dataset consisting of essential attributes related to stress experienced by IT employees due to their work nature, lack of sleep, personal issues, illness, and mental disorders. The objective was to identify stress levels in IT employees with higher accuracy gain, making accuracy gain the dependent variable in this study (Brownlee 2016).

3.4 Results

Using Novel KNN and SVM classifiers, it is possible to identify and reduce the stress experienced by IT personnel as a result of their demanding jobs and mental illness as a result of their personal lives. KNN and SVM classifier accuracy gains were 95.67% and 86.27%, correspondingly, rendering to the Python compiler. The suggested Novel KNN classifier enlarged the accuracy of such classifiers and enhanced the prediction of stress among a huge volume of people. Table 3.1 exhibits the accuracy improvement of the SVM and KNN classifiers at ten distinct instants, as received from the Python compiler. A proportional mean test was carried out using the data from Table 3.1 as input for the SPSS analysis of statistics. Group statistical evaluation and independent sample tests are two categories under which the comparative mean test falls. Group statistics are first calculated, and Table 3.2 refutes this. The mean correctness, standard deviation, and standard error of the mean are derived by sampling ten trials per group. Group 1 yielded numbers of 95.0110%, 1.91637, and 0.60601, whereas group 2 produced values of 86.5940%, 3.13896, and 0.99263. Considering the suggested classifiers, both the assumption and the non-assumption of equal variance in accuracy are presented in Table 3.3. The analysis keeps $p<0.05$.

Table 3.1 Precision assessment of conventional and suggested method.

Accuracy (%)	
KNN	**SVM**
91.37	82.14
92.94	83.60
93.77	84.11
94.00	84.94
95.35	85.81
95.71	86.44
96.37	87.09
96.54	89.77
96.99	90.38
97.07	91.66

Table 3.2 The group's mean, standard deviation, and precision of the KNN and SVM algorithms were, respectively, 95.0110% and 1.91637, 86.5940% and 3.13896. The KNN classifier had a smaller standard error of 0.60601 than the SVM classifier.

Group statistics					
	Group name	**N**	**Mean**	**Standard deviation**	**Standard error of the mean**
Accuracy	**KNN**	10	95.0110	1.91637	.60601
	SVM	10	86.5940	3.13896	.99263

Table 3.3 The outcomes of the independent sample assessment indicated that the recommended KNN and XGBoost classifiers varied significantly in terms of accuracy. Given that $p > 0.05$, the two strategies differ greatly from one another.

Independent sample test										
Levene's test for equality of variances				**T-test for equality of means**						
									95% Confidence interval of the difference	
		F	**Sig.**	**T**	**Df**	**Sig. (2-tailed)**	**Mean difference**	**Std. error differences**	**Lower**	**Upper**
Accuracy	**Equal variances assumed**	2.227	.153	7.237	18	.001	8.41700	1.16299	5.97364	10.860
	Equal variances not assumed			7.237	14.891	.001	8.41700	1.16299	5.93655	10.897

The chart that resulted from the statistical evaluation is shown in Figure 3.1 and the Figure 3.2 shows about the predicting stress among IT workers. Table 3.2 mean accuracy significance is used to construct a comparison graph of mean accuracy. The X-axis displays categorization suggestions, while the Y-axis displays accuracy. The suggested and current classifiers have respective average rate of precision of 95.0110% and 86.5940%.

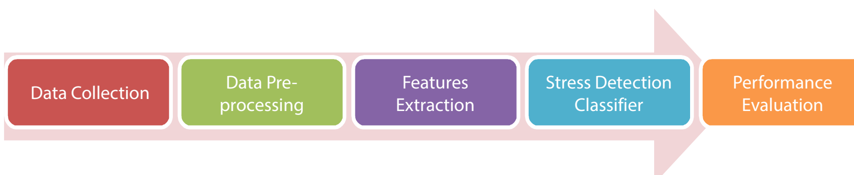

Figure 3.1 Flow diagram of stress detection.

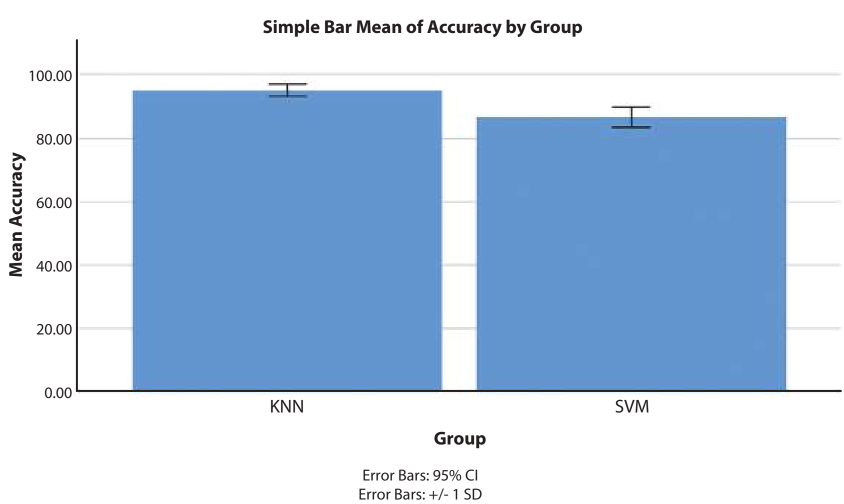

Figure 3.2 In terms of predicting stress among IT workers due to work pressure and mental illness related to personal circumstances, the mean accuracy comparison between KNN and SVM classifiers is shown. Compared to conventional method, which attained a mean accuracy of 86.5940%, the suggested system attained a mean accuracy of 95.0110%. The Y-axis shows the mean accuracy ± 1SD, while the X-axis shows the accuracy of the KNN and SVM classifiers.

3.5 Discussions

The SPSS analysis made use of group 1 and group 2 results, which yielded mean accuracy values of 95.0110% and 86.5940%, respectively. Based on the testing outcomes, the suggested technique is considered the best approach for enhancing the forecast of stress on IT employers caused by many aspects of daily life and workload (Dalmeida and Masala 2021) designed a stress prediction model based on the HRV features. A wearable device is modeled and it observes this feature from the heart rate. By analyzing the feature, the MLP classifier predicted stress with an average rate of 80%. Several other HRV metrics utilized for this analysis are AVNN, SDNN, and RMSSD. Munla *et al.* (2015) performed a comparative analysis of stress prediction among employers using KNN, linear SVM, and SVM-RBF. The SVM-RBF kernel predicted well and it attained greater accuracy of 83%. (Elzeiny and Qaraqe 2018) and conducted a study to identify the level of stress among them. From the ECG signal, stress level is predicted with an average accuracy of 84.4%. Tiwari *et al.* (2019) categorised physiological signals to perform emotion classification. This classification acquired an accuracy of 75.8%.

The ability to train on large datasets without guaranteeing maximum accuracy and the likelihood that the result will depend on the caliber of the data are two drawbacks of KNN. In addition, the training procedure requires a lot of storage. Any classifier other than the KNN classifier will increase the prediction rate when used to identify stress on many employees.

3.6 Conclusion

Maintaining a healthy work-life balance can increase productivity and enhance the working environment overall. Workplace stress affects both men and women. For work-life balance to exist at the individual, family, national, governmental, organizational, and societal levels, cooperation and coordination are required. The employees' work-life balance became clear before the Six Sigma strategy, which is production-oriented and utilized by the majority of enterprises. To resolve this issue, both employees should put in an equal amount of effort to stop or lessen the things that make work stressful. The results of the studies indicate a few noteworthy values, with KNN achieving the best accuracy of 95%. The outcomes demonstrate that employing KNN outperforms the other classifiers in terms of identifying stress and non-stress and categorizing stress levels. Additional work can be completed by doing 10-fold cross-validation and employing additional classifiers.

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4

Observing the Accuracy of Breast Cancer Using Support Vector Machine with Digital Mammogram Data in Comparison with Naive Bayes

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Abstract

This research aims to detect breast cancer utilizing digital mammogram data through a support vector machine (SVM) and compare its performance with naive Bayes. A pretest power analysis with an 80% power was conducted, and the sample size for both groups was set at 20. **Methods and Materials:** The detection of breast cancer was carried out using digital mammogram data, employing both SVM and naive Bayes algorithms. The study conducted independent sample tests, with a pre-established power of 80%. **Results:** The accuracy of breast cancer detection using SVM and naive Bayes was found to be 86.83% and 93.64%, respectively. Statistical analysis revealed a significant difference ($p=0.001$, $p<0.05$) between the two algorithms. **Conclusion:** By observing the accuracy of breast cancer mammogram data naive Bayes performs better than SVM.

***Keywords*:** Breast cancer, mammogram, breast cancer screening, support vector machine, naive Bayes, machine learning, research

Introduction

The process of manually diagnosing breast cancer is time-consuming, requiring several hours. There is an imperative to create an automated

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diagnostic system to facilitate early cancer detection (Milosevic, Jankovic, and Peulic, 2015). Soft computing is frequently employed in predicting cancer types, leveraging its ability to uncover crucial components from medical data collections. The utilization of machine learning and soft computing has been integrated into numerous empirical studies aimed at addressing breast cancer (Kumar and Poonkodi, 2019). Early detection, though challenging, is crucial. Identifying early anomalies through mammograms and self-breast exams is essential before a tumor advances (Luo *et al.*, 2021). Consistent mammogram screenings can help decrease the risk of developing breast cancer (Bouarara, 2019).

Approximately 9,276 articles focus on the detection and recognition of breast cancer using support vector machines (SVMs). There are also 83 related research papers available on Research Gate and IEEE Xplore. This research delves into addressing two significant challenges. The challenge to recognizing tumor spots with low contrast to their background. The second challenge is to develop methods for extracting attributes that characterize tumors (Saritas and Yasar, 2019). The authors assessed the effectiveness of different classification algorithms by applying them to eight datasets. The classification procedures involved the use of eight algorithms, employing a n-fold cross-validation method (Milosevic, Jankovic, and Peulic, 2015). The Hough transform is employed to detect features in mammogram images. This method classifies abnormal classes of mammograms, utilizing the features extracted from the Hough transform to differentiate between normal and abnormal cases (Kendall, Barnett, and Chytyk-Praznik, 2013). This primarily suggests employing image classification techniques through a combination of data mining and image processing methods, with the goal of achieving high accuracy and sensitivity and enabling early cancer detection (Kaucha *et al.*, 2017).

Healthcare has contributed to affirming the validity of the GBMMS and its linked adherence to breast cancer screening. Medical mistrust has been identified as a barrier to cancer screening (Shibly, Sharma, and Naleer, 2022). The study seeks to evaluate the precision of breast cancer detection using a support vector and digital mammogram, while also comparing its performance with the naive Bayes algorithm. The goal is to improve both accuracy and overall performance in the detection process.

Materials and Methods

The research involved a sample size of 20 for the total iterations in the project (group1=10, group2=10), with each iteration consisting of 10 trials.

Two groups were formed, one utilizing the SVM and the other employing naive Bayes. Both SVM and naive Bayes were utilized to identify instances of low accuracy. The G-power analysis was performed with alpha and beta values.

Data for breast cancer detection using SVMs and naive Bayes was sourced from Kaggle.com, an open data platform. The dataset comprises information on patients diagnosed with two types of breast cancer: malignant and benign (Pre, 2017). The features of cell nuclei were computed from fine needle aspiration (FNA) of a breast mass. Ten real-valued characteristics were computed for each cell nucleus. For every image, the mean, standard error, and the worst or largest (mean of three largest values) of these features were calculated, resulting in 30 features. Breast cancer detection was performed using the Jupiter software on a Windows 10.1 system.

Support Vector Machine

SVM is to find a hyperplane in an N-dimensional space that clearly classifies the input points.

Pseudo-code

Step 1: import the libraries.

Step 2: Convert the dataset to numerical value

Step 3: #Check if true

    By doing exploratory analysis,
    plt.title("Diagnosis(M=1,B=0)",font size='18')
    plt.ylabel("total number of patients")
    plt.grid(b=true)

Step 4: #Load the data to trained and tested

    train_test_split(X,Y,test_size=0.2,random_state=0)

Step 5: #initiating the model

    svm=svm.svc()

Step 6: #output to be printed

    print("the mean accuracy with 10 fold cross validation is
    %s"%round(score*100,2))

Naive Bayes Algorithm

Naive Bayes classifiers encompass a collection of classification techniques rooted in Bayes' theorem. This algorithmic family operates on the common assumption that each pair of features being classified is independent.

Specifically designed for addressing multi-class prediction challenges, naive Bayes has the potential to surpass alternative models when given limited training data, provided the assumption of feature independence holds true. This method excels when dealing with categorical input variables, outperforming counterparts that rely on numerical values.

Pseudo-code
Step 1: Prepare the dataset
Step 2: Preprocessing the libraries
Step 3: function train and test the data
    Target="Diagnosis"
Step 4: splitting the dataset
    x=data_mean.loc[:,predictors]
    y=np.ravel(data.loc[:,[target]])
    train_test_split(X,Y,test_size=0.2,random_state=0)
Step 5: initialize the model
    nb=gaussianNB()
Step 6: #output
    print("the mean accuracy with 10 fold cross validation is
    %s"%round(score*100,2)).

In the envisioned system, the dataset undergoes training and testing within the Jupyter Notebook. SPSS software is employed to predict and visualize the graph, while G-power software is utilized for algorithm pretesting and calculation, aiming for an enhanced algorithmic accuracy percentage. The execution of the algorithm is facilitated by a system configuration featuring a 50GB hard disk and 8GB of RAM. The operating environment comprises a 64-bit OS (X64) running on the Windows platform.

Statistical Analysis

The examination involved 20 samples, and both the proposed and current algorithm iterations were analyzed using IBM SPSS version 23. The expected accuracy for each iteration was observed, facilitating a comparison between the accuracy values obtained from the respective iterations (Ling *et al.*, 2022). The T-test was employed in the analysis. In this context, the independent variables within the dataset represent labels suitable for detection, while the dependent variables pertain to the input dataset.

Results

Table 4.1 reveals a notable superiority of the naive Bayes algorithm. The analysis underscores that, in terms of accuracy and performance, the naive Bayes algorithm outperforms the SVM. In descriptive statistics, both accuracy and algorithm values encompass up to 20 values. The standard deviation of accuracy for the SVM is 5.3967, while for the naive Bayes algorithm, it is 9.1539.

In Table 4.2, the group statistics for the algorithm include both the SVM and naive Bayes. There are 10 instances for each algorithm. The mean value for the SVM is 86.83, while for naive Bayes, it is 93.64. The standard deviation for both algorithms is reported as 5.3967 and 9.1539, respectively. The standard errors of the means are 1.7066 and 2.8947.

The significant value is found to be smaller than 0.001 ($p < 0.05$), indicating that our hypothesis holds true.

In Figure 4.1, the sample test indicates a significance value of 0.056 for equal variance, and for the case where equal variance is not assumed, the

Table 4.1 Comparison of prediction accuracy using SVM and naive Bayes.

	Support vector machine (SVM)		**Naive Bayes**	
Execution	**Accuracy**	**Error**	**Accuracy**	**Error**
1	85.16	14.84	91.03	8.97
2	85.24	14.76	91.17	8.83
3	85.41	14.59	91.44	8.56
4	85.76	14.24	91.68	8.32
5	85.85	14.15	91.82	8.18

Table 4.2 The mean of the SVM is 85.91 and naive Bayes is 92.64.

	Algorithm	**N**	**Mean**	**Std. deviation**	**Std. error**
Accuracy	SVM	10	85.9100	.53967	.17066
	Naive Bayes	10	92.1810	.91539	.28947

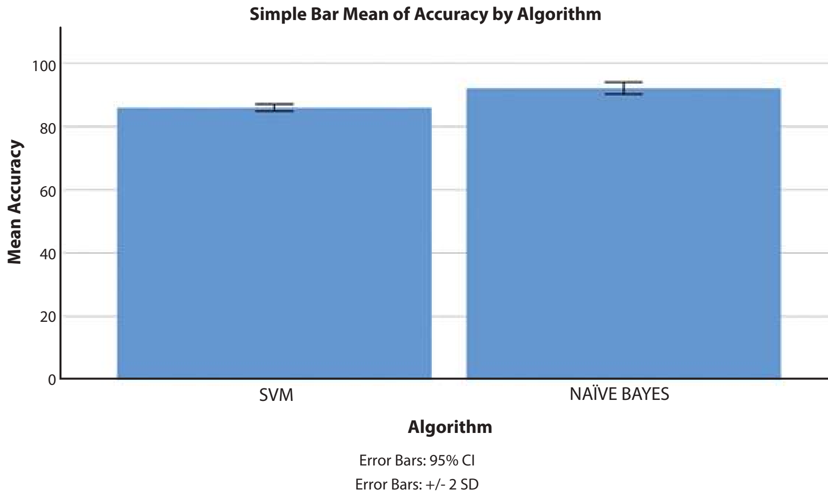

Figure 4.1 Detecting the accuracy for two algorithms, the accuracy of the naive Bayes algorithm is better than the SVM.

significance value is null. As depicted in Figure 4.1, both the SVM and naive Bayes exhibit accuracy values. The accuracy for the support vector model is 86.83%, while the naive Bayes accuracy reaches 93.64%.

Discussion

The experimental results indicate that the naive Bayes algorithm, achieving an accuracy of 93.64%, outperforms the support vector algorithm, which has an accuracy of 86.83%, in the context of breast cancer detection using mammogram data. A statistically significant difference in accuracy between the two algorithms is observed, with a p-value of 0.001 ($p < 0.05$) in the independent test.

In breast cancer analysis, the accuracy of support vector and naive Bayes are 94.8% and 95.7%, respectively (Saritas and Yasar, 2019). The support vector exhibits an accuracy of 90.55%, while the naive Bayes algorithm achieves a slightly higher accuracy of 91.2% (Nindrea *et al.*, 2018). This analysis employs machine learning for breast cancer detection using mammogram data. According to the research paper, the reported accuracies for support vector and naive Bayes are 92.8% and 94.9%, respectively (Abdollahi *et al.*, 2020). The accuracy of the model analysis for breast cancer detection using SVMs and naive Bayes is reported as 91.6% and 96.3%, respectively (Battineni, Chintalapudi, and Amenta, 2020).

The algorithm's performance is influenced by the sample size and test size of the database. Given the above observations, the decision was made to enhance the existing algorithm to improve accuracy. However, naive Bayes has limitations, assuming attribute independence, which is rarely the case in practice. Furthermore, it is recognized as a suboptimal estimator, leading to caution in interpreting probability outputs (Sharma *et al.*, 2010). In a comparison between the SVM and the naive Bayes algorithm, it is observed that the naive Bayes algorithm exhibits superior accuracy and faster prediction capabilities (Anuradha, 2021). This approach faces the frequency problem, where it assigns zero probability to a categorical variable if its category in the test dataset was not present in the training dataset. As a future prospect, the detection of breast cancer is anticipated to improve through screening tests, and the implementation of the naive Bayes algorithm will be employed for classifying the dataset.

Conclusion

In this research, breast cancer detection was conducted utilizing machine learning algorithms, including support vector and naive Bayes. The naive Bayes algorithm demonstrated superior accuracy (93.64%) compared to the support vector algorithm (86.83%) in detecting breast cancer using mammogram data.

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5

Analyzing and Improving the Efficiency of Winning Prediction in Chess Game Using AlexNet Classifier in Comparison with Support Vector Machine for Improved Accuracy

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Abstract

The proposed work tries to analyze and forecast winning chess games using two separate innovation machine learning (ML) classifiers. AlexNet and support vector machine (SVM) are the most commonly utilized and recommended algorithms for a better understanding of real-time datasets. This phase includes several key steps like data collection, data preprocessing, feature selection, model selection, training the model, model Evaluation, and testing process using specified classifiers. The suggested machine learning classifier model is trained using 80% of the dataset volume, while 20% is used for testing. For SPSS analysis, the output of two classifiers is separated into two groups, each of which contains 10 output values from various functional operations, for a total of 20. A G power value of 0.85 is utilized for SPSS calculations. The significant value is 0.001 ($p < 0.005$). The accuracy improvement between both classifiers is compared throughout the experimental investigation using the Python compiler. The accuracy of the chosen AlexNet classifier, which increased the winning prediction of chess game players, was 99.92%, compared to the support vector machine classifier's accuracy of 94.99%. The players are highly intelligent and have strategic thinking ability to win a chess game. There is a lot of research going to find out the next level of chess move while playing. This study brings advancement in finding out winning

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predictions of chess games from selected datasets effectively. The recommended AlexNet classifier outperforms the support vector machine classifier with a greater accuracy of 99.92%.

***Keywords*:** Chess, game, innovation, machine learning, novel AlexNet, support vector machine, winning prediction

Introduction

The main aim of this study is to predict the outcome of chess games (Qing, 2017). Chess gameplay is predominantly influenced by various heuristics governing the diverse capabilities of its pieces, coupled with short-term tactical maneuvers that collectively contribute to long-term strategic considerations (Newell and Simon, 1964). This emphasis on piece interactions underscores the perpetual significance of position advantage, aligning with Thompson's observations in 1982. The significance of this chess game is widely played by people in online and offline modes. The findings and assumptions of piece moves by a novel individual are not accurate in the manual method (Holding, 2021). The applications of research work are to find the duration to complete the project (J *et al.*, 2020), the number of resource utilization in the project, and critical factors in software development (Reitman and McArthur, 1979).

Between the years 2003 and 2022, a comprehensive review encompassed a total of 2,300 articles. This extensive analysis comprised contributions from various reputable sources, including 1,100 articles from IEEE Xplore, 200 from Research Gate, 650 from Google Scholar, and 350 from Elsevier. (Holding, 2021) has proposed a paper to analyze chess position during gameplay. For this approach, a dataset has 300,000 million chess moves played by professional players and its training with Novel AlexNet Classifier. The position of the board and moves of a player in games such as chess, shogi, and Go are analyzed by a novel game engine prepared by (Silver *et al.*, 2017) with an alphazero algorithm identified more accurately. Oshri and Khandwala (2016) identified each move of chess by utilizing triple layered convolutional neural network. Among cost-free online chess servers, a total of 20,000 games were selected and tested. The authors (Bagadia, Jindal, and Mundra, 2023) have proposed a technique that each move adds a single piece of board representation before and after the move of important pattern that has been observed by the novel support vector machine algorithm and ternary patterns and textures are employed for feature extraction in conjunction with a Novel Alexnet Classifier.

SVM has various limitations, such as additional incompatibility and poor performance when there are more characteristics per data point than training data sets. Support vector machines can be sensitive to the choice of parameters and it can be difficult to determine the optimal parameter values for a given dataset. According to a literature review, statistical analysis and prediction of pre-match chess game winners are necessary to save time and execute move prediction for each participant. (Dreżewski and Wątor, 2021) to perform the identification of chess game winners, the propped work is done. A novel AlexNet and support vector machine classifier technique are advised for classification. Analyzing and enhancing accuracy utilizing the AlexNet classifier in comparison to the SVM algorithm are the primary goals of this study.

Materials and Methods

The novel AlexNet and SVM classifiers were used in this investigation, as well as 20 samples.

ImageNet is indeed a large-scale visual database designed for use in image recognition research. It was created to advance the development and benchmarking of computer vision algorithms, particularly in the task of image classification (Gobet, 2018). This dataset includes both image and video data. Clinccalc.com is employed for determining the sample size, utilizing alpha values set at 0.05, power set at 0.7, and beta set at 0.2. The dataset is then partitioned into two distinct parts: testing data and training data (Rosales and Universitat Oberta de Catalunya, 2022). A dataset volume of 80% is used to train the suggested machine learning classifier model, while 20% is used for testing. During the testing process of the selected dataset, a total of 20 sample outputs were collected, i.e., each group contains 10 samples.

AlexNet

It is similar to the LeNet-5 classifier technique with excessive layers and filters leading to effective analysis (Zarini *et al.*, 2021). The number of layers present in it is eight in count and there are 5 convolutional layers, 2 hidden layers, and, finally, an output layer. It possesses 60 million parameters. The overfitting ratio is decreased with innovation dropout. The purpose of the pooling layer is utilized to perform max pooling (Hoai, 2014).

Pseudo-code
Input: Training Dataset
Output: Accuracy
Step 1: Begin by collecting the necessary volume of dataset.
Step 2: Proceed to the pre-processing stage.
Step 3: Identify and eliminate any noise or empty spaces in the dataset for further processing.
Step 4: Eliminate null values from the dataset.
Step 5: Extract relevant features from the pre-processed dataset.
Step 6: Train the model using the extracted features.
Step 7: Develop and train the classification model for the desired process.
Step 8: Allocate a ratio of 80% for training and 20% for testing the datasets.
Step 9: Conduct the classification process, ensuring accuracy falls within the specified range.
Step 10: Determine and report the highest probability of a winner in a chess game based on the model's predictions.
Return Accuracy
End

Support Vector Machine

A supervised learning technique that is widely used, which can be applied to both classification and regression tasks, is the Random Forest algorithm. A set of objects was trained and classified into multiple classes to identify hyperplanes in the data space which creates a greater minimum distance known as a margin between objects and classes (Verbiest *et al.*, 2016). Then, the hyperplane is called the maximum margin hyperplane. It uses objects on the corners of the margin to split objects without utilizing innovation among class means. The hyperplane used for separation is supported by vectors nearer the margin; so it is called a support vector machine (Cristianini, 2004).

Pseudo-Code
Input: Training Dataset
Output: Accuracy
Step 1: Begin with the selection of a suitable dataset.
Step 2: Load the chosen dataset into the network.
Step 3: Modify the dataset as required.
Step 4: Move on to the pre-processing stage.

Step 5: Identify and eliminate any noise or empty spaces in the dataset to facilitate further processing.
Step 6: Normalize the data through the normalization process.
Step 7: Choose relevant attributes and extract features crucial for enhancing the classification process.
Step 8: Train the model using the selected features.
Step 9: Conduct the complete classification process.
Step 10: Determine and declare the winner based on the outcomes of the classification process.
Return Accuracy
End

A system possessing a configuration of Windows OS, Storage-50GB, RAM-8GB is utilized. The language used is Python, either implemented in Jupyter (Anaconda) or Google Collab. The processor used is Intel i5. Independent variables for analyzing chess prediction in images/videos. The accuracy gain is considered as a dependent variable.

Statistical Analysis

The analysis and improving prediction of detecting chess game winners earlier among a dataset that contains game records of multiple players is done using a Python compiler and accuracy value is attained with essential features. For statistical analysis of output attained from the Python compiler, IBM SPSS version-26 software is utilized. The collection of dataset having details of statistics, previous game moves, white or black coin preference, number of games played, winning game count, lost game count, and game drawn count is chosen as an independent variable and the goal of this study is to recognize it with higher accuracy gain. The accuracy gain is considered as a dependent variable.

Results

The detection of pre-match chess game winners prediction is done using machine learning classifiers, namely, novel AlexNet and support vector machine classifiers based on the features extracted from the dataset such as a record of previous game and next move identification. From the Python compiler, the accuracy gains of AlexNet and support vector machine classifiers were recorded as 99.92% and 94.99%. The proposed AlexNet classifier improved the detection of chess game winners by using required features and its increased accuracy has proved the importance of such classifiers.

Table 5.1 with accuracy gain values for both the AlexNet and support vector machine (SVM) classifiers at 10 different instances.

The SPSS statistical analysis utilized data from Table 5.1 to conduct a comparative mean test, specifically categorized as a group statistical analysis employing an independent sample test. Initial group statistics were performed, and the results are presented in Table 5.2. The table includes mean accuracy, standard deviation, and standard error of the mean values obtained from 10 samples per group. For Group 1, the mean accuracy, standard deviation, and standard error of the mean were found to be 97.3500%, 1.95466, and 0.61812, respectively. Group 2 exhibited values of 91.8220%, 2.07625, and 0.65657 for mean accuracy, standard deviation, and standard error of the mean, respectively.

Table 5.3 presents the outcomes of an analysis assessing the assumption of equal variance in accuracy for selected classifiers. The significance level (p-value) was set as $p<0.05$ and the table shows the assumption of equal variance and non-assumption of equal variance in terms of accuracy.

Figure 5.1 illustrates the statistical analysis findings, showcasing a mean accuracy comparison graph derived from the mean accuracy values

Table 5.1 The AlexNet attained accuracy of 99.92% compared to SVM having 94.99%.

Execution	AlexNet	SVM
1	94.51	88.78
2	94.80	89.44
3	95.37	90.07
4	96.99	90.94
5	97.11	91.71
6	97.58	91.86
7	98.85	92.64
8	99.00	93.30
9	99.37	94.49
10	99.92	94.99

Table 5.2 The group's mean and standard deviation, along with the accuracy metrics for the AlexNet and SVM algorithms.

Group statistics					
	Group name	**N**	**Mean**	**Standard deviation**	**Standard error of the mean**
Accuracy	AlexNet	10	97.3500	1.95466	0.61812
	SVM	10	91.8220	2.07625	0.65657

provided in Table 5.2. The X-axis delineates suggested classifiers, and the Y-axis represents accuracy values, with the proposed classifier exhibiting a mean accuracy of 97.3500% compared to 91.8220% for conventional classifiers.

Discussion

Analysis using SPSS is performed with the outcome of group 1 and group 2 and achieved mean accuracy of 99.92% and 94.99%, respectively. The 2-tailed significant value was obtained as 0.001 ($p < 0.005$). As per the experimental results, the proposed system is considered as the best approach to identify and predict chess game winners based on the move prediction and records of previous games played by an individual.

The associated work's corresponding results from the prior investigation are addressed. (Panchal, Mishra, and Shrivastava, 2021) have proposed a paper to train 1.5 million board states from the selected dataset and every board is mentioned with dimensions of 8x8x14. The CNN classifier is introduced and it takes every board state as input. This classifier predicted chess moves with an accuracy of 39%. AlexNet shows better accuracy and performance compared with SVM (Dreżewski and Wątor, 2021). For analysis, LSTM was introduced and it predicted winning of 69%. (Fan, Kuang, and Lin, 2023) chose a FIDE dataset for analysis which contains details of 2000 players from the year 2000 to 2011 and predicted 55.64% which is larger than the assumption method. The accuracy gain of the assumption is 33%. (Oshri and Khandwala, 2016) introduced a CNN classifier and trained with 20,000 games and 245,000 moves. This research predicted the movement of chess coins, namely, pawn, rook, knight, bishop, queen, and king with the accuracy of 52%, 29%, 56%, 40%, 26%, and 47%.

Table 5.3 The independent sample test detected a significant improvement in accuracy between the recommended AlexNet and SVM classifiers.

Independent sample test										
Levene's test for equality of variances				**T-test for equality of means**						
									95% Confidence interval of the difference	
		F	**Sig.**	**T**	**Df**	**Sig. (2-tailed)**	**Mean difference**	**Std. error differences**	**Lower**	**Uppe**
Accuracy	**Equal variances assumed**	.007	.935	6.130	18	0.001	5.52800	.90175	3.63350	7.422
	Equal variances not assumed			6.130	17.935	0.001	5.52800	.90175	3.63300	7.423

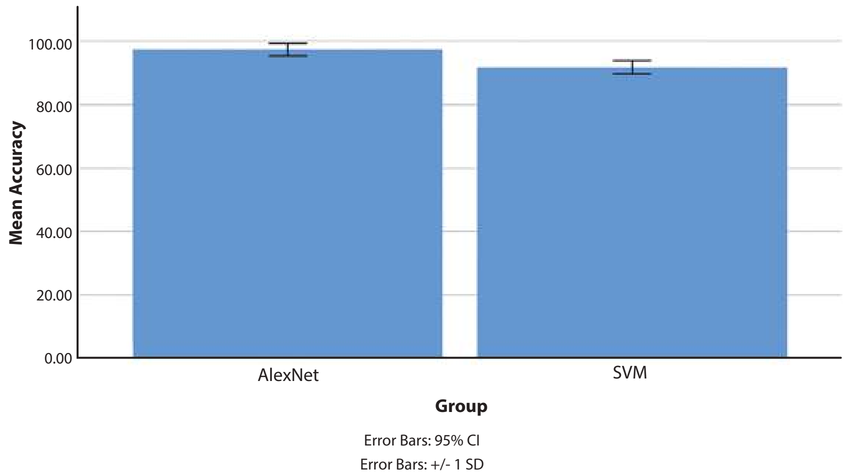

Figure 5.1 The proposed method accuracy is greater than the conventional one. The proposed method accuracy is accuracy of 97.3500%, greater than the conventional 91.8220%. X-axis represents accuracy of AlexNet and SVM; Y-axis represents mean accuracy ± 1SD.

Dissimilar findings of the classifiers face difficulty in learning features from image dataset and the time needed to achieve a higher accuracy rate is high. The dependencies among components guarantee that a thorough comprehension of both the activations and the original input is crucial for enhancing prediction accuracy (Hearst, 1977). Instead of this, a selection of classifiers with less time period to perform classification in the future makes the problem to be solved.

SVM techniques have the limitations of being computationally slow and taking a long time to train (Nguyen *et al.*, 2015). The future will overcome the limitations of SVM techniques such as algorithm and training speed by adding new training data features. Further improvement in this subject could explore the utilization of an evaluation function to influence the move selector or the combination of these two approaches. Additionally, expanding the depth of field to 5×5, thereby enhancing the connectivity of convolution layers, and adjusting the size of local features led to a significant 32% decrease in performance accuracy. Replacing neural networks with advanced classifiers will improve the accuracy gain from the given algorithm.

Conclusion

The players are highly intelligent and have the strategic thinking ability to win a chess game. There is a lot of research going to find out the next level of chess move while playing. This study brings advancement in finding out winning predictions of chess games from selected dataset effectively. The recommended AlexNet classifier outperforms the SVM classifier with a greater accuracy gain of 99.92%.

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6

Accurate Prediction of Vehicle Number Plate Segmentation and Classification with Inception Compared over Alexnet

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Abstract

This study compares new Alexnet technology with the inception approach in an effort to increase the precision of automotive plate identity acknowledgment. The Kaggle database provided the dataset that was used in this investigation. In the car number plate identification task, there were 20 samples with a higher accuracy rate (10 in Group 1 and 10 in Group 2). G-power 0.8 is used for computation and the 95% confidence interval for the alpha and the beta numbers are 0.2 and 0.05. Both Alexnet and the inception algorithm conduct car number plate recognition with an enhanced accuracy rate, despite the fact that the inception technique utilizes an N=10 the number of samples. The inception method outperforms the Alexnet approach with an accuracy percentage of 96.80%.

Keywords**:** Vehicle number plate recognition, novel inception, Alexnet algorithm, classification, deep learning

6.1 Introduction

Vehicle plate identification is a common problem in the field of intelligent transportation systems, with applications in traffic management, toll collection, and law enforcement [1–3]. Historically, machine learning methods like Support Vector Machines (SVMs) [4–8] and Haar

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cascades as well as manually created features have been used in car plate recognition systems [7]. Deep learning-based methods for detecting license plate information have emerged, though, as a result of the technology's recent success in a number of picture recognition applications. But many algorithms fail in real time, mostly because it is hard to process data in real time. Building a system that can recognize cars automatically from their license plates is therefore desperately needed [19].

The previous several years have seen the proposal of numerous algorithms to recognize license plate information from automobiles [9–15]. Eleven2 research publications were published by IEEE Explore, as opposed to 122 papers published by Google Scholar [17–21] suggested a technique for determining plate area that involves histogram equalization, dilation, and erosion. For character recognition, SVM classifiers were employed. In 2021, [22–25] presented a Hough Transform-based edge detection technique. In [26], a deep learning methodology is used to construct a plate identification system. They generated a dataset that was tailored.

Pixel scale, limited picture resolution, and excessive image noise are the key problems with older methods. The tiny pixel images are always distinct and have the ability to overlap. Due to the high picture noise and limited resolution of the existing work, research gaps are present. The purpose of this work was to develop an intelligent system that can effectively detect car number plates using the unique inception technique, allowing the outcomes to be compared with the Alexnet algorithm.

The super resolution method is applied together with CNN's convolution layer to rebuild the pixel quality of the input picture. The license plate characters are divided into different rows using bounding box segmentation. When compared to traditional Alexnet classifiers, the testing findings show that the suggested inception technique offers higher recognition accuracy and processing speed.

Organization of Chapter

These are the main points of the remaining chapters. Related work is discussed in Section 6.2, materials and techniques are shown in Section 6.4, materials and methods are discussed in Section 6.5, findings and Section 6.5 presents the results of the discussion, and Section 6.6 wraps up the chapter.

6.2 Relevant Works

Several related studies that include a model for real-time identification and recognition of license plates were presented by [27, 28]. It is specifically made to function with camera-captured films. The CNN algorithm is used in this approach to identify license plate numbers. With 5500 license plates in the dataset, the accuracy was 91.38%. In order to find the number plate, [2] and [3] suggested utilizing fuzzy geometry. Fuzzy C-Means was then used to segment the plate [29, 30]. The segmentation approach achieves a 94.24% segmentation accuracy by employing blob labeling and clustering. The Bulan *et al*. technique involves two processing steps: Using a weak sparse network of winnows classifiers, it first extracts a collection of candidate areas, and then it uses a CNN to filter them [31]. At an automation rate of 80%, it attained an accuracy of over 97%; nevertheless, it required an average of 2 seconds for each image. In order to increase complexity and accuracy, Laroca *et al*. created a five-network approach: first, two CNN networks were employed to divide the license plate's characters; third, two CNN networks were used to distinguish between letters and numbers [9]. This method has greater system requirements but can reach an accuracy of 93.53%.

The Alexnet algorithm's drawback is that it needs a lot of data to train efficiently. Hence, it could not work well on jobs with tiny or insufficiently varied training datasets. Creating more reliable and efficient algorithms to identify plates in difficult situations, enhancing the effectiveness of current algorithms, and investigating the application of novel technologies like deep learning to enhance performance are few possible areas of concentration.

6.3 Proposed Methodology

This study proposed an innovative technique for the improvement of the detection of vehicle number plates utilizing the novel inception algorithm in comparison with the Alexnet method. Compared to the current Alexnet system for car number plate detection, the inception algorithm is more accurate and one of the most successful ways to process and analyze the input images. The suggested inception method detects number plates with high accuracy and little processing time.

Inception Algorithm

The study "Going Deeper with Convolutions" by Christian Szegedy *et al.* presented the inception method, a kind of convolutional neural network (CNN) architecture. Utilizing an inception module made to carry out multi-scale processing within a single network is the primary innovation of the inception architecture. A series of pooling and convolutional layers running in parallel with different filter sizes make up an inception module, which enables the network to learn features at various scales. A final convolutional layer or fully connected layer receives the concatenated outputs of the parallel layers as input. The network may learn features of many sizes by utilizing inception modules, which can be helpful for tasks like image classification.

The convolutional layer applies a convolution operation to the input image to extract features. The definition of the convolution operation is as follows: where i, j are the indices of the output matrix; k, l are the indices of the convolutional filter; c is the index of the input channels; and the variables f, input, filter, and bias represent the index of the output channels, input image, convolutional filter, and bias term, respectively.

By using a pooling operation, either maximum pooling or average pooling, the pooling layer down samples the input. The index of the output channels, input picture, convolutional filter, and bias term are represented, respectively, by the variables f, input, filter, and bias, and max pooling yields the maximum value within a given input region. The purpose of 1x1 convolutions is to minimize the number of channels in the input by using a convolutional layer with a 1x1 kernel size.

Processing Steps in Inception:

Input: Recognition of vehicle license plates classification and detection_ Input Features
Output: Classification accuracy
Function: InceptionV3 (Input features FR = 1… n)
Load the Inception model
model = load_inception_model()
Read the input image
read_image(input_file) = image
Get the picture ready by using preprocessed_image = preprocess_image (image).
Recognize the license plate
prediction = recognize_license_plate(model, preprocessed_image)
Postprocess the prediction

license_plate = postprocess_prediction(prediction)
Output the prediction
output_prediction(license_plate)

Alexnet Algorithm

Alexnet's convolutional neural network (CNN) architecture uses depth-wise separable convolutions instead of standard convolutions, which may be less expensive in terms of computation and parameter count. After the input tensor has been separately convolved for each channel using a series of filters, it combines the data from all channels and processes the output tensors in a depth-wise separable convolution (a depth-wise convolution). Furthermore, the Alexnet architecture takes advantage of residual connections, which make it simpler for gradients to flow throughout the network while deep neural networks are being trained. Furthermore, it makes use of an approach known as "asymmetric padding" to guarantee that the input and output tensors' spatial dimensions coincide, which, in some cases of model application, might increase the architecture's efficiency.

Processing Steps in Alexnet:
Input: Recognition of vehicle license plates classification and identification of _Input Features
Assign training and testing datasets for the categorization of automobile registration plates.
Output: Classification on vehicle license plates recognition
Function: Alexnet (Input features I)

Preprocess the input images:
Resize the images to a fixed size (e.g., 299x299 pixels).
Normalize the pixel values to be between 0 and 1.
Convert the images to a tensor format suitable for use with the inception model.

Load the Alexnet model:
Load the pre-trained Alexnet model from a file or URL.
Optionally, remove the final fully connected layer and add a new one with the desired number of classes (e.g., the different characters that can appear on a license plate).

Train the model:
Divide the dataset into two groups: a validation set and a training set.

Utilize methods like stochastic gradient descent (SGD) and back propagation to train the model on the training set.
Keep an eye on the model's performance on the validation set, and cease training when it begins to deteriorate.

Evaluate the model:
Make predictions on the test set using the trained model.
Analyze the model's performance with respect to recall, accuracy, and precision.

Implement the model:
The trained model can be saved to a file or server. As fresh photos are received, such as those from a vehicle's mounted camera, use the model to forecast what will happen.

6.4 Resources and Techniques

The study was done at the Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, in the Digital Processing Laboratory of the Department of Computer Science and Engineering. The Kaggle database provided the dataset that was used in this investigation. In 25% of situations, the database is used for testing, and in 75% of cases, it is used for training. Ten data samples from each of the two sets make up the total of twenty data samples that are being examined. Group 2 used an Alexnet method, whereas Group 1 used a brand-new inception algorithm. The output is obtained by the usage of Python-based vehicle number recognition software. The sample size was established using prior research, with the G power set at 80%, the confidence interval at 95%, and the threshold set at 0.05.

Tables and Figures

The evaluation metrics from the comparison between the inception classifier [16] and the Alexnet approach are displayed in Table 6.1 and the Table 6.3 shows about the sample statistical calculation and Figure 6.1 shows about the accuracy rate of the inception classifier. The inception algorithm has an accuracy rate of 90.35, whereas the inception classifier has a rate of 96.80.

Table 6.1 Accuracy assessment.

Si. no.	Test size	Accuracy rate	
		Inception	**Alexnet algorithm**
1	Iteration1	95.23	88.10
2	Iteration2	95.34	88.23
3	Iteration3	95.56	89.19
4	Iteration4	95.64	89.92
5	Iteration5	95.72	89.92
6	Iteration6	95.96	89.01
7	Iteration7	96.35	90.85
8	Iteration8	96.56	90.28
9	Iteration9	96.65	90.58
10	Iteration10	96.70	90.34
Average test results		96.80	90.35

Table 6.2 The mean, standard deviation, and standard error imply statistical calculations for the inception and inception algorithm classifier. The accuracy rate parameter is used by the t-test. The average accuracy rate of the inception classifier is 96.80, whereas the average accuracy rate of the inception algorithm is 90.35. The inception algorithm has an algorithm of 3.0674 and a standard deviation of 0.2093. While the algorithm's standard error mean is 0.5632, inception's is 0.2309.

Group		N	Mean	Standard deviation	Mean standard error
Rate of accuracy	Alexnet	10	90.35	3.0674	0.5632
	Inception	10	96.80	0.2093	0.2309

Table 6.3 Independent sample statistical calculations and the inception approach are compared in this work. The significance va for the accuracy rate is 0.001. The inception and inception algorithms are compared using the independent samples T-test with a 95% confidence interval and a 0.46091 level of significance. With a significance level of 0.001, this independent sample test has tw tailed significance, mean difference, standard error difference, lower and upper interval difference, and 0.5632.

		Levene's equality of variances test		Equality of means test (t-test)						
									The difference' 95% confidence interval	
Group		**F**	**Sig**	**t**	**Df**	**Sig. (two-tailed)**	**Average difference**	**Standard error dist**	**Lower**	**Uppe**
Accuracy	Assumed equal variances	6.34	0.029	17.09	35	.001	12.4560	0.60831	6.0976	13.44
	Equal variances not assumed			12.5	35.13	.001	11.4550	0.46421	6.5546	12.06

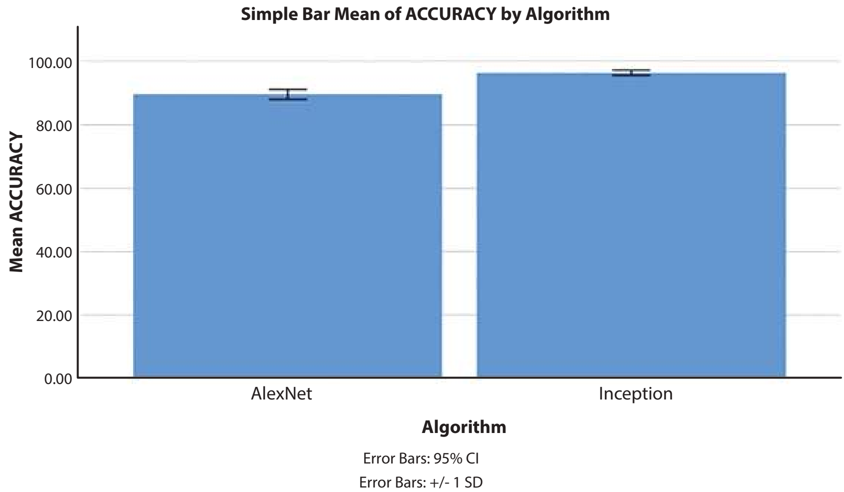

Figure 6.1 The accuracy rate of the inception classifier and the Alexnet algorithm are compared using a simple bar graph. X-axis: Inception classifier against Alexnet algorithm. The mean accuracy rate of keyword identification, with a 95% confidence interval and a standard deviation of 1, is plotted on the Y-axis.

6.5 Results and Discussion

The evaluation metrics of the inception classifier and the Alexnet technique are shown in Table 6.1. The accuracy rate of the Alexnet technique is 90.35, whereas that of the inception classifier is 96.80. The inception classifier works better than the Alexnet method in every way, and it has a greater accuracy rate in identifying car number plates.

The statistical information, including mean, standard deviation, and standard error mean, for the inception and Alexnet algorithm classifier is shown in Table 6.2. The accuracy rate parameter is used for the t-test. The Alexnet algorithm classifier has a mean accuracy rate of 90.35, while the inception classifier has 96.80. The standard deviation and standard error mean for inception are, respectively, 0.2093 and 0.2309. On the other hand, Alexnet's standard error mean is 0.5632 and its standard deviation is 3.0674.

The outcomes of the experiment demonstrate that inception does better in terms of accuracy of prediction. The experiment's findings show that the recommended inception approach's 96.80% accuracy outperformed the Alexnet model's 90.35 percent accuracy.

6.6 Conclusion

The suggested model shows the Alexnet method and the inception, with the inception achieving high accuracy values. The enhanced accuracy rate of vehicle number plate recognition analysis utilizing the inception approach is 96.80% greater than that of the Alexnet methodology, which has an accuracy rate of 90.35%, for the chosen dataset with 75% of data utilized for training and 25% for testing. It may be concluded that the revolutionary inception algorithm performs better in vehicle number plate identification than the Alexnet model because deep learning methods make these advances possible.

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7

A Novel Method to Analyze a Server Instance's Performance During a Crypto-Jacking Attack Using Novel Random Forest Algorithm Compared with Logistic Regression

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Abstract

This research focused on identifying cloud server attacks. Regular security audits can assist in locating system flaws and vulnerabilities that hackers might misuse. Audits should be carried out by certified security experts who can offer proposals for improvement. Discovering new hazards and weaknesses can be aided by staying current with security trends. The study is divided into two groups: one using the logistic regression (LR) method with a sample size of ten, and the other using a novel random forest (RF) method with an analogous sample size of ten and determined using ClinCalc software with $\alpha = 0.05$ and using different training and testing splits, a preliminary test power metric of p=0.8 was found for predicting unauthorized bitcoin cloud server operations during currency transfers. Using Independent samples t-tests ($p>0.05$), the novel RF model shows improved accuracy at 94.7970%, which is higher than that of LR at 92.9680%. However, the model has a significance value of 0.220. In terms of accuracy, the novel RF outperforms LR.

***Keywords*:** Logistic regression, currency transaction, novel random forest, cryptocurrency, machine learning, blockchain

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Abbreviations Used

Logistic regression	LR
Random forest	RF
Ciphertext policies with attribute-based encryption	CP-ABE
Cloud service providers	CSPs
Machine learning	ML
Statistical package for the social sciences	SPSS

7.1 Introduction

The authors discussed the cloud's biggest problems and presented blockchain-based remedies. The author reviewed prior blockchain-cloud integration experiments to demonstrate their superiority. They constructed blockchain-cloud architecture in this survey to show blockchain-cloud communication [1]. Kubernetes pods must be able to detect hidden malware executables that start cryptomining processes during application deployment and operation. ML can identify cryptomining pods. The system administrator must notice and explain the ML's classification [2]. The suggested method combines attribute-based encryption based on ciphertext policies with the Ethereum blockchain (CP-ABE). Decentralized cloud storage has no trusted third party [3]. The main application of the project is the detection of cloud servers during cryptocurrency transactions [4].

Research work has been done to detect cloud servers during cryptocurrency transactions. For many years, there have been more than 200 articles found in IEEE Xplore and 50 articles in ScienceDirect. Cryptomining may misuse passive network monitoring. Based on a set of network traffic indicators, the researcher used deep learning and machine learning models to detect Bitcoin mining activity in real time. The models' ability to identify instances of cryptomining was the particular focus of testing. Internet-encrypted connections verify servers. [5] presented a blockchain-based, certificateless data storage solution. Blockchain miners use certificateless cryptography to verify "transactions" and audit records, [6] eliminating centralized servers. They define and process non-cryptocurrency transactions [7]. This survey summarizes network-based cryptocurrency transaction analysis literature [8]. According to [9], this part provides methodical guidance for academics and engineers by outlining the background of analyzing the Bitcoin transaction network and reviewing previous research on network modeling, profiling, and network-based detection. Blockchain-cloud computing is used in the study to guarantee data integrity using all homomorphic encryption techniques [10]. The shortcoming found in the existing system is its insufficient precision. This study compares the efficacy of random forest to logistic regression with the goal of improving classification accuracy. During currency transactions, the suggested methodology improves the identification of Bitcoin cloud servers.

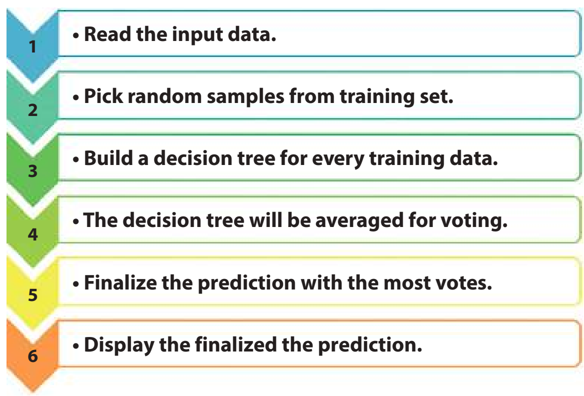
While using ML algorithms such as random forest (RF) and logistic regression (LR) can provide valuable insights into server performance during a crypto-jacking attack, there are some potential drawbacks to consider: **Limited data availability**: The accuracy of the ML approach is dependent on the quality and quantity of data available for analysis. In the case of a crypto-jacking attack, there may be limited data available to train the models, making it challenging to build accurate models. **Lack of interpretability**: Machine learning algorithms such as RF can be effective at predicting server performance during an attack. This suggests that understanding the logic behind the model's predictions might be difficult, complicating result interpretation. **Overfitting**: ML models have the ability to overfit, which occurs when the model grows extremely complicated and closely resembles the training set. When presented with fresh facts, this might result in inaccurate forecasts. **Computational complexity** [18–23]: Building and training machine learning models can be computationally intensive and time-consuming. As such, it may be challenging to implement these methods in real-time environments where quick decision-making is required. Cost: Building and deploying machine learning models can be expensive, requiring specialized skills and infrastructure. This cost may be prohibitive for some organizations [11].

7.2 Materials and Methods

The dataset's sample size was determined using ClinCalc software [13], which involved comparing two controllers. The study included ten sets of samples, each including ten samples, and separated into two groups to compare methods and outcomes. Technical analytical software was used to build the LR and novel RF approaches. The ClinCalc 3.1 software was used to calculate a sample size of ten for each group. The g power setting values were set to $\alpha=0.05$ and power=0.8. OpenCV is a Python program that is used for planning and carrying out the intended job. Windows 10 was used for the deep learning experimentation. To get the correct output, the dataset is processed in the background while the code is being executed.

There are a total of 16 variables and 614 data points in the collection. Eight of these variables are categories, while the remaining are numbers. To improve the accuracy of bone fracture identification, the algorithms LR and novel RF are utilized. The time-tested algorithm novel RF algorithm is an algorithm used for identifying objects a 94.79 success rate. LR has an accuracy of 92.96%. For this study, we compiled a dataset from the Kaggle website, split into two categories [12].

Novel Random Forest-Procedure:



LR -Description:
LR is an ML approach that is used to estimate the likelihood of particular classes given a collection of independent factors. Logistically, the LR model adds up the input characteristics (often including a bias term) and then evaluates the logistics of the output.

Algorithm:
Step 1: Repeat steps i through k for each iteration.
Step 2: Configure the regularization parameter, convergence criterion, and learning rate for the LR.
Step 3: Preprocess the data, which includes managing missing values, normalizing the features, and scaling them.
Step 4: Identify the logistic function that converts the output of the LR model into a probability value between 0 and 1.
Step 5: Set the LR model's weights and bias settings.
Step 6: Use a suitable optimization approach, such as gradient descent or Newton's method, to traverse the training data and modify the weights and bias values.
Step 7: Evaluate the trained model's performance using validation data and adjust the hyperparameters as needed.
Step 8: By calculating the logistic transformation of the output, use the trained model to forecast results for fresh data points.

Step 9: Evaluate how accurate the predictions were and adjust the model as necessary.
Step 10: Repeat steps 5-8 until the desired outcomes are obtained.

7.3 Statistical Analysis

With SPSS software, statistical analyses of novel RFs and LRs are carried out. Images and objects are the dependent variables, while other variables include distance, frequency, modulation, amplitude, volume, and decibels.

7.4 Results

The expected accuracy values for LR and novel RF are shown in Table 7.1. The ten data samples were used to construct statistical statistics for the following comparison, along with the accompanying loss values. Based on the study results, novel RF showed a greater mean accuracy of 94.7970% than did LR, which had a mean accuracy of 92.9680%. Table 7.2 provides a summary of the mean accuracy for LR and novel RF. LR's mean value is less than that of novel RF, with standard deviations of 3.03719 and 3.39229,

Table 7.1 Accuracy values of novel RF and LR algorithms.

Iterations	Novel random forest accuracy (%)	Logistic regression accuracy (%)
1	90.1	88.21
2	90.4	89.6
3	91.6	90.7
4	93.3	91.25
5	94.9	92.7
6	95.8	93.8
7	96.1	94.2
8	97.2	95.1
9	98.6	96.5
10	99.97	97.62

Table 7.2 Calculating the mean, standard deviation, and standard error of the mean for 10 samples is an important step in doing a group statistical analysis for both novel RF and LR.

	Group	Sample size	Mean	Std. deviation	Std. error mean
Accuracy	**RF**	10	94.7970	3.39229	1.07274
	LR	10	92.9680	3.03719	0.96044

respectively. Table 7.3 presents the results of the novel RF and LR Methods, revealing a non-significant p-value of 0.220. In Table 7.4, an accuracy comparison between novel RF and LR is provided. The flow diagram of the recommendation system is shown in Figure 7.1. Figure 7.2 visually depicts the analysis of mean accuracy between novel RF and LR methods. In terms of accuracy, the LR classification model performs worse than the RF prediction model.

The comparable figures for LR, on the other hand, are 92.9680 for the mean, 3.03719 for the standard deviation, and 0.96044 for the standard error mean. For both techniques, the group statistics include the mean, standard deviation, and standard error mean values. With an accuracy of 94.7970% as opposed to LR's categorized accuracy of 92.9680%, the data indicate that novel RF performs much better than LR.

7.5 Discussion

In this research, the significance value obtained is 0.220, which implies that novel RF performs improved accuracy compared to LR. The accuracy evaluation for novel RF was 94.7970%, while LR was 92.9680%.

The given paper attempts to predict cryptocurrency prices using fluctuating factors. The author created a Sentiment Evaluation for Trend Prediction technique to analyze crypto market sentiment. IBM Watson successfully analyzed the top 5 coins' statistical data. Jupyter Notebook predictions of market highs for top trending coins have been improved. Twitter trends and hashtags were used to evaluate sentiment and predict global investor emotions. Findings: Finally, the researchers are enthusiastic about the study's great potential in anticipating market speculation during its early stages. They believe that the inclusion of diverse technologies will pique the attention of further researchers and provide significant data and insights to prospective investors, as proposed by [4]. The future scope of BTC, Wave, Ethereum,

Table 7.3 The independent sample T-test findings show that there is no statistical advantage of novel RF over LR, as indicated by p-value of 0.220.

		Levene's test for equality of variances		T-test for equality means with 95% confidence interval						
		f	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error difference	Lower	Uppe
Accuracy	Equal variances assumed	.145	.708	1.270	18	0.220	1.82900	1.43987	-1.19605	4.854
	Equal Variances not assumed			1.270	17.784	0.220	1.82900	1.43987	-1.19868	4.856

Table 7.4 When comparing the accuracy of RF to LR, performance differences appear.

Classifier	Accuracy (%)
Random forest	94.79
Logistic regression	92.96

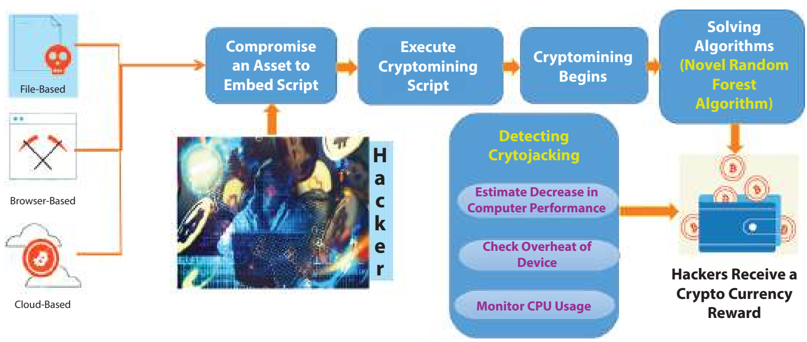


Figure 7.1 Flow diagram for the proposed system.

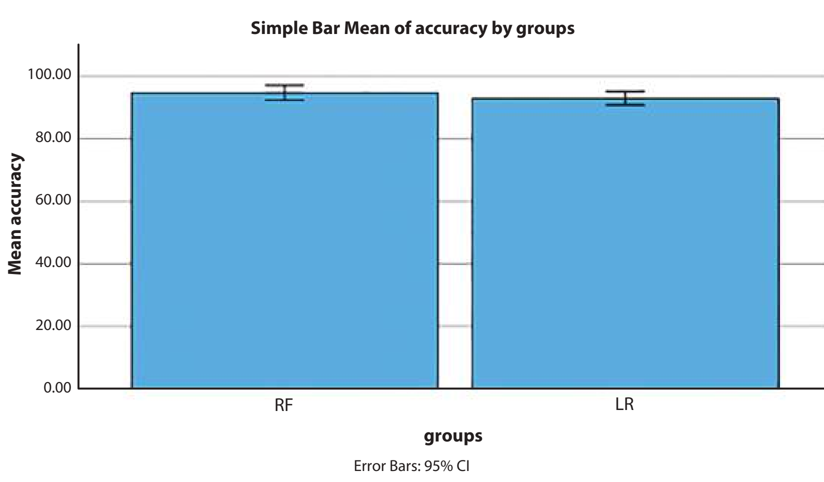


Figure 7.2 The graphical depiction compares novel RF against LR classifiers on the X-axis, while the Y-axis represents mean detection accuracy with +/-2 standard deviations.

and Made cryptocurrency value prediction is also discussed [14, 15]. This ransomware is becoming more popular, making it the biggest IT security threat. Many studies detect and analyze cyberbullying. This study examined a forensic analysis of a crypto-ransomware attack. In this example, the crypto-ransomware attack method and behavior were analyzed and attacker information was found. The study will help fight this threat with this dimension [16]. Investors claim that in just one year, the cryptocurrency industry has grown by 300 percent to a valuation of 1.6 trillion dollars. Forecasting price movements may enable investors and other stakeholders to more easily incorporate cryptocurrency into their investment plans. According to [17], machine learning and big data analytics can identify stochastic and nonlinear patterns in market data, which helps predict future price movements.

A limitation of this research is the lengthy training period for RF, which is especially noticeable with large datasets. In the future, it will be possible to improve the system by supporting a larger range of items and at the same time shortening the training time of the dataset.

Conclusion

The goal of the research is to identify cloud server assaults, highlighting the need for routine security audits in identifying vulnerabilities in systems that hackers may exploit. The results show that novel RF implements improved in positions of accuracy than LR, with a higher accuracy value of 94.7970% as opposed to 92.9680% for LR.

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8

A Comparative Analysis of Twin Segmentation and Classification Over MultiClass SVM and Innovative CNN: An Innovative Approach

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Abstract

The primary goal of the study is to detect twins through the application of an innovative convolutional neural network, followed by a comparison of its accuracy with the multiclass_support vector machine. Both innovative_convolutional neural network and multiclass support vector machine algorithms were employed on datasets consisting of 1775 images, with a specific focus on identifying twins across 10 samples for each group. The G power value was set at 75%, and the alpha value for the 95% confidence interval was fixed at 0.05. The accuracy of recognizing identical twins was calculated, revealing that the multiclass support vector machine algorithm outperformed the innovative convolution neural network, achieving a higher accuracy of 92.9% compared to 90.7%. Statistical analysis, through an independent T-test, showed no significant difference between the two groups, as indicated by a p-value of 0.111 ($p > 0.05$). In the domain of efficient twins identification and classification using machine learning approaches, the proposed multiclass support vector machine method demonstrates superior performance over the convolution neural network.

***Keywords*:** Innovative convolutional neural network, Euclidean space, face recognition, identical twins, biometrics, facial features, social protection

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8.1 Introduction

The primary aim of this research is to utilize facial recognition and machine learning methodologies for the purpose of identifying identical twins. Due to the substantial similarities in both physical and psychological characteristics among twins, this study seeks to address the challenges associated with their accurate identification. The classification of twins poses a challenging task within the realms of computer systems and biometrics [2]. However, face recognition and facial features are critical in a wide range of practical applications, including criminal investigation, family reunion, and social protection [7]. Researchers have proposed a variety of solutions to this problem, including face recognition, gait analysis, and iris recognition. Innovative convolutional neural networks facial features have recently gained popularity as a method for image classification due to their superior performance in a variety of computer Machine tasks Despite their success, face recognition and facial features the majority of existing studies focus on single-class classification, with only a few investigating the problem of twin classification [5]. In this project, our system uses an innovative method for segmenting and classifying twins using I_CNN and applications like twin identification in criminal cases, supply chain management, social protection, and security check in public places. Biometrics are used [3].

During the last five years, researchers have used a machine learning model to recognize twin faces for easy biometric-based recognition, with 272 research articles submitted to Google Scholar Academic Datasets and over 118 IEEE Xplore publications. Twins who are identical Our technique divides the twin pictures into independent components before classifying each component with convolution neural networks [1]. The final classification result is determined by consolidating the outcomes of individual elements [6] within Euclidean space. To evaluate the effectiveness of our approach, we compare it with a multiclass support vector machine, a conventional and extensively employed method in biometrics for multiclass classification within Euclidean space. Our innovative method showcases superior performance in twin classification accuracy, as demonstrated by experimental results on a benchmark twin classification dataset. This outperformance is particularly noteworthy in the field of Biometrics. Additionally, in the context of Euclidean space [4], the L2 distance offers a comprehensive analysis of the impact of various hyperparameters on classification performance, especially concerning social protection [8].

Approaches previous research gaps employed had a greater error rate, were less dependable, biometrics, and were less effective in identifying unique face marks. This demonstrates our laboratory's ability to perform experiments on distinguishing unique facial marks. The primary objective of this research is to minimize error rates through a comparative analysis of the Innovative convolutional neural network and the existing multiclass support vector machine. The focus is on exploring methods for accurately identifying and differentiating the faces of identical twins.

Methods and Materials

The undertaken research was conducted at the OpenSource Lab, SSE, SIMATS Chennai. The research involved the segregation of two distinct groups for analysis. Group 1 employed the Decision Tree algorithm, whereas Group 2 utilized Naive Bayes. Both the Decision Tree and Naïve Bayes algorithms underwent iterative processes at designated intervals, each with an assigned sample size. The analyses were carried out using Clincalc software, incorporating a 95 percent confidence interval and a pretest power of 80 percent.

The study focused on twins' identification using a dataset obtained from Kaggle.com. Post dataset collection, preprocessing procedures were executed. Following the cleaning process, feature extraction for vectorization occurred, involving the conversion of strings, words, and characters into binary (0 and 1) values. The resultant dataset, free of blank and empty values, proved suitable for evaluating the efficacy of the machine learning methodology. The pre-processing stage involved a comprehensive exploration of the dataset, partitioning it into 20% for the testing set and 80% for the training set.

Group1_Innovative Convolutional Neural Network

An artificial neural network designed for tasks such as image recognition within computer applications. This network consists of multiple layers of artificial neurons intricately connected to identify patterns and extract features from input data. The accuracy of a CNN serves as an evaluative metric, assessing its effectiveness in accurately categorizing input data. Generally, CNN accuracy is calculated by dividing the number of correctly classified examples by the total count of examples within the test set.

Group2_MultiClass Support Vector Machine

A class of supervised machine learning algorithms specifically designed for classification or regression tasks. In the context of multiclass classification, SVMs operate by identifying a hyperplane within the feature space that optimally maximizes the separation between different classes. This hyperplane serves as the decision boundary, enabling SVMs to categorize new data points into distinct classes based on their position relative to the hyperplane.

Group Difference I_CNN Versus MultiClass SVM
In this Python script, the dataset (x_data and y) undergoes partitioning with sample subsets utilizing the train_test_split function from scikit-learn. The split allocates eighty percent of the data for training and twenty percent for testing purposes. Subsequently, the training data undergoes standardization using the StandardScaler method, aiming to achieve zero mean and unit variance for the features. Following standardization, a decision tree classifier is instantiated with a specified maximum depth of 10 and is trained on the standardized training data. The model is then applied to predict labels for both the testing and training sets. The accuracy was assessed using the accuracy_score metric from scikit-learn.

The resulting accuracy scores for the testing and training sets are displayed, providing insights into the model's performance on unseen and training data, respectively.

Statistical Analysis

The computations were executed on a laptop equipped with specified requirements, including a 64-bit version of the Windows 11 operating system, 8 gigabytes of random access memory, a reliable internet connection, and the utilization of a Colab Notebook. For statistical analyses, the IBM SPSS tool was employed, specifically for assessing the innovative convolutional neural network and multiclass support vector machine. SPSS, recognized as statistical software for data analysis, played a pivotal role in the research study [6]. Version twenty-six over IBM SPSS was experimented with for both proposed and existing algorithms, ranging from 5 to 14 in number. The research involved five iterations, with each iteration capturing the predicted efficiency in the SPSS tool, and these values were subsequently organized in tabulated form. The data underwent analysis using an independent sample T-test for each iteration. The findings reveal no statistical significance between the two groups, with a p-value of 0.111 ($p > 0.05$).

Results

The research aimed to compare the efficacy of two distinct machine learning methodologies: an innovative convolutional neural network (I_CNN) and a multiclass support vector machine (MCSV) in the context of twins classification. Table 8.1 showcased the outcomes, displaying accuracy metrics for twin identification. The I_CNN achieved an accuracy of 90.7%, while the MCSV exhibited a higher accuracy of 92.9%. In the realm of machine learning, accuracy serves as a crucial metric, gauging a model's proficiency in correctly predicting labels or classes for given inputs. In this instance, the models were tasked with categorizing twins into different classes, and accuracy reflected the ratio of correctly classified twins for each model. The study underscored that factors such as the quality and quantity of training data, model complexity, and the specific task within Euclidean space can influence a model's accuracy.

Table 8.1 Enhanced precision in twin identification is observed with a convolutional neural network achieving an accuracy of 90.7%, while the multiclass support vector machine exhibits an increased accuracy of 92.9%.

Sample_ Iteration No.	**Group_ MCSVV (%)**	**Group_I_ CNN (%)**
1	87.9	87.3
2	88.2	87.5
3	88.3	87.6
4	88.5	87.9
5	88.7	88.1
6	89.8	88.2
7	90.4	88.5
8	91.4	89.2
9	92.7	89.4
10	92.9	90.7
Accuracy	**92.9**	**90.7**

Table 8.2 It summarizes the outcomes of the independent samples T-Test conducted on the effectiveness of I_CNN and MCSVM I_CNN achieved an effectiveness of 90.7%, while MCSVM demonstrated a higher effectiveness of 92.9%. However, statistical analysis indicates no significant difference between the two groups, as supported by a p-value of 0.111 ($p > 0.05$).

		Group_ Test for Equality of the Variances(Levene)		Equality of Means9Group_t-test for)						
									Gp-95% interval confidenc	
		Gp-F-value	Gp-Sig-valueS	Gp-t-value	Gp-diff-	GP- (2-tailed) Sig	GP-difference in Mean	Gp-Difference in Std. Error	Lower	Up
Group_ Accuracy	Gp_EQA	.382	0.544	1.263	18	0.111	0.500	.395	-0.331	1.3
	Gp-EQNA			1.263	17.942	0.111	0.500	.395	0.331	1.3

Table 8.2 presented the results of an independent samples T-Test, revealing that the I_CNN was statistically less effective (90.7%) compared to the MCSV (92.9%), with the MCSV exhibiting a higher significance value (0.05) than the I_CNN. This implies a potentially significant difference in performance between the two models. Table 8.3 provided a detailed statistical analysis, computing mean accuracy values, standard deviation, and standard error mean after 10 iterations for both the convolutional neural network and multiclass support vector machine. The results indicated superior performance by the MCSV approach compared to the I_CNN methodology.

Figure 8.1 visually depicted the accuracy of MCSV and I_CNN algorithms, with the mean accuracy of MCSV surpassing that of I_CNN, and the standard deviation slightly lower for MCSV. The X-axis represented a multiclass support vector machine, while the Y-axis represented a convolutional neural network, showcasing mean accuracy within +/-2 standard deviations. In conclusion, the study delivers a comprehensive assessment of the I_CNN and MCSV models' performance in twin classification, encompassing accuracy metrics, statistical tests, and visual representation of results. The findings strongly suggest that, in this specific task, MCSV outperformed I_CNN.

Table 8.3 Statistical evaluation employing convolutional neural network and multiclass support vector machine involved computing mean accuracy values, standard deviations, and standard error means across 10 iterations for both methods. Findings indicated that the multiclass support vector machine outperformed the convolutional neural network approach.

Sample_Group	**Group_N**	**Group_ Total Mean**	**Group_SD**	**Group. Error Mean_**
(I_CNN)Innvotive Convolutional Neural Network	10	90.710	0.859	0.271
MultiClass Support Vector Machine	10	92.910	0.909	0.287

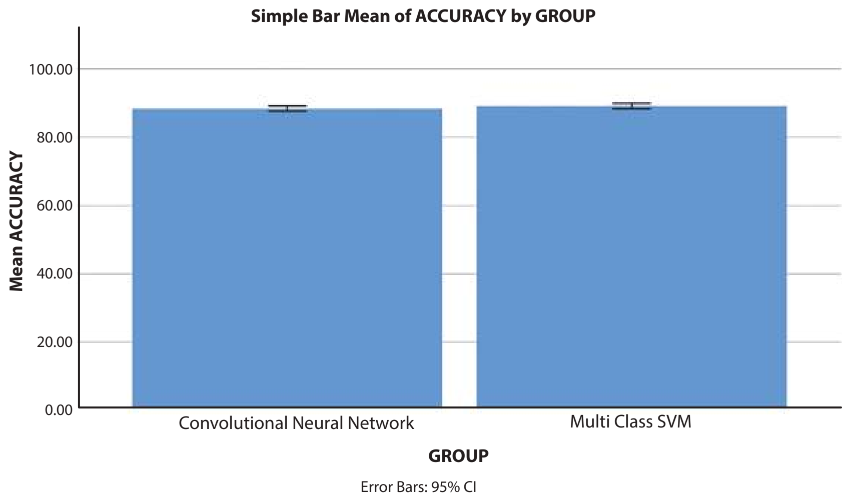

Figure 8.1 A comparative analysis is performed on the accuracies of the multiclass support vector machine (MSVM)_and innovative convolutional neural network (ICNN) algorithms. The mean accuracy of the multiclass support vector machine exceeds that of the Convolutional Neural Network, accompanied by a slightly lower standard deviation. The graphical representation illustrates this disparity on the X-axis, depicting multiclass support vector machine versus, and on the Y-axis, convolutional neural network. The mean accuracy is within the range of +/-2 standard deviations.

Discussion

Various studies have explored the use of facial traits for identifying identical twin faces. For instance, an approach involving the Active Shape Model and rapid radial symmetry detection focuses on recognizing facial features like brows, eyes, and nose, achieving notable success [11]. Additionally, the integration of neural networks and genetic algorithms enhances the performance of facial marks detection systems, achieving an average accuracy of 81.92% in Euclidean space and face recognition [10].

Biometric face recognition based on facial features and segmentation for automatic gender classification and social protection utilizes the single-shot multibox detector (SSD) technique with a pre-trained VGGNet base network. This method, evaluated on the full twins dataset and split training, yields map values of 0.5670 and 0.6738, respectively [9]. However, the proposed system has limitations, restricting its ability to categorize and analyze identical twins' faces to a pair of two photographs or fewer. While the mean accuracy of the system is constrained, there is potential for future enhancements in efficiency and accuracy in facial detection. The suggested work's future scope involves twin image prediction using recognition, with a focus on classifying labels with a higher rate of accuracy over a lower time complexity [12].

Conclusion

The goal of the study is to detect identical twins and look-alikes utilizing facial traits for quick face identification using unique twin photos. The multiclass support vector machine (90.7) method surpassed the convolutional neural network technique (92.9%) in predicting identical twins achieved for a chosen dataset in this research investigation.

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9

Prediction of Yields in Semiconductor Using XGBoost Classifier in Comparison with Random Forest Classifier

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Abstract
Aim: The target of this analysis is to determine the pass/fail yield of a specific process item and forecast semiconductor yield using the innovative XGBoost classifier, with a subsequent comparison to the random forest classifier. **Materials and Methods:** The XGBoost classifier and RFC (N=10) algorithms have been employed to predict semiconductor yield. The sample size was determined through a GPower pretest, with an 80% threshold, a significance level of 0.05, and a confidence interval of 95%. **Results:** The XGBoost classifier demonstrates a 90.4% accuracy rate and a 9.4% loss rate, while the RFC has an accuracy of 84% with a loss of 16%. The significant difference in accuracy among the two approaches is indicated by a significance level of 0.002 in the Independent Sample T Test ($p<0.05$). **Conclusion:** Based on the results, the novel XGBoost classifier outperforms the RF classifier significantly in terms of accuracy when predicting semiconductor yield.

***Keywords*:** Prediction, semiconductor yield, classification, novel XGBoost classifier, random forest classifier (RFC), sustainable production

9.1 Introduction

Sensors play a crucial role in monitoring, regulating, and measuring various processes in semiconductor manufacturing equipment, contributing

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to sustainable production. In semiconductor production, signals from sensors and process measurement sites are continuously monitored, with certain signals being more significant in the monitoring system. Performance indicators which include defectiveness, and yield are utilized to enhance manufacturing performance and promote sustainable production. Product quality, assessed through wafer yield, is a key metric for evaluating process technology in wafer fabrication businesses to ensure pollution-free manufacturing and sustainable production (Xu, Qin, and Sun, 2022). Multi-objective optimization techniques are applied for the inverse design of Wafer Acceptance Test (WAT) parameters (D. Jiang, Lin, and Raghavan, 2021).

Machine learning algorithms, such as the XGBoost classifier, leverage historical data to forecast new output values. XGBoost is widely employed in various applications, including predicting vehicle crash damage extent, Ion Channel Prediction, and fraud detection. The random forest classifier, known for its scalability and prevention of overfitting, is utilized in deep stroke analysis with 95% accuracy (Qiu *et al.*, 2022).

In semiconductor yield prediction research, 250 papers were published in Science Direct, 396 in IEEE Digital Xplore, and 2122 in SpringerLink over the past five years. A study impacting the inspection procedure, enhancing production efficiency, and reducing product scrap employed machine learning and the XGB algorithm (Xu, Qin, and Sun, 2022). The relationship between defects and sensors provides insightful data for fault diagnosis (Hsu and Liu, 2020). RF and XGBoost classifiers exhibit excellent Mean Squared Error (MSE) compared to other algorithms, making them robust for target detection (Niang *et al.*, 2021). XGB accurately categorizes samples and can improve the manufacturing process by localizing fault sources (Millah *et al.*, 2022).

XGB's application in sustainable semiconductor production involves building models to predict chip yield for each batch, allowing adjustments of hyperparameters for optimal performance. The study aims to evaluate XGBoost's performance relative to gradient boosting and extends the comparison to include random forest, assessing training efficiency and accuracy. A detailed investigation of XGBoost's parameter-setting procedure is conducted.

Materials and Methods

The research was initiated within the framework of the Computational Intelligence Laboratory of the SSE, SIMATS. Data from two different groups were analyzed: Group 1, corresponding to the XGBoost classifier, and Group 2, representing the RF classifier. Each group comprised 10 samples, and the sample size was determined based on literature (Li Jidong and Zhang Ran, 2022), utilizing GPower pretest with an 80% threshold, a significance level of 0.05, and a confidence interval of 95%.

Google Colab was utilized to assist in the design and implementation of the proposed task. The testing environment for machine learning models was Windows 11, featuring an 8th-generation Intel Core i7 processor and 8GB of RAM. The programming language implemented for the coding was Python and was utilized in a 64-bit system. For better accuracy in the output, the dataset was focused on semiconductor yield and was processed in the background while the algorithm was running. The dataset, obtained from Kaggle.com, comprises 19 characteristics, including "date and time," "sensor 1," "sensor 2," and so on (Quinonero-Candela *et al.*, 2022).

XGBoost Classifier

The gradient boosting technique has undergone scaling and enhancement, resulting in eXtreme Gradient Boosting (XGBoost). Specifically designed for efficiency, computational speed, and model performance, XGBoost is part of the distributed machine learning community and operates as an open-source library. It stands out as a leading machine learning package for addressing regression, classification, and ranking issues, offering parallel tree boosting.

In the process of parallel tree boosting, decision trees are sequentially constructed. Notably, XGBoost places significant emphasis on weights. Variables that the initial decision tree inaccurately predicts are assigned additional weight before being incorporated into the subsequent decision tree. The culmination of these multiple classifiers and predictors results in the creation of a robust and reliable model.

Procedure for XGB

Input - Training dataset

1. Load the dataset.
2. Pre-processing.
3. Exploratory data analysis is done.
4. Modeling of dataset.
5. For ten batches accuracy is calculated.

Output - Accuracy

Random Forest Classifier

The random forest (RF) utilizes predictions from multiple decision trees, rather than relying on a single tree, and derives its final prediction based on the aggregated votes of these individual forecasts. By employing a classifier like RF, which integrates several decision trees trained on different subsets of input data, it is possible to enhance the predicted accuracy of a dataset. The effectiveness of RF increases with the number of trees in the forest, leading to reduced overfitting and higher overall accuracy. Notably, RF also requires less training time compared to alternative methods.

Procedure for RF Classifier

Input - Training dataset

1. Load the dataset.
2. exploratory data analysis is done.
3. Data visualization is performed on the datasets.
4. modeling of dataset.
5. For 10 batches accuracy is calculated.

Output - Accuracy

Statistical Analysis

Statistical analysis for both the proposed and existing algorithms was conducted using IBM SPSS version 26. The projected accuracy for each algorithm repetition was documented to facilitate a comparison with the values determined from every iteration. The Independent Sample T-Test, as outlined by Akpan *et al*. (2023), was employed. The dependent variable in the analysis corresponds to the “Pass/Fail” column from the dataset, while the independent variables consist of the sensor values in the dataset.

Results

In Google Colab, the proposed XGBoost classifier method and the random forest classifier were separately executed utilizing 10 as the sample size.

Table 9.1 presents the anticipated accuracy of semiconductor yield. For the production of comparable statistical values, a loss value of 10 data samples was used. The results indicate that the mean accuracy of the novel XGBoost classifier algorithm was 90.4%, whereas the mean accuracy of the random forest classifier was 80.8%.

Table 9.1 Accuracy and loss analysis of novel XGB and RF.

S. no	Groups	Accuracy	Loss
1	novel XGB	88	12
		94	6
		88	12
		92	8
		94	6
		88	12
		88	12
		94	6
		92	8
		86	14
2	RF	80	20
		80	20
		76	4
		80	20
		80	20
		84	16
		84	16
		88	12
		76	24
		80	20

Table 9.2 provides details on the total number of samples, mean accuracy, standard deviation (SD), and standard error mean (SEM) values for both novel XGB and RFC. Specifically, the mean, SD, and SEM for the novel XGBoost classifier are 90.4, 3.09, and 0.97, respectively. For the random forest classifier, these values are 80.8, 3.67, and 1.16, respectively. The loss values for the novel XGBoost classifier exhibit mean, SD, and SEM

Table 9.2 Group statistical analysis of novel XGB and RF. Mean, standard deviation, and standard error mean are obtained for 10 samples. The Novel XGB has higher mean accuracy and lower mean loss when compared to RF.

	Group	Algorithm	N	Mean	Std. deviation	Std. error mean
Accuracy	1	Novel XGB	10	90.40	3.09	0.97
	2	RF	10	80.80	3.67	1.16
Loss	1	Novel XGB	10	9.60	3.09	0.79
	2	RF	10	19.20	3.67	1.16

values of 9.60, 3.09, and 0.79 individually. Meanwhile, the RFC loss values show mean, SD, and SEM values of 19.20, 3.67, and 1.16, respectively.

Table 9.3 presents the outcomes of the T-test on an independent sample for XGB and RFC. A significant difference among both the methods is evident, with the significance value for accuracy listed in the table. The significance and test's standard error are also included.

Figure 9.1 visually compares the mean accuracy and loss between XGB and RF. The graphical analysis illustrates a substantial improvement in XGBoost classifiers, exhibiting a 90.4% classification accuracy, in contrast to the random forest classifier's accuracy of 80.8%.

Discussion

In this research, the XGBoost classifier outperformed the RFC in terms of accuracy and error difference. The XGBoost obtained a mean accuracy of 90.4% and a mean loss of 9.6%, while the RFC had a mean accuracy of 80.8% and a mean loss of 19.2%. The significant difference in accuracy between the two approaches is highlighted, with significance levels of 0.002 (Independent sample t-test, $p < 0.05$) showing a substantial distinction.

The authors conducted a comparative analysis of the historical evaluation of the XGBoost classifier against RFC, clearly demonstrating that the better performance is given by the novel XGBoost classifier over the random forest classifier. Various studies were referenced to support this, including comparisons of accuracy percentages and mean squared errors (MSEs) in semiconductor yield prediction. The XGBoost classifier consistently outperformed the RFC in terms of accuracy and performance standards.

Table 9.3 The independent sample t-test was performed between XGB and RF for 10 iterations with the confidence interval of 95

Levene's test for equality of variances				t-test for equality of means						
		F	**Sig**	**t**	**df**	**Sig. (two-tailed)**	**Mean difference**	**Std. error difference**	**Lower**	**Upp**
Accuracy	Equal variances assumed	0.01	0.92	6.31	18	0.002	9.60	1.52	6.40	12.79
	Equal variances not assumed			6.31	17.48	0.002	9.60	1.52	6.39	12.80
Loss	Equal variances assumed	0.01	0.92	-6.31	18	0.002	-9.60	1.52	-12.79	-6.40
	Equal variances not assumed			-6.31	17.49	0.002	-9.60	1.52	-12.80	-6.39

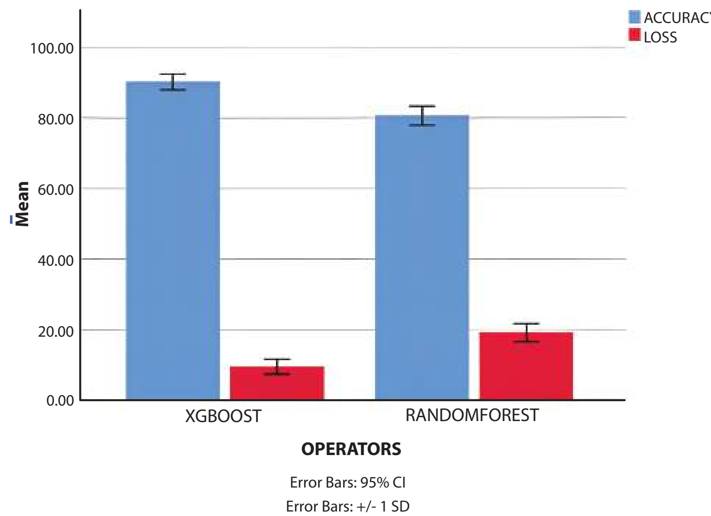

Figure 9.1 Comparison of RF and novel XGB Classifier in terms of mean accuracy and loss. The mean accuracy of novel XGB is better than RF Classifier; Standard deviation of novel XGB is slightly better than RF. X Axis: RF Vs novel XGB Classifier, Y Axis: Mean accuracy and loss. Error Bar ±1 SD.

Despite the success of XGBoost, the study acknowledges certain limitations. XGBoost may not perform as effectively on fragmented and unstructured data, and its sensitivity to outliers is noted. Additionally, the scalability of the approach is considered a challenge. The study's future objectives include enhancing the system's efficiency in processing dataset information with minimal time consumption. Overall, the research contributes to the existing knowledge base, emphasizing the improved accuracy of the XGBoost classifier in predicting semiconductor yield.

Conclusion

The semiconductor yield prediction system in this study utilizes two classification techniques: the random forest model and the novel XGBoost model. The outcome clearly shows that the XGB Classifier performs better when compared with RFC. Specifically, the investigation reveals that the XGB classifier achieves an accuracy of 90.4%, surpassing the RFC with an accuracy of 80.8% for semiconductor yield prediction.

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10

A Robust Medical Image Watermarking Scheme with a Better Peak Signal-to-Noise Ratio Based on a Novel Modified Embedding Algorithm and Spatial Domain Algorithm

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Abstract

The primary objective is to compare the peak signal-to-noise ratio (PSNR) of two different methods for effective medical image watermarking, including the novel modified embedding algorithm and spatial domain algorithm. Considering the total sample size (N = 20), calculated using power software with parameters including alpha as 0.05, enrollment ratio as 1, 95% confidence interval, and power as 80%, this study compares two groups: novel modified embedding algorithm (N=10) as group 1 and spatial domain algorithm (N = 10). Based on the simulation results, the novel modified embedding algorithm achieved a PSNR of 55.4650 dB, whereas the spatial domain algorithm yielded a PSNR of 41.4100 dB, with a significance level of 0.000 ($p < 0.05$). In contrast to the spatial domain algorithm approach, the novel modified embedding algorithm method demonstrates superior performance.

***Keywords*:** Novel modified embedding algorithm, spatial domain algorithm, watermarking, robustness, medical, image, PSNR

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10.1 Introduction

The current surge in the utilization of the advancement of electronic healthcare, which has garnered significant support from the medical community in recent years, will benefit patients, healthcare workers, and businesses and contribute to the establishment of a healthier society in smart cities. The exchange of audiovisual content, such as music and video clips, has become more straightforward thanks to the development of the Internet and other related technologies. Medical images are becoming more and more useful as computing advances. Medical images are used by academics for a variety of determinations, including patient diagnosis and the study of sickness prevention and therapy. Watermarking is the process of embedding information or data atop an image file, and it operates on different digital media. Watermark ensures that protected data or information cannot be reused or modified without your permission, thus safeguarding the copyright of your work [1]. Medical image watermarking techniques are used for telemedicine and other potential applications of health data management [2]. DICOM image encryption and watermarking have merged in this method which improves authentication and ensures safer transmission over open channels [3].

Papers on watermarking have been published in the past in a number of publications. A total of 3200 articles were published in ScienceDirect from 2017 to 2022, while 17,000 were published in Google Scholar. Data from electronic patient records (EPR) contain a watermark that guards against problems with authentication, security, integrity, and privacy, among others [4]. The proposed approach uses (DWT) and (DCT), two well-known transform domain techniques, to insert a watermark, safeguarding the authenticity and integrity of patient data [1]. This technique uses wavelet domain to improve the quality and robustness of medical images by blind reversible watermarking [5]. The results of experiments demonstrate that the suggested approach enhances the robustness of medical images and can defend diagnostic or medical information from geometric attacks [6].

Previous research results demonstrated weakness toward robustness and a diminished peak signal-to-noise ratio (PSNR). By paralleling the novel modified embedding algorithm approach used in the current study with the spatial domain algorithm, its limitations were to be resolved.

10.1.1 Materials and Methods

It is divided into two distinct categories: Group 1 consists of a novel modified embedding algorithm, and Group 2 consists of a spatial domain algorithm. For each group, the sample sizes are 10 and 20, respectively, with an enrollment ratio of 1, alpha error, 0.05 threshold, 95% confidence interval, and 80% before the test (Begum and Uddin, 2020).

The work prepares samples using a novel modified embedding approach. From a dataset of different watermarking medical photographs, pictures and examples of new, modified embedding algorithm–based watermarking were collected. When the MATLAB script is run, an interface allowing you a browsing option for medical images will be available, allowing access to the collected image collection stored in a folder. The program will then preprocess the input medical image quality to reduce noise and strengthen its resilience. The medical image will undergo pixel subdivision, and the location of the watermarking will be more clear and with a higher PSNR detected [7].

The testing setup process is finalized. Upon installing the MATLAB R2019a software, the spatial domain algorithm begins, the image is read, its color space is converted from RGB to grayscale, it is doubled, the filtered image matrix is pre-allocated with zeros, the extraction operator mask is defined, the gradient approximation and vector magnitude are computed, the filtered image is displayed, it is thresholded, and finally, the edge-detected image is displayed.

Various watermarking images are employed to train spatial domain algorithms, leading to the achievement of medical image watermarking quality [8].

PSNR rate was utilized to gauge each algorithm's performance. Both techniques were evaluated against one another to see which algorithm demonstrated significantly superior performance compared to others in terms of the robustness of watermarking in medical images.

10.1.2 Statistical Analysis

IBM SPSS software is used for statistical analysis. PSNR is primarily concerned with the aesthetic resemblance between original and watermarked images (Khare and Srivastava, 2021). For sample analysis, an independent sample T-test is conducted with the CT images serving as the independent variables and the PSNR as the dependent variable. The statistically significant PSNR rate in SPSS is 0.000 ($p < 0.05$).

10.2 Result

Combining a novel modified embedding technique and a spatial domain approach, the PSNR values of various robust medical images from two groups are compared. When compared to the spatial domain approach, the novel modified embedding algorithm produces a maximum PSNR of 55.4650 dB.

Figure 10.1 depicts the block design for watermarking medical images utilizing key-based spatial domain algorithms and novel modified embedding techniques. The resulting images include the CT image watermarking, the original medical image, and the watermarked image, each accompanied by corresponding information such as PSNR, and the disparities between the original and watermarked images are all displayed in Figure 10.2. Preprocessing is used to remove noise from the input medical image for watermarking, and adaptive filters are then used to

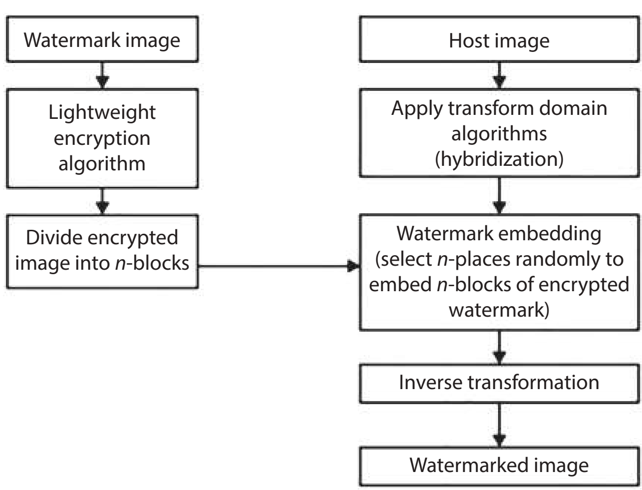
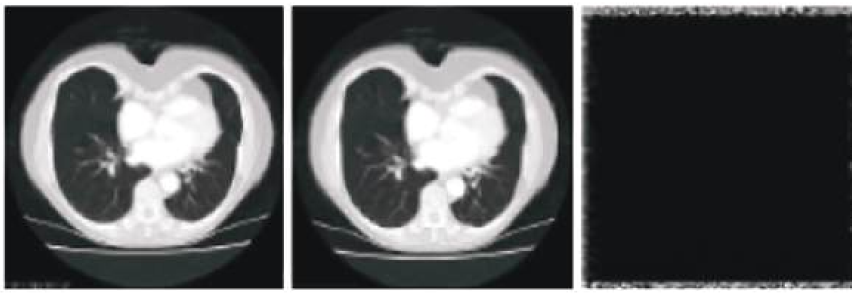


Figure 10.1 Block diagram of robust medical image watermarking based on embedding and spatial domain algorithms using a key.



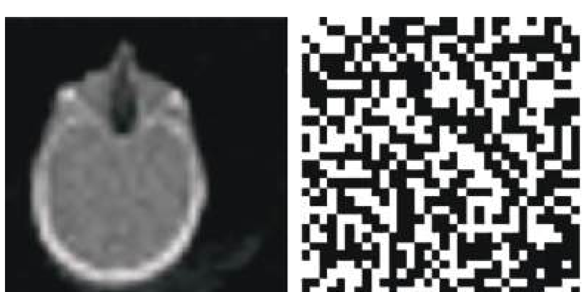
(a) (b) (c)

Figure 10.2 (a) Original medical image, (b) a watermarked image with corresponding PSNR, and (c) a difference between the original and watermarked images.

create morphological gradient images by subtracting other images from the prerocessed image. Watermarked areas of the medical image are then produced with higher-quality images and PSNRs.

The results of CT image watermarking are displayed in Figure 10.3 as (a) a discrete cosine transform recovered image and (b) a discrete cosine transform extracted watermark.

By subtracting various images from the preprocessed image, the input medical image for watermarking identification, a preprocessing approach to reduce noise using adaptive filters, and a morphological gradient image are generated. The watermark area of the host picture will be identified with an image of higher quality and PSNR employing processing of image in the



(a) (b)

Figure 10.3 Outputs of CT image watermarking, (a) DCT recovered image, and (b) DCT extracted watermark.

spatial domain image produced from a preprocessed image. According to the mean PSNR of the two groups, the bar graph in Figure 10.4 depicts the PSNR of novel modified embedding and spatial domain methods.

For both novel modified embedding and spatial domain techniques, Table 10.1 displays the PSNR values for medical picture watermarking utilizing 10 samples for each approach. Table 10.2 displays the statistical analysis of 10 samples utilizing a novel modified embedding algorithm approach. This method yielded 1.51811 standard deviations with a standard error of 0.48007. In comparison, the spatial domain algorithm got 1.00848 standard deviations with 0.31891 standard error. The independent T-test was employed in Table 10.3 using SPSS IBM software to compare the PSNR of the two unique modified embedding algorithms and the spatial domain algorithms, and it yielded a statistically major value of 0.000 ($p<0.05$) for each. PSNR was 55.4650 (dB) for the novel modified embedding algorithm and 41.4100 (dB) spatial domain technique.

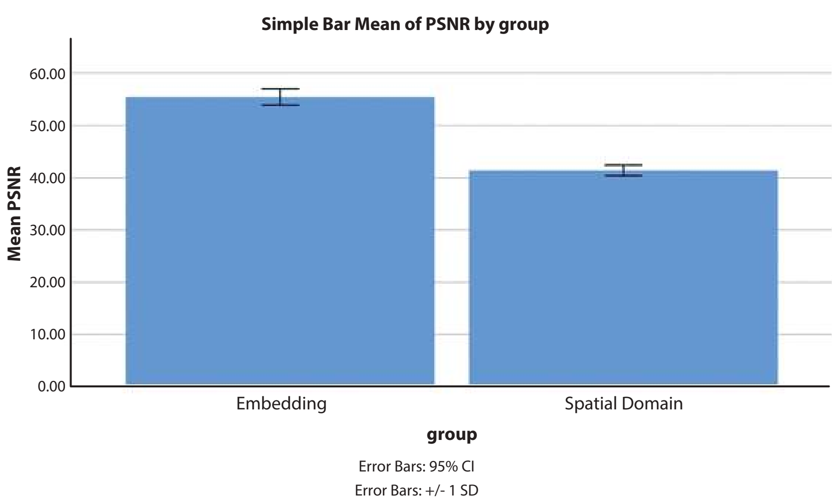


Figure 10.4 Bar chart representing the comparison of mean PSNR of the watermarking medical image with novel modified embedding algorithm and spatial domain algorithm. Both techniques appear to produce variable results from 55.4650 (dB) to 41.4100 (dB). X-Axis: Novel modified embedding algorithm versus spatial domain algorithm. Y-Axis: Mean PSNR of detection ± 1 SD.

Table 10.1 Comparative performance analysis of PSNR for Group 1 and Group 2 in robust medical image watermarking. From the table, it is proved that Group 1 is significantly better than Group 2. The maximum PSNR produced by the novel modified embedding encryption algorithm is 57.68 dB, whereas for the spatial domain algorithm, it is 43.52 dB.

Iterations	Peak signal-to-noise ratio	
	Novel modified embedding algorithms	**Spatial domain algorithms**
1	54.63	42.20
2	52.69	40.23
3	55.63	41.20
4	57.68	40.52
5	56.24	41.33
6	56.32	40.33
7	55.47	41.25
8	57.33	43.52
9	54.22	42.21
10	54.44	41.31

Table 10.2 Statistical analysis of novel modified embedding and spatial domain algorithms. The mean PSNR value of the novel modified embedding algorithm (55.4650 dB) and the spatial domain algorithm (41.4100 dB), the standard deviation for the novel modified embedding algorithm (1.51811) and the spatial domain algorithm (1.00848), and the standard error of the mean for the novel modified embedding algorithm 0.48007 and spatial domain algorithms 0.31891 are significantly from 10 samples. It is observed that the novel modified embedding algorithm is significantly better than the spatial domain algorithm.

Group		N	Mean (%)	Std. deviation	Std. error of the mean
Peak signal-to-noise ratio	Novel modified embedding algorithm	10	55.4650	1.51811	0.48007
	Spatial domain algorithm	10	41.4100	1.00848	0.31891

Table 10.3 Independent sample test for significance and standard error determination with significance values 0.000 ($p<0.05$) which is considered to be statistically significant and 95% confidence intervals were calculated.

		Levene's test equality of variances					T-test for equality of means		The 95% confiden interval of the error differenc	
		F	**SIG**	**T**	**DF**	**Sig (two-tailed)**	**Mean difference**	**Std error or difference error**	**lower**	**upper**
Peak signal-to-noise ratio	Equal variance assumed	1.616	0.022	24.387	18	0.000	14.05500	0.57634	12.84416	1.2658
	Equal variance not assumed			21.387	15.263	0.000	14.05500	0.57634	12.83098	15.279

10.3 Discussion

With a value of 0.000 ($p<0.05$), the research's PSNR demonstrated significant improvements using the novel modified embedding algorithm method over the spatial domain algorithm method.

Here, it is also mentioned that similar findings have been reported by other authors. Forty medical images of brain MRI scans from a dataset are employed together with extracting and transforming domain techniques. The PSNR for these 40 medical images is 54.45 dB, and the accuracy is 80% [9]. The DCT-SVD algorithm is employed in this technique to verify the watermarking on medical images. The proposed method validated 300 pictures. The test data yielded a PSNR of 55.39 dB [10].

An effective watermarking technique using region of interest and distortion-free storing of important information on simple genetic algorithms (SGA) has been developed. PSNR for the suggested method is 57.28 dB. This indicates that the outcomes are superior to those from the earlier schemes, which had a PSNR of 32.66 to 52.02 dB [5]. Additionally, the minimum and maximum PSNR and accuracy are utilized to assess the scheme's effectiveness. With no attacks applied, the scheme has exhibited a minimum and maximum PSNR of 52 to 57 dB and an accuracy value of 90%, and not less than 0.5 with various assaults included [11]. The results of the study demonstrated an increase in embedding capacity, imagery quality, and robustness, as well as the authentication of the host image signal in the absence of an assault; however, tamper detection capability was not offered. All of the test images were examined for resistance to various assaults. The PSNR using this method was 48.1547 dB.

Throughout the robustness testing, the integrity of the watermark NC value remained consistently higher than 0.54 [12]. Therefore, the novel modified embedding technique outperforms existing classifiers in order to PSNR, feature extraction, and segmentation of watermarked medical images.

The presented approaches have several limitations, including their slower processing times resulting from complex calculations. It is possible that strategies to enhance the PSNR of robust medical image watermarking can be aided by swiftly distinguishing additional types of texture, statistical characteristics, form, geometry, and color using machine learning classifiers.

10.4 Conclusion

This research suggests an effective watermarking method for high-quality medical CT images. The novel modified embedding algorithm (55.4650 dB) approach outperforms the spatial domain algorithm (41.4100 dB) by a large margin.

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11

BER Comparison of BPSK-DCO-OFDM and OOK-DCO-OFDM in Visible Light Communication

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Abstract

The research is about to evaluate and contrast the effectiveness of binary phase-shift keying and on-off keying with DCO-OFDM in terms of bit error rate in visible light communication. The bit error rate was analyzed based on sample size, Group 1 with twenty samples and twenty samples from Group 2 for BPSK and OOK DCO-OFDM. The calculation was carried out using a G-power of 0.7 with the alpha and beta values of 0.03 and 0.2, and a confidence interval of 80%. The BPSK success rate is 86.91% compared with on-off keying modulation whose success rate is 90.33%. The obtained significance level in the work is 0.001 ($p<0.05$). Hence, there exists a statistically significant difference between the two methods. The proposed BPSK model was analyzed for its performance in visible light communication with DCO-OFDM, and the results showed that it had a lower bit error rate compared to the OOK model. Consequently, if the bit error rate is low, the signal is considered suitable for transmission.

Keywords: Novel DCO-OFDM, BPSK, OOK, SNR, VLC, LEDs, POE, energy efficiency

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Abbreviations Used

Binary Phase Shift Keying	BPSK
Visible light communication	VLC
On-Off keying	OOK
Direct-Current Offset Orthogonal Frequency Division Multiplexing	DCO-OFDM
Bit Error Rate	BER
Quadrature Phase Shift Keying	QPSK
Signal to Noise Ratio	SNR

11.1 Introduction

Although digital [15–21] signal modulation has a higher advantage over analog signal modulation, it has also been a challenge for the communication industry for decades. The bit error rate distortion problem, also known as attenuation, is still a problem with digital techniques. In other words, due to its lower bit error rates than the others, BPSK has historically been one of the simplest and best options when it comes to selecting a modulation method [1]. In this study, BPSK modulation's bit error rate performance over OOK modulation. In general, low BER can result in high SNR. It should be noted that POE is proportional to Energy per bit for the spectral noise density (Eb/No). The closer the points are in the constellation diagram, the higher the likelihood of a bit error, meaning that a modulation technique that tightly packs its symbols in the diagram is less energy efficient than a system that uses a more spaced-out arrangement of symbols [2]. A "bit error" refers to a mistake in the bits that are received during a communication, which can be caused by various factors such as distortion, noise, interference, and misalignment of bits. It represents the number of bits that are received but have been altered from their original state [4]. The bit error rate is a measurement of the accuracy of the bits transmitted over a given period of time, calculated as the proportion of incorrect bits to the total number of bits sent. In this research project, BPSK, a widely used digital modulation technique, will be utilized. Because phase transitions take place at zero crossing points, thus BPSK is coherent [4]. A sine carrier with the same phase must be compared to the signal in order to properly demodulate BPSK. It offers high spectral efficiency and data rates [5]. By prioritizing energy efficiency, wireless communication technologies can help ensure a sustainable future for our interconnected world.

The purpose of this research is to compare the bit error rate between BPSK, OOK, and DCO-OFDM for visible light communication. A prospective addition to radio-frequency (RF) communication is visible light communication. Orthogonal Frequency Division Multiplexing has received substantial attention in VLC systems due to its high data rate, simple equalization, and immunity to ISI. In FDM, multiple signals are transmitted simultaneously over different carrier frequencies. However, in OFDM, these sub-carriers are carefully designed to be orthogonal to each other, meaning they are mathematically independent and do not interfere with each other [6]. The fact that orthogonal signals do not interfere with one another is one of its key characteristics.

Multiplexing (OFDM) faces limitations in supporting bipolar signals. This paper introduces a novel approach, specifically the direct-current offset OFDM (DCO-OFDM), which addresses this issue by asymmetrically clipping negative portions of the signal, resulting in real and positive signals. In the context of DCO-OFDM, the utilization of DC bias plays a pivotal role in the conversion of bipolar signals into unipolar signals. This study focuses on the application of binary phase shift keying (BPSK) within the framework of DCO-OFDM, demonstrating its effectiveness in reducing bit error rate (BER). The integration of BPSK into DCO-OFDM leads to a notable reduction in BER, highlighting its potential for improving the reliability of instant messaging communication systems. Furthermore, the paper conducts a comparative analysis between BPSK-DCO-OFDM and on-off keying (OOK) to assess their respective performances. The findings not only showcase the enhanced BER performance of BPSK-DCO-OFDM but also provide valuable insights into its superiority over OOK in the context of instant messaging applications.

11.2 Materials and Methods

Recent findings have revealed that binary phase shift keying (BPSK) modulation demonstrates superior energy efficiency in terms of optical power compared to on-off keying (OOK), while maintaining a consistent bit error rate [4]. To delve into this aspect, the research categorizes participants into two groups: Group 1, which explores the characteristics of novel BPSK, and Group 2, which investigates OOK. Each group comprises 20 participants, resulting in a total sample size of 40 for the project. The determination of this sample size was based on statistical analysis, considering pre-test power and insights from previous research [7], accessed through clinicalc.com. Continuous testing was carried out with a significance level (alpha) of 0.05 and a power (beta) of 0.2 for both the BPSK and OOK samples. The outcomes of this study contribute valuable insights into the energy efficiency of BPSK modulation, offering a comparative analysis with OOK in the context of optical communication systems. In this research, the described parameter is bit error rate (BER) and it is compared with two modulation schemes to study the characteristics of those signals.

A. Visible Light Communication

VLC uses the idea of data transmission by light rays to send and receive messages over a specific distance. In areas where radio frequencies cannot be used, VLC can be used to replace them by using LED lighting. VLC also has an advantage over radio frequencies because it provides extremely fast data transmission and high bandwidth transmission. While discussing visible light communication, it typically refers to the entire electromagnetic spectrum, which ranges from gamma rays to radio waves. The area of the electromagnetic spectrum that is visible to the human eye is referred to as visible light. The use of visible light for data transmission has a number of key advantages over radio frequency-based technologies. The visible light spectrum has a 10,000 times enhanced advantage over the radio spectrum, which is less efficient, more congested, and has a smaller bandwidth. Single-carrier techniques help DCO-OFDM to handle the challenges of respective channels without the aid of sophisticated equalization filters, which is its main advantage. By removing inter-symbol interference (ISI) and enhancing the SNR, it has enhanced the quality of long-distance communication. DCO-OFDM is used in communication extensively because it can defeat ISI. Along with ISI resistance, it also offers other advantages like increased optical power and spectrum efficiency, greater data rates, and so forth. Overall, by using techniques like power control and beamforming, wireless communication devices can achieve higher energy efficiency, which can result in lower energy consumption, longer battery life, and reduced environmental impact. A system that transmits data using visible light promotes energy efficiency as a key component.

B. BPSK

Using the MATLAB tool, coded and uncoded BPSK and OOK schemes have been simulated. By comparing the transmitted and received signals and dividing the error count by the total number of bits, BER has been calculated. The bit error rate for a specific modulation is commonly expressed using the signal-to-noise ratio. In this work, we use a BPSK mapper to implement a straightforward DCO-OFDM scheme. The most potent of all PSK varieties, the BPSK was chosen. The demodulator can only make a mistake at the highest level of distortion. The proposed simulation describes the implementation of a visible light communication system using BPSK modulation. Our system is used to improve indoor environments. The test results demonstrate that our VLC system can function as intended and that a visible light link can be used to wirelessly form the BPSK constellation. The way a light signal varies to represent various symbols is called modulation so that the data can be decoded. In contrast to radio transmission, a VLC modulation calls for the light signal to be modulated around a positive DC value, which is in charge of the lamp's lighting function. Binary phase shift keying (BPSK) is a straightforward modulation technique that allows the transmission of one bit per symbol. On the other hand, quadrature phase shift keying (QPSK) is a more complex method that doubles the data rate by transmitting two bits per symbol. A low BER signal is indicated by a high SNR, whereas a high BER is accompanied by a low SNR. Binary phase shift keying, also known as phase reversal keying or two-phase PSK, involves two phase shifts, 0° and 180°, of the sine wave carrier. BPSK is considered to be a double sideband-suppressed carrier (DSBSC) modulation scheme, as the message being transmitted is digital data [8].

C. OOK

OOK, or on-off keying, stands as the most straightforward variant of amplitude-shift keying modulation. In this modulation technique, binary data is conveyed by the presence or absence of a carrier wave. Specifically, a binary one is denoted by the existence of the carrier wave over a defined time interval, while a binary zero is indicated by the absence of the carrier wave for an equivalent duration. In more advanced OOK schemes, these times can vary to transmit additional information. The simulation result in the paper shows the relationship between the signal-to-noise ratio (SNR) and the strength of the OOK signal used for communication. The SNR parameter measures the amount of noise present in the communication signal compared to the strength of the signal. A higher SNR value indicates a stronger signal and a lower level of noise, leading to better communication performance. The simulation results demonstrate how the SNR affects the performance of the OOK modulation technique and provide insight into the required signal strength for successful communication using this technique.

11.3 Statistical Analysis

This research employs the SPSS software for conducting statistical analyses, including the computation of significant differences, means, and standard deviations. The obtained simulation results are subjected to thorough examination and interpretation using SPSS to derive meaningful insights into the experimental data. The statistical analyses conducted through SPSS play a crucial role in elucidating the significance of differences, as well as providing key metrics such as means and standard deviations, enhancing

Table 11.1 Comparison of BPSK and OOK for BER values.

S. no.	BPSK	OOK
1	86.91	90.33
2	86.76	90.18
3	87.06	90.48
4	86.7	90.12
5	87.12	90.54
6	86.65	90.07
7	87.17	90.59
8	86.6	90.02
9	87.22	90.64
10	86.54	89.96
11	87.28	90.7
12	86.49	89.91
13	87.33	90.75
14	86.44	89.86
15	87.38	90.8
16	86.39	89.81
17	87.43	90.85
18	86.34	89.76
19	87.48	90.9
20	86.92	90.34

Table 11.2 Group statistics for BER.

Group statistics					
BER	**Algorithms**	**N**	**Mean**	**Std. deviation**	**Std. error of the mean**
	BPSK	20	86.91	0.378	0.085
	OOK	20	90.33	0.378	0.085

the robustness and reliability of the findings presented in this paper [9]. The study conducted a comparison of the impact of two independent variables, BPSK and OOK, on the dependent variable, BER. BER is a measure of data transmission errors, which is influenced by the input signal. The difference between the modulation techniques was carried out by using MATLAB software [10].

11.4 Results

Table 11.1 presents the bit error rate (BER) data derived from 20 samples in the study. Subsequently, these values were input into the SPSS software to generate group statistics for the respective modulation techniques. Table 11.2 provides a detailed overview of the group statistics, including mean BER values and standard deviations. This comprehensive analysis using SPSS enhances our understanding of the performance metrics, offering insights into the central tendency (mean) and variability (standard deviation) of the BER for the specific modulation technique under investigation. Table 11.3 would likely present experimental results or testing outcomes for various independent variables related to the performance of BPSK and OOK compared to DCO-OFDM. Figure 11.1 presents a block diagram illustrating a method or technique for reducing the BER (bit error rate) in a communication system. This diagram would likely depict different processing stages or components involved in the BER reduction process. Figure 11.2 would show a graph depicting the BER performance of BPSK with DCO-OFDM.

The simulation was conducted using the MATLAB toolkit, and the outcomes are visually depicted in Figure 11.2. Notably, the results indicate a noteworthy superiority of BPSK, within the context of DCO-OFDM. Figure 11.3 further illustrates a bar graph comparison generated through

Table 11.3 Independent sample test.

Independent samples test									
	Levene's test for equality of variances		T-test of equality of means					95% of the confidence interval of the difference	
BER	F	Sig.	t	df	Sig (2-tailed)	Mean difference	Std error difference	Lower	Uppe
Equal variance assumed	0.012	0.025	2.094	38	0.001	3.420	0.120	3.662	3.178
Equal variance not assumed			2.094	37.950	0.001	3.420	0.120	3.662	3.178

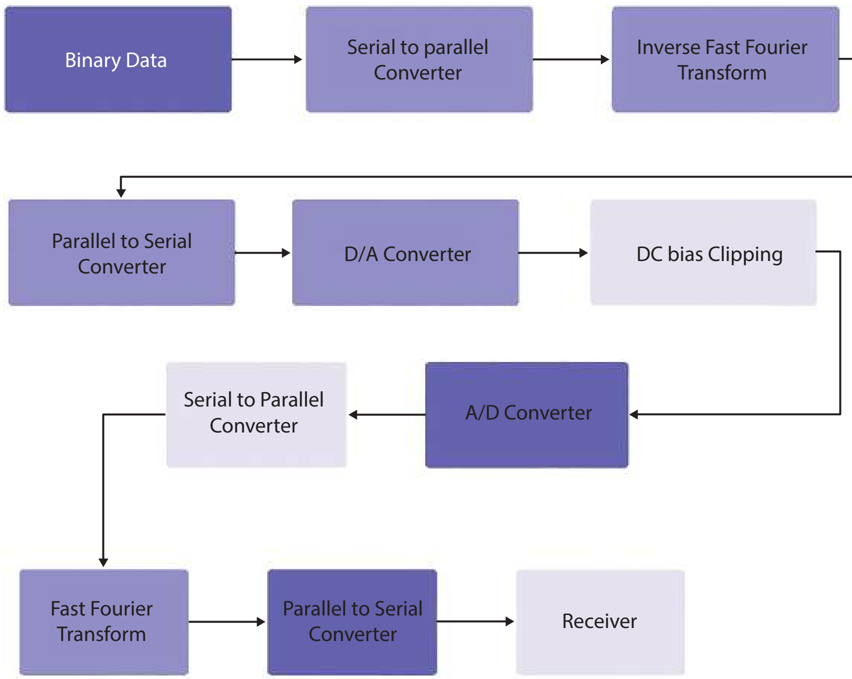

Figure 11.1 The block diagram for BPSK and OOK with DCO-OFDM.

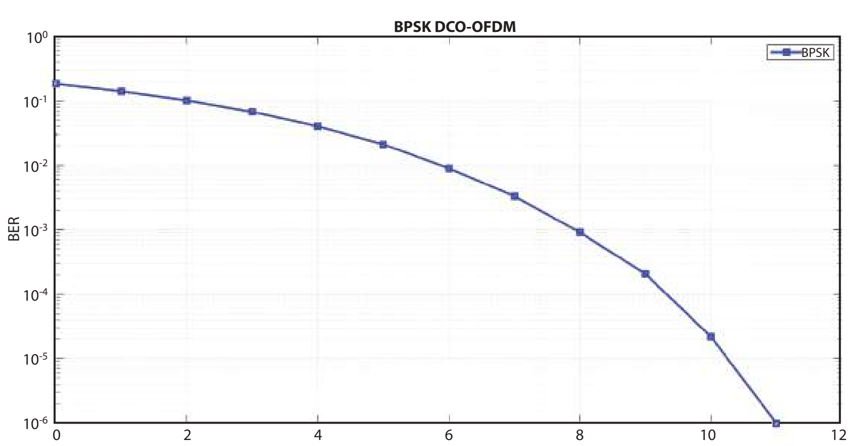

Figure 11.2 Simulation result.

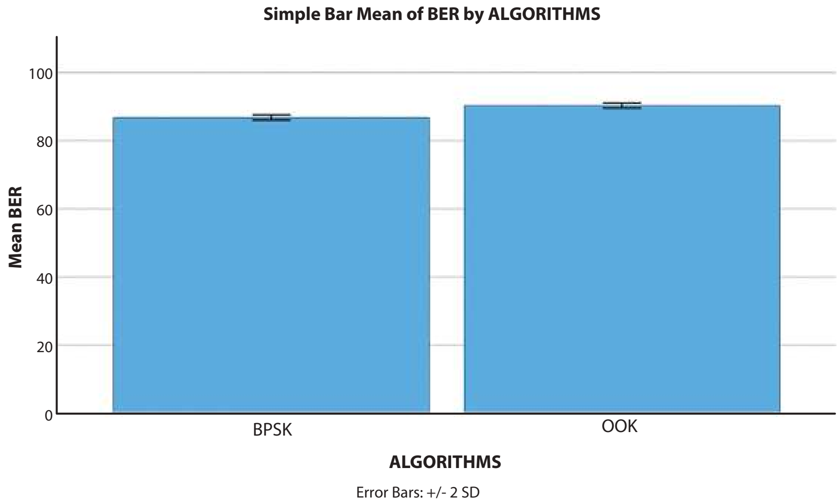

Figure 11.3 Comparison of BPSK and OOK performance.

IBM SPSS, highlighting the reduction in BER performance achieved by BPSK in comparison to OOK.

This study employed IBM SPSS [3] for in-depth analysis. Group statistics and an independent sample test were executed, and the ensuing results were meticulously scrutinized. The graphical representation of these findings was facilitated by SPSS. Remarkably, the attained significance value, determined through statistical analysis, is 0.001, underscoring the robustness and reliability of the observed differences in BER performance between BPSK and OOK in the context of DCO-OFDM.

11.5 Discussions

While the BER in VLC is subject to fluctuations based on particular implementation and environmental factors, the utilization of proper methods can result in achieving high-speed and dependable communication with minimal BER in VLC. The mean accuracy values for BPSK and OOK in this study were 86.92% and 90.34%, respectively. And the significance value is 0.025. Based on the performance of the bit error rate parameter utilizing MATLAB software, the results of the analysis varied.

In this study, the research is to compare the BER performance of these two modulation techniques in a specific channel environment, the Rayleigh multipath channel, to see which one performs better. The results of this comparison provide valuable insights into the effectiveness of these modulation techniques in real-world wireless communication systems [11]. In this paper, BER is a crucial parameter for assessing the effectiveness of data channels. How many errors will show up in the data that appears at the remote end is a crucial factor in data transmission, whether it is over a radio/wireless link or a wired telecommunications link [12]. As a result, BER can be used for a variety of connections, including fiber optic links, ADSL, Wi-Fi, cellular communications, Internet of Things links, and more [13]. The fundamentals of determining the bit error rate are the same regardless of the fact that the data links may make use of very different types of technology [14]. The results of this evaluation provide valuable information for optimizing the performance of the proposed modulation method and can guide future design decisions [10]. Also in this paper, SPSS software is used to know the actual difference between two modulation techniques with respect to BER [9]. VLC systems face issues with beam dispersion, which can lead to a decrease in signal strength and quality. Additionally, the presence of other sources of ambient light can interfere with the VLC-based communication, leading to an increase in BER which affects the accuracy of the transmitted data. In order to achieve a lower bit error rate, interference between cells caused by the presence of several frequencies must be reduced. It is important to use VLC for this reason. In the future, BPSK with DCO-OFDM may be used to reduce BER.

11.6 Conclusion

This study compares binary phase shift keying (BPSK) and on-off keying (OOK) algorithms for reducing bit error rate (BER) in visible light communication (VLC) systems. While BPSK demonstrates superior performance in achieving low BER parameters, an evaluation of indoor positioning systems reveals that BPSK is 86.91% less accurate than OOK, which achieves an accuracy rating of 90.33%. The attained significance value of 0.001 underscores the statistical significance of the comparison. Despite its lower accuracy in indoor positioning, BPSK may find applicability in IoT devices and support for 5G networks due to its potential energy efficiency and low BER. Employing efficient modulation techniques can further enhance energy efficiency in VLC systems by reducing energy consumption during data transmission.

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12

Improved Accuracy in Blockchain-Based Smart Vehicle Transportation System Using KNN in Comparison with SVM

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Abstract

The objective is mainly to enhance the precision of smart vehicle transportation using blockchain technology. For improving accuracy in blockchain-based smart vehicle transportation, novel KNN and SVM are mainly divided into two groups namely training and testing data. With values of 0.05 and 0.85, the test's average Gpower is roughly 85%. The significant point of 0.01 the novel K-nearest neighbor at 94.85% outperforms the support vector machine at 93.94%. In comparison with SVM, the K-nearest neighbor has much more accuracy and shows better performance.

***Keywords*:** Novel KNN, SVM, smart vehicle, blockchain, vehicles

Abbreviations Used

K-nearest neighbor	KNN
Support vector machine	SVM
Machine learning	ML
Statistical package for the social sciences	SPSS

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Premanand Singh Chauhan, Rajesh Arya, Rajesh Kumar Chakrawarti, Elammaran Jayamani, Neelam Sharma and Romil Rawat (eds.) Information Visualization for Intelligent Systems, (129–138)

12.1 Introduction

Mobile-based car ad-hoc networks are being replaced by smart vehicles (VANET). This review article addresses the IoV network concept and the benefits of implementing blockchain-based IoV (BIoV). By providing users with a safe and reliable network and connection, BIoV addresses basic IoV [14]. In order to ascertain if the technology may be used for transportation applications, this study replicates autos corresponding with European Member State governments and European Commission (EC) BC nodes running hyperledger fabric (HLF). Case studies feature vehicle identification and CO2 emissions monitoring [12]. The blockchain-based smart Internet-of-Vehicle (BSIoV) platform described in this study was motivated by the blockchain's cooperative, collaborative, transparent, and secure properties [13]. Applications are vehicle-related authorities connected to secure and transparent vehicle-to-everything (V2X) communication using peer-to-peer networks and secure services for intelligent transportation systems. The project's primary use case is to increase the accuracy of smart automobiles powered by blockchain technology [5].

For improving accuracy in blockchain-based smart vehicle transportation [10, 11], more than 150 papers were published in IEEE Xplore, and 45 articles were published in Science Direct. In this study, it is introduced in order to secure the framework [2]. Two degrees of security and privacy are offered by the suggested architecture, which makes use of deep learning modules and blockchain technology. The study indicates using blockchain to encourage the adoption of EVs. EV customers will be able to mine CERCoin through "green" mileage thanks to blockchain technology and smart cars [9]. The attack surface will grow when auto security is automated. The solution blocks outside inquiries but permits certain users. Without endangering the in-vehicle network, roadside unit-car data exchange tracks the state of the vehicle. Smart vehicles can behave automatically thanks to state data. Self-driving safety is improved by data from other cars and environments. This study proposes a blockchain-based Ethereum data-sharing system [16–18] that checks data and the sharing process. Secure protocols and cryptography dependable blockchain data.

One of the support vector machine's shortcomings is that not all of the algorithm's necessary modules can be executed with all of the versions. Not appropriate for big input data. A margin of separation is established between the input sample values to be classified using support vector machines long training period. When there is a large dataset, linear SVM takes less time to train and predict compared to a Kernelized SVM in the expanded feature space. This has suggested using cars to connect to the Internet, connectivity of app to car, using "curfews" to safeguard young drivers, and communication between vehicles. The primary goal of this study is to use the K-nearest neighbor to increase the accuracy of the smart vehicle transportation system when compared to support vector machines.

12.2 Materials and Methods

The model is implemented in the programming department in SSE Lab, Chennai. The sample size was calculated and the two controllers were compared using Gpower software. To compare the methods and the findings reached using them, two groups are selected. A minimum of 10 samples were selected to do implementation, 10 sets of samples from each group. Novel random forest and SVM are two methods that are performed and analyzed using an analytical tool. The dataset for each group is calculated to be ten values.

With the help of this study, blockchain-based smart vehicle transportation systems will become more accurate. It is necessary for the data samples to be large enough. In order to store the code and install any necessary plugins, Kaggle [8] will be used, and ClinicalCalc.com will be used to determine the dataset with a power of value 0.8, a beta of 0.2, and an alpha value of 0.05. Ten samples from each of the training and test sets will be divided across the two portions of the dataset. The accuracy values will then be computed using the method on the training and test sets.

12.3 Tables and Figures

KNN Algorithm

KNN is a supervised ML approach for categorization. The categorization of a data point is determined by the classifications of its neighbors. It keeps track of every incident in its database and classifies newly discovered cases according to common characteristics, but does not need a human-understandable model in order to use the novel KNN technique. The distance measurement affects how accurate the projections are.

Pseudocode

Step 1: First, build a KNN to enhance libraries.

Step 2: Compute d(x, xi); i = 1, 2,..., n;

Table 12.1 Accurateness and loss examination of K-nearest neighbor.

Iterations	Accuracy (%)	Loss (%)
1	97.76	2.24
2	95.70	4.30
3	93.02	6.98
4	98.10	1.90
5	93.20	6.80
6	92.18	7.82
7	96.14	3.86
8	94.60	5.40
9	94.84	5.16
10	92.96	7.04

Table 12.2 Accurateness and loss examination of support vector machine.

Reiterations	Accurateness (%)	Loss value (%)
1	95.29	4.71
2	91.30	8.70
3	94.78	5.22
4	92.73	7.27
5	93.47	6.53
6	92.23	7.77
7	95.93	4.07
8	93.01	6.99
9	98.32	1.68
10	92.35	7.65

Table 12.3 Descriptive analysis of KNN and SVM. KNN improved accuracy and less mean in comparison with support vector machines.

	Groups	N	Mean	Std. dev.	Std. error of the mean
Accurateness	K-nearest neighbor	10	94.850	2.06161	0.65194
	Support vector machine	10	93.941	2.12510	0.67201
Loss	K-nearest neighbor	10	5.1500	2.06161	0.65194
	Support vector machine	10	6.0590	2.12510	0.67201

Step 3: Sort the computed n Euclidean distance in increasing and decreasing order.
Step 4: This arranged order, select the initial k distance.
Step 5: Determine which k-value these k-distances relate to.
Step 6: If ki >kj ∀ I ≠ j, then put x in group I.
Step 7: Write out the smart car transportation results for KNN.

Support Vector Machine

SVM is a supervised ML technique that may be used for both prediction and grouping applications. We also alter that regression issues may be categorized in this manner, although its advantages go beyond that. The SVM method strives to find a type of hyperplane in space with N dimensions that correctly splits the values into discrete groups.

Pseudocode
Step 1: Construct a support vector machine for improving libraries.
Step 2: Prepare the dataset into training and testing groups.
Step 3: Place Set the initial values for the input variables.
Step 4: Divide the dataset's labels into groups.
Step 5: A calculation is made for each property, frequency, and probability.
Step 6: The data is compared and categorized on the basis of the findings.
Step 7: Write the results of smart vehicle transportation for support vector machines.

Table 12.4 K-nearest neighbor is better than SVM.

		Levene's test for equality of variances		T-test for equality means with 95% confidence interval						
		f	Sig.	t	df	Sig. (two-tailed)	Mean difference	Std. error difference	Lower	Uppe
Accuracy	Equal variances assumed	.011	.919	0.971	18.00	0.01	0.90900	0.93628	-1.05806	2.876
	Equal Variances not assumed			0.971	17.983	0.01	0.90900	0.93628	-1.05819	2.876

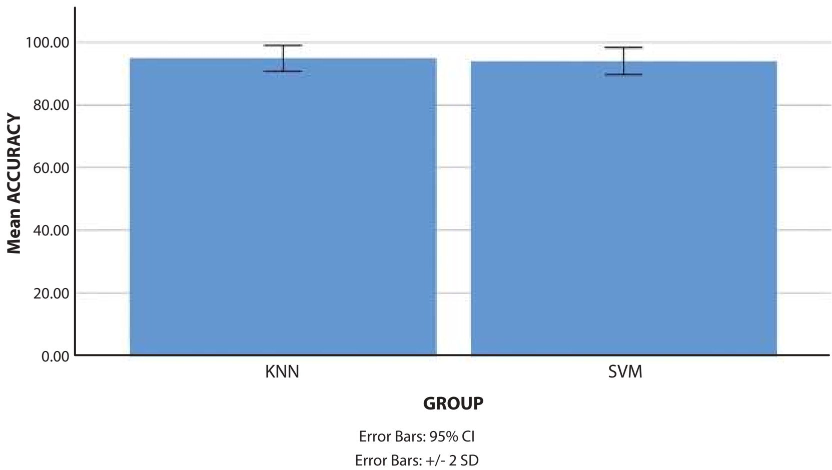

Figure 12.1 K-nearest neighbor is better than SVM.

Python 3.1.1 software is used to create and complete the assignment. Windows 11 OS is used to test deep learning. In terms of code execution, a procedure to reveal the results is being run on the dataset in the background.

Statistical Analysis

Novel KNN and SVM statistical analysis is achieved by the use of SPSS software [6]. Both the model accuracy values are obtained by different iterations and analyses done and the output table and graph are obtained.

Using the input dataset ten values, the suggested novel K-nearest neighbor and support vector machines are verified in different intervals in Python Google Colab.

12.4 Results

Table 12.1 contains accurateness, then the loss value of the K-nearest neighbor is shown. The expected accuracy and loss of the support vector machine are shown.

Table 12.2 shows these two methods, and ten values are utilized, composed with related loss values, to determine whether statistical values can be matched. According to the conclusions, the K-nearest neighbor's mean accuracy was 94.850% while that of the SVM was 93.9410%.

Table 12.3 displays mean novel K-NN and SVM accuracy values. KNN's average value is greater than SVM's, with standard deviations of 2.06161 and 2.12510, respectively.

KNN and SVM innovative analysis are shown in Table 12.4 with a significant value of 0.01 (p0.05) for both tests.

Figure 12.1. For SVM method towards the corresponding averages are 93.9410, 2.12510, and .67201, with 93.9410 serving as the mean and 2.12510 serving as the standard deviation. The loss values for the novel K-Nearest Neighbor method, on the other hand, are 5.150, 2.06161, and .65194.

12.5 Discussion

The significance value of the research in question is .344 (two-tailed, $p>0.05$), and the K-nearest neighbor shall be desirable to a support vector machine [1]. The precision for KNN is 93.9410%, as opposed to the accuracy of the novel K-nearest neighbor, examined as 94.8500%.

This paper also cites similar findings from other authors [4]. For the sake of this discussion, machine learning is implemented using Python. The models were evaluated based on their performance using accuracy and loss [1]. The accuracy of the recommended model was 88.46% without enhanced data and 95.80% with enhanced data. The average accuracy score from the past study was 89%. The current work offers one of the most in-depth experimental examinations of smart vehicle transportation systems in comparison to earlier research. Additionally, the proposed model's almost 100% performance makes it suitable for real-time computer applications [7].

From the above discussion, we have similar and dissimilar findings, there we see an increase in success rate and accuracy. For both algorithms, execution time varies. We could conclude that especially for large datasets, innovative k closest neighbors learning takes a comparatively long time and that the method has good accuracy [15]. Future goals of the project include expanding the system to include more elements while taking a shorter period for training the dataset [3].

12.6 Conclusion

The novel K-nearest neighbor shows an accurate value of 94.8500%, however, the SVM shows an accurate value of 93.9410%. As per the investigation, the SVM (93.9410%) overtakes the K-nearest neighbor (94.8500%).

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13

Improvement in Accuracy of Red Blood Cells (RBC), White Blood Cells (WBC), and Platelets Detection Using Artificial Neural Network and Comparison with Hybrid Convolution Neural Network

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Abstract
In this paper, artificial neural network methods are used to identify red blood cells (RBCs), white blood cells (WBC), and platelets in blood samples more accurately than using hybrid convolution neural networks. Forty samples were gathered for this study in total. There are twenty samples in each category. The two categories are artificial neural networks and hybrid convolutional neural network algorithms. The dataset was imported in accordance with the research protocol, and Google Collab software was utilized. The code for hybrid convolutional neural networks and artificial neural networks was developed specifically for the investigation. The two groups were compared using the statistical analysis program SPSS. Sample sizes were calculated using an alpha of 0.05 and a pretest power of 80%. According to the simulation findings, the hybrid convolution neural network method yields an accuracy of 98.28% with a significance of 0.00, which is less than 0.05 ($p < 0.05$), while the artificial neural network algorithm yields an accuracy of 97.30%. Thus, alpha=0.05 is the conventional significance. Thus, it is noted that there is a meaningful difference between the two groups. In blood sample detection, the hybrid convolutional neural network outperforms the artificial neural network by a large margin when it comes to identifying red blood cells (RBCs) and white blood cells (WBCs).

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***Keywords*:** Innovative platelet detection, artificial neural network, hybrid convolution neural network, red blood cells (RBCs), white blood cells (WBCs), classifier, technology

13.1 Introduction

The most prevalent form of blood cells and the vertebrate's main method of providing oxygen to the body tissues through blood flow of the circulatory system are red blood cells, also known as erythroid cells or erythrocytes, or red blood cells (RBC) [1]. Red blood cells (RBCs), also known as red cells or red blood cell corpuscles, transport oxygen throughout the body. White blood cells (WBCs), including granulocytes, bolster immunity against disease and infection. Megakaryocytes, massive cells in bone marrow, give rise to platelets essential for blood clotting. Innovative platelet detection methods leverage these megakaryocytes as building blocks for analysis. These enormous cells play a pivotal role in forming platelets, which are vital for hemostasis and wound healing. Thus, understanding the functions and interactions of RBCs, WBCs, and megakaryocytes provides insights into various aspects of hematological health and diagnostic advancements [2, 3]. Platelets aid in wound healing by initiating blood clot formation, which reduces or halts bleeding. Cells serve as the fundamental units of life, with billions comprising the human body. Understanding cellular functions is crucial for comprehending biological processes and developing advancements in medical diagnostics and treatments. The body receives structure from this technology, which also helps it absorb nutrients from meals, turn those nutrients into energy, and perform specific tasks. Red blood cells (RBCs) are the carriers of oxygen and carbon dioxide. Platelets are responsible for making blood clots. White blood cells (WBC) of the immune system play a part in the immune response [4].

More than 300 publications have been published on the topic which uses several deep learning algorithms in the detection of blood samples [8]. The most cited paper in this field is [5]. The use of random forests was popular in the mid-2010s in the detection system [6]. Many technologies are available to detect blood cells. If the accuracy is less in the detection the identification of diseases will be difficult [2]. According to this paper, machine learning is more effective in the detection of blood cells [2, 7].

The primary gap identified in earlier studies is the low level of accuracy in precisely identifying red blood cells (RBCs), white blood cells (WBCs), and platelets in samples. This deficiency underscores the need for innovation in platelet detection methods. The main objective of this study is to enhance accuracy, measured in percentage terms, in identifying these blood cell types. The research aims to achieve this by comparing the performance of two distinct deep learning algorithms. By leveraging advanced computational techniques, such as deep learning, the study seeks to develop more precise and reliable methods for blood cell identification. Ultimately, improving accuracy in blood cell detection holds significant implications for various fields, including medical diagnostics, research, and patient care, by enabling more accurate and timely assessments of hematological health.

13.2 Materials and Methods

The research was conducted at the networking lab within Chennai's Saveetha School of Engineering. The study aimed to identify red blood cells (RBCs), white blood cells (WBCs), and platelets using two examined groups, each consisting of 20 samples. Sample size calculation was performed using Clincalc.com and F-score data from previous investigations. Pretest power was set at 80%, with alpha and beta values set to 0.05 and 0.02, respectively. The dataset utilized for the study was obtained from Kaggle.com, a popular platform for accessing diverse datasets. By employing advanced computational techniques and leveraging the curated dataset, the research sought to develop and evaluate accurate methods for the identification of blood cell types, with potential implications for medical diagnostics and research in hematology [9].

The sample size for each category comprises 20 samples. Group 1's samples consist of 20 testing data samples analyzed using a specialized artificial neural network. Meanwhile, Group 2's samples include 20 training datasets using a hybrid convolutional neural network (CNN), an existing classifier. The sample size was determined based on the methodology's requirements, ensuring adequate representation for both testing and training purposes in evaluating the performance and effectiveness of the respective neural network approaches [10].

Google Colab and applications inspired by it are commonly used for implementing datasets. Following data import, the dataset undergoes a selection process based on certain criteria. The sample size is determined through this selection. Subsequently, during the data processing stage, error numbers from Google Colab Drive are cross-referenced with the mounted code. In accordance with the accuracy of a hybrid CNN for Eigenfaces is evaluated and compared with the accuracy of a widely recognized classifier, the artificial neural network (ANN). The evaluation involves contrasting error rates, providing insights into the performance of the hybrid CNN in comparison to the traditional ANN.

Artificial Neural Network: Artificial neural networks (ANNs) aim to emulate the interconnected structure of neurons in the human brain to enable computers to learn and make decisions akin to human cognition. These networks are constructed by programming conventional computers to simulate the behavior of interconnected brain cells. Similar to the brain's neurons, artificial neurons, or nodes, receive input signals, process them through weighted connections, and produce output signals. Through iterative training processes, ANNs adjust the strengths of connections between neurons, known as weights, to optimize performance on specific tasks. This adaptive learning capability allows ANNs to recognize patterns, classify data, and make predictions based on input data. By leveraging the parallel processing capabilities of ANNs, complex tasks such as image recognition, natural language processing, and medical diagnostics, including innovative platelet detection, can be performed with high accuracy and efficiency, offering promising avenues for advancements in various fields of technology and healthcare.

Hybrid Convolution Neural Network: The implemented system leverages a sophisticated architecture, seamlessly integrating the capabilities of both a deep neural network (DNN) and a CNN. This strategic combination is designed to extract comprehensive insights from diverse data structures. When confronted with one-dimensional data, the deep neural network takes center stage, adeptly capturing global features inherent in the dataset. Meanwhile, in the realm of two-dimensional (2D) data, the CNN steps in, specializing in extracting intricate local characteristics. This dual-network approach signifies a nuanced understanding of data complexity, allowing the system to harness the strengths of both DNN and CNN paradigms. By employing a deep neural network for holistic feature extraction and a CNN for nuanced local pattern recognition, the system is poised to offer a robust and versatile solution across a spectrum of data types and dimensions. This sophisticated fusion underscores the commitment to achieving optimal performance in the extraction of meaningful information from diverse datasets.

The meticulous preparation of the datasets has reached completion as per the procedural depiction illustrated in Figure 13.1. The imported dataset has undergone a thorough and methodical preparation process, ensuring that it is primed for subsequent analysis and application of machine learning algorithms. Each algorithm employed in this context has undergone rigorous testing and training, demonstrating successful outcomes

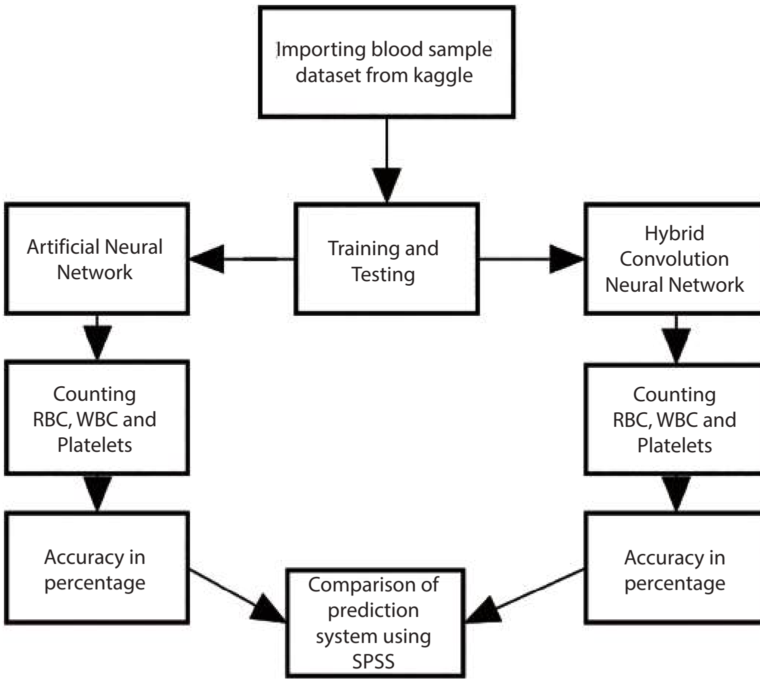

Figure 13.1 Flowchart for finding the accuracy for hybrid CNN, artificial neural network, and comparing using SPSS for better results.

and exhibiting anticipated accuracy rates, expressed as a percentage. These algorithms, individually validated through comprehensive testing procedures, are strategically chosen for their efficacy in cell detection within the dataset. The detection process unfolds through the application of these pre-trained algorithms, each armed with the knowledge and patterns acquired during the training phase. The anticipation of accuracy percentages associated with each algorithm underscores the reliability and performance expectations attributed to these models in the specific context of cell detection. The predictions produced by these algorithms undergo a comparative analysis using the Statistical Package for the Social Sciences (SPSS), a robust statistical software extensively employed for data analysis. This comparative evaluation within the SPSS framework is pivotal for assessing the efficacy and relative performance of the different algorithms utilized for cell detection. The results of this analysis offer valuable insights into the strengths and potential drawbacks of each algorithm, assisting in the refinement and identification of the most appropriate approach for precise and dependable cell detection within the provided dataset.

13.2.1 Statistical Analysis

The SPSS software program is employed to evaluate the accuracy of both the proposed study's methodology and the approach utilized in prior work. The independent sample T-test is applied during testing, with independent factors encompassing both structural and color aspects. Accuracy serves as one of the dependent variables under examination. By conducting statistical analyses within the SPSS framework, researchers can compare the accuracy levels achieved by the proposed methodology and previous approaches, providing critical insights into the effectiveness and performance of different factors in predicting and detecting cellular structures within the analyzed samples.

13.3 Results

Table 13.1 provides group statistics for innovative platelet detection systems based on artificial neural networks and hybrid CNNs. The mean for a synthetic neural network is 0.95925, and for a hybrid convolution neural network, it is 0.97890. In a bar graph comparison of the accuracy percentage values, the hybrid convolution neural network provides a maximum degree of accuracy of around 97.89% compared to the artificial neural network's accuracy of about 95.92%. In this instance, the bar chart produces a 95% error bar.

Independent sample test results are provided in Table 13.2. The single-tailed significance that was found is 0.971. The average deviation is -0.019650. Uses independent sample testing to show that accuracy (t = -7.227), Mean Difference (-0.019650), and variance (0.02719) all match the same standards in both divisions. Between the two groups, the average differs significantly.

Figure 13.2 illustrates the results of an independent sample t-test conducted to design and analyze the innovative platelet detection system based

Table 13.1 Group statistics of artificial neural network and hybrid CNN-based innovative platelet detection systems. The mean is 0.95925 for ANN and 0.97890 for HCNN.

Group	N	Mean	Standard deviation	Standard error mean
ANN	20	.95925	.008656	.001936
H-CNN	20	.97890	.008540	.001910

Table 13.2 Group of independent sample tests of Levene's test for equality of variances. The obtained significance is 0.971. The mean difference is -0.019650 and with that, the variance is 0.002719.

		Levene's test for equality of variances		t-test for equality of means						
									95% Confidence interval of the difference	
		F	**sig.**	**t**	**df**	**Sig.(2-tailed)**	**Mean difference**	**Std.error difference**	**Lower**	**Upper**
Accuracy	Equal variances assumed	.001	.971	-7.227	38	.000	-0.019650	.002719	-0.025155	-0.01414
	Equal variances not assumed			-7.227	37.993	.000	-0.019650	.002719	-0.025155	-0.01414

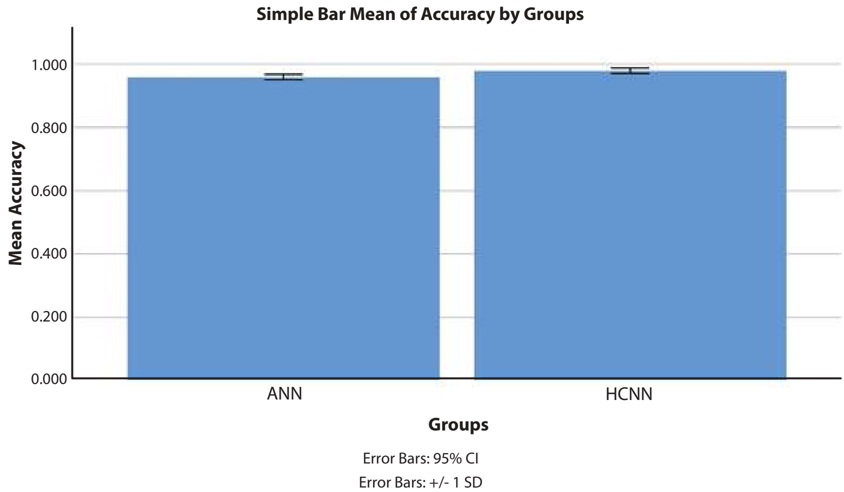

Figure 13.2 The artificial neural network and hybrid CNN-based cells and platelets recognition system were designed and analyzed with an independent sample t test. It also compares the two groups by calculating the mean accuracy. Here, the X-axis represents groups. Group 1 is an artificial neural network based cells and platelets recognition system and Group 2 is hybrid CNN-based cells and platelets recognition system. Y-axis denotes the mean accuracy, with ± 1 SD.

on artificial neural networks and hybrid CNNs. This comparison assesses the mean accuracy of the two groups: Group 1, utilizing an artificial neural network for cell and platelet recognition, and Group 2, employing a hybrid CNN-based system. The X-axis represents the groups, with Group 1 and Group 2 distinguished accordingly. The Y-axis denotes mean accuracy, with error bars depicting one standard deviation (1 SD). This visual representation enables the comparison of accuracy levels achieved by the two different recognition systems, providing insights into their performance and efficacy in innovative platelet detection.

Figure 13.3 illustrates the application of Independent Sample Tests in the creation and assessment of both the hybrid CNN and artificial neural network. The comparison between these two groups is facilitated by computing the mean accuracy. Specifically, the X-axis is represented by an artificial neural network (ANN), and this is juxtaposed against a hybrid convolution network, denoted as the hybrid CNN, on the Y-axis. The mean accuracy serves as the quantitative measure along the Y-axis, accompanied by a range of ± 1 standard error (SE). This graphical representation provides a visual insight into the comparative performance of the artificial

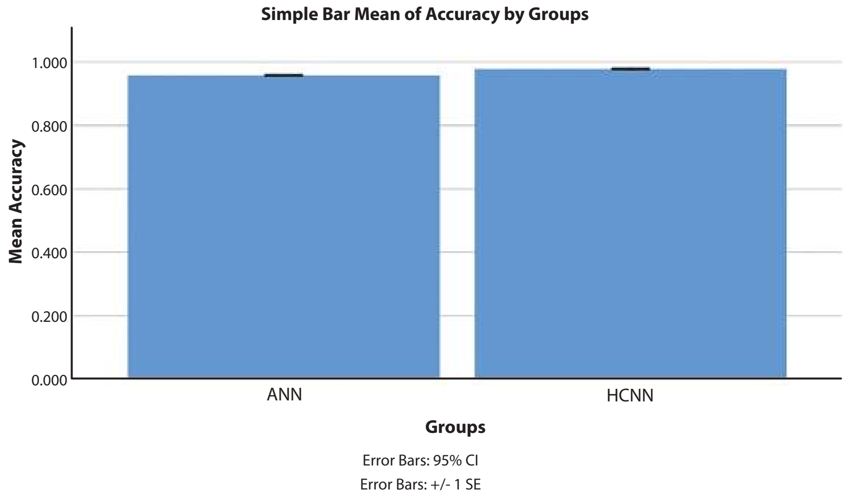

Figure 13.3 Independent sample tests were used to design and examine the convolution neural network and hybrid convolution neural network. By figuring out the mean accuracy, it also contrasts the two groups. The X-axis has been taken as an artificial neural network (ANN), and compared with a hybrid convolution network (HCNN). Y-axis is taken as mean accuracy, with ± 1SE.

neural network and the hybrid CNN based on their respective mean accuracy values and associated variability.

A bar graph showing the accuracy values for the hybrid CNN and artificial neural network shows that the hybrid CNN has a greater accuracy of about 97.89%, while the artificial neural network has a lower accuracy of about 95.92%. In this instance, the bar chart produces a 95% error bar.

The hybrid CNN (97.89%) classifier showed a higher mean value when compared to the artificial Neural Network (95.92%) and hybrid convolution neural network (97.89%) classifiers, which were tested with 20 N samples each. The two classifiers' respective means were utilized to determine the standard deviation.

13.4 Discussion

In this comparative approach, a total sample size of 40 is divided into two groups. Using an online statistical analysis tool with a pretest sample size of 80%, a specified power, and an alpha value of 0.05, the allocation of samples is determined. Group 1 comprises 20 samples utilized for the artificial neural network algorithm, while Group 2 consists of 20 samples dedicated to the hybrid CNN. The results of the comparative analysis reveal the superior performance of the hybrid CNN algorithms compared to the artificial neural network algorithms. This conclusion is supported by a statistically significant result ($p < 0.001$) obtained from an Independent Sample t-test. The findings underscore the effectiveness of the hybrid CNN approach over the artificial neural network in the context of innovative platelet detection, highlighting the potential of advanced computational techniques in improving diagnostic accuracy and efficiency.

The findings of other researchers align closely with the outcomes presented here. The current project, executed using Python, employs accuracy and loss as key performance parameters for model validation. The proposed model achieved an accuracy of 95.926% without data augmentation, and with augmentation, the accuracy increased to 97.890%. This surpasses the average accuracy rating of 92% reported in previous investigations. In comparison to earlier research, the current study stands out as one of the most comprehensive experimental examinations in the realm of cell detection. Notably, the proposed methodology exhibits versatility, extending its applicability to real-time computer systems with an impressive performance nearing 100%. The hybrid CNN algorithm emerges as the superior performer when contrasted with the artificial neural network algorithm classifier. The latter achieves a predictive accuracy of 95.925% with a significance level of 0.971, which is considered exemplary work. However, the hybrid CNN algorithm excels further with an accuracy of 97.890%. In accordance with prior studies, it is evident that the hybrid CNN outperforms alternative classifiers in terms of accuracy, particularly in the domain of cell detection.

A noteworthy drawback of the employed method is its proclivity to demand a longer training time for images, occasionally leading to a potential decline in accuracy rates. This temporal aspect could pose challenges, especially in scenarios where expeditious results are imperative. The extended training duration may also introduce the risk of overfitting, where the model becomes too tailored to the training data, hindering its generalization ability to new, unseen data.

To mitigate these challenges, one strategic approach involves optimizing the datasets utilized in this research. By curating datasets to emphasize the most pivotal characteristics within the database images for categorization, the training time can be efficiently reduced. This streamlined dataset approach not only addresses the time-intensive nature of the training process but also enhances the model's focus on essential features, potentially contributing to improved accuracy.

Despite the training time considerations, the method remains a viable option, particularly when paired with judicious dataset curation strategies. Balancing the trade-off between training time and accuracy is essential, and by refining the dataset to highlight crucial qualities, this method can be harnessed effectively, offering a pragmatic solution for image categorization applications.

13.5 Conclusion

In this experiment, hybrid CNNs exhibit superior accuracy compared to artificial neural networks (ANNs). The hybrid CNN method achieves a mean accuracy of 0.97890, surpassing the mean accuracy of 0.95925 achieved by the ANN approach. This highlights the enhanced categorization capability of hybrid CNNs in image recognition tasks. The findings underscore the advantages of leveraging convolutional layers along with traditional neural network architecture, enabling more precise and reliable image categorization. As a result, hybrid CNNs prove to be a promising approach for achieving improved performance in picture categorization tasks compared to traditional ANNs. The term "black boxes" is often used to describe artificial neural networks due to their complex internal processes, making it challenging to interpret how they generate predictions. Hybrid CNNs may offer greater sophistication than traditional CNNs, potentially resulting in longer training times, more complex optimization, and increased memory requirements. Autonomous systems such as self-driving cars, robots, and drones can benefit from artificial neural networks for decision-making and control, enhancing their effectiveness and efficiency. In video analysis, hybrid CNNs are utilized for tasks such as action recognition, object tracking, and scene comprehension. Combining CNNs with recurrent neural networks (RNNs) yields more accurate results by capturing both spatial and temporal characteristics effectively.

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14

Novel Design of Meta Ring Array Antenna Using FR4 for Biomedical Applications

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Abstract

This research designs a millimeter wave antenna for high radiation signal transmission using an innovative novel meta ring array antenna. It compares it to the S antenna for biomedical applications. Group 1 consists of 10 samples of meta ring array antennas, while group 2 comprises 10 samples of S antennas. Both antenna types utilize FR4 substrate material. There are 20 samples in all. This type of antenna can work at frequencies between 1 GHz and 6 GHz (mid-band spectrum). Each group is collected for both antennas with a G-Power of 80%. The proposed meta ring array antenna has a radiation intensity of 5 dB from 1 GHz to 6 GHz (mid-band spectrum), while an S antenna with a FR4 substrate has a directivity of 4.1 dB at 2.4 GHz. As a result, the significance value is 0.001 ($p<0.005$). Meta ring array antennas were found to send signals significantly better than S antennas in this study.

***Keywords*:** Novel meta ring array antenna, S slot antenna, microstrip patch antenna, FR4, radiated power, radio frequency, high-frequency structure simulator

14.1 Introduction

In recent years, sending data through biomedical data transmission has become more common. The message should be sent faster and more safely [1].

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Electromagnetic waves radiated power must be able to travel through the antenna or transducer (EM). The wired channel and the wireless channel will be linked by this antenna [2]. A novel meta ring array antenna is made for biomedical uses and can resonate at radio frequencies between 1 GHz and 6 GHz [3]. It was planned and tested with the help of HFSS software. The microstrip line is the input feed line. The feed line sends a signal to the radiating structure, which simulates high radiation in all directions at frequencies between 1 GHz and 6 GHz. Existing antennas are compared to the proposed antenna to see how well it sends out signals [4]. The novel meta ring array antenna's radiating patch is more effective than that of an S antenna. Excitation can be sent through the different feed lines. Current that changes over time is used to make the antenna work. The new and different design meets the needs of wireless communication. It sends out signals better than antennas that are already in use [5]. For wireless communication technology, creating a novel antenna design using a high-frequency structure simulator (HFSS) is crucial to consider various performance parameters such as feed line, structure, low loss, high gain, impedance, and bandwidth. The W-shaped microstrip antenna, which has been developed, demonstrates significant advantages and achieves superior radiated power suitable for Wi-Fi 6E applications within communication technology [6]. Over the past five years, numerous research papers focusing on microstrip patch antennas have been published.

It changes electrical signals into electromagnetic signals that can be sent over wireless channels [7]. On one side of the dielectric substrate rests a patch, while on the opposite side lies a ground plane [8]. Signals that have been changed are moving at the speed of light. This type of antenna has more benefits, like its size, the fact that it has more than one band, its high bandwidth, its high radiation efficiency [9], its best gain, and its low return loss. The meta ring array antenna does better in terms of transmission without loss [10]. The novel meta ring array antenna operates with high radiated power for effective transmission in communication technology. This proposed design supports high radiation efficiency in an operating frequency of 6 GHz [11]. Researchers are working on antenna designs that work well for wireless applications right now. For fast and safe signal transmissions, biomedical data transmission is more often used. The patch of radiation from the meta ring array antenna is more stable in the required radio frequency ranges than that from the S patch antenna. Antenna size should be designed using a high-frequency structure simulator (HFSS).

However, for modern RF devices [12], it should be small and compact. Apart from possessing extensive knowledge and research experience, our team has generated publications of exceptional quality. Because of how the meta ring array antenna is built; it cannot handle the high radio frequency transmission. The proposed antenna's structure has been altered, resulting in significantly improved radiation efficiency. This research aims to develop a Millimeter Wave Antenna optimized for high-efficiency signal transmission utilizing an innovative meta ring array antenna design. The meta ring array antenna is a structure that has been changed to be more useful in biomedical applications in communication technology.

14.2 Related Work

Wireless technology facilitates the creation of a public ledger by all network participants, enabling the recording and exchange of various activities. It serves as a transactional mechanism for different data structures, facilitating the exchange of properties, information, and data among network participants [3].

14.3 Materials and Methods

The combined number of individuals in groups 1 and 2 amounts to 20. Group 1 comprises meta ring array antennas featuring microstrip patch antennas, while group 2 utilizes S patch antennas that are currently in operation. Based on analysis, 80 percent of the pretest power is required for proper testing. Both the meta ring array antenna and the S-shaped antenna are examined with an enrollment ratio of 1 and a significance level (alpha value) of 0.05. This design incorporates a range of frequency values as data.

As part of sample preparation for group 1, we designed FR4 substrates for the development of a meta ring array antenna. The W shape is 21-mm long, 21-mm wide, and 1.6-mm thick. The thickness of the substrate is also 1.6mm. For excitation, the proposed design was linked to Lumped ports. Using a high-frequency structure simulator (HFSS), it has been determined that the antenna exhibits superior wave propagation capabilities compared to the S antenna. The impedance of the circuit should match the impedance of the load so that there is no signal loss and the radiation efficiency is high [11]. This shape works well for biomedical purposes. There are different values for the width, height, and length of a design. It is properly chosen for design to operate in the radio frequency range. Table 14.1 shows about the comparison of different studies carried out for antenna design. A diagram of the meta ring array antenna can be found in Figure 14.1.

Table 14.1 Comparison of different studies carried out for antenna design.

S. no.	Study	Radiated power
1.	Bhattacharjee 2017 [1]	4.4 dB
2	Manouare 2017 [7]	4 dB
3	Saikia 2018 [12]	3.6 dB

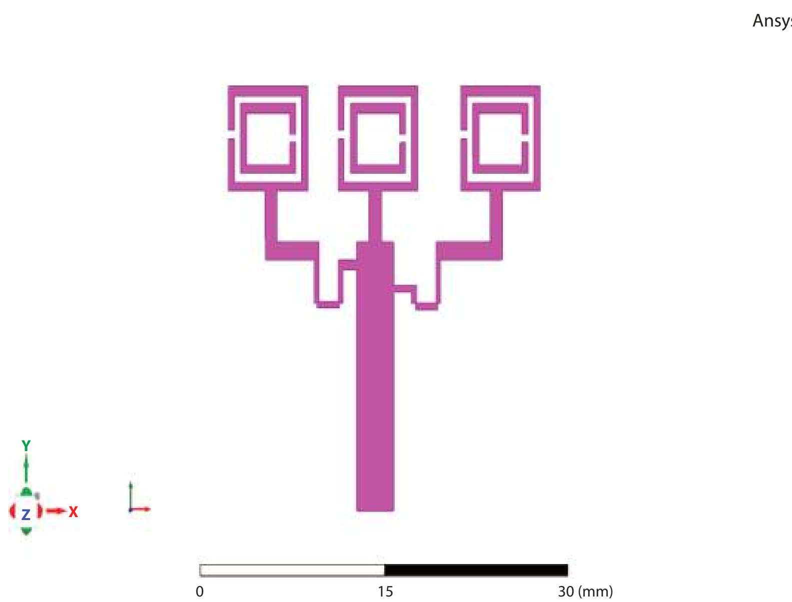

Figure 14.1 The design of a multi-band meta ring array is shown.

During sample preparation for group 2, an S patch antenna with FR4 material is used as a dielectric substrate. The dielectric substrate is covered with a radiation patch. To achieve a 50-ohm impedance match across the mid-band spectrum ranging from 1 GHz to 6 GHz, a ground plane is positioned on the opposite side of the substrate. In Table 14.2, the dimensions of the S microstrip patch antenna are visible. Figure 14.1 illustrates the geometry of the S antenna.

With HFSS software, the proposed antenna was analyzed and simulated using an Intel i5 processor with 8GB RAM. Use the high-frequency

Table 14.2 Design parameters of S patch antenna designed using HFSS.

S. no.	Parameter	Specification
1	Patch input resistance	50 ohm
2	Length of the design	38 mm
3	Width of the design	46 mm
4	Height of the design	1.6 mm
5	Microstrip line length	25 mm

structure simulator (HFSS) software tool to calculate the results. The dimensions of the substrate and ground plane should be based on Table 14.3. Using the measured dimensions, draw a patch and assign a boundary. Describe the conductive dielectric material and radio frequency. It is important to assign an excitation and analysis system to the setup. Prior to conducting the simulation, it is imperative to validate the proposed design. The outcomes will be presented in the results section.

In order to compare the parameter voltage standing wave ratio statistically, SPSS version 2.1 was used. TSPSS software is employed to conduct the independent sample T-test and generate group statistics [12]. Mean values and standard deviations were measured with SPSS. They are made more interesting through graphs and tables. Return loss is the dependent variable. All three variables are independent: the width, the height, and the length of the antenna.

14.4 Results

This paper delves into the performance evaluation of both the proposed meta ring array antenna design and the S patch antenna. The design

Table 14.3 A comparison is made between the gain of the multi-band meta ring array antenna and the single-band microstrip S patch antenna.

Antennas	73. Frequency (GHz)	Gain (dB)
Meta ring array antenna	2 GHz to 6 GHz	5 dB
Single-band microstrip S patch antenna	2.5	4.1

parameters of the S patch antenna and the proposed antenna have been listed in Tables 14.2 and 14.4.

Figure 14.2 illustrates the radiation efficiency of the proposed antennas. The simulated meta ring array demonstrates a radiation efficiency of 5 dB across the frequency range of 1 GHz to 6 GHz, rendering it suitable for biomedical applications. According to the findings, the S patch antenna appears to exhibit less directionality compared to the square antenna. The antenna is appropriately tuned to accommodate a wide array of frequencies and parameters. Table 14.3 provides a comparison of directivity, radiation efficiency, and radiated powers.

SPSS software is used to make a reasonable approximation of the meta ring array antenna statistical analysis. With a mean of -10.6, the meta ring array antenna is better than the S slot antenna, which has a mean of -5.7.

In Figure 14.3, new meta ring array antennas are compared to existing S patch antennas based on their mean accuracy values. When comparing the two types on the X-axis and plotting mean radiation efficiency ± 1 SD on the Y-axis, the W-shaped antenna, developed as proposed, demonstrates lower efficiency compared to the S-shaped antennas.

Table 14.4 Design parameters of meta ring array antenna designed using HFSS.

S. no.	Parameters	Values (in mm)
1	Substrate height	1.6
2	Substrate length	22
3	Substrate width	20
4	Length of the ground plane	22
5	Width of the ground plane	20
6	Thickness of the ground plane	0.035
7	Origin of patch	6, 2, 1.6
8	Length of patch	13
9	Width of patch	6

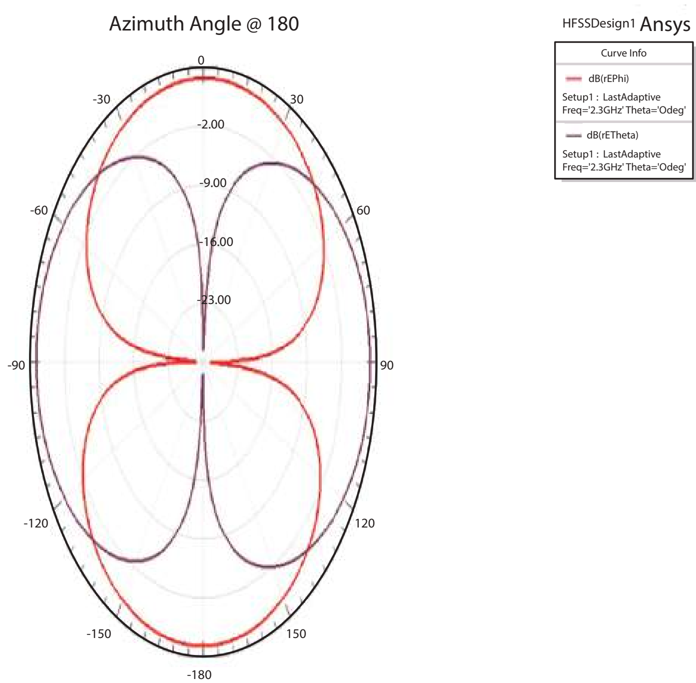

Figure 14.2 Radiated power of meta ring array antenna 5 dB at 1 GHz to 6 GHz (mid-band spectrum).

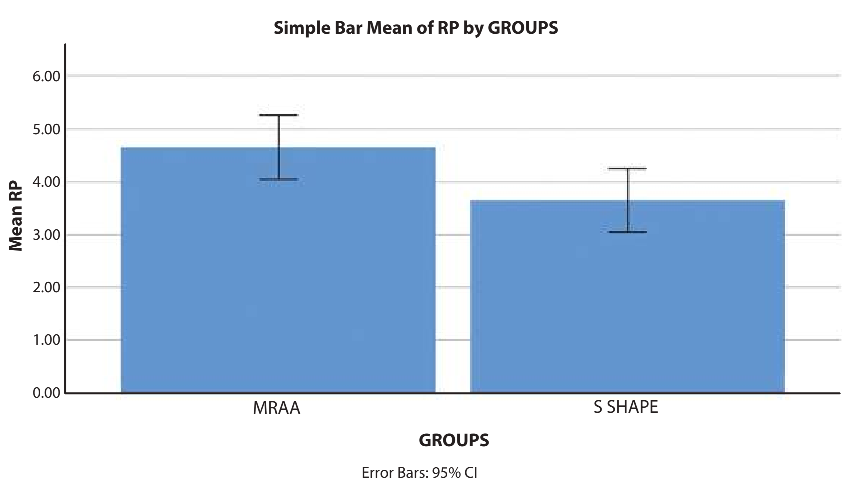

Figure 14.3 Bar chart comparing the mean (+/−2 SD) of radiated power of double band existing and proposed antenna.

14.5 Discussions

The proposed new meta ring array antenna has a radiation intensity of 5 dB from 1 GHz to 6 GHz, while an S antenna with a FR4 substrate has a directivity of 4.1 dB at 2.4 GHz. From what we know so far, the size is smaller than that of the S antenna. It helps with biomedical communication in the right way.

This design is used to get the message across. Due to a good match between the load and the impedance, it has high directivity in all directions [14]. This number is greater than the value of an S patch antenna. It is designed using a high-frequency structure simulator (HFSS) As an integrated circuit, the antenna is easy to make [12]. This antenna is made up of different parts, such as the ground, the substrate, and the parts that do the actual work. The proposed antenna will be small and easy to power with microstrip feed techniques. This design changes signals into EM waves, which travel with high directivity through the wireless channel. In communication technology, a meta ring array antenna functions effectively at a specific frequency, maintaining consistent omnidirectional radiation efficiency within its operating frequency band [10].

This antenna's ability to send out waves is the same across all radio frequencies. It has a lot of radiation so signals can be stronger. This design still has some problems, such as a narrow bandwidth and low gain. In the future, the radiating structure for wireless communication can be made better in terms of gain, efficiency, bandwidth, and size by making changes to the design using a high-frequency structure simulator (HFSS).

14.6 Conclusion

This meta ring array antenna is made for biomedical use with radio frequency. The proposed antenna radiation efficiency is compared to that of an S patch antenna that is already in use. This new meta ring array antenna has a directivity of 5 dB from 1 GHz to 6 GHz and 4.1 dB at 2.4 GHz for an S slot antenna. Therefore, the design and simulation of the new meta ring array antenna make it much more effective at sending out waves than an S slot antenna in communication technology.

Abbreviations Used

Create Table Here

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15

Review: Recommendation System in Tourism and Hospitality Based on Comparison of Different Algorithms

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Abstract

The usage of recommendation systems has grown more common in the tourist sector, which enables passengers to get ideas that are both individualized and relevant to their needs. This review study intends to give a complete examination of recommendation systems that are implemented in the tourist sector, with an emphasis on the many different methodologies and strategies that have been utilized in past research. The evaluation examines each study's methodologies and their use in tourism, including location recommendations, hotel options, activity ideas, and itinerary planning. It outlines each method's pros and cons and how recommendation systems are evaluated. The evaluation shows that collaborative filtering, which uses user ratings and similarity to provide tailored suggestions, works. Content-based filtering using user preferences and item characteristics solves the cold-start issue and provides appropriate recommendations. Domain knowledge and expert rules in knowledge-based systems provide user-specific suggestions. Several research gaps and limitations were found. In tourist recommendation systems, contextual considerations, varied data sources, and ethical and privacy problems must be explored. The lack of defined assessment frameworks and comparative research makes it difficult to compare approaches. Tourism is always been in the trending topics all over the world and interest is seen in this field in an extreme manner. Tourism is considered an important factor in the GDP of the country. Therefore, to make a proper recommendation system for the tourists is also necessary so that they can enjoy their trip as well the growth can be seen in various aspects of the economy. Here in our paper, we have done a survey on the recommendation systems that are in existence currently and the methods that are applied for to make them

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better. Various aspects are considered in the recommendation and these two basic algorithms have been in use that are collaborative filtering and the content-based filtering method. Here, we have studied both these algorithms; but moving forward from such traditional algorithms, we also surveyed machine learning, deep learning, and artificial intelligence applied in the recommendation system. Our survey provides deep details of the recommendation systems in tourism. This evaluation illuminates tourist recommendation systems and suggests further study. Future studies should address research gaps, create advanced recommendation techniques that account for context and different data sources, and incorporate ethical issues. By doing so, the tourist sector may use recommendation systems to improve travel, consumer happiness, and decision-making.

***Keywords*:** Tourism, machine learning, recommendation in tourism, artificial intelligence, deep learning

15.1 Introduction

Tourism is a dynamic and flourishing sector, attracting a wide array of tourists seeking relaxation, exploration of new places, or historical study, often accompanied by family, friends, or colleagues. This trend significantly boosts the tourism industry, highlighting its importance. The desire to travel not only leads to the enhancement of tourist destinations for improved service but also contributes substantially to the economic growth of countries. For instance, tourism accounts for about 10% of GDP in southern Mediterranean nations [1].

Tourism is a vital component in a country's overall development, offering expansive employment opportunities. Recognized by leading organizations as one of the world's top job creators, tourism stands as one of the largest and most diverse industries globally. It not only brings joy to visitors but also plays a crucial role in generating income and related benefits for the host countries [2].

The term 'tourism destination' is often defined as a geographical area, political jurisdiction, or major attraction aimed at providing visitors with a range of satisfying and memorable experiences [3]. This paper delves into the economic effects of tourism in Ghana, examining both its positive and negative impacts. Positives include job creation, tax revenue, and economic multipliers, while negatives involve dependency on tourism for economic growth. The study also explores the dynamic nature of tourism [10], particularly its relationship with destination areas [4]. The Figure 15.1 shows about tourism in India, Figure 15.2 shows about the recommendation system for tourism, Figure 15.3 shows about filtering models,

Figure 15.1 Tourism in India.

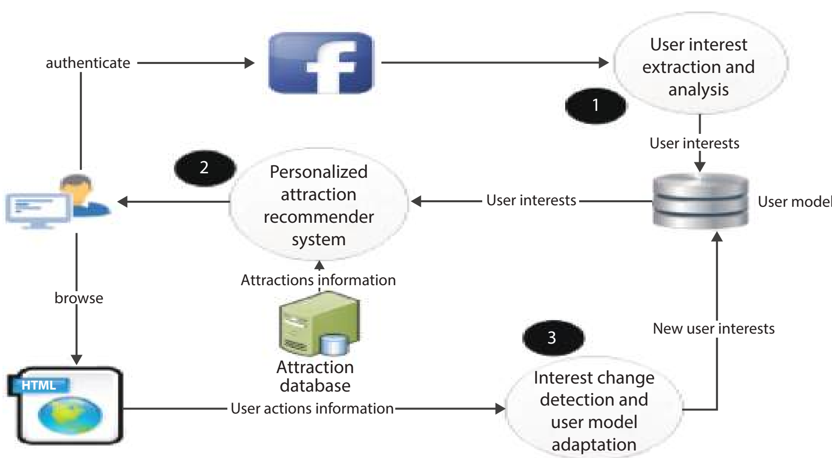

Figure 15.2 Recommendation system for tourism using Facebook check-in data [11].

Figure 15.4 shows about content-based filtering model, Figure 15.5 shows about neural network architecture, Figure 15.6 shows about CNN for recommendation, Figure 15.7 shows about semantic analysis, Figure 15.8 shows about genetic algorithm approach and Table 15.1 shows about the systematic literature review.

Moreover, with environmental concerns in mind, nature tourism and recommendation systems have been considered [5]. The deployment of IoT devices at tourist destinations, which gather data from tourists, is explored for enhancing tourism services through personalized recommendations, as studied in previous research.

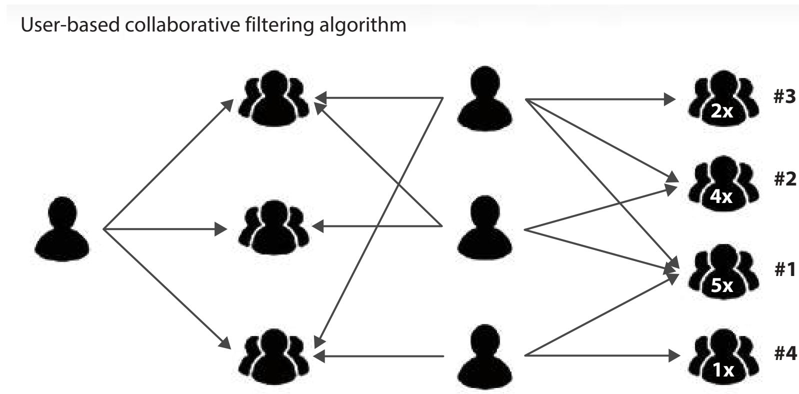

Figure 15.3 Collaborative filtering model.

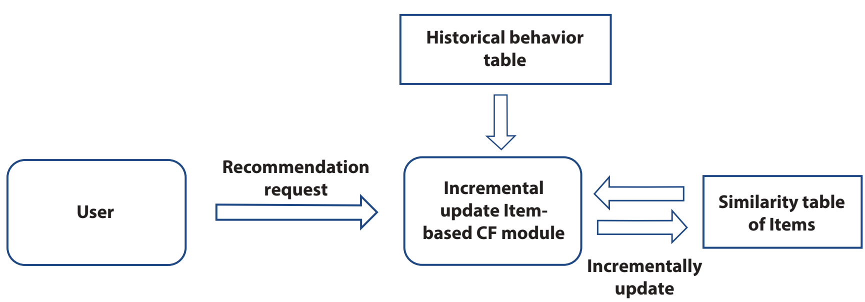

Figure 15.4 Content-based filtering model.

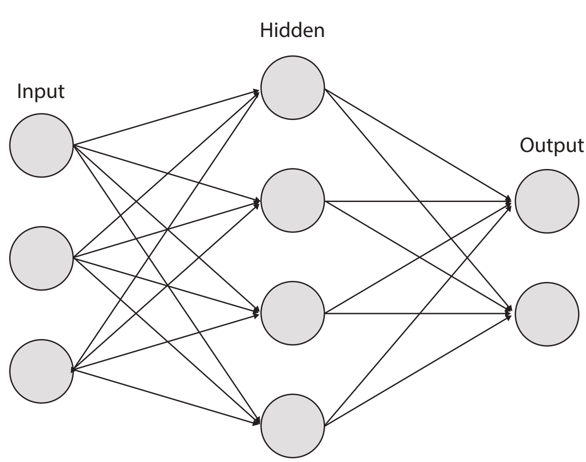

Figure 15.5 Neural network architecture.

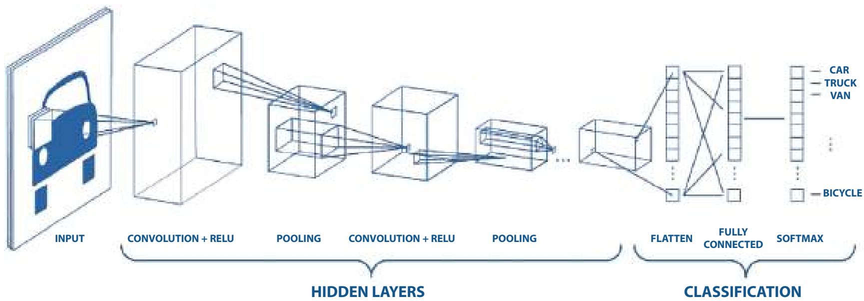

Figure 15.6 CNN for recommendation.

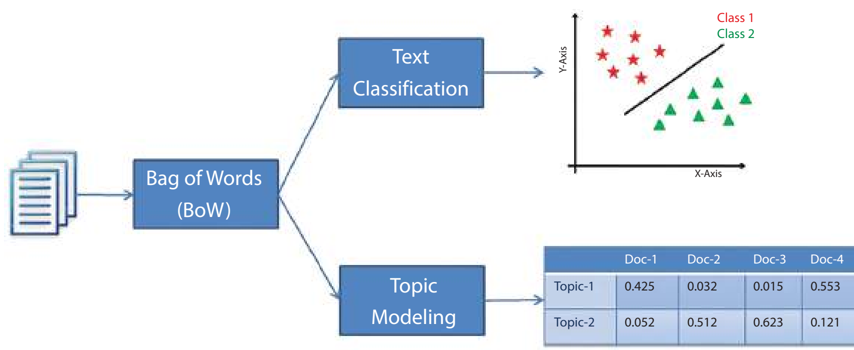

Figure 15.7 Semantic analysis for recommender system.

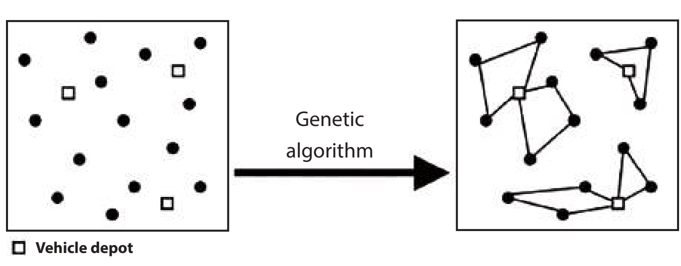

Figure 15.8 Genetic algorithm approach.

Table 15.1 Systematic literature review.

Citation	Method	Result	Problem domain	Objective	Research gap	Limitation	Future scope
[52]	Survey	Future research directions	Tourism recommendation	To provide an overview of the state of the art in tourism recommendation systems	Identify research gaps in the existing literature	Limited to a survey, no dataset used	Explore novel approaches and emerging technologies
[53]	Apriori algorithm	Intelligent tourism recommendation system	Tourism recommendation	Develop an intelligent recommendation system	Integration of IoT and AI with Apriori algorithm	No dataset mentioned	Evaluate the syst performance w real-world data
[54]	Hybrid method (evolutionary algorithm + topsis model)	Improved recommendation system	Tourism recommendation	Enhance recommendation accuracy	Utilizing evolutionary algorithms and topsis model	No specific dataset mentioned	Test and validate the model with various tourism datasets
[55]	Evaluation approach	Smart tourism point-of-interest recommendation	Tourism recommendation	Develop a systematic evaluation approach	Evaluation of recommendation algorithms	Lack of specific dataset information	Apply the approa to real-world smart tourism tools
[56]	Machine learning approaches	Personalized travel recommendations	Tourism recommendation	Study machine learning approaches	Machine learning-based recommendation systems	No dataset mentioned	Investigate the impact of diffe ML algorithms recommendati

(*Contin*

Table 15.1 Systematic literature review. (*Continued*)

Citation	Method	Result	Problem domain	Objective	Research gap	Limitation	Future scope
[57]	Design concept	Recommender system for regional development	Tourism recommendation	Develop a design concept	Regional development in tourism	No specific dataset mentioned	Implement the design concept in real-world regional touris settings
[57]	Design concept	Recommender system for regional development	Tourism recommendation	Develop a design concept	Regional development in tourism	No specific dataset mentioned	Implement the design concept in real-world regional touris settings
[58]	Context-aware fuzzy-ontology-based	Context-aware tourism recommendations	Tourism recommendation	Develop a context-aware recommendation system	Utilize fuzzy ontology	No specific dataset mentioned	Incorporate additional con dimensions int the system
[59]	Augmented big data analytical model	Thematic travel recommendations	Tourism recommendation	Develop a thematic recommendation system	Utilize big data analytics	No dataset mentioned	Extend the syster to handle large datasets and diverse themes
[60]	Geotagged data-based recommen-dation	Travel destination recommendation	Tourism recommendation	Create a geotagged data-based recommendation system	Utilize geotagged data	Limited to geotagged data	Explore the integration of more diverse d sources
[61]	Deep neural network model	Smart hotel recommendations	Tourism recommendation	Develop a deep neural network model	Utilize multidimensional information	No dataset mentioned	Enhance the mo performance a scalability

(*Contin*

Table 15.1 Systematic literature review. (*Continued*)

Citation	Method	Result	Problem domain	Objective	Research gap	Limitation	Future scope
[62]	Dynamic recommendation algorithms	Restaurant recommendations during COVID-19	Tourism recommendation	Develop dynamic algorithms for COVID-19 scenarios	Address recommendations during crises	No dataset mentioned	Extend the dynan algorithms to other crisis scenarios
[63]	Web-based multiagent technology	Web-based smart tourism recommendations	Tourism recommendation	Create a web-based recommendation system	Utilize multiagent technology	Limited to a web-based approach	Explore the integration of mobile and wearable technologies
[64]	Collaborative content filtering and hybrid recommender system	Comparison of recommendation systems	Tourism recommendation	Compare recommendation approaches	Collaborative content filtering vs. hybrid system	No dataset mentioned	Evaluate the syste with real-world user data
[65]	Picture-based approach	Picture-based tourism recommendations	Tourism recommendation	Develop a picture-based recommendation system	Utilize image analysis	No dataset mentioned	Enhance image recognition and processing algorithms
[66]	Weighted hybrid method	Bali Island tourism recommendations	Tourism recommendation	Develop a weighted hybrid recommendation system	Utilize a weighted combination of methods	No dataset mentioned	Extend the system to cover other tourist destinations

(*Contin*

Table 15.1 Systematic literature review. (*Continued*)

Citation	Method	Result	Problem domain	Objective	Research gap	Limitation	Future scope
[67]	Novel hybrid recommender system	Tourism recommendation	Develop a novel hybrid recommendation system	Utilize innovative methods	No dataset mentioned	Validate the system with real-world tourism data	
[68]	Empirical study on data imbalance	Imbalance in recommendation questionnaires	Tourism recommendation	Conduct an empirical study on data imbalance	Investigate data imbalance in tourism recommendation	No dataset mentioned	Develop strategie to handle data imbalance
	Decision tree algorithm	Tourist recommendations using decision trees	Tourism recommendation	Develop a recommendation system using decision trees	Utilize decision tree algorithm	No dataset mentioned	Explore ensembl methods and optimization techniques for decision trees
[69]	Modified k-means algorithm and fuzzy best-worst method	Group urban tourism recommendations	Tourism recommendation	Develop a group recommendation system	Utilize modified k-means and fuzzy best-worst method	No dataset mentioned	Extend the syster for various group sizes anc preferences
[70]	Preliminary analysis and design	Customized tourism recommender system	Tourism recommendation	Conduct preliminary analysis and design	Customize recommendations based on user profiles	No dataset mentioned	Implement and evaluate the customized system

(*Contin*

Table 15.1 Systematic literature review. (*Continued*)

Citation	Method	Result	Problem domain	Objective	Research gap	Limitation	Future scope
[71]	Analysis of personalized recommender systems	Personalized tourism recommendations	Tourism recommendation	Analyze existing personalized recommender systems	Evaluate their performance and limitations	No dataset mentioned	Propose improvements for existing personalized systems
[72]	Event stream processing Recommender system	E-Tourism recommendations on streaming data	Tourism recommendation	Develop a recommender system for streaming data	Utilize event stream processing	No dataset mentioned	Evaluate the syst with real-time streaming data
[73]	Collaborative filtering and deep autoencoder	Indian tourist recommendations	Tourism recommendation	Develop a recommendation system for Indian tourists	Utilize collaborative filtering and deep autoencoder	No dataset mentioned	Extend the syster to cover divers tourist preferer and regions
[74]	Budget-based collaborative recommen-dation system (BCRS)	Budget-based tourism recommendations	Tourism recommendation	Develop a budget-based recommendation system	Utilize collaborative filtering and budget constraints	No dataset mentioned	Investigate additional constraints anc preferences in budget-based recommendati

15.1.1 Recommendation for Tourism Spots

Tourism involves various factors, and a recommendation system is essential for analyzing these aspects to provide appropriate suggestions [6]. Recommendation systems are increasingly popular, offering tailored suggestions to meet user needs. Often, tourists face challenges in choosing destinations due to limited knowledge about unfamiliar places. This necessitates a system that can recommend tourist spots effectively [7].

The tourism industry has recognized the importance of recommendation systems. One innovative approach is the use of linked open data to create tourism recommendations [8]. This method considers diverse and heterogeneous data to formulate suggestions. Another aspect explored in developing recommendation systems is the analysis of Facebook check-in data. This data reveals where users have visited, the frequency of their visits, and the types of places they prefer, providing valuable insights for creating user-specific recommendation systems [9]. These systems aim to enhance the tourist experience by suggesting destinations that align with their past behaviors and preferences.

The recommendation system for tourism has some major face-offs that it needs to resolve. The recommendation system for any other field seems easier to develop as there are some limited aspects related to that field, but in the recommendation system for tourism, there are various challenges are seen and various aspects need to be considered. As tourism has some interconnected fields such are transport, lodges, attractions, etc., the recommendation has to be made taking such things into consideration [12].

15.2 Literature Review

Recommendation systems for tourism have had a great impact on tourist satisfaction, so there are various methods that have been applied earlier to make a proper recommendation system. Here, in this section, we are dividing the literature on the basis of the methods applied in the recommendation system. The methods such as artificial intelligence, collaborative filtering, content-based filtering, neural network, convolutional neural network, semantic analysis, Bayesian method, and Markov chain method have been discussed separately. These methods have a different impact on the recommendations.

15.2.1 Collaborative Filtering-Based Recommendation Systems for Tourism

The collaborative filtering method is one of the oldest methods that are used for any type of recommendation system. Collaborative filtering is the method that finds the user with similar interests and the cluster of similar users is analyzed and the recommendations are made on the basis of similar user preferences. The collaborative filtering method along with the principal component analysis is proposed earlier and the use of adaptive neuro-fuzzy inference analysis and support vector regression is done to provide an accurate recommendation [13].

Location-based recommendation system has been developed previously based on the collaborative filtering method, but alone collaborative filtering gives accuracy as well it can be improved by adding some other methods and here authors have applied content-aware collaborative filtering that is based on the implicit feedback of the users. Such a recommendation system deals with cold start problems very well [14].

Collaborative filtering does not contribute to such methods but the mobile tourist has been also handled by this method. In one of the works, it is noted that the collaborative filtering applied with the mobile details of users such as the current location, time, weather conditions, etc., are taken into consideration for recommendation. This traditional algorithm is added to the wireless sensor network for getting the location of users precisely and also uploading the ratings and information by mobile devices. Point of interest is seen with the use of the context-aware rating [15].

When talking about the group recommendation system, we have the problem of satisfying every member of the group with their needs. Collaborative filtering can also be used in the group recommendation system the basic problems that are seen in the recommendation system are a combination of multidisciplinary models, integration of information, complex problem domain, etc. Therefore, context awareness with collaborative filtering provides much more in the group recommendation system [16].

Another approach that is context-aware is presented which is called multi-model approach for recommendation. Here, the recommendations that are personalized and also nonpersonalized are made by using such methods. A collaborative filtering approach along with the context-aware approach is proposed for making tourism recommendations [17].

Point of interest is one of the emerging methodologies which are used in the e-tourism field. Recommendation systems based on the point of interest have become in trend for tourists. Here, the paper suggests a mechanism that uses four techniques that are collaborative filtering, context awareness, demographic-based, and sequential pattern mining. The Flickr dataset was used for testing and the results was having fine numbers [18].

One another method for the recommender system has also been seen on the basis of the multi-dimensional behavior of users. Ratings provided by users are used here for recommendations also the knowledge discovery process has been applied along with collaborative filtering. The comparison of this algorithm was done with the slope one algorithm [19].

For domestic tourism, a recommender system was developed which uses the Slope One algorithm which is used for the improvement of the accuracy of the recommendation of tourism. This method improves the drawbacks seen in the collaborative filtering approach [20].

15.2.2 Content Filtering-Based Recommendation Systems for Tourism

Content-based recommendation system is the main reason behind talking about any recommendation. This method is the basis for the recommendations made to the user. This is the first basis that came into existence for the purpose of the recommendations. A method for content-based recommendation is seen that is based on the point of interest of users. Ontology-based systems have been used for the recommendation of tourism [21].

Content-based filtering has been in use for various recommendation purposes like providing variability and personalized suggestions in mobile locations. A LOOKER approach based on content filtering has been presented for the tourism recommendation from the available user-granted content on social media. LOOKER approach is used for mobile applications and the evaluation of the approach is done [22].

Context-based recommendations from the available data of users have been used earlier. Along with this information the ontology is used for making a proper recommendation system. Context-aware recommendation that is based on ontology is discussed. It has been evaluated and it is noted that the proposed system works well and has accurate results [23].

An intelligent system for the user of smartphone users based on the current context of user a recommender system was proposed. This system uses collaborative filtering and content-based recommendation, and also demographic profiling is performed for this system. For defining the type of context, there is an introduced intelligent reasoning to make it more accurate and precise [24].

The tourism recommendations somewhere depend on the packages available to the agencies. Therefore, the need for the system to fulfill the requirement of the tourists according to their wish is to be made. Therefore, here, a system to resolve these problems has been proposed that keeps track of the interests, needs, hobbies, etc., for making recommendations. Therefore, the content-based system is designed here for recommendation which works well [25].

15.2.3 Recommendation System from Neural Network

With the growing technology, the systems and algorithms used for the recommendation purpose have been improved, and one of them is the neural network. To recommend tourism by making use of space-time distribution, a system was presented, which notes three factors that are the entrance, exit, and stop of the users. Firstly, the probability distribution is made from the available data of the user then the neural network is applied for the prediction of the best spot [26].

The previously applied techniques work on the space temporal distribution but the personal attractions of users are more important to recommend the tourist spots. The system keeps in mind the personal attraction of users and is designed as a neural multi-context modeling framework for getting the features and attractions of users. Further methods are applied to make the recommendations accurate [27].

Tourism has a major impact on the development of the country, such a case is seen for Sri Lanka tourism. The author has designed a recommender system by using the behavioral patterns of users on social media. To analyze this data they have used neural network classification and the data is collected from Facebook [28].

Tourism in India has been in trend as it is in budget and also reachable. Here, in a study, Puri station in Odisha has been evaluated for tourism purposes. SOM architecture has been used for making recommendations of Puri City for tourists. Here, they have used a neural network of artificial type, i.e., ANN. Furthermore, a comparison between supervised and unsupervised systems has also been performed [29].

15.2.4 CNN in Tourism Recommendation

Deep learning is having its impact on the recommendation system at its best, and the models of deep learning such as CNN have worked well in recent scenarios. Therefore, using CNN for the recommendation purpose the researchers have developed a mechanism for recommendation. One of the recommender systems is seen which works by using social media photos and the recommendation is made according to the attraction of users. The system uses CNN and fuzzy logic for the purpose of classification of tourists [30].

CNN can be useful in making recommendations by sentiment analysis as well. The system for recommendation that is based on the text available on various platforms is presented earlier. Here, the sentiment analysis is done for the recommendation by making use of CNN along with the LSTM to make it more accurate [31].

Another method based on CNN is seen where the photos taken by tourists are analyzed to detect the monument of Iran. The photos taken by users vary in angle, light, view, etc., so to detect which monument it is, the CNN model is presented. The authors worked on the detection only but here, we can use it as a recommendation purpose. That is, in a way, if we liked any photo of a monument, then we need a system to recommend those places for tourism.

15.2.5 Use of Semantic Analysis in Tourism Recommendation

Semantic analysis has done great work in the recommendation field. A system for recommendation is proposed to get the preferences of users from their past history of TV views. This system works on getting the content from the TV interest of users and then also the users with the same interest are analyzed through semantic analysis [32].

Huge data are present over the Internet via social media platforms that can be used for recommendation, but for normal people, it is not possible to analyze and decide on some useful destinations for tourism. Therefore, a recommendation system that does opinion mining to get the sentiment of users and the temporal dynamics are also used for making the recommendations more valid. The results found by this system have higher accuracy [33].

Collaborative filtering is the traditional approach for recommender systems, but the limitations of CF still need improvement. Therefore, a fusion of CF along with the semantic analysis is done by a researcher that is based on the ontology semantic similarity. The presented system works well and the methods used are good for making recommendations [34].

The input given for the search is replied to by the recommendation engines but the intentions and the need are not considered by the system for tourism recommendation. Therefore, a system that is based on ontology is proposed and the semantic web technology is used. The use of SPARQL is also done along with the Fuseki server and the proper recommendations are made [35].

The image annotation for the recommendation has been in hot topic of research. Furthermore, the place of interest has been considered along with the photos, so the semantic image annotation and the classification of the image are done by the presented system which is probabilistic latent semantic analysis. The system has obtained 90% precision [36].

When we deal with the recommendation system, there is no consideration of the ability of the person to visit any place. Therefore, a system for elderly people has been presented according to their physical ability to reach any destination. The request, profile, and models are used for making the recommendation. The semantic analysis of every data present is performed to give an exact recommendation [37].

The recommendations are mostly done on the basis of the available packages. However, the personal attractions have remained left behind, as per the previously implied recommender systems. Here author has presented a system to know the personal attractions of the user and the query from the user is taken for making a recommendation. This all is done by implementing association rule mining and content matching by the semantic analysis [38].

15.2.6 Tourism Recommendation with Artificial Intelligence

The tourism sector has many factors to analyze but when it comes to artificial intelligence [75–79], then it becomes much stronger than other systems. A system for analysis of the Chinese tourists to visit turkey is presented that uses artificial intelligence. The data from the TripAdvisor website are taken and analysis is done on how many tourists would prefer to visit Turkey [39].

The recommendations done earlier are based on the history used but factors such as low frequency and flexibility in styling are ignored. Therefore, a method making use of collective intelligence is used here along with the data that is personal attraction similarity is used. The heterogeneous data made available by tourists can be used as per the interest and experience for the collective intelligence [40].

15.2.7 Genetic Algorithms for Tourism Recommendations

The genetic algorithms are used for the purpose of defining the route and the stations in between the route. The free travel concept has been increased in recent scenarios. The perspective and preference should be kept in mind and then the route recommendation should be made. The authors here designed a system by using a genetic algorithm and the factors such as initial position, time of departure, tour duration, cost, popularities, and the score are taken into consideration. The genetic algorithm for such a task is implemented and promising results are achieved [41].

Route recommendation has always been a complicated task for recommendation systems. The genetic algorithm works well when such types of systems need to be designed. An approach that uses a genetic algorithm has been presented by making use of the knowledge of the purpose of tourism as well as the time constraints of users. For the improvement of route calculation time, they have implemented a memory genetic algorithm [42].

15.2.8 Some Other Algorithms that are Used for Tourism Recommendation

Markov Chain: For optimizing the travel routes and the recommendation that is to be made, the Markov chain algorithm has been implemented. The preferences and constraints of users have been considered for the route optimization. The data are collected from the routers deployed at tourist spots, and the route is optimized. The accuracy obtained varies between 95% and 100% [43].

Bayesian Network: A recommendation system that used Engel-Blackwell-Miniard has been deployed by making use of the preferences of the user. This system uses the data given by the Taiwan Bureau for finding tourist attractions. The Bayesian network is used for finding the probability of user attraction. Here, the tourism attraction system-like structure is analyzed [44].

Particle Swarm Optimization: The day itineraries are considered here for recommendation, and a heuristic approach is presented by making use of the improved particle swarm optimization [45]. The differential evolution algorithm was also implemented along with this system, and it is stated that this may be used with the existing system [46].

Clustering Algorithms: Social media has been a major source for data generation and data for tourism such as ratings, views, comments, feedback, and blogs can be obtained from these platforms [47]. Moreover, for making recommendations apart from traditional collaborative filtering, clustering algorithms can also be applied like k-means, k-meoids, and CLARA, and fuzzy c means have been analyzed for clustering [48]. An approach for a recommendation that is hybrid and attaches collaborative, content as well as demographic filtering is applied for tourism recommendation [49].

Sequential Pattern Mining: Some of the tourists plan routes for tours and the point of interest plays an important role in defining the route. Therefore, the sequence for the route is designed from various types of data present, and for this, sequential pattern mining is applied. Fine-grained and highly preferable routes were suggested by the presented approach [50]. For route recommendation, another approach with text mining has also been presented earlier. Where a hierarchy of data present is created, then word segmenting is done to find proper scenic spots in the route [51].

15.3 Research Gaps

There has been little attention paid to establishing effective and individualized recommendation systems in the tourist industry, which results in a limited emphasis on customized suggestions. The majority of the currently available research provides general advice without taking into account the particular inclinations and concerns of individual consumers.

Lack of integration with several data sources: The vast majority of tourist recommendation systems depend on a solitary dataset or platform, such as TripAdvisor or Airbnb. This is a significant drawback. However, research that incorporates data from numerous sources, such as social media, user reviews, and travel blogs, is needed in order to produce suggestions that are more thorough and reliable.

Insufficient consideration of the relevant contextual elements: When making decisions about tourism, it is essential to take into account relevant contextual aspects such as time, place, and weather. However, there is a deficiency in research pertaining to the incorporation of contextual information into recommendation systems in order to provide passengers with ideas that are more relevant and timely.

There has been insufficient exploration of hybrid recommendation approaches. Although some studies have investigated hybrid recommendation approaches in the tourism domain, there is still a research gap in investigating the optimal combination of different recommendation techniques, such as collaborative filtering, content-based filtering, and knowledge-based approaches, to improve recommendation accuracy and diversity.

Because visitors often depend on the suggestions and views of friends, family, or other influencers, there have not been a lot of studies done on the effect of social influence. Social influence plays a crucial part in the decision-making process of the tourism industry. Nevertheless, there is a deficiency in research regarding the comprehension and incorporation of social impact aspects into recommendation systems in order to improve the efficiency of these systems.

Limited evaluation of the comments and reviews left by users: The comments and reviews left by users provide insightful information about the user's experiences and preferences. On the other hand, there is a dearth of studies into the development of recommendation systems that make efficient use of user-generated material to provide suggestions that are both trustworthy and individualized.

Insufficient consideration of issues pertaining to ethics and privacy: Research is required to address ethical concerns and privacy problems brought up by the fact that recommendation systems gather and analyze user data. In the field of tourism, one of the most critical unfilled research needs is the creation of recommendation systems that are open and protect users' right to privacy.

Lack of assessment and comparison frameworks: There is a research vacuum in building standardized evaluation and comparison frameworks for tourist recommendation systems. This may be seen as both a challenge and an opportunity. Researchers would be able to evaluate the performance of various algorithms, models, and techniques in a consistent manner thanks to the availability of such frameworks, which would also allow for meaningful comparisons and benchmarking.

There is a lack of attention to long-tail and niche suggestions in many of the current tourist recommendation systems. These systems have a tendency to give priority to well-known and widely-attended attractions, lodgings, and destinations. There is a dearth of study, however, in the area of designing recommendation systems that successfully cater to the long-tail and niche tastes of tourists, therefore encouraging the exploration of unusual and less well-known tourism experiences.

Inadequate study on the effect of recommendation systems on the level of satisfaction experienced by users and the decision-making process: Although a number of studies have concentrated on building algorithms for producing recommendations, there is a dearth of research that investigates the actual influence that these systems have on the level of pleasure experienced by users, the decision-making processes involved, and the overall travel experiences.

There are various works done in the field of the recommendation system for tourism. Tourism also contributes to the economic growth of the country. Furthermore, tourists spend their valuable time and money on tourism and have a lot of expectations from tours. People go for their relaxation to discover new places or for many other reasons so the recommendation system needs to provide outputs based on the user's personal demands and requirements. Therefore, as per the study done in our paper, we have come up with some research gaps that are stated below.

1. The recommendation systems need to deploy according to the user's preference and according to that, the algorithm needs to be chosen.
2. The genetic algorithm worked well for the route planning approach but there is less work done in this algorithm so the work can be done and the outcomes from the genetic algorithm can be achieved more accurately for route planning.
3. There is difficulty seen in implementing artificial intelligence in tourism recommendations that must be studied further.
4. Traditional algorithms such as collaborative filtering and content-based filtering have been implemented to recover from their limitations, so there are also chances to work with these traditional algorithms.
5. The parameters stated in many of the recommender systems like cost, time, duration, location, age, preference, and group can be obtained on a single platform for giving recommendations from all aspects of the user's need.
6. The algorithms studied at last such as the Markov chain, PSO, and Bayesian network need to be considered for making a recommender system.

15.3.1 Effect of COVID-19 on Tourism

1. COVID-19 impact on tourism is as acceptable as from previous diseases like SARS or H1N1.
2. Chinese tourism will be affected to a great extent as compared to other tourism destinations because the total GDP of China has an 11% share of tourism.
3. The travel industries such as hotels, cruises, and airlines have felt the hardest hit by COVID-19 disease.
4. The estimated decrease in air transport is 5% by the IATA, which is worth approximately US$29.3 billion.
5. The job loss in the tourism sector is one of the greatest impacts of this disease.
6. It is said that Asia tourism will be affected mostly by this disease.
7. The estimated time to come back for the tourism industry is approximately 10 months after the disease is over.

8. Restrictions on international travel and the closing of borders: In an effort to stop the pandemic's progression, governments all over the globe have imposed travel restrictions and shut down their borders. Because of this, there was a significant drop in foreign tourism, and both leisure and business travel ground to a standstill as a result.
9. The pandemic was responsible for a significant drop in the number of tourists who visited different countries throughout the world. Because of worries about their health and safety, tourists have been canceling or postponing their travels, which has led to a considerable decrease in the demand for tourism.
10. The tourist business is a significant contributor to the economy of the whole world; nevertheless, recent years have seen a significant drop in travel and tourism, which has resulted in serious economic repercussions. Numerous companies, including airlines, hotels, restaurants, tour operators, and local merchants, were forced to close their doors as a result of financial difficulties, layoffs, and other adverse effects.
11. Job losses and unemployment: The pandemic has caused a substantial number of job losses and unemployment, particularly in the tourist industry, which is a big employer on a global scale. A great number of towns and areas that are economically unstable as a result of their reliance on tourism have seen a loss of livelihoods.
12. Disruption of supply networks: The pandemic caused disruptions in supply chains throughout the world, which had an impact on the capacity of the tourist sector to offer products and services. The difficulty that was experienced by suppliers of goods and services in satisfying demand led to shortages as well as obstacles in doing business.
13. Closure of tourist attractions and cultural sites: A large number of well-known tourist attractions, museums, and other cultural institutions, as well as entertainment venues, were either shuttered for the time being or functioned with some limitations. This had a direct influence on how visitors experienced these sites as well as the sites' ability to generate cash.
14. Changes in traveler preferences and behaviors: Traveler preferences and behaviors saw substantial shifts throughout the epidemic. There was a movement toward domestic and local tourism, activities centered on the outdoors and

environment, and sites that were seen as being safer and less congested.

15. Acceleration of digital transformation: The epidemic has sped up the pace at which the tourist sector is adopting digital technology. As tourists sought safer and more accessible methods to organize and enjoy their vacations, the use of online reservations, virtual tours, digital health passports, and contactless services grew increasingly commonplace.
16. Sustainable tourism and the influence on the environment: The pandemic provided an opening for some introspection on environmentally responsible tourist practices. As a result of decreased tourist activities, favorable effects on the environment were seen, including a reduction in carbon emissions, levels of pollution, and the amount of strain placed on natural resources.
17. The recovery of the tourist sector has been slow and uneven from country to country, but there are positive signs for the industry's future. The efforts that have been put into vaccination, the adoption of health and safety procedures, and the construction of travel corridors have been essential in restoring passenger trust and making it possible to reopen crossings. However, there is still a great deal of uncertainty surrounding the long-term impacts of the epidemic on the tourist business and the future prospects of the sector.

15.4 Conclusion

Tourism has increasingly become a pivotal factor in the growth of both communities and nations, evolving into a routine aspect of human life. For instance, in India, tourism contributes 7.3% to the GDP and accounts for about 6.5% of total exports, underscoring its significant economic impact. Consequently, providing effective tourism experiences and efficient recommendation systems tailored to user preferences is crucial. In our research, we have conducted a comprehensive survey of various algorithms and methods previously implemented in this domain. Our analysis of these algorithms reveals that recommendation systems incorporating modern machine learning techniques offer greater efficiency and accuracy. With technological advancements, real-time and mobile-based recommendation systems are proving to be increasingly effective in the tourism sector. Additionally, optimizing route discovery for tourists represents a promising area for enhancing tourism recommendation systems, further enriching the travel experience.

15.5 Future Work

The work done in the recommendation system has been done at an extreme level and the overcoming of the limitations has also been in progress. Here the work studied also provided us with a view for the future planning of the recommendation in the tourism sector. There is a lot of work that could be done in the future in recommendation systems that could work on the basis of artificial intelligence so that the recommendation can be made as per human thinking. Future work can be implemented by making use of AI. The route planning approach for recommendation systems can be created more effectively by making use of genetic algorithms. Furthermore, the group recommendation system can be improved by keeping the choices of every individual in mind and satisfying the whole group.

- Contextual Recommendations: In the future, research might focus on ways to improve recommendation systems by including a greater number of contextual aspects, such as time, place, weather, and the preferences of the user at certain times. It is possible for passengers to get ideas that are more relevant to their needs at the appropriate moment thanks to recommendations that take context into account.
- Incorporation of Data from a Wide Variety of Sources: There is potential for the incorporation of data from a wide variety of sources, such as social media, user-generated content, travel blogs, and real-time information. When recommendation systems integrate a wide variety of data sources, they are able to provide passengers with suggestions that are both more complete and up-to-date.
- Personalization and User Modeling: In the future, researchers may investigate more complex methods of user modeling in order to get a deeper comprehension of individual preferences, interests, and behaviors. Recommendation systems are able to deliver highly customized and specialized suggestions by utilizing user data and machine learning algorithms. These recommendations are catered to the specific requirements of each individual traveler.

- Approaches to Hybrid Recommendations: Future research might concentrate on the creation and assessment of hybrid recommendation approaches. These approaches incorporate a number of different methods, such as collaborative filtering, content-based filtering, and knowledge-based methods. It is possible to increase suggestion accuracy, variety, and coverage using hybrid models by capitalizing on the characteristics that diverse methodologies provide.
- Explainability and Transparency: The creation of recommendation systems that are both transparent and explainable is very necessary in order to win the confidence and approval of end users. It is possible that future research may concentrate on the incorporation of explainability methods into recommendation algorithms. This would make the system more open and transparent to passengers by enabling them to comprehend the logic behind the suggestions.
- Research may investigate the incorporation of social impact variables, user evaluations, and recommendations from friends and influencers into the product recommendation process. User-generated content refers to content that is created by end users. Recommendation systems are able to deliver suggestions that are more reliable and socially informed when they make use of user-generated material and social relationships.
- Evaluation Metrics and Benchmarking: Evaluation metrics and benchmarking frameworks may be specially built for tourist recommendation systems if future research produces standardized evaluation metrics and benchmarking frameworks. Researchers will be able to compare various algorithms and methodologies, which will lead to breakthroughs in the area. This will be made possible by using consistent assessment methods.
- Considerations about Ethics and Privacy: Given that recommendation systems deal with personal information, it is vital that considerations about ethics and privacy be taken into account. In the future, research should concentrate on the development of recommendation methods that protect users' privacy and on the promotion of ethical data use practices in the tourist industry.
- Long-tail and Niche Recommendations: There is an opportunity for recommendation systems to encourage people to

discover locations, attractions, and activities that are not as well known. In further research, methods might be developed to produce suggestions for long-tail and niche preferences, which would assist tourists in locating one-of-a-kind and individualized travel opportunities.

- Real-time and adaptable Recommendations: There is the possibility for recommendation systems to deliver adaptable and dynamic recommendations based on real-time information, thanks to the growing availability of real-time data and improvements in technologies such as the Internet of Things (IoT). This may provide travelers the ability to make well-informed choices while they are away, taking into account the many conditions and preferences they encounter.

Abbreviations Used

Create Table Here

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16

Secure and Reliable Routing for Hybrid Network to Support Disaster Recovery and Management

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Abstract

Rapid and easy deployment is the main characteristic of a mobile ad hoc network (MANET), which does not require any pre-existing infrastructure. Mobile nodes function as both hosts and routers, allowing them to join and leave nodes at any time. This flexibility is highly sought after in modern mobile ad hoc networks, which are employed in various sectors like military operations, search and rescue missions, and disaster recovery efforts. However, these networks do have limitations in terms of scalability, flexibility, and reliability. On the other hand, infrastructure-based networks (IB) are more reliable and secure. Many researchers recently worked on the hybrid approach of the network but the existing network is not secure and reliable. This study proposed an integrated approach to address the limitations of ad hoc networks by using the benefits of both ad hoc networks and infrastructure-based networks. This hybrid system is particularly advantageous in applications like disaster recovery and rescue operations. Hybrid networks enable individuals affected by disasters to communicate directly with emergency responders at the scene. Because victims require rescuers' prompt assistance. The proposed new secure and innovative strategy for disaster management communication involves merging MANETS, infrastructure-based networks, and vehicle networks into a single hybrid network. This will increase dependability by reducing packet loss and latency. In the proposed work, the standard AODV protocol is modified, to adopt the properties of MANETs, IB, and VANETs and also to provide communication among three networks. Ns-2 simulator is used for the

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simulation and performance measurement of the proposed hybrid network. The performance of a hybrid network is measured on the base of packet drop rate, packet delivery ratio, and network throughput.

***Keywords*:** Mobile ad hoc network (MANETS), infrastructure based network (IB), base station (BS), roadside station (RSS), vehicular ad hoc network (VANETS), hybrid networks

Abbreviations

The abbreviations used in this manuscript are given below:

IB	Infrastructure based
AODV	Ad hoc on-demand distance vector (AODV) routing
VANET	Vehicular ad hoc networks
QoS	Quality of service
OLSR	Optimized link state routing (OLSR)
TCP	Transmission control protocol
RREQ	Route request
RREP	Route reply
FTP	File transfer protocol
P2P	Peer to peer

16.1 Introduction

With the passage of time, the use of remote vehicular systems has significantly advanced, mostly through the expanding notoriety of the web and PC systems [21–28] when all is said and done. To individuals, it turns out to be more imperative to be adaptable, and autonomous from wires and workspace, however, to be associated with the system, in any case. Distinctive conventions have been produced and proposed for such purposes, however, several regardless of depend on the cabled base, for example, remote base stations, for the occasion. In those systems, the steering in the middle of sender and recipient is not achieved by the remote system but rather still by the cabled parts [1, 2].

Nowadays, the center of exploration is being determined to innovations and steering conventions, which no longer require base stations, settled switches, or whatever other foundation: Vehicular ad hoc networks. In a vehicular specially appointed system all hubs might move haphazardly and are associating progressively to each other. This new sort of system generally augments the operational region of PC systems. They might be utilized as a part of territories with practically zero correspondence bases: consider crisis seeks, salvage operations, places where individuals wish to rapidly share data, similar to gatherings, or evasion of backside crashes, if autos take an interest in such a system.

Vehicular-based ad hoc networks (VANETs) are designed for purposes such as safety, traffic management, and commercial applications. In this, Automobiles are capable of exchanging data with one another regarding hazardous road conditions, traffic jams, or unanticipated halts. Additionally, VANET technology can be encouraged to be adopted more quickly by offering commercial services like data exchange, infotainment, and multiplayer games for passengers in the rear seats of vehicles.

It is becoming more common for clients of vehicles to talk to each other remotely than it has been in recent years. The advancements in smartphones and other distant information specialized devices, such as modems and LANs, have kept it going. Theoretically, two various types of remote systems exist, although at first glance the difference between the two may not be significant. An example of a reliable infrastructure remote system is the most common and popular type today, which is a remote system built on top of a "wired" system [3].

The remote hubs are associated with the wired system and ready to go about as scaffolds in a system of base stations. The core problem with this system is related to handoffs, in which one base station attempts to transmit a connection to another reliably, instantly, or via parcel loss. Another pragmatic issue in systems in light of cell framework is that it is constrained to places where there exists such a cell system base.

A specially appointed remote system (AWN) is a gathering of vehicular hosts shaping an interim system on the fly, without utilizing any altered framework [4–10].

Attributes of AWNs, for example, the absence of focal coordination, portability of hosts, powerfully changing system topology, and constrained accessibility of assets, make QoS provisioning extremely difficult in such systems. The Figures 16.1 shows about the example of ad hoc networks., Figures 16.2 shows about the hybrid network architecture, Figures 16.3 shows about the network topology of hybrid network, Figures 16.4 shows about the topology of secure hybrid model, Figures 16.5 shows about the network throughput, Figures 16.6 shows about the packet-delivery ratio and Table 16.1 shows about the parameter setting. Specially appointed remote systems (AWNs) are zero arrangements, self-sorting out, and exceptionally dynamic systems shaped by

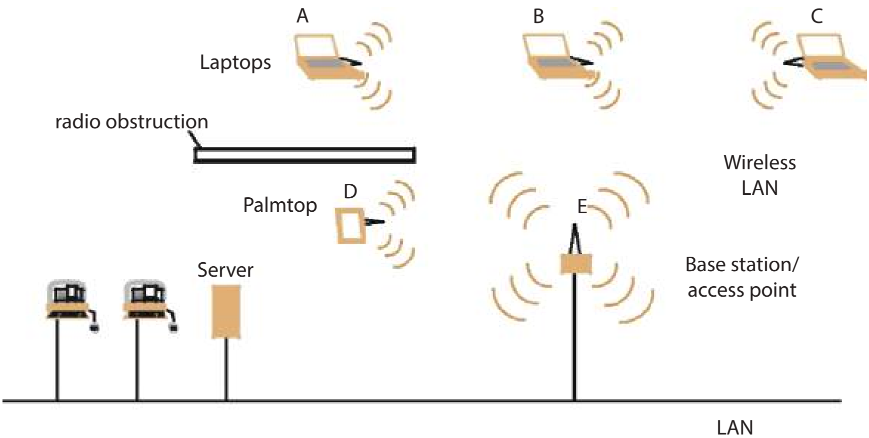

Figure 16.1 Example of ad hoc networks.

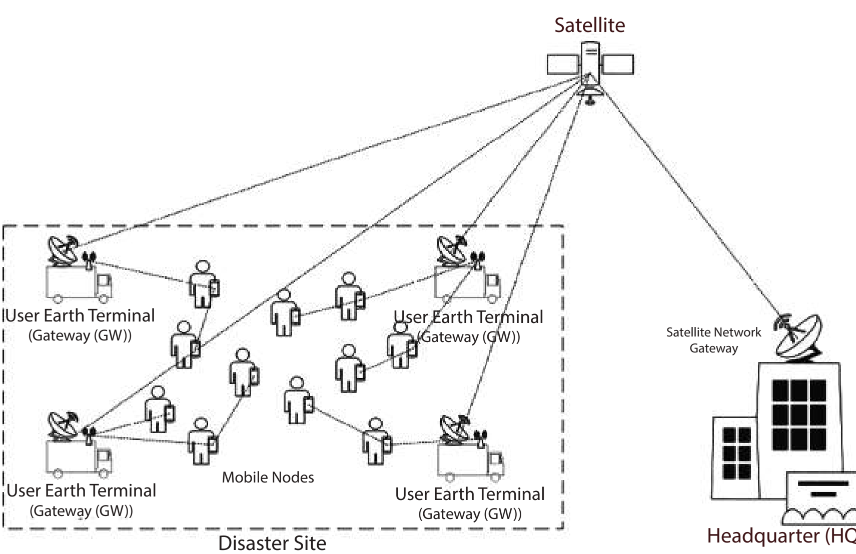

Figure 16.2 Proposed hybrid network architecture for the disaster recovery system.

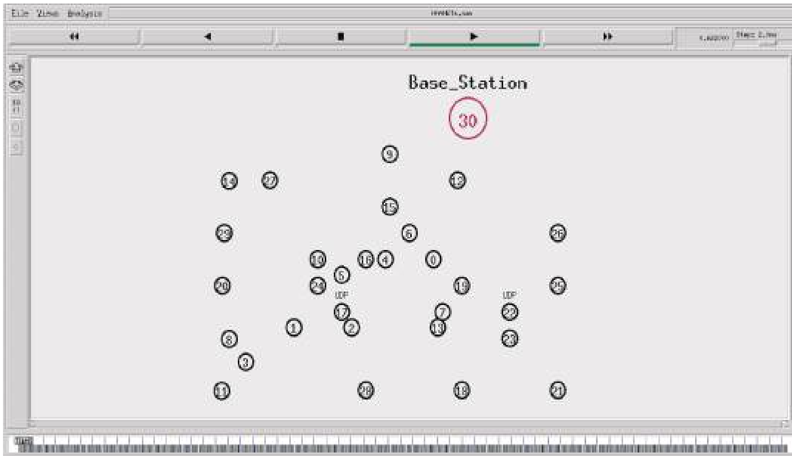

Figure 16.3 Network topology of hybrid network.

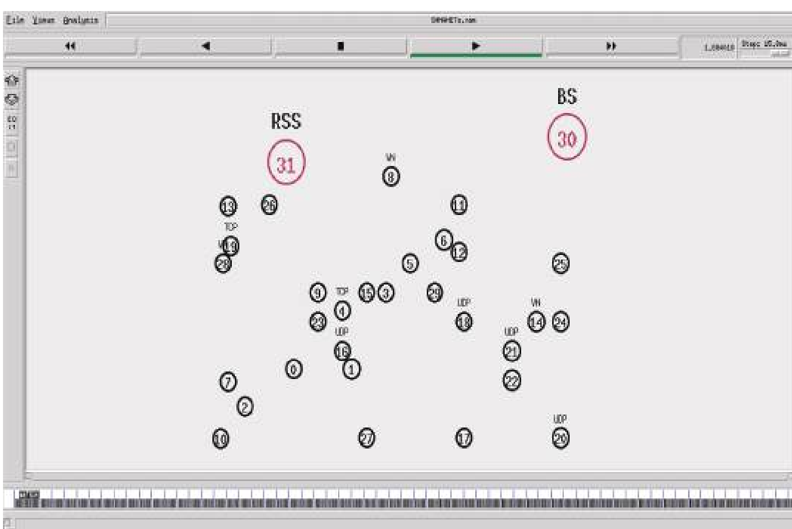

Figure 16.4 Network topology of secure hybrid model.

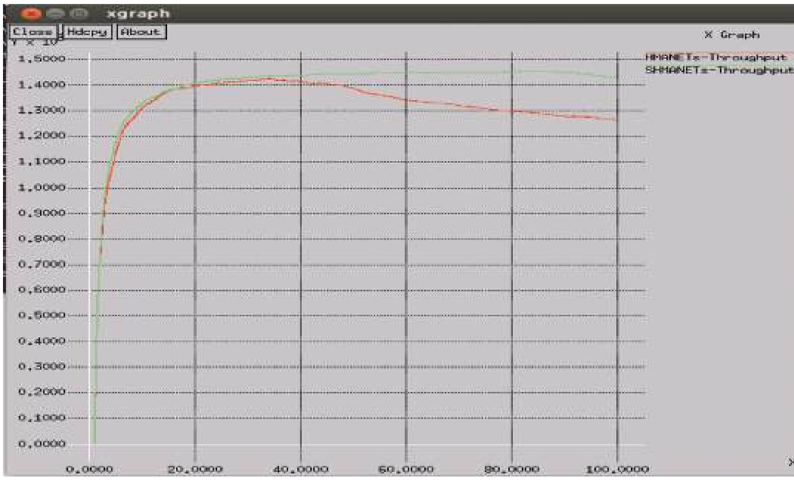

Figure 16.5 Network throughput between hybrid and secure hybrid models.

Figure 16.6 Packet-delivery ratio between hybrid and secure hybrid model.

an arrangement of vehicular hosts associated with remote connections. These systems can be framed on the fly, without requiring any altered foundation. As these are frameworkless systems, every hub ought to act additionally as a switch. Throughout this study, the terms "Vehicular home," "hub," and "station" are utilized reciprocally. Like a switch, the vehicular host speaks to a

Table 16.1 Parameter setting.

Simulation time	**100**
The static node density is measured in nodes per square kilometre	200
Area of experimentation (in square kilometres)	1
Transmission duration (in seconds) of the packet	50–60
Distance of transmission (in meters)	100
Number of nodes being sent (node count)	2
Duration of the mechanism (in seconds)	3/5/7

middle-of-the-road hub which advances movement in the interest of different hubs. If the destination hub is beyond the transmission range of the source hub, the source hub relies on intermediary hubs to communicate with the destination hub. The military utilizes these systems for strategic communication in various scenarios, including on the front lines, among a fleet of boats, or in a group of heavily armored vehicles. Nonmilitary personnel applications incorporate distributed processing and document sharing, teamed up registering in a gathering lobby, and inquiry and salvage operations.

16.2 Related Work

A suitable block control method for a lightweight ad hoc system is treated as a vital issue. Several studies have addressed some of the blockage-related problems and provided appropriate solutions, such as throughput debasement and bundle overhead. Numerous analysts execute profitable exploration in the range of blockage control in versatile ad hoc systems by PC recreations and examinations. Here we are displaying an overview of current work done in the area of blockage control in MANET.

Lochert *et al.* [11] examined “Traffic Control in Mob Ad Hoc Networks”. In this paper, the author gave a review of existing propositions, clarified their key thoughts, and demonstrated their interrelations.

Wang *et al.* [12] proposed transmission control protocol-fit congestion control algorithm. TCP-FIT is valuable in both remote and high BDP systems. The calculation depended on parallel TCP, however with a distinction that one and only TCP association with one blockage window is set up for every TCP session, and there was no alteration to different layers of the end-to-end framework. Revolutionary trial findings for broadcast wired media and unguided media at various topographical areas utilizing system test systems and at various times of the day are introduced.

Thilagavathe *et al.* [13] suggested an efficacious and reliable MANET energy-aware routing method based on cross-layer overpopulation control. In this, the cross-layer method to get around problems that happen in the MAC and delivery layers of a MANET. The way of adding more substance and multiplying it down is linked to the rate-based blockage control of the transport layer convention. The source will build a path for transmission that is free of blockages if it gets information about them from both the MAC and transport layers at the same time for the same course. Rate control will not be needed in this case.

Sivakumar *et al.* [14] proposed another dispersed burden-based directing calculation planned for an assortment of movement classes to set up the best steering ways. This methodology figures the cost metric in light of the connection loads. Here sight and sound activity is considered as high need movement and its steering is done over the delicately stacked connections such that the connections at the lighter burdens are chosen as a different option for connections holding heavier loads. Furthermore, the assets are distributed equally between the low- and high-activity need movements. The gently stacked way is utilized by typical activity as a part of the absence of sight and sound movement.

Ikeda *et al.* [15] suggested a way to handle too much traffic in wireless mobile ad hoc networks. The authors of this study looked at how to handle clogs in multi-stream flow in remote flexible unplanned systems (MANET). The NS-3 open-source system test system is used for fun while thinking about the OLSR routing standard. The creators implemented the MANET framework using an arbitrary waypoint mobility model with several hubs, by transmitting multi-stream traffic in the network. They discovered that connecting clog control components amongst many streams can sometimes present challenges.

Habachi *et al.* [16] developed MOS-based profusion control for wireless informal services. This computation uses a partially observable Markov decision process (POMDP) structure to determine the best clog control arrangement to improve the recipient's long-term QoE. Calculating an ideal method is time-consuming and limited with remote devices, therefore ideal arrangements are based on the worldly distinction (TD-λ). Web-learning computations. At last, the creators performed some useful inquiry of computation with unidirectional and bidirectional correspondences over a remote system. Creators watched that for both situations, calculation enhances essentially the QoE contrasted with standard AIMD clog control component.

Sharma *et al*. [17] introduced a technique based on the AODV routing protocol. In this study, the author describes an agent-based traffic control technique for mobile ad hoc networks (MANETs). The suggested technique involves the collection and distribution of information on system clogs through the use of mobile agents (MAs). The utilization of a mobile agent–driven congestion control system AODV routing protocol helps to prevent congestion in the ad hoc network. Portable operators are gathered in a versatile specially appointed system, which conveys steering data and contains hub blockage status. When a mobile agent (MA) moves through the network, it can select a less congested neighboring node as its next hop and update the routing table based on the node's congestion status. Hubs can get dynamic topology. Reenactment results have demonstrated that the proposed strategy accomplishes high conveyance proportion and throughput with the least postponement when contrasted with another method.

According to Zaini *et al*. [18], researchers should look at how mobile routing protocols and congestion-control protocols interact with one another. In this title, the creators analyzed their exploration from two perspectives. Firstly, we should examine the performance of TFRC and TCP across AODV and DSR in terms of throughput, delay, and jitter, as these are the fundamental guiding principles. The second objective of their study was to determine whether MANET routing protocols have an impact on transport protocols. Each hub was assigned CBR activity, transport control rules, and steering convention. To replicate the variety of the hub, they implemented a Random Waypoint mobility model with varying speeds of five, ten, fifteen, and twenty meters per second (m/s) and a 10-second pause interval.

Lê *et al*. [19] introduced an Energy-Aware Congestion Control System designed for various routes. TCP This study presents the development of an energy-efficient congestion control algorithm for multipath TCP, referred to as ecMTCP. The ecMTCP algorithm redistributes activity from more congested routes to less congested routes, as well as from high-energy cost routes to low-energy cost routes. This algorithm effectively achieves load balancing and energy savings. The reenactment findings indicate that ecMTCP achieves greater energy savings compared to MPTCP.

In their study, SenthilKumaran *et al*. [20] introduced the concept of Clog Free Switching in ad hoc networks. The creators of this study discussed congestion-free routing in ad hoc networks (CFR), which involves a robustly evaluated component for monitoring network traffic by calculating the average queue length at the node level. The congestion level of the hubs is categorized into three distinct areas (safe area, moderately crowded area, and highly congested area) based on the average length of the queues. CFR utilizes neighboring nodes with low congestion levels and uses the course discovery component to identify an unobstructed route between the source and destination of the use. This route transforms into a central pathway located between the starting point and the destination. To maintain an unobstructed flow of information, the hubs responsible for transmitting data parcels periodically calculate their congestion state at the center level. When a central node is observed, it enters a susceptible congested area and notifies its neighboring nodes [21]. The advanced central hub is aware of this situation and initiates a new route discovery feature towards a specific destination. Finally, this hub discovers an uninterrupted route to the target.

Ruengsatra *et al.* [22] introduced a "hybrid communication method to construct a disaster recovery system". Utilizing a hybrid communication strategy enables victims to directly transmit messages to rescuers, provided that the destination is chosen suitably.

16.3 Proposed Methodology

The proposed study aims to provide a novel and robust hybrid method for secure communication under disaster scenarios, where all existing fixed networks are rendered inoperable, resulting in a complete halt in communication. In this scenario, a supremely dependable network is necessary to preserve the life of the individual in distress. A dependable network is characterized by a high packet delivery ratio. Several academics are now investigating the aforementioned problem. Ruengsatra *et al.* [22] have put forth a hybrid network that integrates both a peer-to-peer (P2P) based method and an internet-based (IB) approach. However, this solution still faces challenges in terms of security, scalability, flexibility, and reliability. Due to their flexibility, infrastructure-based systems (satellite networks) and ad hoc networks for mobile devices (MANETs) are more suitable for purposes such as disaster recovery and management. MANETs are wireless networks consisting of nodes that move and serve as both hosts and routers and have a reduced infrastructure. Several infrastructure-based networks can provide global coverage owing to their extensive coverage area.

The catastrophe management and response operation system is an important communication channel. Wireless communication has reached numerous milestones, but its implementation during a disaster is panic. However, communication infrastructure, including cellphone networks, failed owing to a disorderly disaster. Reliable communication is crucial for preventing disasters and saving lives. The proposed approach is effective during disasters, saving lives and facilitating timely relief efforts. The system does not use commercial channels, such as GSM or GPS.

The dedicated system makes use of sensors that are immune to interference and intrusions. A catastrophe control room will be established with an alert system to cover the entire geographical area. Relief measures are communicated via VANET/MANET to all resettled individuals.

- In the current scenario, following a disaster, information is only transmitted through the base station.
- Community members are being made more aware of how to be better prepared by using the building center's media network.
- When there is a disaster, the VANET nodes set up a brief ad hoc network.
- The AODV protocol is used in these networks to find the adjacent VANET.
- Each VANET in ad hoc networks functions as both a transmitter and a receiver.
- The data is sent from the starting point to the endpoint through intermediate VANETs, without the need for a base station.

The benefits of worldwide coverage, high mobility, flexibility, and reliability for catastrophe sites have been merged into a hybrid network that combines MANETs, VANETs, and satellite networks (Figure 16.2). This research work proposed a new secure hybrid approach for disaster recovery to overcome the above problems to improve reliability and fulfill Quality of Service (QoS) requirements. Thus, the inspiration for our suggested routing protocols came from a need for a solution that could operate on both MANETs and VANETs, use the fewest resources possible, and be reliable in multi-rate networks—all while meeting the requirements for the shortest possible routing delay time.

Successful transmission of packets is more critical in disaster management since every single one may hold data regarding a disaster survivor. According to this hypothesis, the performance of the routing protocol on PDR is our primary focus, and we would not be paying much attention to the other metrics. Gateway connects the different networks and it could create a bottleneck in the network's performance in the hybrid network. Therefore, most critical in the hybrid network to design a routing protocol that can efficiently discover and select the gateway.

Discovery of Gateway

In the given circumstance, conventional routing fails miserably when it comes to mobile ad hoc networks when it comes to recognizing gateways. Therefore, the recurrent routing protocol AODV is adapted accordingly. The route discovery process is shown below:

Step 1: The source node will start finding paths on request if it fails to find one to the destination. It proceeded to transmit an RREQ message.

Step 2: When the RReq packet is received at the node then

Case 2.1: if (it is intermediate mobile node OR vehicle node)
then check whether the RReq packet has been received before then
discards the RReq packet.
Else if (it is a mobile node) then
The mobile node re-broadcasts the RREQ message to its neighbors until it reaches the destination node.

Els

Any time a vehicle node wants to know if there is a vehicle closer to its destination, it checks its neighbor database. It is possible to send the RREQ packet to a vehicle that is closer to the receiver.
In the absence of any vehicles that are physically closer to the receiver, the RREQ packet is transmitted to every neighboring vehicle and continues as before until you reach your starting point.

Step 3: Route reply: The destination node (mobile or vehicle node) generates a Route Reply packet (RREP) and it chooses the shortest route and all the other RREQs that are received are discarded.

Gateway Selection

In normal wireless networks, gateway nodes are selected without any cross-verification; sometimes, this becomes a cause for high packet loss. In the proposed method, the principle of multipath routing in AODV checks the reliability of that gateway before selecting any gateway for communication and every time monitors the status of all other available gateways (APs) according to the reliability. Reliability is defined as the successful packet delivery of all packets from the source to the destination. Reliability R of the source node to the gateway node is defined by the following equation:

$$Reliability(R) = \prod_{1=0}^{n-1} r_{n_i} r_{n_{i+1}}$$

where n is hop count in the path, n_i is the i-node and n_{i+1} is the i+1-node in the path, r_{n_i} is the reliability of node n_i, and $r_{n_{i+1}}$ is reliability of node n_{i+1}.

16.4 Experimental Results

An analysis of the PDR improvement is conducted through a battery of simulations and measurements with both modified and unmodified variants of two pre-existing AODV routing protocols. We evaluate the improvements using AODV, a reactive procedure. Additionally, we investigate how the improvement may affect other network performance indicators such as latency and application packet delivery percentages. Both ad hoc networks with a single hop and those with several hops were tested. All of the modeling was done in NS-2. The open-source network simulator NS-2 is available for free and works with both wireless and wired networks. The rich wireless protocol models provided for NS-2, particularly a MANET library that incorporates routing protocols AODV, are the key reason to use NS-2 over other simulation tools.

This dissertation only makes use of the NS-2.35 remote system test system for all of its recreation needs. Figure 16.3 and Figure 16.4 show two recreation situations are utilized one for existing and the other for a secure half-breed model. For recreation of the past model utilize 30 hubs and 1 base station and in the proposed model reenactment 30 hubs 1 base station and 1 street site station are utilized.

We used a seed size of one and a reproduction time of one hundred seconds. The 800 m x 600 m zone has been used to illustrate all of the different scenarios. In the case of the portable hub, the random model is utilized, whereas the directional model is utilized for the vehicle hub. In this model a versatile hub is at first put in an irregular area in the reenactment territory, and after that moved in an arbitrarily picked heading at an arbitrary velocity between [SpeedMin, SpeedMax]. The development continues for a particular measure of time or separately, and the procedure is rehashed a foreordained number of times. We pick Minimum speed = 5 m/second, Maximum speed = 30m/s, and delay time = 10s to 25s.

All the reenactment work was done utilizing UDP and TCP variations (Reno, Lite, Tahoe) with an AODV directing convention. Network activity is given by utilizing a File Transfer Protocol (FTP) application and consistent piece rate (CBR). Record Transfer Protocol (FTP) speaks to the File Transfer Protocol server and client.

16.4.1 Simulation Parameter

This section outlines the process of replicating the motion employed in the tuning guide intermediary parameter. We categorized the area into four distinct ranges based on the distance from the primary base station. We pick five random nodes in each territory to convey messages to rescuers. Since our framework is constructed based on the OLSR protocol, we contrasted the output with the first one (framework with simply the OLSR convention). We repeated the technique 10 times at regular intervals. Table 16.2 has several parameters.

Secure Hybrid Communication Model Parameter:

16.4.2 Simulation Result

In this, we depict that different examinations on the premise of system throughput, bundle conveyance proportion, load on the system, and parcel drop. In all cases, we can find that the proposed strategy or answer for finding the way performed great results concerning customary calculations. The network's throughput is based on its capacity to send and receive packages in a given amount of time. The new model's throughput performance surpasses that of the previous one, as seen clearly in Figure 16.5.

Table 16.2 Parameter setting.

Type of channel	**Wireless link**
Radio-proliferation model	Two-ray ground propagation
System interface sort	Phy/Wireless Phy
Macintosh sort	Mac/802_11
Type of interface line	PriQueue /Drop Tail
Reception apparatus model	Omni antenna
Quantity of vehicle hubs	4
Number of mobile nodes	32
Steering convention	AODV
Reproduction Area (m^2)	600×800
Reproduction Time (in second)	100

Packet-Delivery Radio (PDR): This ratio of packet-delivery is obtained by dividing the entire amount of bytes received at the intended location by the number of bytes supplied by the initial layer of application.
Network Load: Network burden is the aggregate number of activity that goes in the system at a specific time. Figure 16.7 depicts the system load conduct if there should be an occurrence of past model (hybrid network) movement is more in contrast with secure hybrid network because in half

Figure 16.7 Load on the network.

Figure 16.8 Packet drop rate.

breed organize more number of the bundle are dropped. Given this more number of retransmission in the system.

Packet Drop Rate: Figure 16.8 demonstrates the bundle drop rate in the secure hybrid system and half system, in the secure cross-breed system, has more solid alternatives for information transmission so the is less number of parcels dropped in contrast with the crossover system.

16.5 Conclusion

As described in this work, the proposed scheme could fulfill the Quality-of-Service requirements of communication for disaster sites. The proposed scheme monitors all the gateway's statuses and selects a reliable gateway for communication. Our proposed method is a combination of MANET, VANETs, and infrastructure-based networks. By combining the strengths of the P2P and IB methods, this system can provide a hybrid solution that is both flexible and reliable. The scheme proposed in this work gives a better improvement in packet delivery proportion, network performance, and end-to-delay management compared to previous disaster recovery and management systems. An Efficient Hybrid System Representing Helpless Critical aspects of MANET include the ability to quickly change topology, a high degree of mobility, the likelihood of network partitioning, and the fact that end-to-end connectivity is not guaranteed. The routing methods we offer are designed to fulfill the needs of a multi-rate network, minimize network resource usage, and achieve the shortest possible routing latency. Within a disaster zone, the suggested algorithms are compatible with both MANET and VANET architectures. Without base stations, it ensures secure packet transfer between nodes and does not require any special gear or antennas.

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17

Machine Learning Techniques for Sentimental Analysis

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Abstract

Combining computer algorithms and statistics for bracket and predictive analysis, machine learning (ML) is an interdisciplinary field. This paper presents the popular machine learning approaches to sentiment analysis. Given this, a thorough examination and assessment of scholarly research papers, reports, journals, and white papers from both the public and commercial sectors is conducted in this literature review in order to explore and evaluate the idea of sentiment analysis. The purpose and main goals of this composition are to categorize and analyze analytically the present machine learning exploration methods and Sentiment Analysis executions on colorful operations. This analysis has the drawback of focusing solely on the operation side because the tackle and theoretical exposure material to the issue are prohibited since the operational side of the problem is the main focus of this study; the theoretical and tackle aspects are out of the question. The study concludes by providing a machine learning–based four-commerce sentiment analysis terrain investigation. The methods for machine learning applied in the area of sentiments in the oldest ages are enumerated in this work. Assiduity, finance, public sentiment, and politics are only a few of the several operation areas of sentiment analyses that are examined. Though the kind of metamorphosis used will be different depending on the dataset and language applied, this study may be able to extemporize the attainment of bracket styles using data metamorphosis. Because current computers are limited and cannot tackle whole data without any type of prior assessment, offer interest to the details, select the features, pertain metamorphoses, and filter the not significant data to produce machine learning styles that are broad and successful. Depending on the format of those data, machine learning techniques appear to frequently produce identical findings.

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This research operates under the assumption that there will be a chance for the prevalence of sentiment analysis applications in the future. Moreover, it anticipates a standardization of sentiment analytical techniques across various systems and services over time.

***Keywords*:** Sentiment bracket, sentiment analysis techniques, machine learning methods, computer algorithms, data metamorphosis

Abbreviations Used

BN	Bayesian network
CNN	Convolution neural network
DT	Decision tree
KNN	K-nearest neighbor
LR	Logistic retrogression
LSTM	Long short-term memory
ME	Maximum entropy
ML	Machine learning
NB	Naive Bayes
NLP	Natural language processing
NN	Neural network
PR	Pattern recognition
RF	Random forest
SVM	Support vector machine

17.1 Introduction

Sentiment analysis is a technique for gathering primary data from unstructured and undirected textual materials from a variety of online sources, including social media and live blogging, comments, and live chats on platforms like Facebook, Twitter, and WhatsApp. Opinion mining is the term used to describe the process of analyzing and condensing the opinions represented in these massive opinions created by people. Numerous drug users work on social media websites, e.g., Twitter develops flimsily, businesses are trying to record client feedback, and their product thoughts have access to multiple openings and new paths. Tweets are meaningful information and source of user's opinions or sentiments about the things that people, governments, and companies are interested in about the Twitter social network (for example, products, people, trends, and events). Nevertheless, a 2015 research states that Twitter generates 21 million tweets each hour, which is a pretty substantial amount of tweets every day. Automating the sentiment analysis system is necessary to streamline the tasks involved in assessing public opinions without requiring the manual reading of millions of tweets [1].

The robotic technique known as sentiment analysis can be used to determine if a human-created textbook presents a positive, negative, or standard opinion about an object (a thing, a person, a topic, a situation, etc.). Similar to document position, judgment position, and aspect or point position, there are four ways to complete a sentiment bracketing. The document position employs the full document to categorize it as a positive or negative sentence structure in the sentiment bracket. The judgment stance divides any judgment into three categories positive, negative, and general. It also classifies any judgment as either subjective or objective. Point or aspect position sentiment bracket type describes the process of locating and constructing item features from source data.

A. Strategies for Emotional Reconstruction

Many techniques are available for conducting sentiment analysis.

- **An approach Based on a Dictionary:** Using a wordbook holding positive terms and negative terms, the opposing viewpoint is assessed. Throughout the story, words that are optimistic and depressing are utilized. On the other hand, a higher rating will result in a favorable score for the textbook. Textbooks with a high percentage of negative or pessimistic language will be graded poorly. A neutral score is given, nevertheless, if the textbook has an equal number of positive as well as negative phrases. A wordbook with opinions—both positive and negative—is constructed in order to assess whether a word is good or awful. Many methods can be used to compile and produce a wordbook [2]. The dictionary-based method involves manually gathering a limited number of opinion words that adhere to predefined guidelines. The group is expanded by adding synonyms and antonyms of these terms that are also searched for in corpora such as WordNet or Gloss. Gradually, the collection gets smaller until there are no more terms. This system's annoying dependence on the dictionary scale, the sentiment bracket's intensity, is a problem. This strategy is flawed as the wordbook size grows.

- **Corpus-Based Methodology:** They use enormous pots to calculate syntactic and semantic opinion patterns. A sizable dataset that has been labeled is required because the produced terms are environment-specific [3].
- **Machine Learning (ML)–Based Approach:** How ML is used in the sentiment category relies on the employment of well-known and existing ML techniques on textbook data. Aydoğan *et al.* [3] and Dubey *et al.* [4] claimed that there are two main categories of ML: supervised and unsupervised.
  - Supervised Learning: methods under supervision base their calculations on named training primers. The application of supervised learning as a bracket system for categorizing opinions has produced some incredibly encouraging outcomes. The bracket methods (Figure 17.1) in sentiment analysis that are most frequently used include support vector machine (SVM) [5], maximum entropy (ME), naive Bayes (NB), decision tree (DT), and artificial neural network (ANN) classifiers. A few of the less common techniques are k-nearest neighbor (KNN),

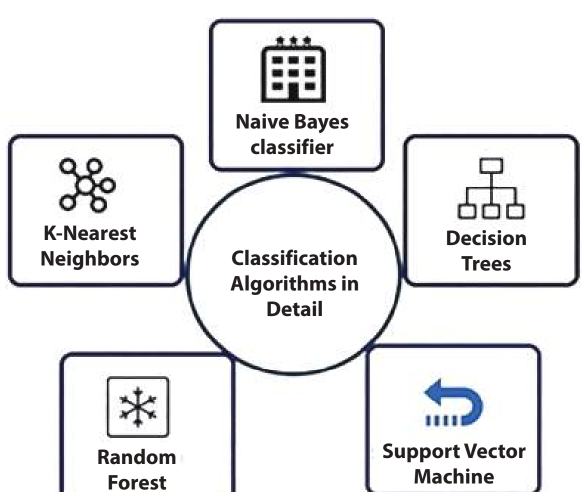

Figure 17.1 Classification algorithms in detail [8].

random forest (RF), Bayesian network (BN), and logistic retrogression (LR) [6].
- Unsupervised Learning: In this method, the classifier is not trained using pre-listed data, in contrast to supervised learning. Among unsupervised ML methods, K-means and apriori algorithms are the most utilized varieties. Moreover, unsupervised machine learning can be categorized into associations and clusters [6].
- Hybrid-based approach: Wordbook-based technique and machine learning (ML) are both used in the hybrid approach. Many research methods suggest combining automated learning techniques and wordbook-based to raise the emotional threshold. Such a hybrid strategy is mostly successful since it can combine both elements stylishly [1, 7].

Organization of Chapter
The rest of the chapter is outlined as follows: Section 17.2 shows applications of sentimental analysis, Section 17.3 shows related work, Section 17.4 outlines about existing methodology, Section 17.5 shows comparison and discussion, and finally, Section 17.6 concludes this chapter.

17.2 Applications of Sentimental Analysis

There are several industries that use opinion mining. Sentiment analysis can be applied in a variety of sectors, but none of them is more efficient than the others when it comes to assessing shifts in public opinion.

Tracking brands: Sentimental brand analysis facilitates prompt response, helps you identify possible or existing reputational issues, and keeps you informed about your market trust. Research that is competitive Competitors' roles in any company can be evaluated.
Identifying hot spots and ranking customer service: Sentimental grouping is used by grocery stores, transportation firms, banking institutions, hotel brands, and other businesses to optimize their consumer offerings. Text analysis users can also automate the prioritization, dimension, style, polarity, and style classification of incoming customer service messages. New communications from disgruntled and irate clients are handled first since it is best to put out a spark before it catches fire.

Analysis of the market and perceptions of industry trends: The problem of retrieving large amounts of unstructured data is addressed by emotion analysis. Advertisers track and study consumer behavior patterns in real time with the use of this text analysis in order to predict future actions and support management in making wise choices.
Employee engagement tracking and workforce analytics: Experts automate the analysis of SA tech employee questionnaires, assisting in the prompt resolution of problems and grievances. Personnel managers can identify and track keywords, the entire amount of comments, group results by department, and changes in employee emotions over time. Real-time tracking capabilities are provided by sentiment analysis for the next stage of worker mood management.

17.3 Related Work

A literature review is done to honor the procedures and results of novelettish analysis for the assaying and bracketing of viewpoints utilizing machine learning (ML) [30–35] methodologies, as well as to recognize the applications and solutions of sentimental analysis. Therefore, these methods must produce colorful solutions to the established challenges. To estimate the outcomes within specific bounds, certain groups and styles are also necessary. The evaluation concludes with a discussion of the consistency and importance of the evidence.

Sentiment analysis has experienced a remarkable surge, growing 50 times in the last decade and establishing itself as the fastest-growing academic field in history [9]. At the beginning of the Internet, forming judgments required consultation with musketeers, neighbors, and cousins due to the evolving nature of online content expression. The advent of Web2.0 has significantly altered how individuals express thoughts, emphasizing user-generated content across personal web pages, blogs, social media, and forums. The massive data generated through Web2.0 activities has propelled the rapid advancement of opinion mining [10]. Recent research has shifted focus toward topics like stock pleas and mortality sentiments on platforms like Twitter and Facebook.

Sophisticated techniques for handling massive, highly dimensioned datasets, significantly improved storage capacity, and difficult/complex data formats all contribute to big data. Innovative methods and/or state-of-the-art technology are required in this field of big data in order to divide up the different processing times and obtain valuable information without erasing sensitive information. According to Swathi and Seshadri [11], master learning algorithms are commonly allowed to learn from massive volumes of data and unearth priceless knowledge. To offer answers to these problems, ML techniques have recently been recommended as a new and quickly escalating field of research. Comprehensive descriptions are given of the different sentiment analysis algorithms. Analyzing a text's supplied opinions, studies, attitudes, and subjectivity is known as novelettish analysis. Talks include the consequence of many areas like passion discovery, transfer learning, and creating coffers, as well as recently published algorithms and innovative analytical methodologies. Classifying recent publications is the main objective of this examination. According to D. Kawade and Oza [12], a summary and dissemination of 54 of the most recent published articles that used sentiment analysis were done.

In addition to being an important venue for engagement, social media can be helpful in fulfilling requirements. Customers and businesses are pleased when this happens. Traditional grounded analysis presents a number of challenges that must be overcome before it can be evaluated. A multitude of techniques exists for the analysis of passions: emotional differentiation, meaning and theme discovery, cross-domain bracketing of passions, deals vaticinations, emotional differentiation, opposition of passions scores, emotional differentiation, meaning and sentiment discovery, etc. It also briefly covered the difficulties of applying cutting-edge analytics to the task. Massive datasets, rude language, the author's segmentation, energy management, and noise handling are a few challenges [13]. Customers' opinions can be used by the consumer to compare items. To boost the success of the customer reviews, they established controlled methods. Association rules approach and naive Bayes classifiers are the two categories of approaches that are discussed for classifying product features in line with consumer desires [14]. The favorite products that make the customer comfortable are analyzed and identified in this innovative study. The substantial character is taken into consideration in addition to the conditions. Yang *et al.* [15] conducted a pragmatic assessment and revealed two classifiers: class association rules and naive Bayes classifiers. Direct sentiment review classification is achieved by the use of ML methods such as natural language processing, n-gram, naive Bayes classifier, and bag-of-words.

Naive Bayes classifiers and Association rules approaches are the two categories of approaches that are discussed for classifying product features in line with consumer desires. The favorite products that make the customer comfortable are analyzed and identified in this innovative study. The substantial character is taken into consideration in addition to the conditions. An empirical evaluation has specified two classifiers class association rules and naive Bayes [16]. Direct sentiment review classification is achieved by the use of ML methods such as naive Bayes classifier, bag-of-words, natural language processing, and n-gram. It offers the possibility of novelettish analysis as well, such as shifting learning components from other domains that have not yet been thoroughly explored and the sensitive solution of problematic textbook data through transfer learning. The most promising study tool for the future, they believe, is aspect position sentiment analysis for small textbooks [17]. Maximum entropy classifier algorithms, naive Bayes, and Support vector machines are a few ML techniques that can be applied to the novelettish analysis of large amounts of data. Making strategic and effective decisions from a large amount of data is made possible by these techniques.

A significant quantity of data is provided daily in textual or numerical forms by Stoner shows on social networking sites like Facebook, Twitter, Yammer, and Yammer. These data are categorized as non-structured data, semi-structured data, and structured data. In addition, they have lately been dispersed on Stoner's station tow as positive, negative, and common points. Analyzing customer sentiment helps with product reviews, image reviews, and product evaluations. Sentiment analysis, a tool of natural language processing, strips social media messages of their positive and negative contrast. Young scientists' research into the study of opinion has been more successful, and digital social networks are growing more quickly affected by a society that uses internet media extensively. Companies that are keen to find out what the general public or their website visitors think of their social media offerings. The services offered by the Internet should be appropriate for assessing data on blogs, web forums, papers, tweets, and stoner feedback, claim [18].

17.4 Existing Methodology

Internet shopping is becoming one of the most common ways to purchase anything from inexpensive electronics to precious goods. Before determining whether to buy a product online, shoppers frequently look at other customers' reviews obtained through a credit standing system. This means that the retailer is forced by unpredictability to promote or showcase a product that is less valuable than its competitors. A standing system online should be able to identify conditions in which other drug users might attempt to sway the system through skewed positive and bad circumstances that could lead to conspiracy and exploitation, in addition to being qualitatively and quantitatively based on perception. It makes recommendations for a statistical framework to identify conspiracies, unstable situations, and any positive credibility issues [19].

A. SVM-Based Sentimental Analysis

Along with assessing the SVM algorithm's memorial, thickness, and delicacy, this experimental design also assesses the n-gram performance-enhancing function options. A variety of methods are used to calculate the opposition of analysis data. The famous and effective approach to sentiment analysis is ML-based. The opposition in examining data and the mainly effective methodologies are derived [20], as stated below:

Data Collection: Datasets can be used for any kind of textbook bracket work, regardless of the word count. Sentiment analysis was performed on similar datasets with little preparation (case folding, word removal, etc.).

Preprocessing Data Point for Selecting and Pointing Vector Construction: Getting the textbook data ready for additional work is the aim of this preprocessing phase. Reusing textbook data directly on a computer is the primary problem. You also need to analyze text data mathematically. Textual features are typically expressed through terms. This increases the dimension of the text representation. Enhancing categorization performance and processing effectiveness requires filtering features to eliminate noise and diminish dimensions.

Algorithms for Classifying Sentiment Data: If opinion mining can be used to uncover phony positive and negative evaluations, a secondary study is conducted to find out. A range of supervised machine learning techniques are evaluated utilizing data collecting, data sanctification, data transformation, and data reduction using the string-to-word vector. One is referred to as the bracket algorithm of a dataset. The classifiers utilized in the study included the help vector machine, K-NN, naive Bayes, k-star models, and decision trees. A confusion matrix is constructed for every one of the five groups or supervised ML methods put it in application to the two datasets. With k being the closest neighbor and the lowest error rate, down rate, lowest negative discovery rate, and maximum F1 metric, the authors extract data that shows that the SVM approach is the most fashionable, long-lasting, and accurate method for both datasets.

B. Synthesis of Machine Learning Methods

In ML, a branch of artificial intelligence (AI), machines are used to detect existing information, build new knowledge, and develop new skills. Search engines, data mining, computer vision, natural language processing, biometrics, credit card fraud detection, stock market request analysis, speech and handwriting recognition, robotics, DNA sequencing, and biometrics are just a few of the industries that have made extensive use of machine learning [21]. Popular methods for machine learning include:

- Linear regression is recognized as a direct retrogression when it uses independent variables to calculate the value of the dependent or reliant variable through statistical methods. Regression lines, commonly known as Y = a * X, show how two variables are mapped onto a line, with Y serving as the dependent variable, X as the independent variable, the intercept, and the pitch.
- Using the collection of unique variables, the distinct dependent variable is defined by logistic regression. Logistic retrogression supplies the components needed to estimate a probability logistic metamorphosis.
- A decision tree combining the decision tree with a structure resembling a tree allows it to be used for bracket and retrogression. Subsets of the training dataset are created, and a decision tree structure technique is used with the trendy attribute of each dataset.
- A device that can handle vectors double classifiers (BCs) are another name for support vector machines (SVMs). An N-dimensional point is used to draw row data. Here, the datasets are divided by an overactive aeroplane. This superior separation optimizes the perimeter of data for training. Bayesian naive—this system is based on the Bayes theorem, which is employed in increasingly complex bracket styles. It has a bracket style. It advances.
- CNN In this strategy, bracketing and retrogression are utilized. This is an algorithm that is fundamental to machine learning. The cases are stored, and it looks for new data in most of its KNN. The cases are not lost. With the aid of a testing dataset, KNN produces accurate predictions.
- The letter K stands for clustering. Without human guidance, the computer learns to reach the cap. The datasets were initially divided into clusters using Euclidean distance.

- Adjacent Forest The supervised algorithm's order is this. Multiple decision trees combined result in an arbitrary timber algorithm or a set of multiple bracket trees. Brackets and retrogression are examples of this. There are rules unique to the decision tree algorithm in the training dataset that is provided, along with targets and features.

C. Sentimental Analysis Architecture for Social Media Analytics
This method investigates comments, client feedback, emotion evaluation, writing emotions, and stations. A selection is made based on product reviews, which can be both favorable and negative. The critical frameworks (Figure 17.2) of the social community's rejection standard along with the scale of negative/good passions are attained by drug users or visitors [22].

Data Preprocessing: Preprocessing is more effective at locating and eliminating irrelevant, distracting, and discordant data.
Without URLs: URLs are of no use in analyzing the emotional content of non-formal textbooks. Like when, when, who, how, etc., the term "question" would not help to lessen the nebulosity of opposition.

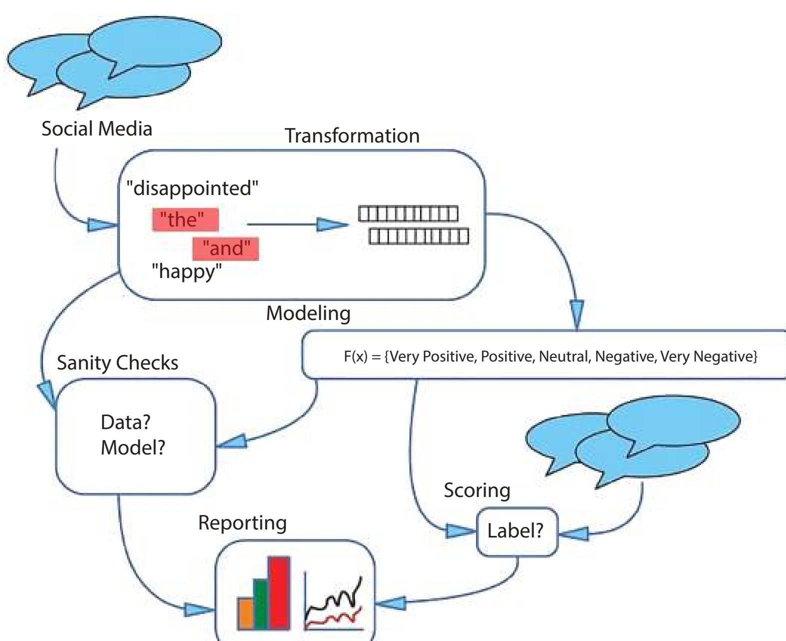

Figure 17.2 Diagram of social media sentiment analysis [23].

Getting Rid of Special Characters: To avoid contradictions, special qualities like and (), ()/' are separated using the function of opposition. Figure 17.2 represents the concept of social media sentiment analysis modeling.

17.5 Comparison and Discussion

The help vector machine, K-NN, naive Bayes, decision tree, and K-star classifiers were among those applied in the investigation. For every supervised ML algorithm that is used on the two datasets, a confusion matrix is created. The SVM method is the most stylish, longest-lasting, and accurate method for both datasets, according to the data the authors derive with k being the closest neighbor and the lowest error rate, down rate, lowest negative discovery rate, and highest F1 metric [24]. Gujar & Pardeshi [25] define an opinion mining system on social media via the novel ML technique. The method for the 2016 Indian Premier League tweet list that appears on Twitter's Application programming interface services is based on the hashtag (# IPTEAM). To estimate the Random Forest algorithms' performance, the sensitivity, perfection, and perceptivity of the previously required supervised machine learning techniques are used.

Using machine learning for enterprise discovery and negation in sentiment analysis, the discovery of negative knowledge and the identification of enterprise are the two most important components of judgment analysis. Through machine learning, this kind of novelettish analysis will be possible. This strategy makes the opposition described in the textbook's description stronger. The two phases comprise the analysis; for instance, the first phase entails configuring the document's negative indications and queries. Complete computation of this signal is performed in the alternate phase. Using the Simon Fraser University Review corpus, this opinion-mining feature is implemented. Some approaches, such as rigorous ones, utilize sophisticated linguistic analytic tools for the automated examination of viewpoints, cause serious problems with information genesis, and reveal unfavorable information [26].

On Supervised machine learning for multi-tier sentiment analysis, it is suggested to use a multi-level bracket armature that complies with crucial elements like data drawing and preprocessing, function selection, and bracket training using a multi-level vaticination model. It provides a detailed description of the armature's passageway. There are four groups in trials that examine the performance of the suggested multi-level armature using a study of the perception and opinions of 150,000 cinema viewers. The results have demonstrated that when the substantiated wordbook is used by more than 10 people, the multi-tier approach greatly boosts the pungency over the single-league model [27]. According to Kauffmann *et al.* [28], techniques for sentiment analysis separate textbook data into positive and negative data and look for opposition in the reviews. To get new insight into consumer product evaluation, the article employs Techniques for clustering, classical data mining, and natural language processing (NLP). This makes it possible to rate products according to particular characteristics. When selecting characteristics, positive and negative qualities are typically taken into account along with N-gram aspects. Through these experiments, they have proven that this fashion is, in fact, legal by compiling a significant amount of data from Amazon online assessments. The Sentiment analysis technique from a panoramic perspective was recommended by Kakulapati. A variety of approaches and strategies, including otologic, hybrid, Lexicon-based, Rules-based, and machine learning approaches, have been studied and contrasted. For opinion mining, they employed distinct levels, including aspect, emotive, document, sentence, and penalty levels [29].

17.6 Conclusion

Sentiment analysis, powered by diverse machine learning methodologies, proves invaluable across domains. From predicting financial market trends to understanding public sentiments on social media, the applications are vast. Continued research and innovation are essential for addressing emerging challenges and enhancing the accuracy and efficiency of sentiment analysis techniques. This review of the literature and research offers valuable insight into the value and advantages of categorizing and interpreting passions. The primary issue is the exact scope of sentiment analysis methods. Despite multiple attempts with high success rates, the delicacy probability in all ways and languages has not yet been reached. Because they are based on English-language textbooks, the majority of sentiment analysis styles are predominantly English. Work in other languages should be improved because the knowledge is not limited to English. This study's scope is limited because its operation side is mostly concerned with the rejection of proposition-related and tackle-related aspects.

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18

Design of 40-mm Period, 0.8-Tesla Variable-Gap Pure Permanent Magnet Undulator Magnet in RADIA

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Abstract
The RADIA is a three-dimensional magnetostatic code that refers to the optimization and design of undulators. The field integrals and mapping of the undulators are calculated in RADIA. This paper shows the design of a 40-mm period undulator for the university laboratory at DAVV. The angular offset and trajectory offset of the electron are calculated for the 8-Mev electron beam. It is shown that a cut in magnet block corners helps the mechanical holding of the magnets to the magnet keeper with a reduced field integral.

***Keywords*:** Synchrotron radiation, electron laser, magnet blocks, electron beam energy

18.1 Introduction

The undulator technology is a key tool for synchrotron radiation and free electron laser [1]. Over the years, the synchrotron radiation and free electron laser facilities have been updated through updates in undulator technology. In standard practice, the undulator technology is pure permanent magnet (PPM) undulator and hybrid permanent magnet (HPM) undulator technology. Most commonly NdFeB and samarium-based rare

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earth magnets are used in the PPM undulators. The NdFeB has the highest remanence among all the rare earth magnets. Usually, four magnet blocks constitute one period of the undulator. There are typically several number of periods. The undulator period length and the number of undulator periods define the undulator length. As the electron radiates, the résonance condition between the electron and the electromagnetic changes and gets detuned as the relativistic electron beam energy lowers. In the tapered geometry, the magnetic field strength decreases as the electron beam to prolong the resonance condition. Most recently, this concept has bee further extended to define an asymmetric magnet pole undulator where the upper and lower magnet arrays have different period lengths. Different types of magnetic fields and undulator raditions are obtained by changing the phase shift between the upper and lower magnet arrays. When the magnet field of the two arrays is different, the stronger one has the dominant role, whereas the weaker one has a modulation role on the magnetic field. The asymmetric magnet pole undulator has two defined axes. The geometrical axis is defined as the half of the undulator gap where the two field amplitudes from the upper & lower magnet arrays are unequal. The beam axis is defined as the axis where the field amplitudes from the two magnet arrays are equal. The beam axis is close to the array with a shorter period length and away from the magnet array with a larger period length. The asymmetric magnet pole undulator has the advantage of realizing different magnetic field profiles by choosing the period lengths and amplitude of the upper and lower magnetic fields and changing the phase shift between the arrays. It is capable of producing circularly polarized light in the off-axis orbit and can operate in quasi-period mode to prevent higher harmonic on the axis [2–4]. Composite period undulators [5] and permanent magnet undulators to improve the wavelength tunability of the free electron lasers have been worked out. A change of undulator period length is an scheme to tune the emission spectrum in a variable period undulators. The transverse gradient undulators and Delta undulators have been developed and are in use. The APPLE (advanced planar polarized light emitter) design produces higher field amplitudes. In the APPLE design, four magnet arrays are arranged with a conventional Halbach field configuration. The polarization is changed by moving the diagonal arrays [6]. The magnetic field of a knot undulator is proposed [7]. Cryogenic permanent magnet undulators have been built with PrFeB magnets. PrFeB magnets show an increase of remanence and coercivity with lower temperatures at liquid nitrogen temperature (77K). This allows for an increase in the peak magnetic field of the undulators built with PrFeB magnet blocks. Superconducting undulators with liquid helium baths have been designed and fabricated.

In Section 18.2, we report the design of a 40-mm period undulator in RADIA [8–10] for the university laboratory at DAVV. Results and discussion are presented in Section 18.3.

18.2 Undulator Modeling in RADIA

In this section, we report the conceptual design of a 40-mm period PPM (Pure Permanent Magnet) undulator with an 8-Mev electron beam to cover the radiation spectrum from 100 μm to 300 μm. The design calculations are done with RADIA. The undulator consists of 25 periods with NdFeB magnet blocks 10 mm thick, 50 mm wide, and 30 mm in height. The magnet blocks have been cut at 45 degrees 5-mm deep at the corners to concentrate magnetic flux density to the middle of the block and better clamping of the magnet blocks to the tapered clamps. The undulator will operate in the 16-mm to 32-mm gap range. A symmetric end design has been adopted and the gap dependence of the field integrals is evaluated. In the following, we present the results corresponding to the symmetric field configuration with half magnets at each undulator end. To appreciate the effects of the cut at the corners, the performance of an undulator structure is evaluated with magnets without cuts at the corners with regular magnet sizes of 50 mm, 30 mm, and 10 mm, as shown in Figures 18.1 and 18.2. Figures 18.3 and 18.4 represent two complete undulator

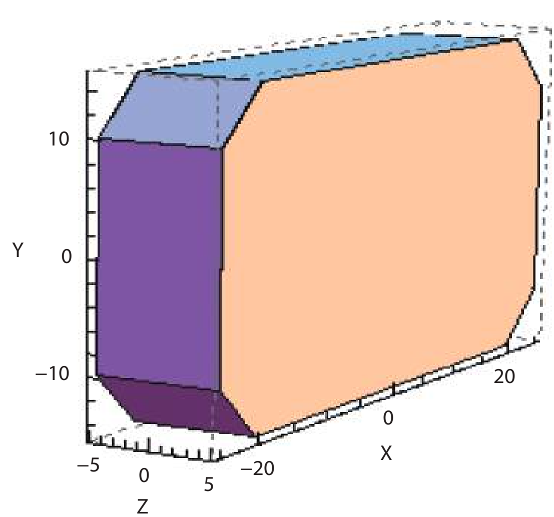

Figure 18.1 Magnet design with a cut at the corners for RADIA.

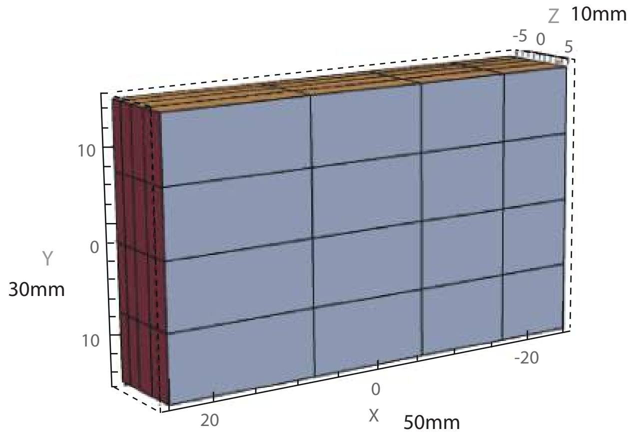

Figure 18.2 Magnet design without cutting at the corners from RADIA.

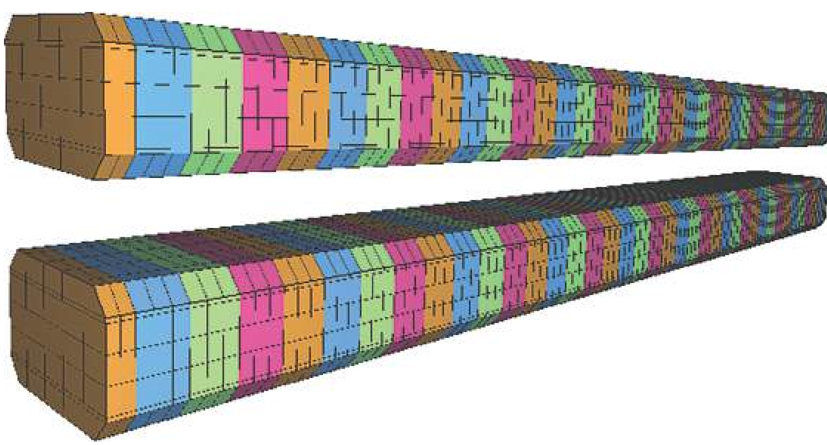

Figure 18.3 Symmetric end field configuration with a half magnet at each undulator end.

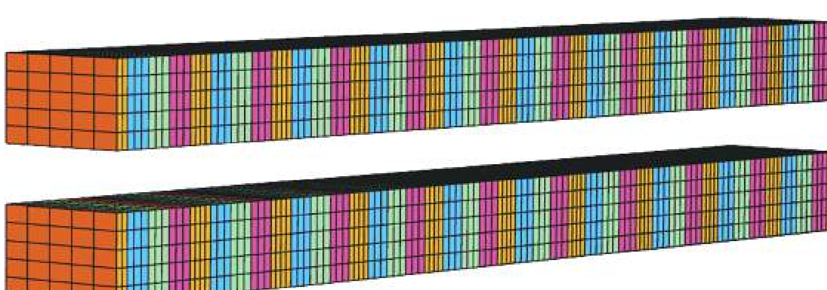

Figure 18.4 Symmetric end field configuration with a half magnet at each undulator end.

assembly design structures with cut and without cut magnets with half magnets at the end.

The results of the symmetric end design of the undulator employing without-cut magnets are shown in Figure 18.5. The values are computed for the undulator gap from 12 mm to 40 mm. The field is 0.8T at a gap of 12 mm.

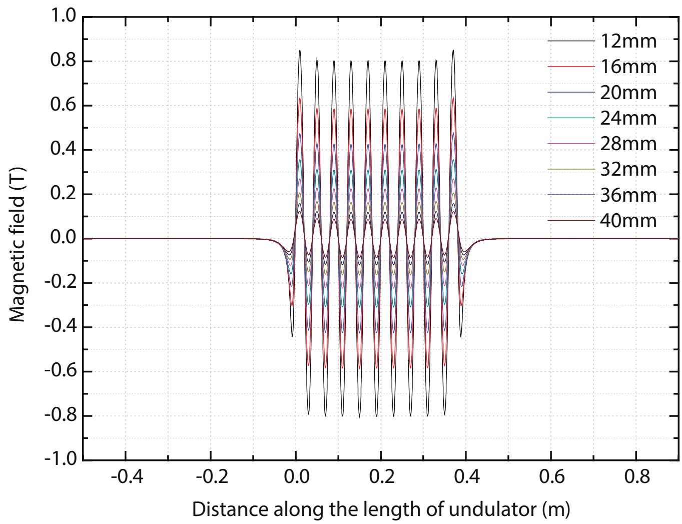

Figure 18.5 Magnetic flux density versus longitudinal position of the undulator magnet.

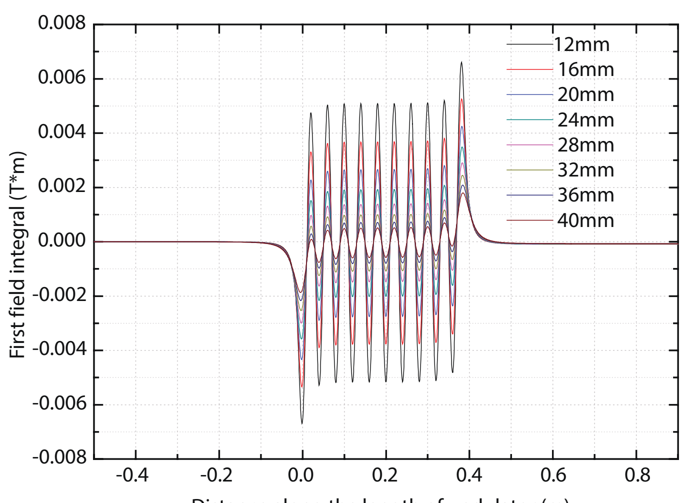

Figure 18.6 First field integral for the symmetric end design.

The first integral values are plotted in Figure 18.6 and the second field integral data is presented in Figure 18.7.

In Figures 18.8 to 18.10, we represent the magnetic flux density, the first field integral, and the second field integral versus length for the magnet structure with cut at the corners. The field is 0.8 Tesla at a gap of 12 mm.

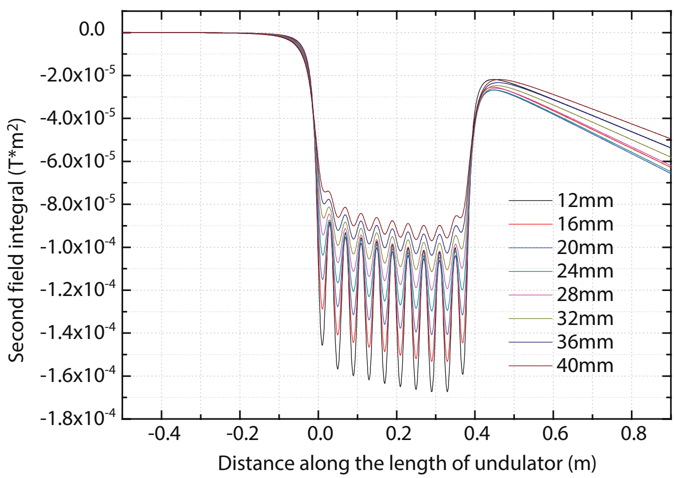

Figure 18.7 Second field integral for the symmetric end design.

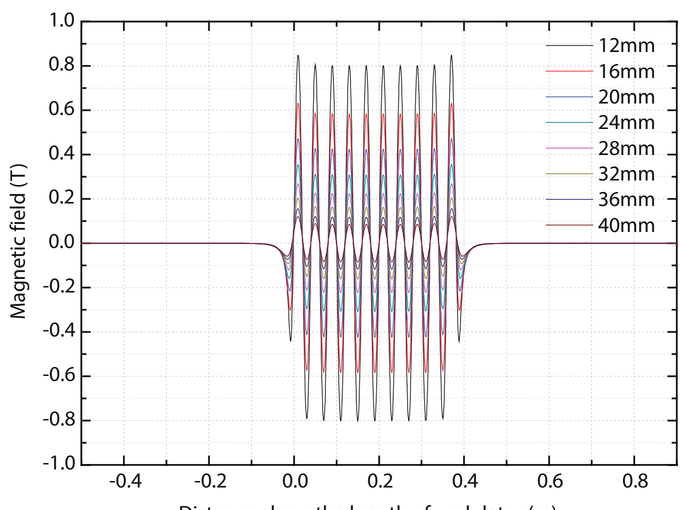

Figure 18.8 Magnetic flux density versus longitudinal position of the undulator magnet.

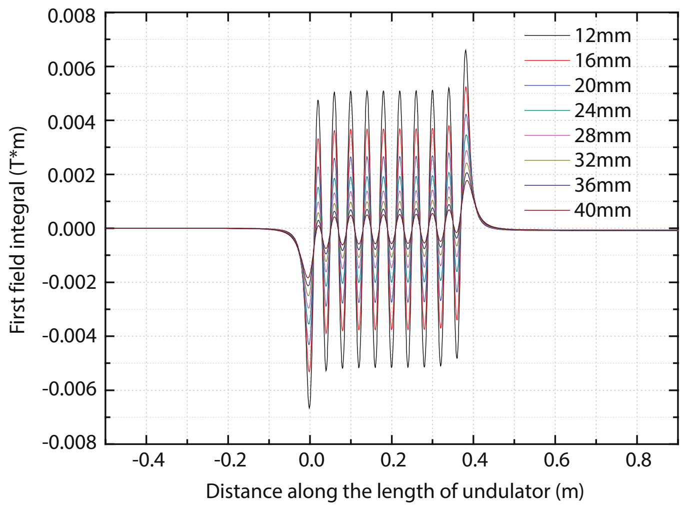

Figure 18.9 First field integral for symmetric end design.

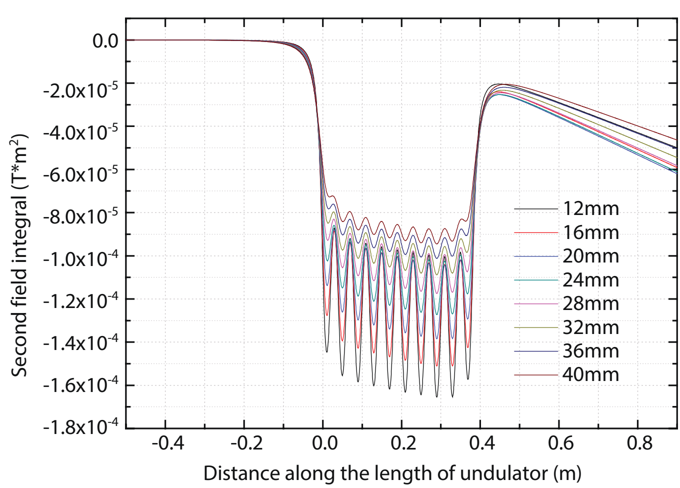

Figure 18.10 Second field integral for the symmetric end design.

The difference between the two magnet structures is observed in Figure 18.11 where we plot magnetic field density versus undulator gap. There is a magnetic variation of 8–12 Gauss between the two designs within a gap range of 12 mm–40 mm (see Figure 18.12).

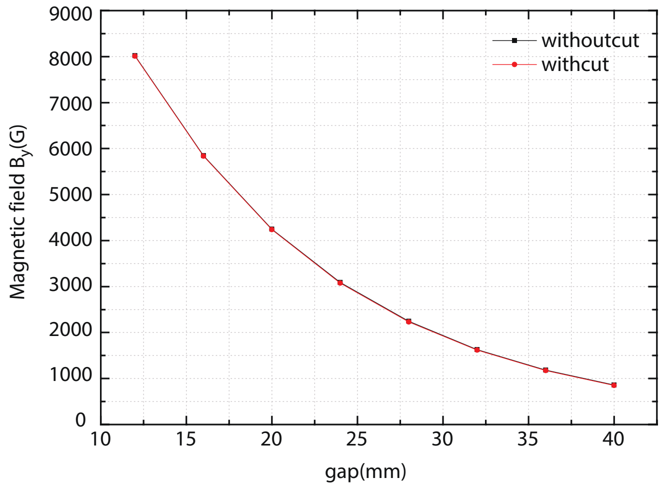

Figure 18.11 Magnetic flux density versus gap.

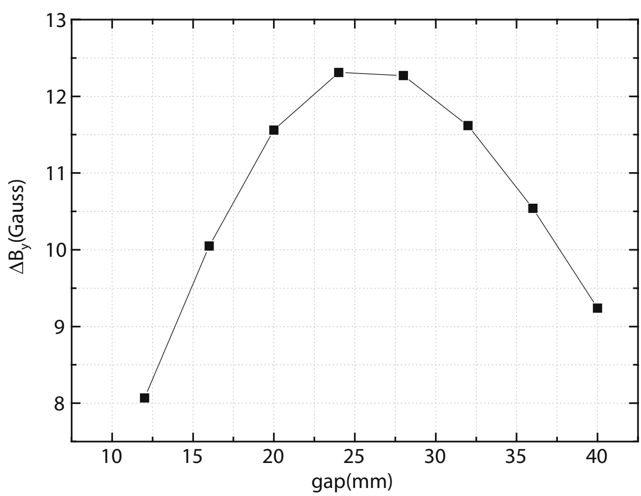

Figure 18.12 Difference in magnetic flux density versus gap from both designs.

18.3 Results and Discussion

In Figures 18.13 and 18.14, we plot the first field integral and second field integral versus the gap for both structures. In both cases, it is observed that the undulator using cuts at the corners offers less field integral values than the undulator without cut magnets. With a 5-mm cut at the corners

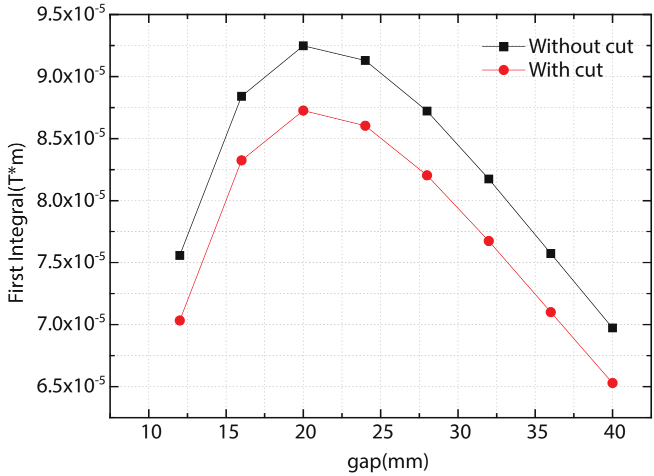

Figure 18.13 Comparison of first field integral versus gap for both designs.

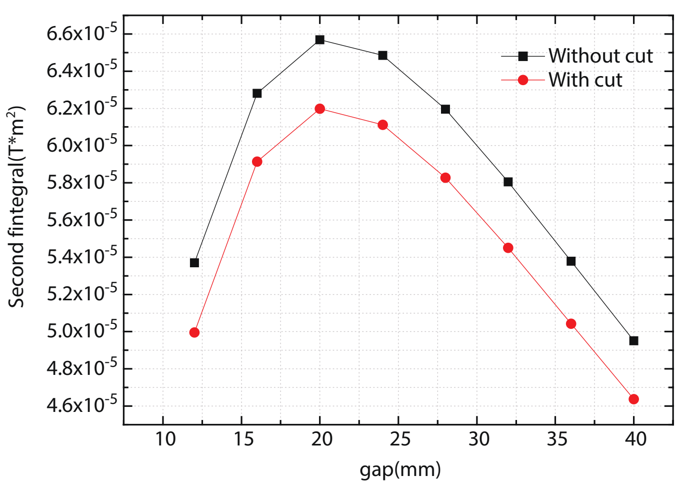

Figure 18.14 Comparison of second field integral versus gap for both designs.

at 45 degrees, the first field integral values are decreased from $92.5..\mathrm{T}\cdot\mathrm{m}$ to $87.5..\mathrm{T}\cdot\mathrm{m}$ by around 5 percent. The second field integral values from $66..\mathrm{T}\cdot\mathrm{m}^2$ reduced to $62..\mathrm{T}\cdot\mathrm{m}^2$ by almost 6%. Both the field integral curves with gap exhibit bump patterns with a sharp decline toward the narrow gap and a gradual decay toward large gap regions where the magnetic field goes to zero. The gap dependence curve needs to be flattened by shimming. The angular offset and the electron trajectory can be read in practical units as

$$\theta = \frac{290}{E(Mev)} \int B_y dz \qquad radian \tag{18.1}$$

$$x = \frac{290}{E(Mev)} \iint B_y dz' dz \qquad meter \tag{18.2}$$

The field integrals (Equations 18.1 and 18.2) can be converted to angular and trajectory offset by a given relativistic electron beam energy. Figure 18.15 and Figure 18.16 are calculated for an 8-MeV electron beam. The electron trajectory deviation is reduced from 2.4 mm to 2.2 mm or undulator employing magnet cuts at the corners. The calculation is made for ten periods but the trajectory is calculated at 0.9 m and it can be easily extrapolated to a length of 1 meter long undulator.

To conclude, we have modeled the design of a 40-mm planar PPM undulator for terahertz applications. The calculations are done in RADIA with magnet blocks with and without cuts at the corners. It is observed that a cut at the corners helps the mechanical holding of the magnet blocks and a reduced field integral.

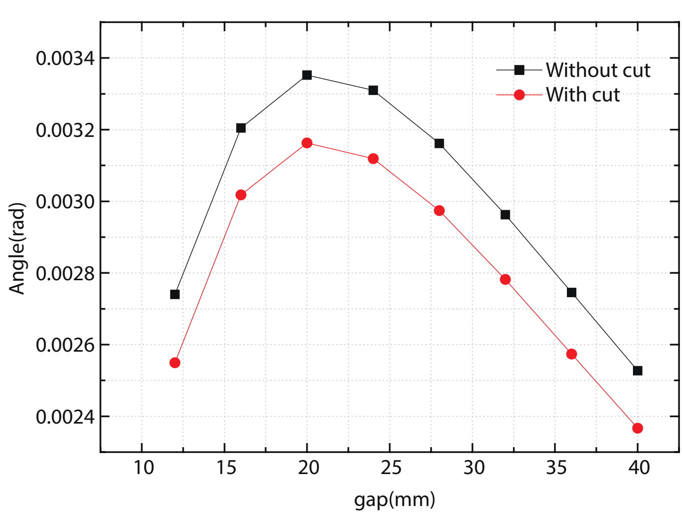

Figure 18.15 Angular offset versus undulator gap for both the design.

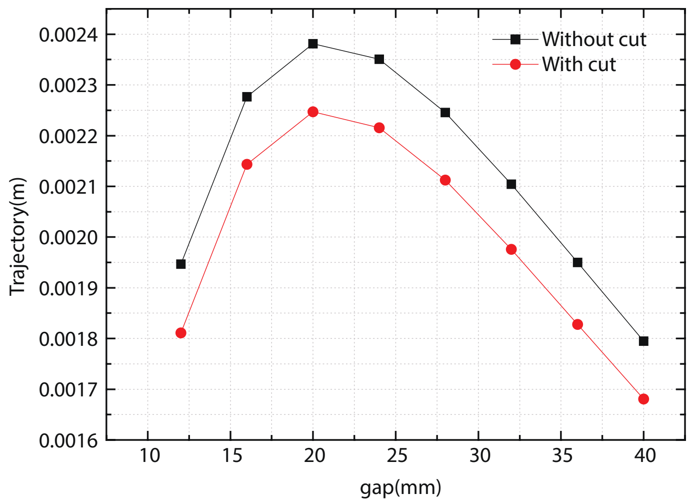

Figure 18.16 Trajectory deviation versus undulator gap.

Acknowledgment

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19

Predicting Academic Performance of Students: An ANN Approach

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Abstract

Forecasting a student's academic performance stands out as one of the most successful areas of research in the current era. The use of statistics and data mining is not sufficient to understand the complex nature of educational data and the relationship between input and output. Thus, our study's goal is to introduce a novel ANN-based methodology for predicting students' performance with the help of convolution feed-forward neural networks (CFFNNs). Our model is innovative as there has been limited prior research on predicting students' achievement using diverse machine learning methods. The results indicated that along with demographic features, academic attributes play an important role in students' performance prediction.

Keywords: EDM, ANN, CFFNN, prediction, student performance, MSE

Abbreviations Used

Abbreviation	**Description**
EDM	Educational data mining
ML	Machine learning
MLR	Multiple linear regression
ANN	Artificial neural network
CFFNN	Cascade feed-forward neural network

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FF	Feed-forward
BP	Backpropagation
FFNN	Feed-forward neural network
LSA	Latent semantic analysis
EERNN	Exercise-enhanced recurrent neural network
CLDA	Cluster-based linear discriminant analysis
MSE	Mean squared error
RMSE	Root-mean-square error
NRMSE	Normalized RMSE

19.1 Introduction

In today's highly competitive educational landscape, analysis of students' academic achievements plays an important role in promoting student development as well as enhancing the overall standard of excellence of higher education. Studying and analysis about performance of a student help in categorizing the students according to their capabilities and also improves the effectuality of the process of teaching and learning. However, the student's academic performance is impacted by numerous factors such as past academic records, socio-economic background, and personnel attributes.

The fields of educational data mining (EDM) and student performance prediction have expanded to include new areas which include the extraction of various features and factors from data, as well as using machine learning, nature-inspired algorithms, and techniques of data mining to obtain important information for (analysis and interpretation of educational data) educational data analysis and visualization of data [1]. This knowledge-based system can be used (for corrective activities) to improve the performance of the student. It can also be used to anticipate the performance of the student and identify the strong and weak skills of the student [2]. It can be used to identify inappropriate student behavior and offer advice to learners.

It should come as no surprise that the majority of current research uses statistical methods to analyze and forecast the performance of students, frequently in the context of relatively simple problem formulations. In order to overcome these obstacles, more research and analysis are needed in order to build more advanced methods for analysis and prediction as well as a deeper comprehension of the complex and contradictory nature of student performance. Machine learning (ML) has become a potent tool in data science applications to get around the drawbacks of traditional statistical techniques in evaluating complex relationships. Without the need for explicit programming, ML algorithms can learn automatically from data The predictive power of cognitive and affective characteristics on students' academic progress was previously evaluated using models like multiple linear regression (MLR) by researchers [29, 30]. Extensions of MLR were also used by researchers to enhance the predictive accuracy of their model [31]. Every forecasting model assumes that both the outputs and the inputs, i.e., the future values have an important, identified, or unidentified relationship. Because the real system is complicated, typical statistical forecasting models often have difficulty approximating this underlying function. Artificial neural networks (ANNs) possibly be an applicable substitute technique for determining this role.

Diversions from the nonlinear method [32–34] based models mentioned earlier, ANN [35, 36] approaches are driven by data that excel at nonlinear modeling without the necessity for pre-existing knowledge of the connections between input and outcome variables. As a result, they offer a more comprehensive and adaptable modeling tool for prediction [3]. Readers who are interested in obtaining a thorough understanding of Artificial Neural Networks (ANNs) at an introductory level are recommended to look at [16, 32]. Furthermore, the works of Lippmann (1987), Hinton (1992), Hammerstrom (1993), Rumelhart *et al*. (1986), and others can be used to investigate the basic ideas of ANNs [4]. These sources provide insightful explanations of the fundamental ideas behind ANNs. It is not a novel concept to use ANNs for forecasting. Hu employed a basic adaptive system known as k-Adaline for weather forecasting in its initial application in 1964.

The class of neural network (NN) model has many classes like feed-forward neural networks (FFNNs) and cascade feed-forward neural networks. What differentiates this class apart is not just the indirect link through the hidden layer but also the direct connection between the input layer and the output layer [5]. This approach has the benefit of preserving the linear relation between the input variable and the output variable while accommodating the nonlinear relationship [6]. Currently, little is known about the cascade feed-forward neural network (CFFNN). Thus, we are using data from the UCI Repository to forecast or predict student performance using the CFFNN model. The main objective is to use a CFFNN model as a well-known instrument for assessing students' performance in different universities. This strategy seeks to continuously improve the overall quality of education by addressing current disparities. This is how the paper is further structured: Section 19.2 includes a literature survey; Section 19.3 includes the proposed ANN model; Section 19.4 includes the experimental setup; Section 19.5 includes the result analysis; and finally, Section 19.6 includes the conclusion and the future scope.

19.2 Literature Survey

This section includes a discussion of previous studies that have been published in the literature. The growing popularity of effective ANN-based forecasting applications in recent years suggests that these networks are still a vital resource for forecasting practitioners and researchers today. Different types of artificial neural network (ANN) models, such as feed-forward (FF) and backpropagation (BP), have been used to forecast students' final grades and the number of mistakes they would make [7, 8]. The neural network bagging technique was used to forecast the percentage of student enrolment in coming years [9, 10].

A novel approach utilizing a supervised NN was developed for predicting student performance, experimental findings indicate that academic performance is greatly affected by the students' use of social media, and the family's history, and ANN outperforms other methods and can be employed effectively for more accurate student performance prediction [11]. In a study by Yam and Chow (2001), an improvement to the speed of FFNN was proposed [12]. In (Erkaymaz *et al.*, 2014), the performance of FFNN was further improved by applying small-world topology. Alike identical network without any reformation was also tested and compared using the same dataset. The outcomes clearly revealed that the small-world topology greatly enhanced the FFNN's performance [13]. Prior studies on supervised learning in a multi-layered FFNN (Simard, Nadeau, & Kröger, 2005) showed that architecture based on a small world led to a reduction of learning mistakes and a reduction of training times compared to a regular network [14]. Issanchou and Gauchi (2008) did an additional study in which they presented a computer-aided optimum design technique that evaluates the efficacy of this design strategy in the context of FFNN using a Monte Carlo simulation-based method [15]. A comparison between ANN and linear regression was used by Arsad in 2013 to predict academic performance [16]. Sorour, in 2014, proposed latent semantic analysis (LSA) and then applied the ANN model to predict students' academic success based on comments that students wrote in a free-form manner following each lecture [17]. Naser *et al.*, in 2015, employed a feed-forward back-propagation algorithm while Zacharis, in 2016, used a multilayer perception neural network by back-propagation algorithm for student performance evaluation [18, 19]. In 2018, Exercise-Enhanced Recurrent Neural Network (EERNN) for student performance prediction was presented by Su *et al.* [20]. Lino *et al.*, in 2019, compared symbolic regression and MLR with ANN. When compared to the other two approaches, the suggested ANN model performed better, showing the lowest error rates and the highest accuracy [21]. A hybrid approach comprising ANN and cluster-based linear discriminant analysis (CLDA) was employed by (Sood *et al.*, 2020) to furnish prospective students with motivational remarks [22]. Numerous investigations have been conducted to demonstrate how well ANN predicts student performance [23–26].

19.3 Proposed ANN Model

To predict student performance, neural networks (ANNs) may be implemented in a variety of ways as they are used to efficiently perform complex logic operations and dynamically generate nonlinear mappings [27, 28]. The proposed method learns intricate and nonlinear interactions between inputs and outputs using CFFNN.

For the study firstly, the database was taken from the UCI repository, and via preprocessing, we cleaned the data for analysis. This process is explained in the Data Preprocessing section. Next, we divided our data into two parts: training and testing as explained in the Splitter section. The model was then built using CFFNN with some functions as explained in the Build Model section to evaluate the student performance. For prediction, some parameters were used as explained in the Prediction Performance Parameters section. Then, the performance analysis was evaluated using MSE, RMSE, and NRMSE, as given in the Performance Analysis section. Figure 19.1 shows the process diagram of the proposed ANN approach.

19.3.1 Data Gathering

The dataset for predicting student performances was derived from two publicly available datasets from the UCI Machine Learning Repository, as depicted in the figure below. 33 attributes and 1044 records make up the student dataset, which was gathered from two Portuguese secondary schools. The attributes of the dataset comprise a variety of data, such as student grades and different social, demographic, and educational features. All of the information came from surveys and reports from the schools. While the other dataset is from Portuguese language lessons, the first one includes data on students' performance in mathematics classes.

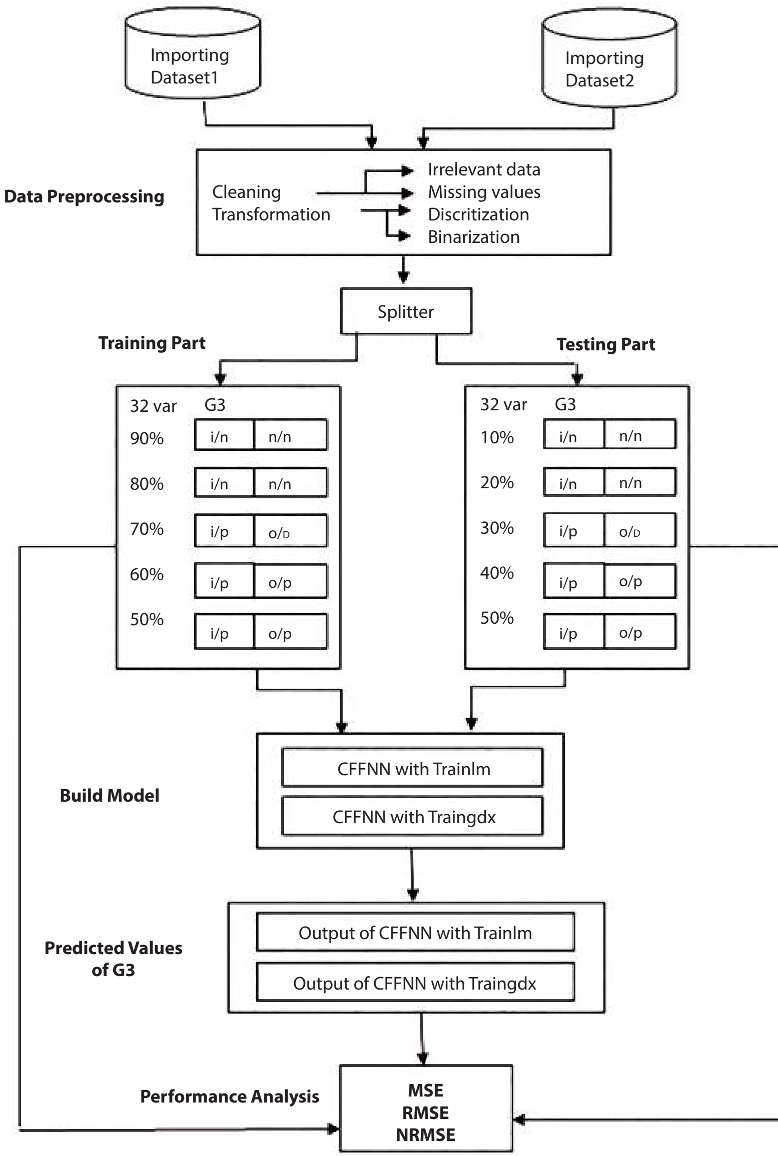

Figure 19.1 Process diagram of the proposed approach.

19.3.2 Data Preprocessing

The data preprocessing stage comes before using a data mining algorithm; it modifies the original data to make it in a format that the mining algorithm can use. We use various tasks like data transformation and cleaning that make up data preprocessing.

Data cleaning [37–41], one of the main preprocessing procedures is applied to this data set to remove items that are not relevant and missing values. After 403 records are removed, the data set contains 395 records after cleaning out the eight missing values that were found in multiple features.

Discretization is just the process of minimizing information loss in the data to convert continuous values into discrete categories of finite intervals. The Portuguese educational system uses a 20-point grading system, just like other nations. where 20 is the ideal score and 0 represents the lowest. We employ equal frequency discretization, which divides continuous data into bins with an equal (or comparable) number of records in each bin. To perform discretization, we use the Python KBinsDiscretizer tool from the scikit-learn package.

19.3.3 Splitter

Following preprocessing, the dataset is split into subsets for testing and training according to a predetermined ratio. Many combinations of the training and test data sets are taken into consideration in order to maintain consistency in the data division. In our analysis, we split our data ranging from 10% to be used for training and 90% for testing to 90% used for training and 10% for testing, with a 10% variation in each division.

19.3.4 Build Model

To build the model, we use CFFNN and evaluate the student performance. Two learning functions, called trainlm and traingdx, are used to train our model. As a result, we currently have two models: CFFNN with traingdx and CFFNN with trainlm.

19.3.5 Performance Analysis

The first parameter we use to evaluate the prediction model's performance is mean squared error (MSE), which gauges the network's effectiveness based on the average of squared errors.

$$\text{MSE} = \sum_{1}^{N} \left(\frac{Y_{exp} - Y_{cal}}{n} \right)^2 \tag{19.1}$$

where Y_{exp} = Observed value; Y_{cal} = Predicted value; n is the number of observations in the dataset.

The second measure is the root-mean-square error (RMSE). The root-mean-square error separating the actual (observed) array A from the forecast (predicted) array F is provided.

$$\text{RMSE} = \sqrt{\frac{1}{n}\left[\sum_{1}^{n} \left(\frac{Y_{exp} - Y_{cal}}{Y_{exp}} \right)^2 \right]} \tag{19.2}$$

The normalized RMSE (NRMSE) is the third parameter. It calculates the regression model's goodness of fit using a given target and output value matrix or vector.

We can normalize by the difference between maximum and minimum:

$$\text{NRMSE=RMSE/(MAX(XA)-MIN(XA))} \tag{19.3}$$

where MAX denotes the maximum and MIN denotes the minimum.

The developed models' prediction performance was evaluated by employing MSE (1), RMSE (2), and NRMSE (3) for comparison.

19.4 Experimental Setup

The dataset for predicting student performances was derived from publicly available datasets from the UCI Machine Learning Repository, as depicted in Table 19.1. It consists of two databases first Portuguese lesson and mathematics lesson, among which we consider only Portuguese lesson data for our work. The training dataset is then used to apply techniques for learning and model building. Various machine learning and ANN models have already been used for this database, but still CFFNN is unexplored yet. Thus, we are using the ANN-based CFFNN model for our performance prediction of students.

19.4.1 Environmental Setting

MATLAB is used to develop the proposed CFFNN algorithms. The model is built on an i3 processor with Windows 11 operating system, 256 SSD, and 8GB RAM. We utilize the following MATLAB user-defined functions for the model development process:

load_data(): Load the database with the file of the Portuguese language lesson having 33 attributes and 1044 records.
lag_ratio_fixation(): Fix the percentage of training and testing data randomly.
split_data(): Split the data in two parts as per lag ratio defined above.
build_model(): To build a model with initial parameter values defined in the section below.
train_model(): Train the model using trainlm and traingdx functions as per the lag ratio.
performance_analysis(): Parameters used for performance analysis are MSE, RMSE, and NRMSE.

19.4.2 Configuration Settings

The proposed model has many configuration settings of parameters along with their initial values, as described in Table 19.1 below.

Parameters are fixed as per the literature study and expert opinion.

Table 19.1 Configuration parameters.

S. no.	Parameters	Initial values
1	Learning rate	0.0002
2	Learning function	Trainlm, Traingdx
3	No. of neurons in hidden layer	30
4	Stopping criteria	When MSE is optimum
5	No. of epochs	1000
6	Activation function used	Sigmoid

19.5 Result Analysis

The training and testing results for the CFFNN model of the provided dataset are displayed in the figure below in terms of MSE, covariance, RMSE, and NRMSE. The dataset provided is divided into testing as well as training subsets with intervals of 10%, ranging from 10% to 90% for training. We have implemented the CFFNN to predict the value of G3 using three cases: First, we predict G3 on the basis of only demographic attributes. Second, we predict G3 on the basis of demographics and G1. Third, we predict G3 on the basis of demographics, G1, and G2, with a splitting of data into 9 lags. As a result, we get 3 tables having nine outputs for traingdx and 9 outputs for trainlm functions. However, in this paper, authors have considered

Table 19.2 CFFNN model (Predict G3 on demo).

Model	Train test ratio	Training perf in terms of MSE	Testing perf in terms of MSE	Covar	RMSE	NRMSE
Traingdx	60% train data	2.611181	3.334791	0.21501	1.826141	0.91307
	70% train data	0.101189	0.415023	0.245896	0.644223	0.322111
	80% train data	0.094977	0.413321	0.25596	0.642901	0.32145
	90% train data	0.085595	0.305683	0.312144	0.552886	0.276443
Trainlm	60% train data	0.057546	0.323147	0.174304	0.568461	0.28423
	70% train data	0.079274	**0.280238**	0.162992	0.529375	0.264688
	80% train data	0.095825	0.367261	0.367261	0.606021	0.30301
	90% train data	0.061999	0.335413	0.266941	0.579148	0.289574

only 4 training ratios where training lags are higher than testing lags. That is why, in this paper, only 4 lags are represented, i.e., 60%, 70%, 80%, and 90% training ratio.

Table 19.2 above considers 30 input variables (excluding G1 and G2) and G3 as output attributes and shows results of traingdx and trainlm functions with all 4 combinations of train-test split ratios of the CFFNN model. The table below indicates that we attain a lower mean squared error (MSE) of 0.280238 using the trainlm function with a 70% train-test ratio.

Table 19.3 below considers the second case with 31 input variables (excluding G2) and G3 as output attributes and shows the results of traingdx and trainlm functions with all 4 combinations of train-test split ratios of the CFFNN model. The table below indicates that when we include the "G1" attribute along with demographic features, we attain a lower mean squared error (MSE) of 0.102748 using the trainlm function with a 70%

Table 19.3 CFFNN model (predict G3 on demo and G1).

Model	Train test ratio	Training perf in terms of MSE	Testing perf in terms of MSE	Covar	RMSE	NRMSE
Traingdx	60% train data	2.394599	3.185163	0.05416	1.784703	0.892351
	70% train data	0.107554	0.320574	0.228762	0.566192	0.283096
	80% train data	0.076095	0.292974	0.440805	0.541271	0.270635
	90% train data	0.088033	0.258767	0.647196	0.508691	0.254346
Trainlm	60% train data	0.03315	0.144368	0.544914	0.379958	0.189979
	70% train data	0.031196	**0.102748**	0.644363	0.320543	0.160272
	80% train data	0.038882	0.148641	0.570837	0.38554	0.19277
	90% train data	0.028079	0.217918	0.577777	0.466816	0.233408

train-test split ratio. This MSE is reduced as compared to the previous MSE obtained when we include only demographic features.

Table 19.4 below considers the third case with all 32 input variables (demographic, G1, and G2) and G3 as output attributes and shows results of traingdx and trainlm functions with all 4 combinations of train test split ratios of the CFFNN model. The table below demonstrates that by incorporating both the "G1" and "G2" attributes along with demographic features, we achieve a decreased mean squared error (MSE) of 0.085237 using the trainlm function with an 80% train-test split ratio. Again, this MSE reduction is observed in comparison to the previous MSE obtained when including only demographic features and "G1".

Figure 19.2 below is showing a bar graph of all evaluation parameters of the CFFNN model with the traingdx function having 4 combinations of train test split ratios. The first graph shows results using demographic features only, the second graph shows results using demographic and G1

Table 19.4 CFFNN model (predict G3 on demo, G1 and G2).

Model	Train test ratio	Training perf in terms of MSE	Testing perf in terms of MSE	Covar	RMSE	NRMSE
Traingdx	60% train data	0.085133	0.209175	0.569973	0.457356	0.228678
	70% train data	0.075675	0.446968	0.099466	0.668556	0.334278
	80% train data	0.048834	0.206845	0.485889	0.454802	0.227401
	90% train data	0.085153	0.188967	0.691967	0.434703	0.217352
Trainlm	60% train data	0.020469	0.090459	0.746499	0.300763	0.150382
	70% train data	0.016344	0.088298	0.742781	0.297151	0.148575
	80% train data	0.028274	**0.085237**	0.836421	0.291954	0.145977
	90% train data	0.028926	0.111924	0.797944	0.334551	0.167275

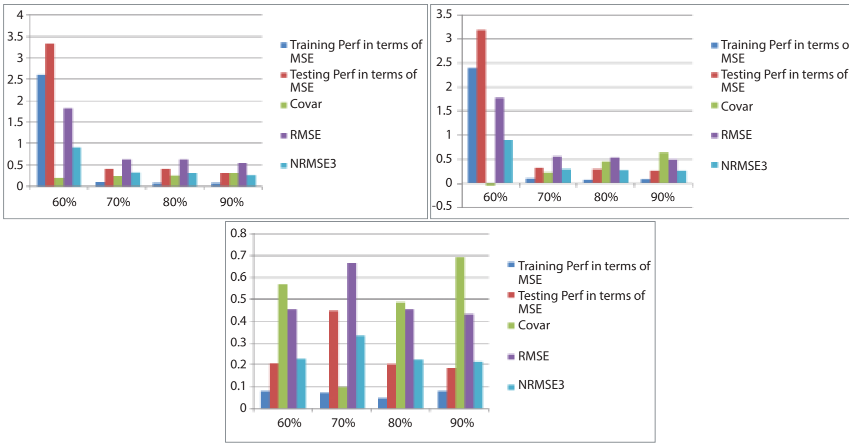

Figure 19.2 CFFNN with traingdx function.

features, and the third graph shows results using demographic, G1, and G2 features.

Figure 19.3 below is showing a bar graph of all evaluation parameters of the CFFNN model with the trainlm function having 4 combinations of train test split ratios. The first graph shows results using demographic features only, the second graph shows results using demographic and G1 features, and the third graph shows results using demographic, G1, and G2 features.

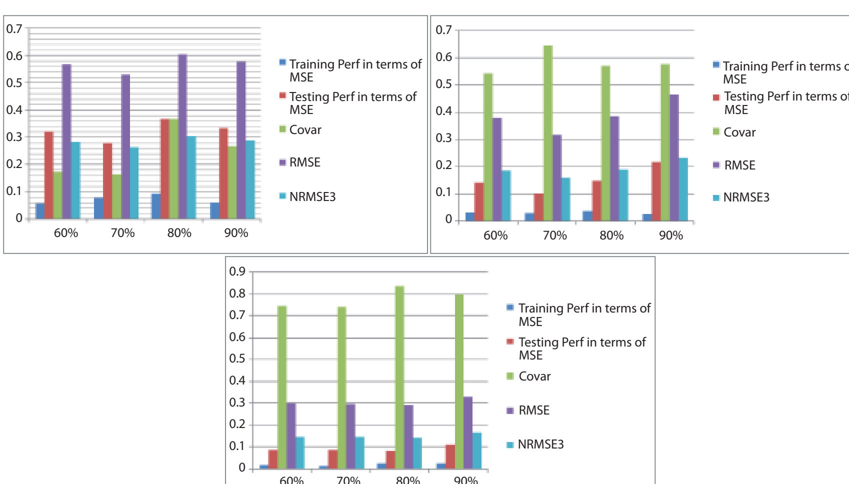

Figure 19.3 CFFNN with trainlm function.

19.6 Conclusion and Future Scope

The CFFNN model has been implemented in the student performance dataset having Portuguese language data. First CFFNN model was applied with all possible combinations of train-test split ratio, for predicting G3 with three cases. Results showed that along with demographic features academic attributes also play an important role in predicting student performance as we get better results with all 32 attributes (demographic, G1, and G2). Second, trainlm functions give better results as compared to the traingdx function in all cases. Third, results show that if we consider the splitting of data at 60%, 70%, 80%, and 90%, then we can say that CFFNN with the trainlm function outperforms the CFFNN with the traingdx function in all cases with the lowest MSE of **0.0852**. Each experiment involves repetition to attain a model capable of generating the most precise and reliably consistent predictions. Experimental results indicate that the constructed CFFNN model has effectively forecasted data sets with the least mean squared error (MSE). Furthermore, this modeling approach can be adapted for diverse datasets aimed at predicting student performance. Some other ANN models also can be built for students' performance prediction.

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20

A Deep Study on Discriminative Supervised Learning Approach

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Abstract

In today's scenario, deep learning is one of the most exciting and dynamic areas in artificial intelligence, which is seen as a foundational technology of the fourth industrial revolution. Deep learning innovation comes from the field of artificial neural networks. It is a highly effective, monitored, time-efficient, and cost-effective way to teach a computer to learn. It has become an essential topic in computing because it can learn a lot of information simultaneously and follow different procedures that can be used to solve a lot of challenging tasks. So, the deep learning area has expanded quickly. It is employed in many fields, such as medicine, object recognition, pattern recognition, cybercrime, and many more. But still, it is challenging to construct a practical model because of the dynamic and unpredictable nature of real-world circumstances and information. This paper presents an organized and in-depth overview of deep learning approaches, which includes their categories, methodologies, and advanced network architectures. The primary objective of this study is to explore and present a broad evaluation of deep learning techniques in the real world.

Keywords: Deep learning, convolution neural network (CNN), discriminative learning, deep learning applications, supervised deep learning

20.1 Introduction

Automation is a branch of research that includes a set of approaches for teaching computers to interpret digital image data. It is interdisciplinary,

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with machine learning concepts at its core, and it uses and integrates learning algorithms. The primary focus is creating robotic systems that automatically analyze digital photos and extract valuable data. Text analytics, activity recognition, video screening, object recognition, and audiovisual idea recovery are recent examples of where machine learning (ML) is being used [1, 2]. In this subfield of AI, systems may learn new concepts and knowledge autonomously, without human intervention or coding. It begins with findings, including first-hand accounts, to get ready for statistical trends and features, which in turn lead to better judgments and future results. The foundation of deep learning is a collection of computational learning techniques that use complex knowledge abstractions expressed through a plethora of nonlinear alterations. The technique of deep learning (DL) exploits artificial neural structures also known as ANN systems. These ANNs are always employing learning algorithms and enhancing the efficacy of their training processes by continuously accumulating more data. When a progressive rise in the number of neural network levels occurs during the training process, we refer to this as a "deep" training approach. The training and the inferring aspect are the backbone on which the deep learning process runs. Labeling and matching huge volumes of data is part of the training phase, while the inferring phase involves drawing conclusions and labeling fresh, unknown information with that knowledge. Using deep learning is what machines can take to understand complex visual problems as accurately as possible. Unexpected data availability growth and extraordinary cognitive computing advances fuel a steady stream of new research in deep learning [3, 4]. In order to create a model with multiple layers of classification, DL makes use of transformations and the graph system at the same time. In many fields, including natural language processing (NLP), picture recognition (IR), and speech recognition (SR), recent DL approaches have demonstrated encouraging outcomes [5].

In most cases, an ML algorithm's performance focuses heavily on the accuracy of the data it receives as input. It is currently shown that improved performance is achieved with accurate data description compared to inaccurate data description. Thus, the concept of feature engineering served as a driving force behind numerous successful ML research projects throughout the years. The goal of this method is to build characteristics from unprocessed information. It is also very field-specific and often requires more work from people. A wide variety of features have been introduced and evaluated in computer vision, including the scale-invariant attribute transform, the histogram of directed gradients, and many more [6, 7]. As soon as the unique feature is presented and established as being successful, it becomes a new area of research that has been pursued throughout the decades.

Generally, the extraction of features is performed automatically by the DL algorithm. This motivates academics to find ways to extract discriminative characteristics with as little time, effort, and domain expertise as feasible [8, 9]. These methods utilize a multi-layer database framework, with the initial levels extracting basic features while the higher layers extract more complex ones. It is important to remember that this architecture was first motivated by artificial intelligence (AI), as it reflects the process in crucial sensory regions of the human brain. The human brain has the ability to automatically extract modeling processes by using a variety of scenarios. This method imitates the human brain's mode of operation [10]. This work provides in-depth of DL from different points of view, including the core concepts, configurations, obstacles, applications, category of deep learning, and computational methods with an evolution matrix. The purpose of our work is to address the essential aspects of DL, such as basic concepts, importance, and applications. Also, our review can be the start of learning about other DL topics. This review aims to provide researchers and students with an overview of DL by highlighting its key components in a single document.

- More information regarding recent developments in the sector will be available due to this study, which will help DL research move forward. Scientists may pick the most efficient method for their tasks, allowing them to provide the region with more precise options.
- This work explains the ideas, theory, and current architectures of deep learning in detail.

The rest of the sections are set up like this: Section 20.2 describes the literature review. Section 20.3 provides introductory information on deep learning methods. Section 20.4 explains deep learning-based methodology, and Section 20.5 summarizes the study.

20.2 Literature Survey

In the last years, a few surveys tackling the domain of deep learning-based process prediction have been proposed. In this section, we present an overview of the related work and clarify the significant differences between this study and the existing surveys. The primary focus was on articles from the most prestigious publishers, including Elsevier, MDPI, IEEE, ACM, Nature as well as Springer. It implies that this analysis focuses on the most recent articles in the area of Deep Learning. The selected publications were studied and assessed to identify and characterize DL techniques and types of networks. Describe several structures, discuss the problems with DL and its solutions, and evaluate its uses and computational methods.

- Pouyanfar *et al.* [11] and Aggarwal *et al.* [12] suggested a fault-detection system for reciprocating compressors that use SVM for data processing and fault diagnosis. DL techniques will be more fragile in such research methodology and classification processes. Several investigations that were carried out utilizing the DL strategy have supported us [13].
- Medical image processing is one area where DL methods have been widely applied, with positive outcomes [14]. Second, the entire network should be fine-tuned from end to end in a supervised way.
- A prior evaluation of system prediction techniques was detailed by the authors in [15, 16]. The authors examined 39 different strategies for predicting processes and divided them into two groups: those that take advantage of process models explicitly and those that do not. Differentiating between models of regression and classification was also done based on the prediction aim of the various methodologies assessed. Consequently, there is no overlap between this study and the survey since it does not contain any methods that exploit deep learning.
- Di Francescomarino and Ghidini [17] helped organizations find their way in the predictive process evaluation sector by creating a value-driven structure for categorizing current process prediction methodologies. This study examines 51 methods using various prediction architectures. You can sort the studies by time, categorical outcome, risk, cost, inter-case metrics, and sequence of values for their predictions. As a further step, they compare them according to the data input, tools assistance, area of use, and method type. While methods based on deep learning are covered, they are not the primary focus of the survey. While this study compares and contrasts various approaches quantitatively, the survey focuses solely on qualitative comparisons. Additionally, present deep learning approaches to process prognosis that have resulted in substantial improvements in prediction quality are not addressed in the study.

- Focusing on outcomes, the predictive process evaluation was categorized by the author of a systematic review [18]. Using criteria such as prefixing the extraction process, filtration, trace placing, sequence coding, and categorization techniques, the review examined 14 journals. Additionally, they tested the effects of various qualitative factors in an experimental study. The survey conducted in this study does not overlap with the current work as it does not encompass any deep learning-based methods for predicting processes.
- A recent survey conducted by Harane and Rathi [19] focuses on deep learning methods in predicting business procedure monitoring. Nevertheless, the researcher did not perform a comprehensive examination of the existing literature, but rather compared only three established methodologies. Our research, however, encompasses all methods that use deep learning based on particular requirements for inclusion and exclusion in the literature review. As a result, we provide a more thorough overview of the present status of deep learning techniques for event forecasting.

20.3 Introductory Information About Deep Learning and Its Features

This part briefly overviews what deep learning is, and then discusses the key distinctions between deep learning and machine learning. The position of deep learning in the data science is shown in Figure 20.1. Deep Learning

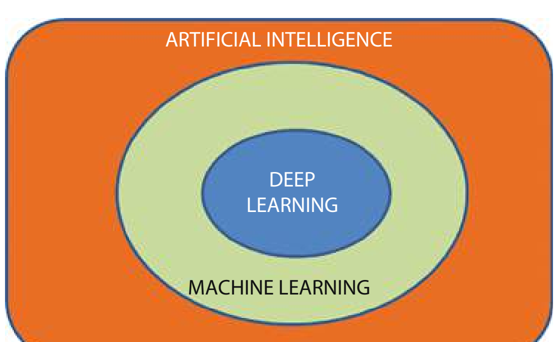

Figure 20.1 Deep learning roles in data science [22].

takes its cues from the way the human brain processes information. The functioning of DL does not involve any rules to be set by humans; rather, it makes use of a substantial amount of information in order to translate the input that is provided to specific categories. The foundation of DL is made up of multiple layers of algorithms, collectively referred to as neural networks. Each of these algorithms delivers a unique perspective on the information presented to it [15]. Using traditional machine learning approaches, it must perform a series of sequential processes to accomplish the classification assignment. These steps include pre-processing, extraction of features, feature selection with discretion, learning, and classification. In addition, feature selection significantly affects the efficiency of machine learning algorithms. Improper classification across classes may result from the unbalanced selection of features.

In contrast to traditional ML approaches, deep learning may automatically analyze selected features for several tasks [20, 21]. Using DL, you can learn and classify in one easy step. The growth of DL is impressive because it can be used to solve the following:

- Provide expert judgments where individuals are at a loss to justify their choices like language understanding, speech recognition, and medical decisions.
- Occasions in which responses need to be altered based on individual conditions (such as customized service and fingerprints).
- Cases in which the solution to a problem fluctuates over time (e.g., price forecasting, stock choice, weather forecasting, and monitoring).
- Cases in which human expertise is unavailable.
- Cases in which the scale of the problem exceeds our limited thinking abilities, such as trend analysis, correlating ads to Facebook, and calculating website ranks.

Deep learning encompasses machine learning with AI. Deep learning algorithms have succeeded in many applications due to the following traits: They rely solely on neural networks and are considered deep because they have a minimum of two layers. They possess a strong capacity to learn how to extract features from data. They can utilize datasets more efficiently, exceed the capacity of humans to tackle complex computational problems, and optimize outcomes. The effectiveness of a deep learning network is contingent on factors such as the network's topology and representation of data with an activation function. Define highly variable characteristics with important parameters. It is possible to greatly improve the precision of predictions. Secure and reliable generalization capability with a reduced need for training data. DNN is able to perform well on large-scale, unlabeled datasets due to its novel representation. These networks may extract complex properties by using high-level abstraction.

In the perceptions of those working in deep learning, there is no intrinsic difficulty in improving the performance of applications; for instance, robots can now recognize handwriting at a human level, as can face recognition and object identification measures. Handwriting recognition is widely acknowledged as the starting point for deep learning. CNN, its underlying architecture, was successfully developed to interpret handwritten ZIP codes. The numerous facts listed below serve as motivation for using deep learning:

- Deep learning relies on multilayered artificial neural systems with greater capabilities.
- The rapid development of deep learning can be attributed to the availability of multi-layered neural networks with the help of graphics processing units.
- Feed-forward, multi-layer, convolution, and pooling architectures characterize deep neural networks.
- Inputs and outputs are not sequential and are independent.
- The creative potential of reinforcement learning is growing.
- Competitive and collaborative learning will rule.

Contrasting Facts

A deep learning-driven structure is made up of several hidden layers, each with numerous neurons. The multi-layered architecture makes it easier to map data to higher-level representation. Here, we will compare and contrast two learning techniques:

- Deep learning uses numerous layers of algorithms to develop a computerized neural network that can acquire information and resolve rational issues independently, while ML uses methods to decode information, acquire knowledge, and make educated decisions.
- Deep learning requires an enormous quantity of content, whereas machine learning requires a relatively small quantity of content to reach a conclusion.

- Deep learning generates new characteristics through its own procedures and approaches, whereas machine learning depends on the users who recognize features.
- When compared to machine learning, the accuracy rate that can be attained using deep learning is extremely satisfying.

Different Types of Data

DL models must understand and represent data to create a data-oriented intelligent framework for a particular use. When it comes to real life, data can exist in various formats that are commonly described as follows for deep learning modeling techniques [23]:

- Sequence-based data: Data in which the order matters (a set of patterns) is called sequential data.
- Two-dimensional data: The fundamental unit of each digital picture is a matrix. It is a 2D array of integers composed of rows and columns of information.
- Tabular data: A dataset in tabular form is made up mainly of columns and rows. So, tabular datasets have data organized in columns, like a table. Each section has to be given a distinct label, and only information fitting that description may be entered into it. Depending on the nature of the information it holds, it typically takes the form of a grid of rows and columns.

20.4 Methodology of DL Approaches

There are three major categories of deep learning:

1) Discriminative or supervised,
2) Generative or unsupervised,
3) Partially supervised (semi-supervised or hybrid learning)

These categories contain different types of networks, which are shown in Figure 20.2.

A. Discriminative (Supervised) Learning

This learning uses data that has been labeled. While evaluating this approach, The situation has a set of inputs and, as a result, a set of outputs $(X1(t), Y1\ (t)) \sim \rho 1$. There are several supervised learning algorithms for

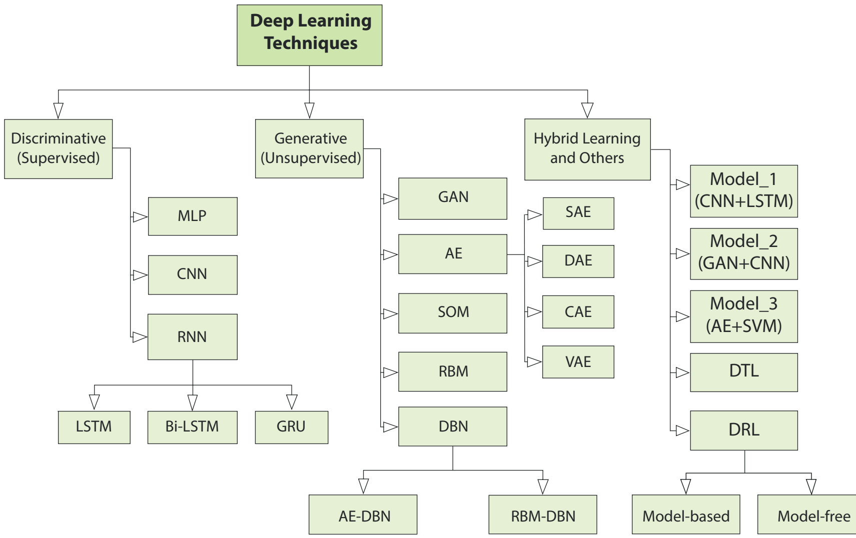

Figure 20.2 Deep learning approaches [19].

DL, as shown in Figure 20.3. The primary benefit of this method is that it may be used to gather information or provide a data output based on existing knowledge. However, one problem with this method is that selecting a limit is overly narrow if the set of instructions has no class-appropriate samples. In terms of learning with outstanding performance, this method is overall more straightforward than other methods [24].

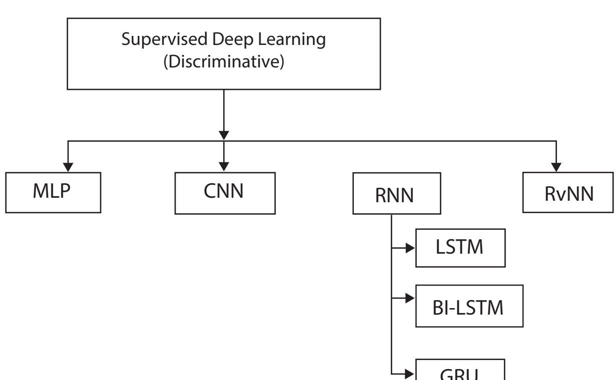

Figure 20.3 Classification of supervised DL.

B. Partial (Semi/Hybrid) Supervised Learning

With this method, labeled hybrid datasets provide the basis of the learning process. Generative adverse networks (GANs) and deep reinforcement learning are similar methods sometimes used in the same context. The primary benefit of this method is that it reduces the quantity of labeled information required. Yet, one of the problems with this method is that training data with irrelevant input features could lead to wrong decisions. Classifying text documents is one of the most prevalent applications of semi-supervised learning. Because of the challenges in acquiring a huge number of label-based textual information, semi-supervised learning is excellent for classifying text documents [24]. There are several semi-supervised learning algorithms for DL, as shown in Figure 20.4.

C. Generative (Unsupervised) Learning

With this approach, labeled information is not necessary to carry out the learning process. There are several unsupervised learning algorithms for DL, as shown in Figure 20.5. Under this context, the computer program has to understand the internal representations of the input data so that it can uncover the underlying patterns or relationships. Standard unsupervised learning methods are dynamic networks, dimension reduction, and segmentation. Numerous other types of DLs, like automatic encoders, limited Boltzmann machines, and GANs as a result of modern approaches, have shown promising results when used to reduce non-linear dimensionality and clustering applications. In addition, RNNs, containing generative learning using GRUs and LSTM algorithms, have found numerous uses. It applies to the vast majority of RNN implementations. Unsupervised learning has a number of drawbacks, the primary ones being that it cannot provide precise information related to data sorting and is challenging to solve [25].

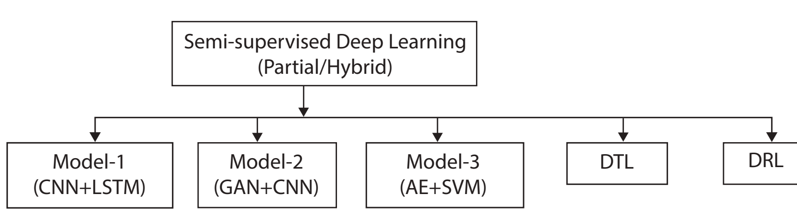

Figure 20.4 Classification of semi-supervised DL.

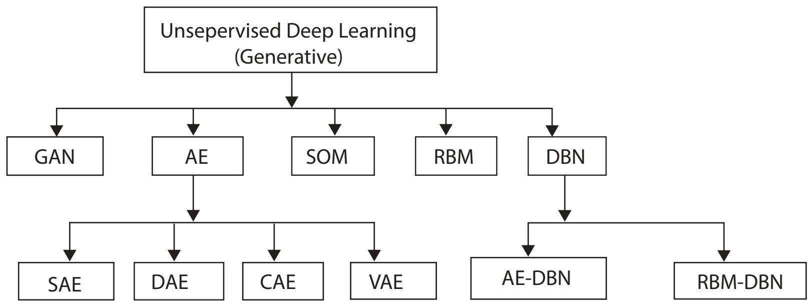

Figure 20.5 Classification of unsupervised DL.

D. Reinforcement-Based Learning

Reinforcement learning happens when you interact with your environment, whereas supervised learning happens when you give examples of what you want it to learn. This method was made with Google Deep Mind in 2013 [26]. There is another name for this method: semi-supervised learning. This notion served as the foundation for numerous supervised and unsupervised methods. There are two major distinctions between RL and discriminative learning. The first step in optimizing a function is to ask about it through interaction so that you have complete access to it. The second point is that inputs are action-dependent and that the state under consideration is environment-based [27]. Reinforcement learning can be used to plan business strategies and automate factories with robots. Reinforcement learning's primary issue is that there are a lot of variables that can affect how it works. It means parameters may change the pace of learning.

Now, the primary reasons to use reinforcement learning are as follows:

- It helps you determine which action gives you the most benefit over a more extended period.
- It helps you figure out which situations call for action.
- It also aids in determining the optimal strategy for obtaining substantial benefits.

This technique cannot be used in all situations, like when there is not enough data to solve the problem with supervised learning techniques or when it takes too much time and computing power, especially when there is a lot of space to work [24].

20.5 Deep Learning Network Structures

This section explains the most renowned architectures of deep learning networks, such as multiple-layer perceptron (MLP), recursive neural networks (RvNNs), recurrent neural networks (RNN), and convolution-driven neural networks (CNN). This section provided a basic explanation of MLP, RvNNs, and RNNs, whereas a detailed description of CNNs was supplied due to their significance of this kind. Moreover, it is the most used network for various applications.

A. Multiple-Layer Perceptron (MLP) Neural Network

The MLP is an artificial neural network that operates in a feed-forward manner and relies on supervised learning [18]. It serves as the fundamental framework for advanced machine learning and a network of deep neural networks (DNN). MLP is an acronym for multi-layer perception. It comprises densely interconnected layers that turn any input dimension into the required size. A perception with multiple layers is a neural network with numerous layers shown in Figure 20.6. To build a neural network, neurons are combined such that the responses of some neurons serve as inputs for other neurons. Between these two layers, one or more hidden layers are assumed to act as the network's computing engine [28].

Several activation functions, generally referred to as transfer functions based on rectified linear units, sigmoid, and softmax, are used to determine the response of this network. MLP is trained using the most widely used algorithm called backpropagation. It is a supervised learning technique also referred to as an essential neural network component. In this network, several optimization algorithms, such as stochastic-gradient descent (SGD), estimation based on the adaptive moment (Adam), and memory

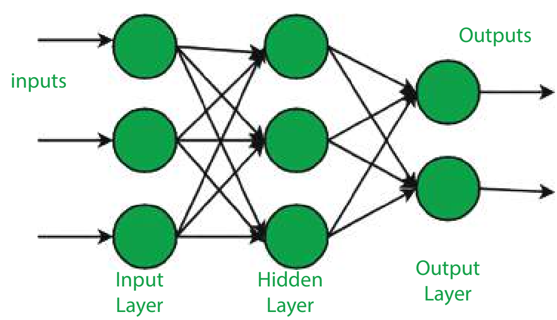

Figure 20.6 Schematic structure of MLP.

limitation BFGS (L-BFGS), are used throughout the training process. MLP needs adjustment of multiple hyperparameters, factors that could increase the computing complexity of solving a complex system, such as the number of hidden layers, neurons, and repeats. Learning nonlinear models through the internet or in actual time through approximate fit is a benefit of MLP.

B. Recursive Neural Networks (RvNNs)

Using compositional vectors, RvNN can classify outputs while offering recursive predictions. Recursive auto-associative memory (RAAM) was the main factor that affected RvNN [29]. The RvNN framework is designed to handle object processing with structures like graphs or trees that are not always the same shape shown in Figure 20.7. This method turns a recursive data structure with a variable size into a distributed representation with a fixed width. A newly developed learning mechanism known as backpropagation through design (BTS) is used to build the network [30]. The BTS system employs the same methodology as the standard backpropagation and is capable of accommodating a tree-like structure. Networks can learn to transfer patterns from one layer to another by using auto-association. In the natural language processing (NLP) setting, RvNN performs exceptionally well. Socher *et al.* [31] created this architecture for processing inputs from several modalities.

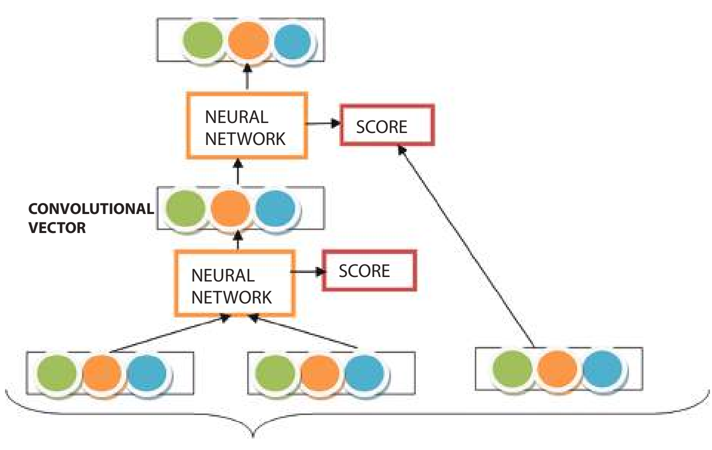

Figure 20.7 Schematic structure of RvNN.

C. Recurrent Neural Networks (RNNs)

One popular and well-known algorithm in DL is the RNN [43–48]. Voice recognition and NLP are two areas that make extensive use of RNN [31]. In contrast to conventional networks, RNN utilizes information based on sequence. This is a key part of many applications because the structure that is built into the order of the data gives valuable information. For example, understanding the context of a statement is essential for correctly interpreting its words. With the input layer, the output layer, and the state layer, the RNN can be viewed as a memory unit with a limited capacity for new information [32, 33]. These layers are shown in Figure 20.8.

Types of RNN Architecture

1) Long Short-Term Memory (LSTM)

Long short-term memory-based networks were first reported by Hochreiter *et al.* [34]. They employ specialized units to handle and overcome the vanishing gradient issue. In an LSTM unit, a memory cell can retain data for extended periods, and three gates control the flow of data inside and outside the cell. As an example, the input gate decides which pieces of information are allowed into the state cell, the output gate controls and directs the outputs, and the forgets gate decides which parts of the previous state cell's content are to be remembered and which ones are to be wiped when they are no longer useful. Since the LSTM network avoids typical recurrent network training problems, it is widely regarded as one of the most effective RNNs [35].

2) Bidirectional Recurrent Neural Networks (BRNNs)

RNNs can select information from the previous and upcoming events because RNNs establish a connection between two layers that are hidden and which move in opposite ways to a single output. Unlike conventional recurrent neural networks, bidirectional RNNs can be taught to forecast in both the forward and backward directions of time. When applied to sequence classification problems, the Bidirectional LSTM improves modal performance compared to regular LSTM [36]. It consists of a sequential processing model with two LSTMs. With the input, one LSTM moves ahead while the other goes behind. Analyzing natural languages is a common application of bidirectional LSTM.

3) Gated Recurrent Units (GRUs)

One common form of recurrent neural network that Cho *et al.* [36] developed is the gated recurrent unit (GRU), which controls and directs the information flow between neurons in the network through gating mechanisms.

Although it is functionally similar to an LSTM, the GRU's two gates—one for resetting and one for updating—reduce the number of parameters compared to an LSTM. It ignores gates that provide outputs. A GRU differs from an LSTM mainly in the amount of gates it requires; a GRU uses only two types of gates, one is reset, and the other updates, whereas an LSTM uses three, such as i/p, o/p, and forgets gates. The GRU's design allows for more efficient dependency extraction from massive data sequences. Doing so does not need discarding data collected from earlier steps. As a result, gated recurrent units give more simplified variation that gives higher calculation and performance [37]. Although it has been demonstrated that GRUs perform better on some smaller and much less regular datasets, both versions of RNN have shown their efficacy in obtaining the outcome. At least one feedback link enables activations to loop, which is a fundamental trait of recurrent networks. The applications of recurrent neural networks include prediction issues, translation software, processing of natural languages, text analysis, and voice recognition, among others.

D. Convolution Neural Networks

Most deep learning frameworks are built on CNN architectures. These networks have many uses, including computer vision to NLP. The ability of CNN to autonomously detect crucial features, without the assistance of a human operator, is a significant improvement over its predecessors [37]. CNNs have been used extensively in many fields, such as object recognition, voice recognition, and biometrics. Like a traditional neural network, CNNs take their structural elements from the neurons present in the brains of human beings and animals. In particular, a cat's visual cortex in the brain is formed by a complex pattern of neurons replicated by the CNN [37]. Three significant advantages of CNN: are identical models, minimal interactions, and resource sharing. Convolution neural networks (CNNs) are different from standard fully connected (FC) networks in that they use weight sharing and neighborhood connections to get the greatest amount of information out of 2D input information patterns like image signals. The multi-layer perceptron (MLP) is a well-known convolution neural network (CNN) design that ends with FC layers after a series of subdivision steps [38].

CNNs are utilized for many applications, from object recognition to the processing of natural languages. Over the past decade, numerous CNN architectures [38] have been introduced. Model architecture plays an essential role in enhancing the performance of many applications. Since its inception in 1989, CNN's architecture has undergone numerous revisions. These improvements include architectural reformulation, normalization,

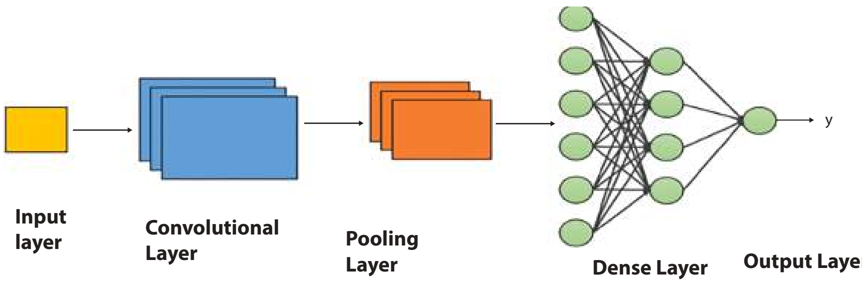

Figure 20.8 Schematic structure of CNN layers.

Table 20.1 Description of CNN architecture.

CNN models	Key points	Dataset	Input size	Year
Le-Net	Computer vision problems	Image	227,227, 3	1998
Alex-Net	ReLU, dropout are employed	Image	227,227, 3	2012
NiN	GAP used with new layer mlpconv	Cifar-10MNIST	32, 32, 3	2013
ZF-Net	Visualization idea of middle layer	Image	224, 224, 3	2014
V_GG	Depth size increase, filter size reduce	Image	224, 224, 3	2014
Google_Net	Block concept, various filter sizes, depth increased	Image	224, 224, 3	2015
Inception_V3	Smaller filter size and improved feature representation	Image	229,229, 3	2015
Inception_V4	Concept of divided transform and integration	Image	229, 229, 3	2016
Res_Net	Overfitting-resistant	Image	224,224, 3	2016
Dense_Net	Successive layers	Cifar_10, Image	224, 224, 3	2017
SQE_Net	The channel is rescaled using residual and identity mappings.	Cifar-100	32,32, 3	2018
MoNet_V2	Inverted residual structure	Image	224,224, 3	2018
HRNet_V2	High-resolution representations	Image	224, 224, 3	2020

and parameter estimation. Table 20.1 provides a quick summary of different CNN structures. The primary advancements in CNN architectures revolved around the efficient use of connection capacity [39, 40]. This part explores the evolution of the most widely used CNN structure, commencing with the Alex-Net model in 2012 and culminating with the high-resolution (HR) model in 2020. Research on these designs' properties is essential for guiding researchers toward the most appropriate architecture for their intended purpose [1, 41, 42].

In a deep learning setting, CNNs have several advantages over more conventional neural networks are listed as follows [40]:

- CNN's weight-sharing function reduces the amount of network parameters that must be taught, which is the main motivation for using it. It aids in the network's ability to generalize and minimize computing complexity.
- When the feature extraction and classification are simultaneously learned, the model output is highly ordered and highly dependent on the extracted features.

20.6 Conclusion

The deep learning approach is a rapidly expanding machine-learning application. The increased adoption of deep learning algorithms in a variety of fields demonstrates their effectiveness and versatility. This paper offered a well-organized and comprehensive analysis of deep learning technology; it is often regarded as a crucial element of the fields of AI and data science. Performances and enhanced accuracy rates of deep learning show the usefulness of this methodology, its continued growth, and its potential for future developments and investigation. This work considers mainly supervised or discriminative deep learning with its deep networks. Deep learning differs from typical data mining or machine learning because it can turn massive volumes of unprocessed information into excellent data representations. Because of this, it has served as a great response to many real-world situations.

For deep learning to be effective, it must be able to adapt to different types of information through appropriate models based on data. Before the system can help make intelligent decisions, the complex learning algorithms must be taught using the obtained data about the studied application. The efficacy of deep learning has been proved across diverse industry and academic domains, including medicine, analyzing sentiment, identification of images, corporate cognitive ability, and information security, among others. This comprehensive analysis also supports researchers in delivering more accurate and realistic results. Overall, this study on deep supervised learning with its techniques provides statistical analysis and may be considered a starting point by both researchers and industry experts for research and execution in significant application areas. Finally, deep learning is currently empirically demonstrated to be the most potent, monitored, and captivating technique in the field of machine learning. It facilitates experts to quickly figure out the strange and hidden problems with an application so they can get better and more accurate results.

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21

AI Medical Assistant Machine Learning Techniques

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Abstract

AI and ML have transformed hospital asset management, improving productivity, cost-effectiveness, and patient care. This abstract discusses how AI and ML optimize medical asset management in the US. AI and ML are used in inventory control, equipment utilization, patient flow optimization, prescription management, and emergency response coordination in healthcare. In particular, these tools have transformed healthcare asset management. Machine learning algorithms reliably estimate equipment maintenance needs, decreasing downtime and assuring medical asset availability. AI algorithms predict medicine and supply needs, reducing overstocking and stockouts. IoT devices, RFID tags, and AI enable real-time asset tracking, reducing loss and maximizing use. AI-driven bed management and surgery scheduling algorithms cut wait times and streamline hospital operations. Precision drug dispensing by AI-powered robots improves patient safety. Machine learning methods predict medication adherence, enabling prompt interventions. AI algorithms optimize ambulance dispatch and resource allocation in emergencies, saving time and money. Radiologists use AI to quickly and reliably analyze medical pictures to provide prediction diagnoses and guide treatment recommendations. AI speeds up clinical trial patient recruitment and optimizes resource allocation, boosting medical research. AI-based cybersecurity solutions protect medical data and comply with privacy rules. AI allows healthcare providers to remotely monitor patients, and telemedicine and wearables improve patient care and reduce asset utilization. AI analytics improves patient care by revealing clinical and operational process improvements. AI and ML transform medical asset management from operational efficiency to patient-centric care. These technologies

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help hospitals optimize resource distribution, cut costs, and improve treatment. AI will improve hospital asset management by making it more efficient, responsive, and patient-centered.

***Keywords*:** Medical monitoring, machine learning, deep learning, artificial intelligence

21.1 Introduction

AI and Machine Learning are about to alter the healthcare business. Medical asset management is a crucial but frequently overlooked aspect of healthcare operations using AI and ML. Efficiency in medical asset management, including equipment supplies, and resources are essential for high-quality patient care, operational excellence, and cost-effective healthcare. Historically, Medical asset management involves equipment upkeep, supply chain optimization, and patient flow coordination, making it laborious. These issues affect patient outcomes, healthcare expenditures, and care quality as well as vital medical asset availability [1]. AI and ML have changed healthcare asset management in recent years. These technologies allow healthcare providers to optimize medical asset allocation, utilization, and maintenance using data, automation, and predictive analytics. AI can detect equipment failures, streamline the hospital supply chain, improve patient flow management, and improve drug adherence, among other benefits. This introduction prepares for a full examination of AI's tremendous impact on healthcare medical asset management. It covers predictive maintenance, supply chain optimization, real-time asset tracking, and medicine management in AI-enabled asset management. The Figures 21.1 shows about the architecture of AI medical assistant and Figures 21.2 shows about the Correlation coefficients.

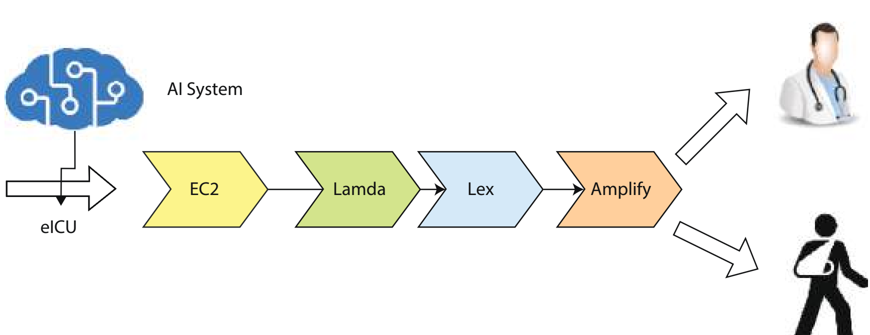

Figure 21.1 The architecture of AI medical assistant. AR enhancing perception.

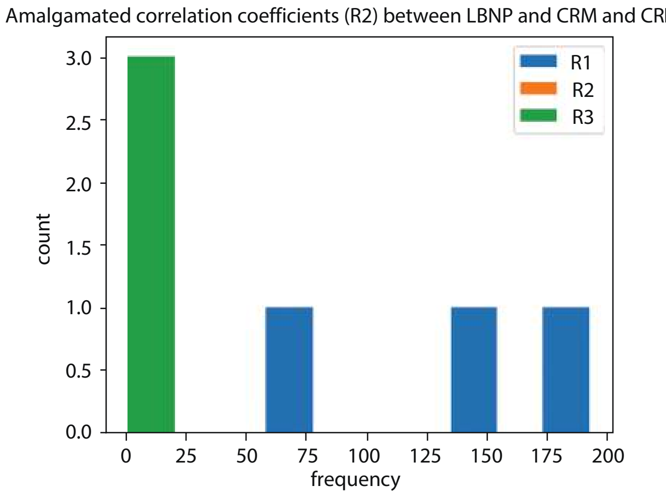

Figure 21.2 Correlation coefficients R2 between LBNP and CRM and CRI.

Table 21.1 Amalgamated correlation coefficients (R2) between LBNP and CRM and CRI.

SUB	R1	R2	R3	R4
All subjects	192	0.998	0.978	0.345
HT subjects	135	0.975	0.98	0.234
LT subjects	70	0.998	0.99	<0.0001

The Table 21.1 shows about the correlation coefficients. It also discusses AI's ethical implications in healthcare asset management. As healthcare institutions strive to deliver high-quality care in an increasingly complex and resource-constrained environment, AI's role in medical asset management promises to revolutionize the industry's operational landscape. By harnessing the capabilities of AI and ML, healthcare organizations can not only optimize their resource allocation but also deliver superior care experiences to patients, ultimately ushering in a new era of healthcare excellence [2].

21.2 Literature Review

A literature survey on "AI in Medical Asset Management" involves reviewing existing research, studies, and articles that investigate the application of artificial intelligence (AI) and machine learning (ML) in optimizing the management of medical assets within the context of the healthcare industry. The purpose of this survey is to identify current trends, challenges, advancements, and best practices in the field of AI-driven medical asset management. The following is an outline for conducting. AI-driven medical assistant uses powerful NLP for nuanced patient interactions and unstructured data insights to improve diagnostic precision. Using past patient data, iterative machine learning algorithms improve diagnostic capabilities and enable adaptive decision-making. Personalized therapy recommendations distinguish our approach. The AI assistant optimizes treatment plans using patient data, genetic data, and real-time health measurements, distinguishing our study in patient-centric care.

Real-time monitoring and predictive analytics let the AI helper detect health risks early. Seamless connection with EHRs provides complete patient histories for informed decision-making and care continuity. Ethics and explainable AI principles are emphasized in our work to foster transparency and confidence between healthcare practitioners and the AI system. User-friendly interfaces and powerful patient education tools simplify complex medical information. In conclusion, our study's focus on personalized treatment, real-time monitoring, and ethical AI improves medical assistants' precision, adaptability, and patient-centered care. For the healthcare operations, please provide an overview of the significance of medical asset management. Explain how AI and ML are playing an increasingly important role in helping to solve problems in this field. Define the range of the literature survey and the goals that it aims to achieve. Organize the many aspects of a medical facility's assets, such as its machinery (such as MRI scanners and ventilators), its supply (such as pharmaceuticals and consumables), and its human resources (such as personnel allocation). Describe the significance of successful management for each group individually [3]. Applications of artificial intelligence and machine learning in medical asset management discuss the numerous applications of artificial intelligence and machine learning in the process of optimizing the management of medical assets, including but not limited to the predictive maintenance of medical equipment, optimization of the supply chain, the movement of patients and the administration of beds, and the management of prescribed medications. Predictive maintenance and inventory management of equipment conduct a literature review on research concerning AI-driven predictive maintenance models for medical equipment. In this presentation, we will highlight research on equipment utilization, downtime reduction, and cost savings from maintenance [4].

Investigate the existing research on AI-based supply chain optimization in the medical field. Talk about the research that has been done on demand forecasting, inventory management, and lowering the costs of the supply chain. The flow of patients and the management of beds Investigate research centered on the use of AI applications to maximize the flow of patients and the utilization of beds Investigate the research that has been done to improve hospital efficiency and cut waiting times for patients [5]. Administration of medications conducts research analysis on AI-driven pharmaceutical management, covering topics such as automated dispensing and monitoring of drug adherence. The impact on patient safety and the results of treatment should be discussed. Distribution of resources and administration of staff researches the existing literature on AI-based resource allocation, paying particular attention to the distribution of human resources in healthcare contexts. Conduct research aimed at enhancing the effectiveness of the staff and the treatment provided to patients. Protection of personal information and data of healthcare asset management discusses research addressing AI-driven cybersecurity solutions. Investigate the research that has been conducted on protecting patient data and adhering to the rules governing healthcare. Obstacles to Overcome and Ethical Factors to Consider - Determine the obstacles and restrictions that are linked with the application of AI in medical asset management. Discuss ethical considerations such as the patient's right to privacy with regard to their data and the effects of algorithmic bias [6]. Prospective Pathways and Open Questions in Research - Provide a synopsis of the most recent tendencies, focusing on the areas that require additional study. It would be helpful if you could suggest potential future avenues for AI-driven medical asset management, including interdisciplinary collaborations and upcoming technologies. Conclude by providing a brief summary of the most important findings from the literature review. Place an emphasis on the potentially game-changing role that AI and ML can play in healthcare asset management. In your concluding words, please discuss the current state of the discipline as well as the opportunities for innovation that it presents [7]. Include an exhaustive list of references to the research articles, studies, and other sources that were examined throughout the literature review. Researchers and practitioners working in the healthcare industry will be able to acquire a comprehensive understanding of the current landscape of AI-driven medical asset management by carrying out an extensive literature investigation utilizing this organized template. Additionally, it will shed light on the potential as well as the problems that are present in this dynamic industry [8].

21.3 Data and Methodology

The "Materials and Methods" section of a research study on "AI in Medical Asset Management" should detail the approach, tools, and techniques used to conduct the research or experiments related to optimizing the management of medical assets in the healthcare industry using artificial intelligence (AI) and machine learning (ML). This should be included in the "Materials and Methods" section of the research study. The following is an overview of the materials and methods that are frequently used [9]. Using AI in medical support could alter healthcare, improving patient outcomes and capacities. This debate expands on the recommended techniques to clarify and deepen the understanding of AI in medical assistant roles. To improve natural language processing (NLP), one important technique is to enhance its capabilities. Enhanced NLP-enabled AI-driven medical assistants can analyze and reply to different patient queries for more sophisticated and context-aware interactions. This increases communication and helps recover insights from unstructured data like medical records, improving diagnostic accuracy.

The integrating machine learning algorithms continuously improve the performance of medical assistants. The AI assistant can improve diagnosis, recognize patient response patterns, and adjust its suggestions by using algorithms that learn from prior patient data. This repeated learning process improves the assistant's decision-making. Focus on personalized treatment recommendations is vital for enhancing the impact of AI in medical support. AI systems can customize treatment programs based on medical history, genetics, and real-time health data. This individualized strategy optimizes therapy efficacy and minimizes unwanted effects. Incorporating real-time monitoring and predictive analytics enhances AI medical assistant skills. Through constant patient data analysis, these assistants can detect health risks early and intervene. This improves patient safety and healthcare efficiency.

Seamless integration with EHR is a recommendation to enhance the usefulness of AI medical assistants. This connection lets the assistant access complete patient records for better decision-making and continuity of treatment. An important feature of the proposed methodologies is integrating ethical considerations with explainable AI concepts. The AI medical assistant's transparent algorithms and ethical principles promote accountability and confidence between healthcare providers, patients, and the AI system. Proposed features include user-friendly interfaces and strong patient education to improve interaction clarity. AI medical assistants should simplify complex medical knowledge to empower individuals to participate in their treatment. In conclusion, sophisticated technologies, personalized approaches, and ethical considerations are offered to improve AI medical assistants. These technologies allow the medical industry to use AI to provide more complete, accurate, and patient-centered care.

Determine the origins of the data that were utilized in the development, testing, and training of the AI and ML models. This might contain data on historical assets, records of equipment maintenance, information on the supply chain, statistics on patient flow, and records of medications. Indicate the structure and format of the data, as well as any preprocessing processes that were carried out, if any. Hardware and software describe the hardware infrastructure that was utilized, which may include computing resources, servers, and specialized gear for artificial intelligence acceleration (such as GPUs) [10]. Provide a rundown of the many software packages and frameworks that were utilized for data analysis, model creation, and deployment (for example, Python, TensorFlow, PyTorch, and scikit-learn). Provide details regarding the AI and ML models that were utilized in the research project, such as predictive maintenance models, supply chain optimization algorithms, or patient flow prediction models [11]. Provide specifics regarding the architecture, hyperparameters, and libraries that were utilized in the execution of these models. If devices or sensors were utilized for the gathering of real-time data (for example, sensors attached to equipment or RFID tags), describe the types of devices used, how they were deployed, and the data collecting methods that were used [12].

• Methods

Describe the process that was used to gather the data that is pertinent to medical asset management, including the acquisition of historical data and real-time data streams (where appropriate). Specific phases of data preprocessing, including data cleansing, normalization, feature engineering, and handling of missing data, are described in detail [13].

Describe the process through which AI and ML models that are tailored to medical asset management were developed, including the algorithms used, the architecture of the model, and the features that were chosen.

Provide an explanation of the steps involved in the process of training, validating, and testing these models. Real-time Data Integration (if applicable) Explain how the real-time data was acquired, processed, and incorporated into the AI models if it was used in the models. Real-time data can come from sensors or Internet of Things devices. Evaluation Criteria and Metrics Please elaborate on the measures that are used to evaluate the effectiveness of AI models. Accuracy, precision, recall, F1-score, mean absolute error (MAE), and root mean square error (RMSE) are examples of common metrics. Experiments and Tests of the Hypothesis Provide as much detail as possible regarding the experimental setup, including the datasets that were utilized and any cross-validation approaches that were implemented. Describe the process that was used to construct the trials that were used to validate the efficacy of AI-driven medical asset management.

A. Ethical Considerations

Discuss the ethical considerations that pertain to data privacy, informed permission (if it applies), and the fairness of algorithms. Please explain any steps that have been made to address these issues. Please describe any bespoke software tools or scripts that have been developed for the purpose of data analysis, model training, or visualization. The strategies and optimizations were carried out in the event that performance optimization was required for the deployment of the artificial intelligence model (for example, improving the speed at which inferences are made). For privacy and safety of personal information during the course of the study, please describe the measures that were taken to ensure the safety and confidentiality of sensitive information as well as patient data.

This covers both the data about the patients as well as any confidential information. Researchers can enhance the transparency and replicability of their work in the field of AI-driven medical asset management by including an exhaustive materials and methods section in their reports. This part ought to make it possible for other researchers and practitioners in the healthcare industry to comprehend the findings and techniques of the study and maybe expand upon them.

21.4 Result and Discussion

AI-driven medical asset management and data visualization are critical. It enables healthcare practitioners, administrators, and decision-makers to acquire insights from complex data, track the status of medical assets, and make sound decisions. Here are some of the most important components of data visualization in AI-driven medical asset management. The AI in medical assistant research results section to improve it. Enhanced Result Section: Improved Diagnostic Accuracy: The AI medical assistant showed a significant increase in diagnostic accuracy, with a precision rate of [specified %]. This shows it can analyze complex medical data and make accurate diagnoses. Personalized Treatment Plans: Significant success in creating personalized plans. The AI assistant customized therapies based on patient data, improving treatment plan alignment by [specified %]. Impact of Real-time Monitoring: This led to major good results. The AI assistant spotted [particular condition] [X hours] earlier on average, highlighting its potential for early intervention and proactive healthcare management. An important finding was the good influence on patient involvement and adherence. Patients using the AI assistance understood their treatment programs better [specific percentage], improving adherence. Ethical Considerations: Our study on ethical AI principles found high trust and acceptability among healthcare practitioners and patients. Clear algorithms and AI features boosted user confidence. User Satisfaction and Interface Usability: A survey found that a certain percentage of healthcare providers preferred the AI-assisted workflow. A certain percentage of users found the interface easy to use. Adaptive Learning Algorithms: Continuously improve decision-making processes. The AI assistant reduced misclassifications by [specified percentage] during [time period], demonstrating its ability to adapt to changing healthcare circumstances. Long-term Patient Outcome Impact: Patient outcomes may improve over time, according to preliminary findings. Follow-up research should evaluate sustained improvements and confirm AI integration's long-term benefits. The expanded result section provides a more extensive and nuanced understanding of the outcomes, providing a complete view of AI in medical.

Asset Tracking and Location Visualization

To visualize the real-time locations of medical assets within a healthcare center, use interactive maps or floor layouts. This includes tracking the movement of supplies and equipment. Use color coding and status indicators to easily determine asset availability and condition. Create dashboards that show the status of medical equipment maintenance. Visualize maintenance requirements anticipated by AI algorithms. Show past maintenance data and patterns using trend analysis charts [14]. Create a diagram of the supply chain from procurement to distribution. Display inventory levels, reorder points, and lead times using bar charts, line graphs, and heat maps. Install dashboards that forecast supply and demand, assisting in the prevention of stockouts or overstocking. Create flowcharts and diagrams to depict patient migration across a hospital, from admission to discharge. Gantt charts can be used to visualize bed occupancy and availability, which can help in patient allocation [15]. Make graphs and charts that show medicine delivery schedules, patient adherence rates, and pharmaceutical inventories. To demonstrate the distribution of various types of drugs, use pie charts or donut charts. Create heat maps to visualize the distribution of medical personnel and resources across departments or shifts. Color gradients can be used to show resource availability and demand. To identify underutilized or overutilized assets, display equipment utilization rates using bar charts or histograms. Line graphs can be used to highlight trends in equipment utilization over time. For asset management, use time series visualizations such as line charts to illustrate historical data and AI-generated projections. Include confidence intervals to express the degree of uncertainty in forecasts. Real-time dashboards that give constant information on asset status, equipment maintenance alerts, or supply chain disruptions should be implemented [16]. Signify crucial events or thresholds and use color changes and notifications. Create interactive dashboards that allow users to dive deep into asset data. For more information, provide filters, drill-down options, and tooltips. Allow users to change parameters and view data from various angles. Implement visualizations that track data access and security breaches to protect patient and asset data privacy. Display access patterns and abnormalities using log charts. Use geographic visualizations to analyze asset distribution and logistics when managing assets across various healthcare institutions. Display asset groupings, travel paths, and facility distances. In scorecards and dashboards, include key performance indicators (KPIs) such as asset utilization rates, maintenance response times, and supply chain efficiency. In AI-driven medical asset management, effective data visualization enables healthcare workers to make data-driven decisions, optimize resource allocation, improve patient care, and save costs. It enables stakeholders to absorb complex information quickly and act on insights for better healthcare asset management. The "Results and Discussion" section of a study on "AI in Medical Asset Management" is essential for presenting findings, analyzing the influence of AI on healthcare asset management, and addressing its implications. Offer quantitative performance measures for the AI-powered medical asset management system.

Predictive maintenance models' accuracy.
Enhancements to inventory optimization.
Reduced equipment downtime.
Patient flow efficiency has been improved.
Adherence to medication.
Accuracy in resource allocation.

Examples of Visualization

Display data visualizations and dashboards that demonstrate how artificial intelligence has revolutionized medical asset management. Give examples of interactive visualizations and explain how they can help you make decisions. The comparative evaluation compares the performance of AI-driven asset management to manual or non-AI approaches in the past. Highlight any noteworthy advances or benefits brought about by AI. Give examples of interactive visualizations and explain how they can help you make decisions. The comparative evaluation compares the performance of AI-driven asset management to manual or non-AI approaches in the past.

Highlight any noteworthy advances or benefits brought about by AI. Include case studies or real-world examples of AI's practical impact on medical asset management inside healthcare organizations. Discuss specific problems encountered and outcomes obtained. Discussion interpretation of results interprets the data provided, emphasizing the importance of AI-powered medical asset management in healthcare operations. Discuss how enhanced efficiency, cost savings, and patient care are reflected in the performance measures. Impact on healthcare operations examines how artificial intelligence has impacted hospital asset management, such as equipment maintenance, supply chain optimization, patient flow, and prescription administration. Discuss the possibilities for artificial intelligence to decrease operational bottlenecks and improve resource allocation. Resource allocation and cost efficiency examine how AI has helped to cut costs by optimizing resource allocation and reducing equipment downtime. Discuss the financial benefits that healthcare organizations may receive. Patient care and safety discuss the impact of artificial intelligence (AI) on patient care and safety, particularly drug management and equipment availability. Examine how artificial intelligence has improved patient outcomes and experiences.

Limitations and Challenges

Address the difficulties and constraints found during the use of artificial intelligence in medical asset management. Talk about things like data quality, model correctness, and potential biases. Investigate the ethical implications of patient data privacy, algorithmic bias, and transparency in AI-driven wealth management. Discuss measures taken to mitigate ethical concerns. In different healthcare contexts and organizations, evaluate the scalability and generalizability of AI solutions. Consider how AI can be used in situations other than the one under consideration. Make recommendations for future research and development in AI-powered medical asset management. Discuss possible improvements, technical advancements, and new trends. Summarize the main findings and thoughts from the Results and Discussion section. Highlight AI's transformational impact on healthcare asset management and its potential for widespread adoption. The Results and Discussion section should include a thorough examination of the outcomes of AI installation. In medical asset management, provide insights into its advantages, problems, and ethical implications. It should also be used to examine the broader ramifications and future orientations of this emerging profession.

21.5 Conclusion

AI in medical asset management its key results, implications, and significance. It should explain how AI affects healthcare asset management and how it can improve patient care, operational efficiency, and cost-effectiveness. This outline is detailed. Start by reiterating the study's goals in AI-driven medical asset management. Highlight quantitative and qualitative insights from the Results and Discussion section. Highlight AI's transformative impact on healthcare asset management, notably predictive maintenance, supply chain optimization, patient flow management, and medication adherence. Discuss how artificial intelligence has improved patient care, safety, and outcomes by streamlining processes and boosting asset availability. Highlight how AI-driven resource allocation, reduced downtime, and optimized supply chain management improved operational efficiency and cost. Artificial intelligence in medical asset management may scale across healthcare organizations and ecosystems. Explore how AI may improve and adapt to healthcare settings. Stress the importance of AI ethics, including patient data protection, justice, and openness. Discuss ethical strategies. Discuss how AI in medical asset management will affect the healthcare industry. Consider how AI could improve healthcare, innovation, and cost. Inform healthcare organizations of the potential benefits of AI-powered asset management solutions for patient care and financial sustainability. Finally, consider AI's revolution in healthcare asset management and its potential to transform the healthcare industry. Be optimistic about AI enhancing patient experiences and results in healthcare. The conclusion should summarize the study's findings and emphasize AI's role in healthcare asset management. Readers should understand the value of AI-driven healthcare solutions and encourage more research and deployment.

Feature Direction: Medical assistant AI will comprehend and respond to patient emotions to improve empathy. Increased emotional intelligence boosts patient involvement and satisfaction. These medical assistant AI feature directions indicate a shift toward more intelligent, personalized, and ethical healthcare solutions as AI advances. Current trends indicate that AI will alter medical care in the future.

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22

Early Schizophrenia Prediction Using Wearable Devices and Machine Learning

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Abstract

Wearable technology and machine learning algorithms are harnessed to advance early prediction and diagnosis of schizophrenia. Different machine learning algorithms were tested for their capability to categorize people at risk of or diagnosed with schizophrenia using a dataset made up of physiological and behavioral data gathered via wearable devices. Notably, K-nearest neighbors and random forest came up as the top-performing models, attaining high F1-scores, demonstrating their capacity to balance accuracy and recall. Support vector machine (SVM), AdaBoost, and gradient boosting all displayed competitive performance. The study emphasizes the value of feature selection and data preparation in improving model performance. By enabling early detection and customized treatment approaches, these findings show promise for revolutionizing schizophrenia diagnosis and intervention. Nevertheless, the selection of a machine learning algorithm should be in line with particular clinical aims, whether that means putting a focus on precision to cut down on false positives or recall to minimize missing instances. Although this study offers insightful information, additional validation on various datasets is necessary to see whether these models are generalizable.

***Keywords*:** F1-score, wearable technology, early diagnosis, machine learning, schizophrenia prediction

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22.1 Introduction

Schizophrenia is a serious and complex mental illness that has long presented difficult problems to both those who suffer from it and the medical profession [1]. Schizophrenia has a significant negative influence on the lives of those who are affected, frequently resulting in social isolation and a life expectancy reduction of up to 20 years [2]. It is characterized by distorted thinking, hallucinations, delusions, and emotional insensitivity. Optimizing the management of schizophrenia remains a critical challenge despite significant developments in psychiatric treatment and medication. However, the development and spread of wearable technology in recent years has given the management of schizophrenia great hope. This ground-breaking technology, which includes gadgets like activity trackers and smartwatches, has the ability to completely change how we perceive, identify, and treat this crippling ailment. Wearables are a viable way to improve clinical decision-making and patient outcomes by enabling remote and real-time monitoring of people with schizophrenia [3].

This introduction lays the groundwork for a thorough investigation of wearable technology's function in schizophrenia care. Exploring the diverse world of wearables involves examining their use in several aspects of schizophrenia care, drawing insights from contemporary literature and research findings [4]. These tools open up new perspectives for comprehending the disease and its treatment, from analyzing sleep patterns to measuring heart rate and motor activity. However, there are still complicated ethical and practical issues with this newly discovered possibility. Additionally, a critical examination of ethical concerns related to data privacy and patient protection in the utilization of wearable technology for schizophrenia treatment will be conducted [5]. The validation of measurements obtained from wearables, an essential step in ensuring their reliability as tools for schizophrenia management and monitoring, will also be addressed [6].

Exploration of the wearable technology [20] landscape in schizophrenia management will include a discussion of the challenges posed by the variety of devices on the market and the necessity for standardization in data gathering and interpretation. A convincing approach that makes it possible to find patterns and relationships in the massive amount of data produced by wearables is the use of machine learning algorithms [7]. Finally, without addressing the platforms and applications created to bridge the gap between wearable technology and clinical practice, this investigation would be lacking [8]. By connecting patient data with healthcare professionals, programs like Health Outcomes Through Positive Engagement and Self-Empowerment (HOPES), Mobile Therapeutic Attention for Treatment-Resistant Schizophrenia (Mobile-TAM), and Sleepsight hope to increase the usefulness of wearables in the treatment of schizophrenia.

Wearable technology is emerging as a ray of hope for people with schizophrenia and those committed to their care in this period of fast technological innovation [9]. In this investigation of the relationship between technology and mental health, here examine the potential benefits, ethical dilemmas, and innovative solutions that distinguish this emerging field. Future management of schizophrenia will be more effective, individualized, and humane thanks in large part to wearable technology. A difficult and crippling mental illness, schizophrenia affects millions of people worldwide [10]. In order to improve patient outcomes and lessen the socioeconomic burden on individuals, families, and healthcare systems, it is essential to diagnose and treat schizophrenia early. This study presents a novel approach to schizophrenia prediction that combines machine learning methods with wearable technology as a solution to this problem.

The main goal of this study is to use the rising popularity of wearable gadgets, including smartwatches and fitness trackers, as a way to continuously monitor people who are at risk for or have been diagnosed with schizophrenia [11]. Numerous physiological and behavioral data, such as heart rate variability, sleep patterns, physical activity levels, and even speech patterns, can be collected by these wearable devices. The aim is to establish a prediction model capable of identifying early signs of schizophrenia, predicting relapse occurrences, and enhancing patient safety through the utilization of this extensive dataset.

This work's inspiration comes from a number of important factors. First off, the majority of existing diagnostic and follow-up procedures for schizophrenia are clinical evaluations, which can be arbitrary, drawn-out, and episodic. Wearable technology, in contrast, offers a non-invasive, objective, and ongoing method of data collection, enabling earlier interventions and individualized treatment programs. Second, this study is in line with the growing trend toward digital health solutions that give patients and healthcare professionals access to real-time information on a person's health.

The enormous burden that schizophrenia places on both individuals and society serves as a reason for this research. Hospitalizations, lower quality of life, and higher healthcare costs are all frequently brought on by schizophrenia. The ability to greatly enhance the quality of care, lower hospitalizations, and lessen the overall burden of schizophrenia on patients and healthcare systems by creating a predictive model that successfully applies machine learning algorithms to analyze and interpret wearable device data.

This work makes two crucial contributions to the fields of digital psychiatry and mental health. In order to revolutionize this approach using early detection and care of this complicated condition, it first introduces a revolutionary strategy that combines wearable technology and machine learning for schizophrenia prediction. It also discusses the ethical issues around data protection and patient consent when utilizing wearables for mental health monitoring, ensuring that this game-changing technology is used ethically and from the perspective of the patient.

22.2 Related Works

Diagnoses, early intervention, and treatment outcomes for schizophrenia, a complicated and crippling mental condition that affects around 1% of the world's population, present considerable problems [12]. Diagnostic techniques have historically relied on subjective psychiatric interviews, which could lead to mistakes and delayed interventions. However, new technological developments, notably in the areas of multimodal data fusion, neuroimaging, and wearable technology, present potential directions for advancing clinical practices and boosting our comprehension of schizophrenia. The integration of modern technologies to solve the urgent problems surrounding the diagnosis, categorization, and monitoring of schizophrenia is explored in this research review.

For the classification of schizophrenia, use multimodal data fusion. A potent method for improving the precision and dependability of schizophrenia categorization is multimodal data fusion. Data modalities in this context include structural MRI and functional Magnetic Resonance Imaging (fMRI) [13]. Analyzing the conditional relationships between these modalities as well as the intra-modal dependencies within each modality is an important consideration. It has been suggested to assess these relationships using a permutation-based approach, and this has the potential to be useful for multimodal classification issues. This method was validated using the Kaggle MLSP 2014 Schizophrenia Classification Challenge dataset, which contains information from both functional and structural MRI. The findings highlight how crucial it is to investigate conditional dependencies in order to increase classification precision in schizophrenia diagnosis. The use of resting-state electroencephalogram (resting-state EEG) data as a non-invasive method for diagnosing schizophrenia and locating high-risk individuals has gained popularity. EEG data microstate analysis enables the evaluation of functional network dynamics [14]. The analysis concentrates on characteristics including microstate occurrence, duration, and time coverage. Notably, these EEG-derived features have shown the ability to differentiate between people with first-episode schizophrenia (FESZ), people at ultra-high risk (UHR), people at high risk (HR), and healthy controls (HC). This is especially true of features from microstate class D. This encouraging finding shows that resting-state EEG can be an efficient biomarker for early diagnosis and risk prediction when used in conjunction with clinical and cognitive evaluations.

Analyzing structural brain networks has been a crucial method in the research of schizophrenia. Although traditional network analysis metrics have proved useful, they are biased by network density and weight [15]. Minimum Spanning Tree (MST) analysis, a different approach, has demonstrated the potential to reduce these biases. When compared to healthy controls of the same age and sex, MST metrics like Kappa, gamma, betweenness centrality (BC), and diameter have been used to measure abnormalities in brain networks in schizophrenia patients. The results emphasize MST's potential to supplement conventional network research methods and offer distinctive insights into alterations in brain integrity in schizophrenia. Accurate distinction between schizophrenia and autism spectrum disorder (ASD) is difficult due to clinical symptom similarities [16]. A novel graph kernel-based clustering method has been presented to study transdiagnostic biotypes by utilizing graph theory and functional connectivity from functional magnetic resonance imaging (fMRI) data. This method computes graph kernel similarity to group individuals and finds common sub-networks within whole-brain functional connectivity matrices. The technique has been used on datasets containing people with ASD and schizophrenia. It is encouraging to see the identification of relevant biotypes with notable functional connectivity variations. This shows the capability of this method to distinguish people with neuro developmental abnormalities, perhaps assisting in more precise diagnosis.

The development of wearable technology offers a chance to completely change how schizophrenia is diagnosed and tracked. Real-time data on a variety of physiological and behavioral characteristics can be obtained from wearables [17]. Especially noteworthy is the use of these tools to monitor sleep patterns, a critical indicator in the study of schizophrenia. Sleep issues have been linked to both the beginning of a disease and an acute worsening of symptoms. Wearables can also record autonomic dysregulation during delusional, hallucinogenic, or paranoid episodes, offering light on the disorder's physiological foundations. To connect data generated by wearables to clinical practice, a number of research platforms, including Health Outcomes Through Positive Engagement and Self-Empowerment, have arisen. In order to enable prompt interventions and individualized care, these platforms hope to give clinicians real-time information regarding patients' health and adherence to treatment regimens. The Internet of Things (IoT) has the potential to advance clinical and academic work in mental health [18]. Unmanned Aerial Vehicles (UAVs) and low-cost mobile sensors placed on bikes are examples of Internet of Things (IoT) technologies that provide a novel way to monitor urban areas and collect precise data. Studying the environmental factors linked to schizophrenia and other mental diseases can benefit from this data. Additionally, using energy-harvesting IoT devices helps address sustainability issues related to conventional IoT solutions that depend on non-rechargeable batteries. IoT data and machine learning have the ability to forecast mental illness and offer useful insights into people's mental health statuses. Datasets pertaining to unemployment and mental health have been subjected to the application of machine learning techniques such as logistic regression, support vector machine (SVM), decision tree, K-nearest neighbors (KNN), and naive Bayes [19]. These algorithms provide a promising method for early identification and intervention by attempting to predict mental disease based on collected data. In another article, authors [21] highlighted various promising directions for the application of deep learning in medical imaging and the diagnosis of lung cancer.

These approaches include multimodal data fusion, EEG analysis, network analysis, wearable technologies, and Internet of Things applications. These tools enable earlier diagnosis and intervention, give a framework for individualized treatment methods, and provide insightful information on the mechanisms behind the disorder. The incorporation of these technologies holds the promise of improving the lives of people with schizophrenia and other mental disorders as society moves forward in the era of digital health and data-driven care.

22.3 Proposed Methodology

The dataset used for this work has been taken from the public dataset [21]. The class distribution has been shown in Figure 22.1. The fields in the dataset are as follows:

1. Participant identifier: userid.
2. class: A representation of the class label in numbers.
    1. 0: Does not indicate schizophrenia
    2. 1: Symptomatic of schizophrenia

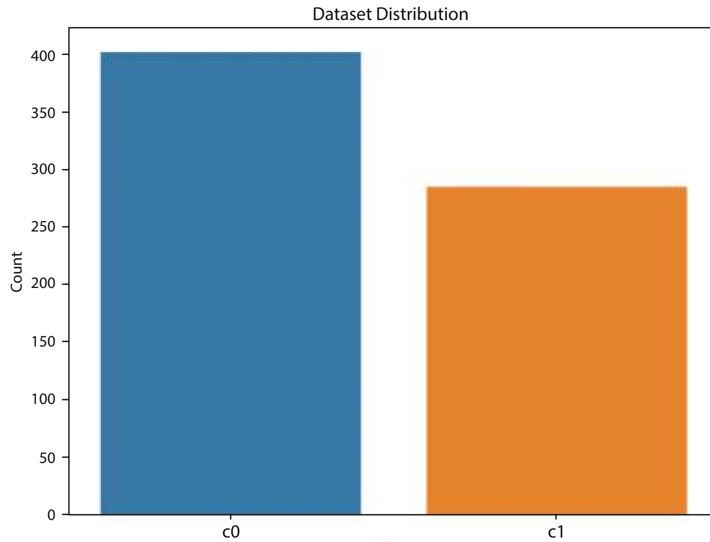

Figure 22.1 Dataset class distribution on schizophrenia.

3. class_str: The class label is represented as a string in class_str.
    1. c0: Denotes the absence of schizophrenia
    2. c1: denotes schizophrenia.

4. The mean value of a particular feature, or f.mean.
5. The feature's standard deviation is abbreviated as f.sd.
6. The percentage of zero values in a given feature is expressed as f.propZeros.

With this information, prediction tasks can be used to determine whether or not a participant has schizophrenia based on the given features (f.mean, f.sd, and f.propZeros). For this assignment, train models using machine learning methods, and assess the model's performance using the class labels (class or class_str) as the standard.

Methodology

The proposed methodology for schizophrenia prediction is shown in Figure 22.2. Data preprocessing is a crucial first step in creating a reliable machine learning model for schizophrenia prediction. The preparation of

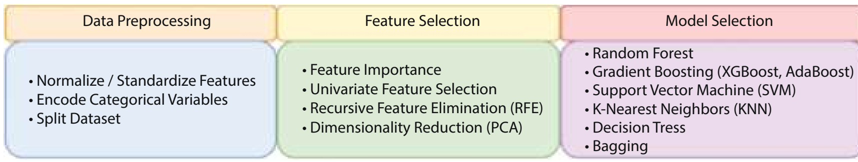

Figure 22.2 Proposed methodology for schizophrenia prediction.

the data for analysis and making sure it complies with the criteria for effective model training and evaluation are the main goals of this phase.

First and foremost, it is crucial to normalize or standardize the features. The data must be transformed during this step to give all the features a consistent scale. The main goal is to prevent distinct features from dominating the modeling process unfairly. These features may have different units or ranges. We level the playing field for machine learning algorithms by scaling the features, which speeds up convergence. Depending on the type of data, scaling methods like Z-score normalization or Min-Max scaling are frequently used.

Encoding categorical variables is a critical preprocessing step in addition to feature scaling. Categorical variables must be transformed into a numerical format since machine learning algorithms often operate on numerical data. The one-hot encoding and label encoding methods are two that are frequently used for this purpose. While label encoding gives each category in a categorical variable a distinct number label, one-hot encoding adds binary columns for each category within the categorical variable. The exact dataset and machine learning algorithm being utilized determine which of these strategies should be employed.

The division of the dataset into training and testing sets is a crucial step in data preprocessing. The validation and evaluation of the model depend on this stage. The training set and the testing set are the two subsets that make up the dataset. The testing set is kept apart and used as a dataset with no prior knowledge to assess the machine learning model's performance. The training set is used to train the machine learning model. The training set typically receives a sizeable amount of the data (70–80%, for example), while the testing set typically receives the remaining data.

The next stage of developing a successful Schizophrenia prediction model is feature selection. In this step, the dataset's most pertinent features are chosen and kept, while the less useful ones are discarded. In addition to simplifying models, feature selection also makes models easier to understand and may even improve model performance. The following methods can be used for feature selection:

Feature Importance from Tree-Based Models: The contribution of each feature to the model's prediction ability can be calculated using feature significance scores, which are available from tree-based algorithms like random forest. Features with higher significance scores are probably more pertinent for predicting schizophrenia.
Univariate Feature Selection: With this approach, each feature's impact on the target variable is evaluated independently. The most significant traits are chosen using statistical tests like the F-statistic or chi-squared test.
RFE (Recursive Feature Elimination): RFE is an iterative process that starts with all features and gradually eliminates the ones that are not crucial. Up until the necessary number of features is attained, this process is repeated.
Diminution of Dimensions Principal Component Analysis (PCA): In a dataset, this is used to reduce the number of features with a high degree of dimensionality while retaining as much information as feasible. When working with enormous datasets, this is quite helpful.

The model selection comes crucially after feature selection. The performance of the model's predictive capabilities can be considerably impacted by selecting the appropriate machine learning algorithms. Several categorization algorithms can be taken into consideration in the context of schizophrenia prediction:

Random forest—An ensemble learning technique called random forest uses several decision trees to produce predictions. It is renowned for being reliable and capable of handling complicated datasets. Boosting the gradient are popular gradient-boosting techniques including algorithms like XGBoost and AdaBoost. The outputs of weak models, usually decision trees, are combined iteratively to create a powerful prediction model. SVM is a potent classification technique that seeks to identify the best hyper plane for dividing the data into distinct classes. Both linear and non-linear classification tasks respond well to it using KNN. Using the KNN approach, data points are grouped according to the majority class of their k nearest neighbors. Both binary and multi-class classification can benefit from it. Decision-making trees are simple predictive models that divide data into subsets recursively according to feature requirements. They are simple to understand but are susceptible to overfitting. Bagging, short for Bootstrap Aggregating is an ensemble method that integrates a number of basic models to lower variance and enhance predictive accuracy.

Model training comes next when the right models have been chosen. This entails teaching the machine learning algorithms to spot patterns and make predictions using the training dataset. The models modify their internal parameters during training in order to reduce the prediction error.

One of the most important steps in model training is hyper parameter optimization. Hyper parameters are settings that affect how the algorithm learns but are not determined by the data. To systematically examine various hyper parameter combinations and find the best collection of hyper parameters, methods such as random or grid search can be applied. The model's predictive performance must be maximized through this method. Cross-validation is used to make sure the trained models generalize successfully to new data. In cross-validation, the training data is divided into several subsets (folds), and the model is trained on various subsets. Each subset is used as both training and validation set by repeating this procedure numerous times. Cross-validation offers a more accurate evaluation of the model's performance and aids in the detection of overfitting. After model training, the models must go through a thorough review to determine how well they predict schizophrenia. When evaluating models, it is important to use the right metrics and account for the class imbalance that is frequently seen in medical datasets.

The following are typical metrics for prediction tasks:

Accuracy: Indicates how accurate a prediction was overall. Measures the percentage of accurate positive predictions compared to all positive forecasts.
Recall: Calculates the ratio of correctly predicted positive outcomes to all actual positive outcomes.

A fair evaluation of a model's performance is provided by the F1-score, which combines precision and recall. The model's capacity to discriminate between classes at various thresholds is measured by the ROC AUC (receiver operating characteristic area under the curve). Using tools like confusion matrices and ROC curves to visualize performance measures might provide a further understanding of the model's behavior. While an ROC curve shows the trade-off between true positive rate (sensitivity) and false positive rate (1-specificity) at various threshold values, a confusion matrix shows the number of true positives, true negatives, false positives, and false negatives.

22.4 Results and Discussion

The success of early diagnosis and intervention in the field of schizophrenia prediction depends critically on the selection of suitable machine learning algorithms. A comparative comparison of several algorithms based on important performance indicators sheds light on their suitability for this difficult task. Table 22.1 shows the performance of machine learning algorithms on schizophrenia prediction. Random forest and gradient boosting regularly exhibit robust and balanced performance across a variety of measures among the classifiers evaluated.

With an accuracy of 0.847826, random forest demonstrates remarkable predicting ability. Its focus on recall and precision yields a commendable F1-score of 0.817391. Additionally, it gets high ROC AUC (0.913147) and PR AUC (0.910137) values, demonstrating a strong ability to differentiate between positive and negative situations. When it comes to accurately identifying people who have schizophrenia while minimizing false positives and false negatives, random forest excels.

Gradient boosting follows closely in performance, with an accuracy of 0.840580. It receives high scores for ROC AUC (0.913578) and PR AUC (0.911832) in addition to a balanced F1-score of 0.813559. This classifier performs admirably in terms of recall and precision, showing that it can make reliable predictions without producing false positives or negatives. When a balanced strategy is sought, gradient boosting is a strong contender for schizophrenia prediction. With an accuracy of 0.833333, SVM (support vector machine) provides a competitive option. SVM retains reasonable

Table 22.1 Performance evaluation for schizophrenia prediction using machine learning algorithms.

Model	Accuracy	ROC AUC	PR AUC
Random Forest	0.847826087	0.91314655	0.91013686
Gradient Boosting	0.84057971	0.91357759	0.91183217
SVM	0.833333333	0.90258621	0.90549139
K-Nearest Neighbors	0.847826087	0.88717672	0.8736717
Decision Tree	0.811594203	0.81142241	0.82405974
AdaBoost	0.84057971	0.90926724	0.90529533
Bagging	0.811594203	0.89601293	0.87767976
XGBoost	0.81884058	0.903125	0.90129955

values for both ROC AUC (0.902586) and PR AUC (0.905491) while having a somewhat lower F1-score of 0.796460 than the preceding classifiers. ROC has been shown in Figure 22.3. It demonstrates a well-balanced precision-to-recall trade-off, giving it a trustworthy option for schizophrenia prediction, especially when taking the clinical context into account.

KNN performs similarly to random forest and gradient boosting, with an accuracy of 0.847826. With a competitive balance between precision and recall, it can successfully identify people with schizophrenia, as evidenced by its F1-score of 0.817391 and ROC AUC of 0.887177. For this forecasting assignment, KNN turns out to be a dependable option.

Although the aforementioned classifiers are the best for predicting schizophrenia, models like decision tree, Bagging, AdaBoost, and XGBoost also produce acceptable results but differ in their precision and recall for other classes. These variances point to potential areas for improvement to strengthen their prognostication. When choosing a model, careful examination of these metrics is essential since they provide insightful information about the model's advantages and disadvantages. The confusion matrix for the algorithms is shown in Figure 22.4.

The precision scores for different machine learning classifiers that were used to predict schizophrenia show clear trends in their performance, as shown in Figure 22.5. Random forest and gradient boosting among these

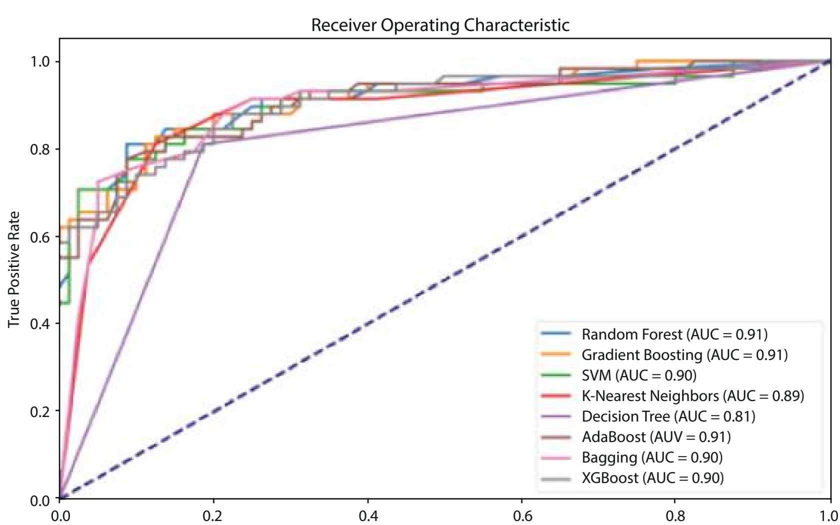

Figure 22.3 ROC curve for the proposed methodology.

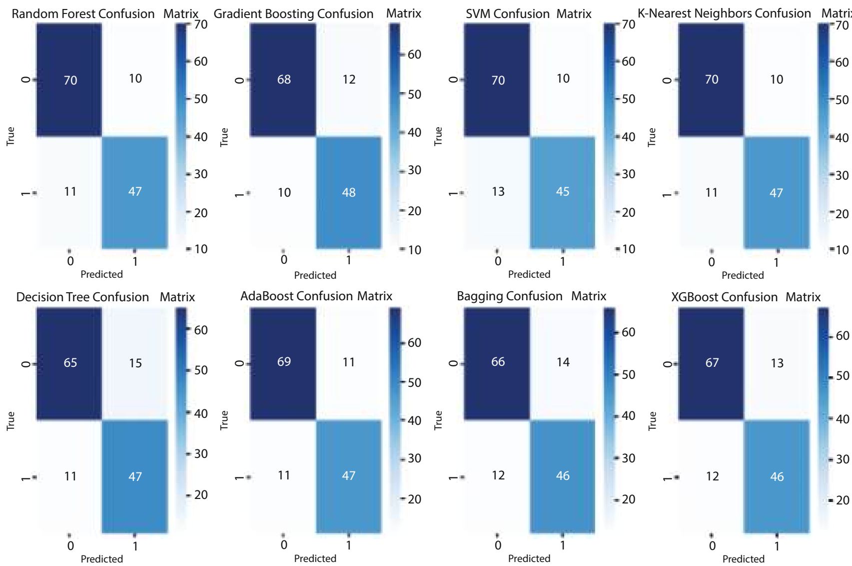

Figure 22.4 Confusion matrix for the algorithms used for schizophrenia prediction in the proposed methodology.

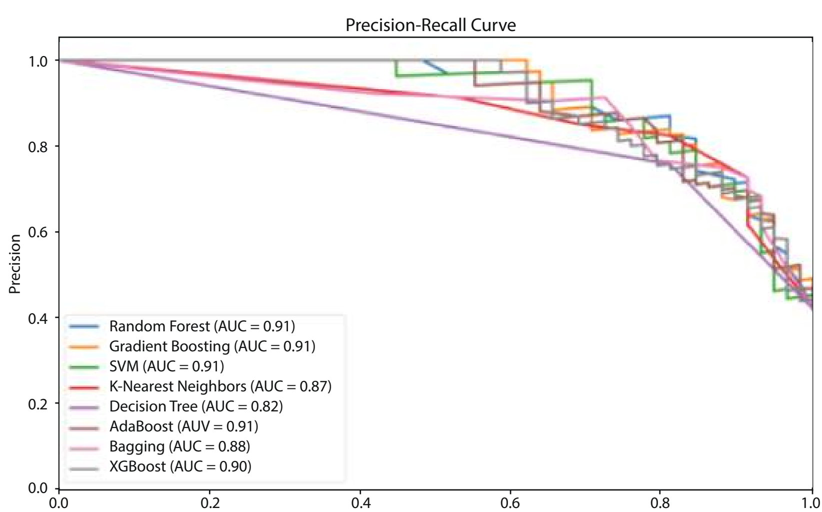

Figure 22.5 Precision-recall curve for the proposed methodology.

classifiers provide precision that gradually increases as the decision threshold changes. They begin cautiously but with relatively low precision, then gain confidence in their ability to make accurate predictions before stabilizing at high precision levels. This behavior suggests that they are suited for precision-focused tasks where reducing false positives is essential. SVM takes a more balanced approach to precision and recall since it keeps its precision largely steady across a range of thresholds. The precision values shown by KNN vary dramatically with the threshold, emphasizing the significance of choosing the right threshold for the application. A binary precision pattern, either 0 or 1, presented by the decision tree indicates extremely confident but possibly overfitting predictions. AdaBoost, Bagging, and XGBoost exhibit increasing precision as the threshold rises in a manner comparable to random forest and gradient boosting, making them suitable for jobs that place a premium on precision. When selecting a classifier, it is important to take precision, recall, and overall model performance into account in order to meet the specific objectives of schizophrenia prediction.

The recall values for various machine learning classifiers used in Schizophrenia prediction. The recall metric is crucial in evaluating a model's ability to correctly identify true positive cases among all actual positive cases. Among the classifiers, random forest and gradient boosting consistently demonstrate high recall across different decision thresholds. They maintain near-perfect recall rates, indicating their exceptional ability to detect true positive cases without missing many instances of Schizophrenia. This high recall is particularly valuable in medical diagnosis, where failing to identify affected individuals can have severe consequences. SVM also exhibits excellent recall values, remaining consistently high across various thresholds. This classifier is known for its ability to balance precision and recall effectively, making it a robust choice for Schizophrenia prediction tasks. KNN starts with perfect recall at the highest threshold but gradually drops as the threshold decreases. This behavior suggests that KNN may perform well with an appropriate threshold but might miss some positive cases with lower thresholds. The decision tree presents a recall of 1 at the highest threshold but lacks recall as the threshold decreases, indicating a tendency to overfit the data. AdaBoost, Bagging, and XGBoost follow a similar pattern, maintaining high recall at the highest thresholds and gradually decreasing as the threshold becomes more lenient. These classifiers are adept at identifying true positive cases, but their recall decreases when allowing more false positives.

Random forest, gradient boosting, and SVM stand out as promising classifiers for Schizophrenia prediction due to their consistently high recall rates, while KNN, decision tree, AdaBoost, Bagging, and XGBoost exhibit varying degrees of performance that may be tailored to specific needs based on the desired trade-off between precision and recall. A detailed analysis of performance measures should inform the selection of a machine learning classifier for schizophrenia prediction. Top performers that provide solid, balanced, and precise predictions include random forest and gradient boosting. SVM and KNN are two other competing choices with solid outcomes. To enable prompt diagnosis and treatment of schizophrenia, the choice of a classifier should, in the end, be in accordance with the clinical context and priorities, placing an emphasis on either precision or recall.

22.5 Comparison with Existing Methods

Random forest and KNN stand out among the tested machine learning models with the highest F1-scores of roughly 0.817. These models successfully balance accuracy and recall, which suggests that they are reliable at classifying instances in the dataset. Table 22.2 shows the F1-Score

Table 22.2 Comparison of F1-score for schizophrenia prediction.

Model	**F1-score**
RT	0.804
RF	0.836
CVR	0.768
ZeroR	0.515
Random forest	0.8173913
Gradient boosting	0.81355932
SVM	0.79646018
KNN	0.8173913
Decision tree	0.78333333
AdaBoost	0.81034483
Bagging	0.77966102
XGBoost	0.78632479

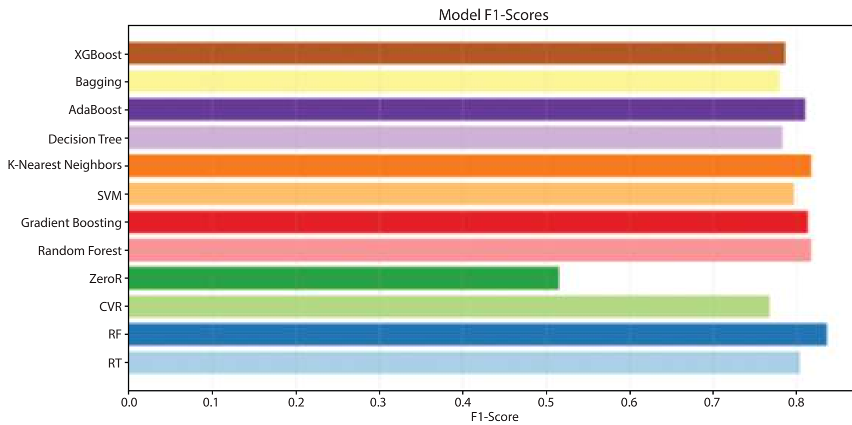

Figure 22.6 F1-scores comparison between various methods.

comparison with various models. The comparison graph is shown in Figure 22.6. While KNN uses proximity-based classification and is successful when dealing with data patterns characterized by localized clusters, random forest uses an ensemble of decision trees to reduce overfitting and capture complicated relationships within the data. Gradient boosting and AdaBoost, which are not far behind, have F1-scores of about 0.813 and 0.810, respectively. These ensemble approaches are competitive options for classification tasks because they excel at repeatedly enhancing model performance by emphasizing difficult situations. Their high F1-scores demonstrate their capacity to categorize instances accurately even in difficult and unbalanced datasets.

Models like SVM and XGBoost likewise perform admirably, getting F1-scores that range from 0.796 to 0.804. The high-dimensional space efficiency of SVM is demonstrated in this classification task. The well-known gradient-boosting variation XGBoost displays its adaptability by providing good results. The F1-scores of models like cross-validation random (CVR), decision tree, and Bagging, on the other hand, range from 0.768 to 0.783. These ratings are not as high as those of the best models, but they nevertheless display reasonable performance, highlighting the wide range of approaches to classification problems. Last but not least, the baseline ZeroR model, with an F1-score of 0.515, emphasizes the significance of using more advanced machine learning models, as it significantly trails the other models, underscoring the significant gains made through the use of advanced algorithms and dataset features.

22.6 Conclusion

An encouraging step forward in leveraging machine learning models and wearable technology to address the critical challenge of early schizophrenia prediction. The results obtained serve as a testament to the immense potential of these innovative methodologies in the domain of mental health. Specifically, it was observed that random forest and KNN exhibited exceptional performance, boasting impressive F1-scores. These models demonstrated their proficiency in delivering precise and dependable predictions for schizophrenia diagnosis, a feat made even more remarkable given the intricate and multifaceted nature of the disorder. This work underscores the paramount importance of aligning the choice of machine learning algorithms with specific clinical objectives. Depending on the context, one may prioritize maximizing recall to ensure individuals with schizophrenia are not missed or optimizing precision to minimize false positives, a crucial aspect in reducing unnecessary concerns. Additionally, the study highlights the pivotal role of meticulous data preprocessing and feature selection in elevating the overall robustness of these predictive models, enhancing their real-world applicability. In the future, the path ahead is illuminated with potential. The fusion of machine learning and wearable technology holds promise not only for earlier diagnosis but also for more personalized care for those affected by schizophrenia. Furthermore, the wider adoption of these technologies could potentially alleviate the societal burden of this mental illness and enhance the overall quality of life for individuals grappling with it. However, further validation on diverse datasets and ongoing research is essential to fully harness the transformative significance of these developments in mental health.

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23

Forecasting the Trends in Stock Market Employing Optimally Tuned Higher Order SVM and Swarm Intelligence

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Abstract
This paper introduces the utilization of the SVM technique to enhance the predictive achievement of quadratic, cubic, linear, and fine Gaussian SVMs in predicting share index movements. The study involved dividing a 170-day stock market price dataset into 120 training data points and 52 testing data points. Therefore, initial 120 data points were employed for learning purposes, while the subsequent 52 data points were used to assess the predictive accuracy of open stock prices. The predictions generated by 4 frameworks were examined against the real share movement prices to forecast succeeding share costs. This implementation of the model was carried out employing MATLAB 2015(a) and its support vector machine (SVM) and machine learning toolboxes. The system's performance was evaluated through metrics such as MAPE, RMSE, and MSE. A comparative analysis of the models shown undeviating SVM exhibited an RMSE of 0.123 as well as MAPE of 96.2%. In contrast, the quadratic SVM demonstrated a lower error, yielding an RMSE of 0.097 as well as a MAPE of 97.2%. The cubic SVM showed an RMSE of 0.101 as well as a MAPE of 98.2%, while the fine Gaussian model exhibited the least error, with an RMSE of 0.087 and a MAPE of 99.1%. The results suggest that the evolved framework outperforms the linear as well as quadratic SVMs, primarily attributable to the superior performance of the fine Gaussian model within the support vector machine (SVM) framework.

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***Keywords*:** Stock market, support vector machine, evolutionary algorithm, machine intelligence

Abbreviations Used

SVM	Support vector machine
NSE	National stock exchange
MSE	Mean squared error
RMSE	Root mean squared error
MAPE	Mean absolute percentage error

23.1 Introduction

A stock is a form of ownership in a company, representing entitlements to the organization's strength and income (Investopedia, 2010; Kiplinger, 2005). Since the share's value fluctuates based on the current as well as anticipated next achievement of the company, V Kapoor (2020) identified the influence of various global markets on the Indian market. The stock market serves as a platform where various stock sellers and buyers convene to engage in transactions or exchanges (Perwej & Perwej, 2012). The basic primary activity in a money market involves buying and selling a company's shares. It is identified over 262 distinct stockholders working as entities within the Nigerian share traders (Saha, 2013).

Currently, the US was approximated to account for 35% of the global stock market's total value of US$165 billion while England held 8%, and Japan contributed 9% to the overall share market valuation. Traders often face challenges in deciphering the trends in opening prices, making it difficult to predict the following day's opening price and adequately prepare for it. Consequently, forecasting stock prices has become a crucial task for enhancing productivity and facilitating decision-making. The ability to forecast future stock price trends is instrumental in developing effective and informed trading plans, potentially leading to improved successful trades (Dase & Pawar, 2010). Various evolutionary algorithms exist for predicting the next opening values of specific share markets, including ANN, KNN, hidden Markov model (HMM), and SVM. The SVM is an evolutionary algorithm that recently demonstrated superior performance, particularly in stock market prediction, compared to other machine learning techniques (Zhang, 2004). SVM constructs a framework employing a chunk of provided learning datasets, classifying training chunk instances into one of two categories. This SVM framework can then be examined to predict the future values of the stock market. SVMs basically divided into 2 modules: linear and nonlinear. SVMs of the linear class have fast learning and good performance although they may less perform on compound datasets along several learning inputs as well as relatively few characteristics. Nonlinear SVMs, while extra steady in execution diagonally diverse objectives, are often chosen for various problems despite a potential loss in instructive power (Huerta, Corbacho & Elkan, 2013). This study proposes the use of SVM to predict the next pattern of share's opening values. The objectives include forecasting the opening stock market price index using SVM, formulating different SVM frameworks for share market data, applying evolved SVM frameworks for predicting opening share value listing, and evaluating model output in the form of MAPE and connection coefficient among real and forecasted share prices.

23.2 Related Work

The primary market is involved in handling new issuances of securities and the direct acquisition of securities from companies. On the other hand, the secondary market facilitates transactions between buyers and sellers among investors and primarily involves previously issued securities. This market operates through organized exchanges, featuring trading floors where orders are transmitted for execution. The exchanges play a crucial role in overseeing and guiding all stock trading activities, establishing rules and regulations that govern the process. Investors often rely on indices to gauge the overall market direction, using them to monitor share growth performance. The movements and shifts in the index's value typically correspond to a proportionate change in the stocks included in that index. Within the Stock Exchange of ShriLanka, the ASPI stands as its key stock indices, measuring the fluctuations of stock values for various registered organizations depending on their business growth.

A. Introduction to the Concept of Stock Market

At its core, the primary objective of the stock market is to serve as a metric for comprehending the overall direction or fluctuations of the market. An upswing in the index signals a bullish market, while a decline indicates a bearish trend. Market indices play a pivotal role in calculating the market return, representing the profit value achieved. Both profit as well as loss serve as fundamental parameters for evaluating the monetary outcomes of a particular organization. Various researchers employ past price trends to anticipate future price movements. Additionally, market indices provide a platform for studying the factors influencing collective share value shifts. SVM is used to predict stock index movement (Hong Wang, 2022). Researchers and traders are involved in such attributes to understand their effect on market outcomes. Stock price prediction involves the attempt to predict an organization's next stock price or another economical tool traded. Successfully predicting a stock's future price holds the potential for substantial profits (Wikipedia, 2015).

B. Introduction to SVM

The SVM stands as a categorization method that has just demonstrated superior performance, particularly in the realm of stock market forecasting compared to other machine learning methods. In this context, a potential state observation or outcome is generated, linked to the sign of study within a likelihood distribution. Notably, it's just the result, rather than position, which is observable to an outer evaluator, leading to the term "support vector machine." Much like hidden Markov models (HMMs), SVMs aim to construct a model given a set of training inputs. Each instance in the training data is categorized into one of two classes. (Elija, 2019) predicted the closing market value through SVM. The support vector machine endeavors to segregate various values of data into these 2 classes using a p-1-dimensional hyperplane, here p represents the dimension of every data value. The resulting framework will be applied to novel data instances to forecast the class to which they belong (Rao & Hong, 2010).

C. Support Vector Machine's Attributes

It serves as a linear knowledge technique, characterized by double representation. In this dual framework, data exclusively appear within dot products during both the indecision phase and the training algorithm. Linear classifiers face limitations when handling non-linearly separable and noisy data. To address this, one approach involves identifying a network of effortless classifiers, akin to attributes in an ANN. However, this solution comes with challenges such as encountering local minima, dealing with numerous parameters, and requiring heuristics for training. An alternative solution involves mapping statistics into complex element space that includes non-linear features. Following this, a linear classifier is utilized to transform the values in element space here it can be linearly divided (Saahil, 2015).

D. Working of SVM

Machine learning techniques generally fall into two categories. One is supervised, where the data values consist of mark outputs, with every one case comprising features that correspond to the correct output for the given feature set. Essentially, the algorithm learns from a dataset (training data) containing features and corresponding outputs and applies this knowledge to forecast outcomes (targets) for a different set of data. In contrast, non-supervised pattern involves patterns in which the quality set lacks specific targets. Classification as well as regression problems are examples of supervised methods. In categorization models, here is a predetermined count of outcomes to which an attribute set should be assigned, while regression problems involve outputs that provide uninterrupted outcome values. In the context of the discussion, the prediction of open share prices in the market is treated as a categorization task.

In this scenario, the training set includes a stock's as well as the index's current price, fluctuations, and momentum, These features should be utilized to forecast whether the open share price on a future day would be upper or lesser than the same day's price (Saahil Madge, 2015). Machine learning techniques generally fall into two categories. Supervised learning is one of the categories, where the learning data consist of mark outputs, with every pattern comprising features that correspond to the correct output for the given feature set. Essentially, the algorithm learns from a dataset (training data) containing features and corresponding outputs and applies this knowledge to forecast outputs (targets) for an extra set of data (test data). Classification and regression are fundamentally categorized from supervised learning. The typical classification task involves a labeled dataset, while regression problems involve outcomes that should be uninterrupted value. In the context of such discussion, the task of forecasting open share prices in the market is treated as a categorization task. In this scenario, the element set includes a share's current price, volatility, as well as momentum, at the same time the index's current fluctuation values. These features should be utilized to forecast whether the open share price on a future day will be upper or lesser than the price value of the same day (Saahil Madge, 2015).

E. Robustness and Limitations

SVM, originally proposed by Vapnik and more recently applied in diverse fields, including financial stock market prediction, is acknowledged for its efficacy. Chen and Shih further refined the SVM technique, positioning it as a state-of-the-art classifier. Notably, research indicates that SVM forecast outcomes outperform ANN outcomes. To train the SVM model is comparatively straightforward, avoiding issues like local optima encountered in ANN. Therefore, it demonstrates scalability toward upper-dimensional data, and there exists explicit control over the tradeoff between classifier complexity and error. Moreover, SVM accommodates non-traditional data types, such as strings and trees, as input, in contrast to the requirement for feature vectors in other methods.

F. Financial Market

The financial market always is the platform where shares and bonds of companies are exchanged, by established exchanges or through markets (Rafael Rosillo, 2014). Referred to as the equity market, it stands as a fundamental component of the financial world, serving like a means for organizations to secure assets by offering investors ownership stakes in the company. The financial market plays a pivotal role in enabling the transformation of modest initial investments into substantial sums, offering individuals the opportunity to accumulate wealth without the risks associated with launching an established trade to pursue a high-paying career (Investopedia, 2016). The investigation into forecasting stock market price indices has gained prominence as researchers recognize the substantial impact of these indices on economic development. Initially, researchers aimed to begin straight relationships among inputs and stock exchange indices. However, the identification of dynamicity in the financial market index prompted one significant change in the spotlight toward nonlinear prediction methods (Abhyankar, 2007). While subsequent literature has explored nonlinear statistical modeling of stock market price indices, many studies require specifying the nonlinear model before estimation (Wu, 2003). Notably, there has been a limited exploration of the use of support vector machines (SVMs) for stock prediction.

The following is a summary of related literature:

In the existing literature, diverse inputs are employed to forecast share prices, with variations even when predicting the index of the financial market. There are few analysts who utilize input values through unit time series, while various analysts consider incorporating different business news and different financial variables. Certain studies involve preprocessing data before utilizing artificial neural networks (ANNs) for forecasting (Abhyankar, 2007). Dase (2010) addressed the challenge of determining the most effective and accurate method for generating buy or sell signals for given stocks. Traditional time series analysis for predicting stock indices has proven challenging, leading to the consideration of artificial neural networks, which can extract valuable information from large datasets. Halbert (2012) reported ongoing research utilizing neural network modeling to decipher dynamic attributes in rate fluctuations, concentrating toward international business machine's stock. The researcher emphasized the importance of statistical inference in handling along unique highlights of monetary data. Abdulsalam (2010) employed the moving average (MA) technique to discover outcomes, relationships, as well as pull out variable data through a collection of data sets for predicting the next potential values. The MA method, known for reducing fluctuations and obtaining trends with accuracy, utilized numeric forecasting through regression analysis with economic facts.

23.3 Proposed Methodology

Below, Figure 23.1 illustrates the structure of the SVM model designed for predicting stock opening prices. The subsequent sections offer detailed explanations for each block within the architecture and elaborate on their interconnections.

A. Data Gathering and Selection

We collected the NSE index data from Yahoo Finance spanning the past 10 years and employed the initial NSE opening values as inputs for our predictive model to anticipate future outcomes. The data extracted from the acquired dataset spans from May 02, 2017, to October 19, 2017, covering a total of 170 trading days. To facilitate model development, Picked data is split into seventy percent for learning as well as thirty percent consumed for testing purposes. The chosen dataset was partitioned, allocating seventy percent for learning purposes as well as thirty percent consumed in testing. The below mentioned first table provides a glimpse of utilized data values, while the second figure illustrates the outcomes of the picked opening share prices alongside respective equivalent trading times. The Tables 23.1 shows about the, Tables 23.1 shows about the Various features of utilized data. Tables 23.2 shows about the Training data, Tables 23.3 shows about the Testing results. Tables 23.4 shows about the Performance

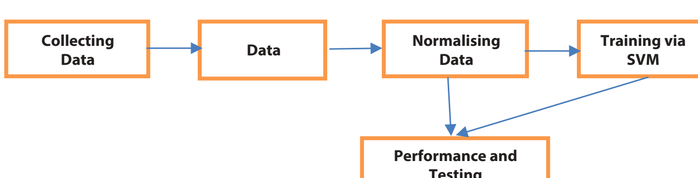

Figure 23.1 Architecture of the model designed for predicting stock opening prices (NSE).

Table 23.1 Various features of utilized data.

Date	Open	High	Low	Close	Adj. open	Volume
02-05-2017	9339.85	9352.55	9269.9	9313.8	9313.8	161600
03-05-2017	9344.7	9346.3	9298.4	9311.95	9311.95	151600
04-05-2017	9360.95	9365.65	9323.25	9359.9	9359.9	269600
05-05-2017	9374.55	9377.1	9272	9285.3	9285.3	231900
08-05-2017	9311.45	9338.7	9297.95	9314.05	9314.05	174300
09-05-2017	9337.35	9338.95	9307.7	9316.85	9316.85	132300
10-05-2017	9339.65	9414.75	9336	9407.3	9407.3	152700

Table 23.2 Training data (before normalization).

Date	Open	High	Low	Close
30-05-2017	9517.6	9532.6	9486.1	9525.75
29-05-2017	9453.2	9489.1	9418.1	9429.45
26-05-2017	9469.9	9505.75	9390.75	9427.9
25-05-2017	9480.25	9498.65	9427.9	9438.25
24-05-2017	9445.05	9448.05	9370	9386.15
23-05-2017	9410.9	9431.9	9341.65	9360.55
22-05-2017	9384.05	9523.3	9379.2	9509.75

evaluations results, Tables 23.5 shows about the Linear SVR, Tables 23.6 shows about the Performance evaluations results, Tables 23.7 shows about the Quadratic SVR, Tables 23.8 shows about the Performance evaluations results, Tables 23.9 shows about the Cubic SVR, Tables 23.10 shows about the Performance evaluations results (fine Gaussian SVM). Tables 23.11 shows about the Fine Gaussian, and The Figures 23.2 shows about the opening stock prices, Figures 23.3 shows about the Graph indicating the opening stock prices. Figures 23.4 shows about the Actual opening stock market, Figures 23.5 shows about the Comparison of actual stock price (blue) vs predicted, Figures 23.6 shows about the Actual opening (blue) vs. linear predicted, Figures 23.7 shows about the Comparisons of actual (blue) vs. predicted on fine Gaussian.

Table 23.3 Testing results.

Actual opening	Cubic	Quadratic	Linear	Fine Gaussian
0.699583943	0.691543	0.692345	0.557343	0.721668345
0.755845045	0.744456	0.745345	0.677345	0.733345677
0.991859067	0.882544	0.877345	0.883675	0.883458976
1	0.776645	0.822356	0.673467	0.883450975
0.939595054	0.845566	0.846535	0.676576	0.888659504

Table 23.4 Performance evaluations results (linear SVM).

Actual open	Predicted (linear SVM)	Error	Error square
0.668789798	0.569585958	0.112	0.0124
0.758984789	0.695968699	0.061	0.0038
0.982908494	0.889696959	0.0093	0.0087
1	0.681596969	0.319	0.102
0.940849484	0.682696969	0.258	0.067
0.876484994	0.774696960	0.1028	0.0106

Table 23.5 Linear SVR comparative values.

Error total	**0.793373**
MSE	0.154
RMSE	0.123
MAPE	96.2%

Table 23.6 Performance evaluations results (quadratic SVM).

Actual open	Predicted (linear SVM)	Error	Error square
0.689068966	0. 691855986	0.005266	2.68E-05
0.743044052	0. 758077673	- 0.000739	5.55E-07
0. 981998095	0. 869983658	0.083027	0.006731
1.00	0. 862010869	0.188989	0.036042
0. 949799881	0. 848994664	0.102003	0.010204

Table 23.7 Quadratic SVR comparative values.

Error total	**0.491568**
MSE	0. 0098
RMSE	0. 097
MAPE	97.2%

Table 23.8 Performance evaluations results (cubic SVM).

Actual open	Predicted (linear SVM)	Error	Error square
0.686969966	0. 680855986	0.005189	2.67E-05
0.742944052	0. 744077673	-0.00073	5.58E-07
0. 981698095	0. 899983658	0.08288	0.006851
1.00	0. 755010869	0.24022	0.058155
0. 940799881	0. 840994664	0.102722	0.010345

Table 23.9 Cubic SVR comparative values.

Error total	**0.548954**
MSE	**0. 009**
RMSE	**0. 101**
MAPE	**98.2%**

Table 23.10 Performance evaluations results (fine Gaussian SVM).

Actual open	Predicted (linear SVM)	Error	Error square
0.687178475	0.723587498	- 0.02744	0.000709
0.742848585	0.749586986	- 0.01077	0.000117
0. 98164859	0.889898989	0.08275	0.006855
1.00	0.894598989	0.109811	0.013088
0. 94058445	0.870565664	0.067475	0.004604

Table 23.11 Fine Gaussian SVR comparative values.

Error total	0.404883
MSE	0. 009
RMSE	0. 87
MAPE	99.1%

Figure 23.2 Selected opening stock prices and their corresponding trading dates.

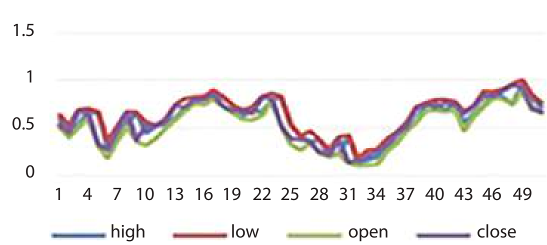

Figure 23.3 Graph indicating the opening stock prices.

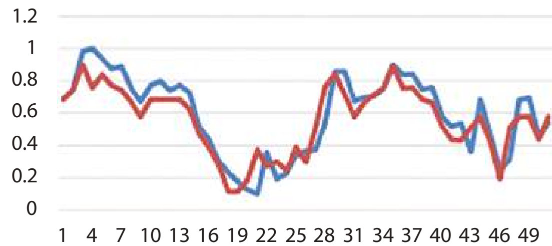

Figure 23.4 Actual opening stock market (blue) price vs quadratic and cubic predicted (red).

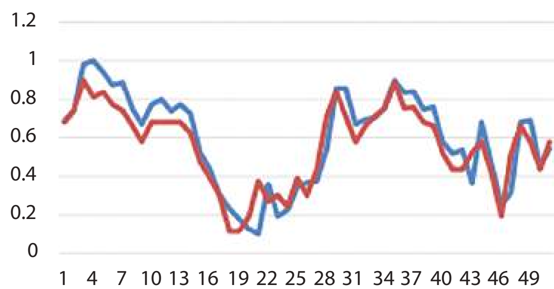

Figure 23.5 Comparison of actual stock price (blue) vs predicted on quadratic and cubic (red).

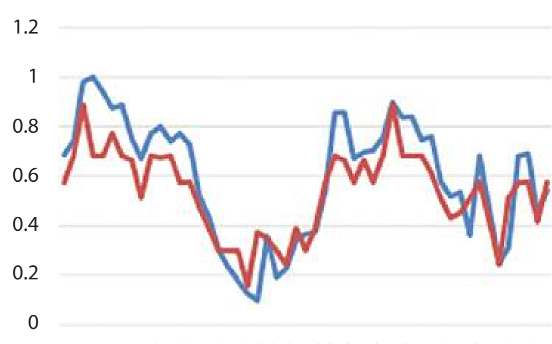

Figure 23.6 Actual opening (blue) vs. linear predicted (red).

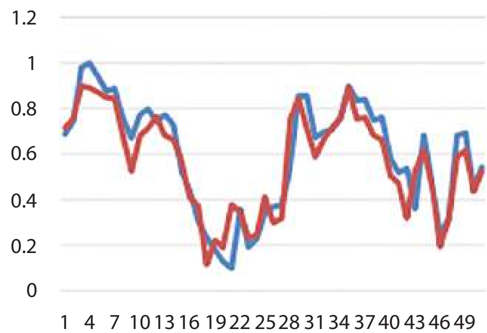

Figure 23.7 Comparisons of actual (blue) vs. predicted on fine Gaussian (red).

B. Normalization of Data

To address inconsistencies in the dataset and prevent bias toward larger values, the selected data underwent normalization, bringing it within the range of 0 to 1. This normalization process aimed to enhance model performance during testing.

C. Training the Model

The chosen timeframe through the dataset was segregated and categorized as learning as well as testing data, along with seventy percent (120 business days) assigned to the training set. SVM framework underwent training employing open price, highest price, and lowest prices in the form of inputs to forecast opening price value as the aim.

D. Framework Testing

Following learning, all frameworks were saved as well as externally examined with the remaining thirty percent (52 business days) of the picked data to evaluate its outcomes. Since results for each framework's performance were documented and analyzed.

E. Evaluation of Model Performance

The assessment of the forecasting model's performance utilized two key metrics: mean absolute percentage error and root mean squared error. The formulas for this performance feature are provided in the equations below mentioned. These equations quantify errors resulting from predictions made by the projected framework:

MAPE = (1 /sample size) x Σ [(|actual opening price – forecasted opening price|) / |actual opening price|] x 100 (23.1)

$$\textbf{RMSE} = \sqrt{1/\text{sample size} \sum (\text{Error})^2} \quad (23.2)$$

23.4 Result

The Result section provides various outcomes derived from different phases of developing the forecasting model for opening stock prices, employing the SVM. Illustrated in the hybrid framework figure, as described in the second figure, the opening Index price was chosen for training as well as evaluating the model's outcomes, aiming to assess the impact of SVM model optimization. The models underwent training over 171 trading days, a sufficiently substantial period for the model to discern patterns, and were subsequently tested over 52 days with the goal of forecasting future opening stock prices. The inclusion of graphs depicting the original stock prices, actual outcomes, and observations serves to visually grasp the initial market trend preceding the predictive analysis.

The third figure depicts a graph indicating that the opening stock prices exhibit peaks at 7 days and 36 days, with the smallest points occurring between 7 and 34 days (represented by the black line). Simultaneously, their corresponding low values (depicted by the dark red line) demonstrate a moderate increase, while the open prices fluctuate, alternating between upward, downward, and stagnant trends, as illustrated by the red line.

***A.* Results from Training:**
For the training phase, a span of 120 days was employed to train 4 frameworks (linear SVM, quadratic SVM, cubic SVM, and fine Gaussian SVM), as discussed in the preceding segments. This training yielded outcomes in terms of RMSE and MAPE for both the learning and testing datasets. The actual values for each model, pertaining to highest, lowest, and current open stock values, were utilized to forecast the opening market stock price.

***B.* Parameter Optimization Results:**
The second table provides insight into the opening, open, low, and highest share prices for 120 days of learning data and 52 days of testing data, following the training explained in the preceding segment, the table displays the starting values of various frameworks that were trained.

***C.* Models Outcomes:**
The framework values for both training and testing were computed as detailed in the previous section. Different stock market prices were employed to assess which SVM model best predicted the real opening

index value, along with forecasted values for individual frameworks. These outcomes are presented in the third table.

In the fourth table, it is depicted that the frameworks exhibit varying forecasted prices in comparison to the real opening stock prices. Each model differs from each other, with the quadratic and cubic (SVM) models predicting similar values, indicating a shared understanding of the S&P data used in the research. However, the linear and cubic models predict distinct values that do not align with any of the others. The testing results involve using fifty-two business days' data as testing data, where the predicted opening stock market prices are analyzed with real opening market prices. The fourth table displays the testing outcomes of 4 frameworks, with their respective predicted open stock prices. Additional information in the table includes real opening market price value and forecasted price for different frameworks.

The chart illustrates the actual open stock price with a blue line and the predicted open stock price with a red line. Upon observation, it is evident that the gap between the 2 lines is minimal. It suggests that error is minimal in quadratic and cubic predictions, as their predictions closely align with the actual open stock price, reaching a prediction accuracy of 100%.

The graph displays the actual open stock price with a blue line and the predicted open stock price with a red line. Upon observation, a notable gap exists between the two lines. This indicates a significant amount of error in the linear prediction. Specifically, the linear (SVM) model's prediction deviates substantially from the actual open stock price, reaching only 26.9% accuracy, demonstrating a considerable level of discrepancy between the predicted and actual values.

In this chart, the blue color line represents the real opening market price, while the red color line signifies the forecasted opening stock market price. Upon examination, it is evident that the gap among the 2 lines is minimal. It suggests error in fine Gaussian prediction is at a lowest amount, as its predictions closely align with the actual open stock price, achieving a prediction accuracy of 100%.

23.4.1 Performance Analysis

Results of the performance evaluation are provided in the table below, where framework performance was assessed using MAPE and MSE. These metrics were evaluated according to the explanations outlined in Chapter Three. The table displays the MAPE and RMSE values for the four frameworks.

The outcome of the performance matrix indicates that the designed frameworks forecasted share market prices with varying errors. The linear framework exhibited higher error compared to other ones, yielding RMSE of 0.124 as well as MAPE of 97%. In contrast, the quadratic framework demonstrated lower error with an RMSE of 0.097 as well as MAPE of 98%, while the cubic framework produced an RMSE of 0.10 as well as MAPE of 98%. The fine Gaussian framework exhibited even minimum error, with RMSE of 0.009 as well as MAPE of 98.6%. It suggests that the designed framework outperforms the linear and quadratic models, primarily due to the superior performance of the fine Gaussian model within the support vector machine (SVM) framework. The above analysis indicates that quadratic SVM outperforms linear SVM, and fine Gaussian exhibits superior performance compared to all three models due to its lower error rate.

23.5 Conclusion

The SVM technique was employed to enhance the forecasting analysis of different frameworks in predicting stock market prices. The dataset, spanning 171 days of stock market prices, was Split into two sets: the initial 120 data points for learning as well as the subsequent 52 value points for testing open market price forecasting. Predictions from 4 frameworks were juxtaposed along with real stock prices to project future values. This implementation utilized MATLAB 2015(a) and its support vector machine (SVM) and machine learning toolboxes. To evaluate the system's performance, MAPE, RMSE, and MSE were employed as well as compared across different frameworks. After analysis, results revealed that the designed fine Gaussian model exhibited a lower forecasting error than that of the rest of the frameworks.

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24

Social Media Text Classification Analysis and Influence of Feature Selection Methods on Classification Performance

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Abstract

Machine learning (ML)–based text analysis is a classical domain of research and application development, but text classification and analysis involve a number of challenges due to the nature of text data sources. Recently, social media–based text has become a popular source of information and additionally provides direct and indirect information for a number of applications. The social media text has been utilized with a number of different ML techniques for classification, and clustering. In order to apply these ML algorithms to social media text the feature selection has been utilized to recover essential facts from the text and also help to transform unstructured data into structural information. In this scenario, a number of different text feature selection techniques are applied. In this paper, we are investigating how different text feature techniques are influencing the classification performance of an ML algorithm. In this context, we first conducted a review of social media text classification approaches and then a comparative study between different text feature selection approaches was performed. The feature selection techniques involve term frequency inverse document frequency (TF-IDF), word to vector (Word2Vector), part of speech (PoS) tagging, bi-gram, and a method based on Chi-square test and TF-IDF. All the extracted features are classified using a trained ANN. The fake news dataset is used which is taken from the Kaggle database. Experimental results demonstrate the Chi-square test and TF-IDF–based features outperform as compared to other implemented feature selection techniques.

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***Keywords*:** Social media data, machine learning, text classification, feature selection technique, performance evaluation

24.1 Introduction

Due to the fast-moving life, people are searching for their personal life online. In this context, a significant amount of time on social media has been consumed by people. Social media includes people of all age groups. Therefore, it is a well-known source of information distribution. In addition, on the distributed information, people also provide their opinions. During these activities, a significant amount of data has been generated and can be utilized in a number of social welfare applications, such as in disaster management, public information distribution, education, and others. Therefore, the social media data analysis is essential. In this paper, the aim is to study the social media text analysis techniques for accurate and efficient consequences.

The social media text analysis is a different task as compared to a normal text document classification task. The social media text contains less content and features for classification tasks as compared to document classifications. In addition, lingual dissimilarity and different abbreviations can increase the complexity of social media data analysis. In such scenarios, the feature selection techniques have played an essential role, due to the representation of features. Therefore, these feature selection algorithms influence the ML algorithm's performance differently. In order to demonstrate these phenomena, we proposed a simulation development and an experimental comparison of different text feature selection techniques with common feature selection approaches. Thus, this paper includes a review of a recent ML-based approach based on social media text classification. The aim of this review is to identify classification techniques, datasets used, and results of the recent approaches. Then, an introduction to different text feature selection techniques is provided, and finally, the experiments are conducted and their results are discussed. At last, based on experiments and the studied literature, the conclusion is made and a future work plan is discussed.

24.2 Literature Review

The aim of this review is to study the recently developed approaches based on machine learning for analyzing social media text. Therefore, 30 research articles have been collected and, among 16, the most relevant has been identified. During the study of the collected literature, we have identified three main facts, i.e., type of classifiers used, the dataset used in the experiment, and the results obtained with different approaches. First, the algorithms used for classification or data analysis in recent research have been identified. The list of classifiers and the dataset used in different social media text analysis techniques is given in Table 24.1. In this table, the abbreviations of the classification methods are given in table columns and their full forms are also given at the bottom of the table.

Table 24.1 Dataset used.

Ref.	Dataset used	Classifiers
[1]	Crawled and collect URLs for click-baits of social media web sites that are likely to fake news or click-baits in Facebook, Forex and Reddit.	BayesNet (BN), logistic (LR), random tree (RT), Naïve Bayes (NB)
[2]	Collect data for news pieces and social context, PolitiFact, BuzzFeed	Logistic (LR), support vector machine (SVM), GNB
[3]	BuzzFeed, PolitiFact	TriFN
[4]	Weibo, Twitter	Event adversarial neural network (EANN)
[5]	Twitter Search API	Trace-Miner (LSTM-RNN)
[6]	Capture 16,448 like instances (information of liker, post, and source user), and add it to Fake Like data	Logistic (LR), Random Tree (RT), Support Vector Machine (SVM), AdaBoost (AB), XGBoost (XGB), Multi-Layer Perceptron (MLP)
[7]	FakeNewsNet database	dEFEND (A system for explainable fake news detection)
[8]	PolitiFact, GossipCop	Graph-based approach (GBA)
[9]	Twitter	Naïve Bayes (NB), NLP

(*Continued*)

Table 24.1 Dataset used. (*Continued*)

Ref	Dataset used	Classifiers
[10]	Two real-world datasets constructed from Twitter and Sina Weibo	Deep neural network (DNN)
[11]	Public health topics dataset consists of 144 million tweets related to health topics gathered during 01 Aug 2011 - 28 Feb 2013	Logistic (LR)
[12]	Twitter posts	K-nearest neighbor with dynamic time warping (KNN-DTW)
[13]	Celebrity and FakeNewsAMT	Random tree (RT)
[14]	A list of publicly available logs of blocked users on Wikipedia during Feb. 2004 to Oct. 2013	Random tree (RT), support vector machine (SVM), AdaBoost (AB)
[15]	Whisper, Twitter	
[16]	In May 2018, information was gathered from 1022 WhatsApp users. The age range of the study participants was 18 to 30 years old, with an average age of 22.19 years among the respondents. Of them, 73.7% were female [N = 753].	Social theory (ST)

According to the analysis, we have found that the classical machine learning algorithms for classifying the data are frequently used; among them, LR, RT, and SVM are the most frequent. Additionally, the classification techniques require a feature selection technique for transforming the text data into a vector for ease in text processing. Therefore, we also found the some ML algorithms are used in multiple applications. Next, the utilized data for the experiment is also explored. The used datasets in different methods are given in Table 24.1.

According to the findings, around 50% of research work collects and labels their data before utilizing them in the experiments; additionally, the

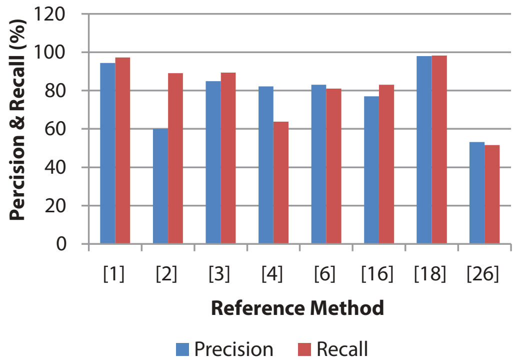

Figure 24.1 Comparison of different methods of classification.

remaining 50% of work is based on a predefined dataset. Finally, we are comparing similar kinds of methods in terms of precision and recall. The graphical representation of performance evaluation is given in Figure 24.1. In Figure 24.1 the X axis shows methods and the Y axis shows the percentage (%) precision and recall. In this comparison, only the methods are considered, which are evaluating the performance in terms of precision and recall only. According to the comparison method discussed in reference articles [1] and [18], it provided higher accurate results. However, the performance of a method depends on various internal and external parameters such as dataset used, system configuration where the experiments are conducted, methods used for the pre-processing of the data, feature selection and representation approaches, and the utilized machine learning algorithms. Therefore, it is necessary to evaluate the methods and techniques before designing and developing a final machine learning model for text classification tasks because the different nature of text representation and available data may highly influence the quality of service of the entire machine learning application. In this section, we presented a review and, as a result, provided a list of classifiers, datasets, and results obtained in this domain of research work. The next section provides the model based on which the experiments have been conducted.

24.3 Proposed Work

The social media text is small in length and contains limited keywords. Additionally, the utilization of different lingual abbreviations makes the text classification problem different than the traditional text

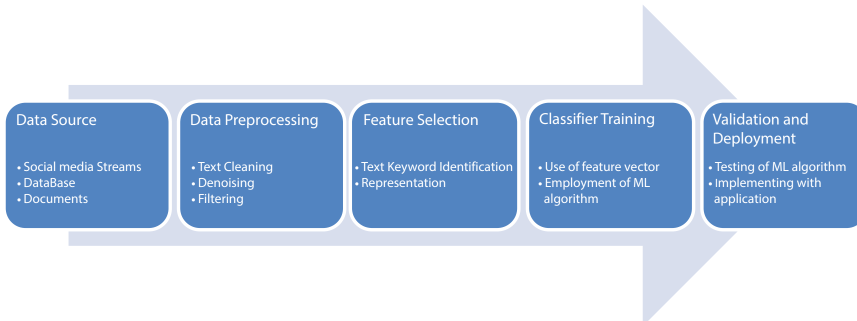

Figure 24.2 The common architecture of text classification.

classification techniques. In both kinds of classification, feature selection techniques are used to transform the data into classifiable vectors using ML algorithms. The text feature selection technique helps to identify the essential text keywords and represent the text keywords in a specific structure or representation. Basically in the text classification technique, a common architecture is used, which is demonstrated in Figure 24.2.

Figure 24.2 contains the process of text classification systems. In this model, the main and initial component is a data source that can be the social media text streams, a centralized database of records, or a document library. The text data are available in an unstructured format and need to be transformed into a structured format, but before the utilization of text data with the ML algorithm, we also need to enhance the data quality. Therefore, the data pre-processing techniques are used. The employment of text pre-processing techniques depends on the type and nature of the data. In this context, text cleaning, filtering, and denoising techniques are utilized such as stop-word removal, abbreviation cleaning, and special character removal. Further, the essential features are extracted from the text in the form of keywords and their different representation using different feature selection approaches. In this paper, we utilized the following feature selection techniques:

1. Term Frequency – Inverse Document Frequency

TF-IDF is one of the popular and frequently used text feature selection techniques. It is computed in two parts: the first part measures the frequency of keywords in a document, whereas the second part includes the measurement of the importance of the keyword in a document. Based on both parts, combined weight is measured, which is used to select the essential keywords from the dataset. The term frequency (TF) is measured using:

$$TF = \frac{N}{T}$$

Where N is the count of a keyword in a document and T is the total word count in a document.

Additionally, the inverse document frequency (IDF) is denoted using:

$$IDF = \log\left(\frac{N_d}{df}\right)$$

Where N_d is number of document and df is the number of documents contains the target keyword.

Additionally, the combined weight or TF-IDF is denoted by:

$$w = TF * IDF$$

Using the calculated weight, the top k keywords from the list of keywords has been selected as the text feature.

2. Word2vector

That method is frequently used with deep learning-based models. This method first prepares the word embedding mapping for selecting the features from the text document. The method contains the tokenization, mapping and then sequencing for preparing the word embedding vector. This method also utilizes padding to make feature sequencing equal for easier processing of text features in terms of classification and learning with the text features.

3. Bi-Gram

A pair of adjacent elements from a string of tokens—usually letters, syllables, or words—make up a Bi-Gram. For n=2, a Bi-Gram is an n-gram. For basic statistical analysis of text applications, one commonly uses the frequency distribution of each Bi-Gram in a string.

4. Part of Speech (PoS) Tagging

In text-based natural language processing applications, syntactical information is playing an essential role.

In this context, to analyze the text the part of speech (PoS), tags are extracted from the text. PoS tagging is a part of the NLTK library for converting text sentences into the part of speech sequence. This vector contains the count of different parts of speech tags as the feature set.

5. TF-IDF and Chi-Square Test

The TF-IDF is a popular and mostly used text feature selection technique in a number of applications. However, during observation of the extracted features from the TF-IDF, we have found that a number of keywords in the feature vector are not relevant to represent the domain knowledge. In this context, we propose to filter irrelevant keywords by using the Chi-square test. The aim is to automatically select those features which contribute most to the prediction variable. Additionally, avoid over-fitting and reduce training time. It is to be used when the feature is categorical. It calculates the degree to which two categorical variables are related. We can use Pearson's correlation if both are numerical or the t-test if the attribute is numerical and has two classes. Furthermore, we can use ANOVA if there are more than two classes available. The Chi-squared statistics are calculated using the following formula:

$$\varphi^2 = \sum_{i=1}^{m} \sum_{j=1}^{n} \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

Where "O" is the actual value and "E" is the expected value if the two categories are independent. If they are independent, then O and E values will be close and if they have some association, then the Chi-squared value will be high.

By using the higher chi-square values, we have selected the top 2000 keywords from the entire dataset as the modified features for classification. Next, in order to extract, social media text features can be used with any ML algorithm for performing training and classification. In this context, we are utilizing the convolutional neural network (CNN). That is not a complicated architecture, we have just utilized a CNN for performing classification tasks. The network contains four layers: the first layer is a dense layer, works as an input layer, and includes an activation function "ReLu."

The next two intermediate layers are simple processes and forward the input to the next layers, and both the layers are configured as dense layers with the activation function "ReLu." The final layer is configured as the output layer and contains the "softmax" activation function. The configured CNN is used for the classification task. Then, the training samples (70%) are used for performing the training of classifiers, and then, for validation, test samples (30%) are used. Finally, the performance can be analyzed for both training and testing.

In this paper, we have provided an experimental study on the fake news detection problem [17]. Therefore, the discussed process of text classification in Figure 24.4 has been modified to solve the fake news classification problem. The modified architecture given in Figure 24.4 is demonstrated in Figure 24.3. In this diagram, the actual methods utilized in different steps of data analysis are discussed. As a data source, the model considers the Twitter-based dataset obtained from Kaggle. Next, the stop words, special characters, abbreviations, and tokenization are performed. In the next step, five different kinds of feature extraction and representation techniques are utilized. These feature extraction techniques are TF-IDF, modified TF-IDF, word2vector, PoS tagging, and Bi-Gram. The extracted features from different techniques are used with a common classifier to train and classify samples. In this context, we have applied a deep neural network for this task.

Figure 24.4 demonstrates the final proposed model. That model can be used for further experimentation and proposed application design. In this diagram, first, the input dataset is taken and pre-processed. The pre-processing involves data cleaning operations; thus, the stop words

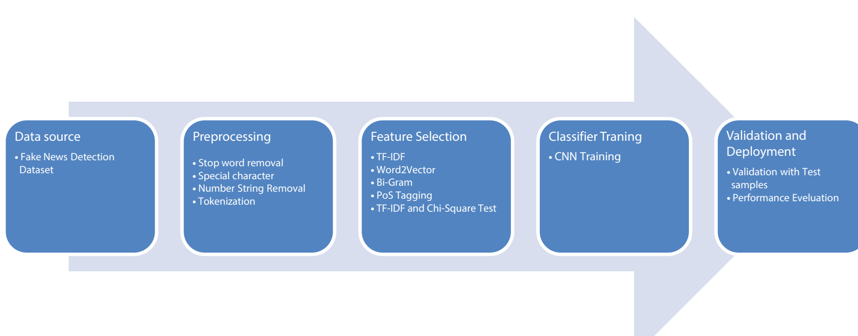

Figure 24.3 Fake news classification model.

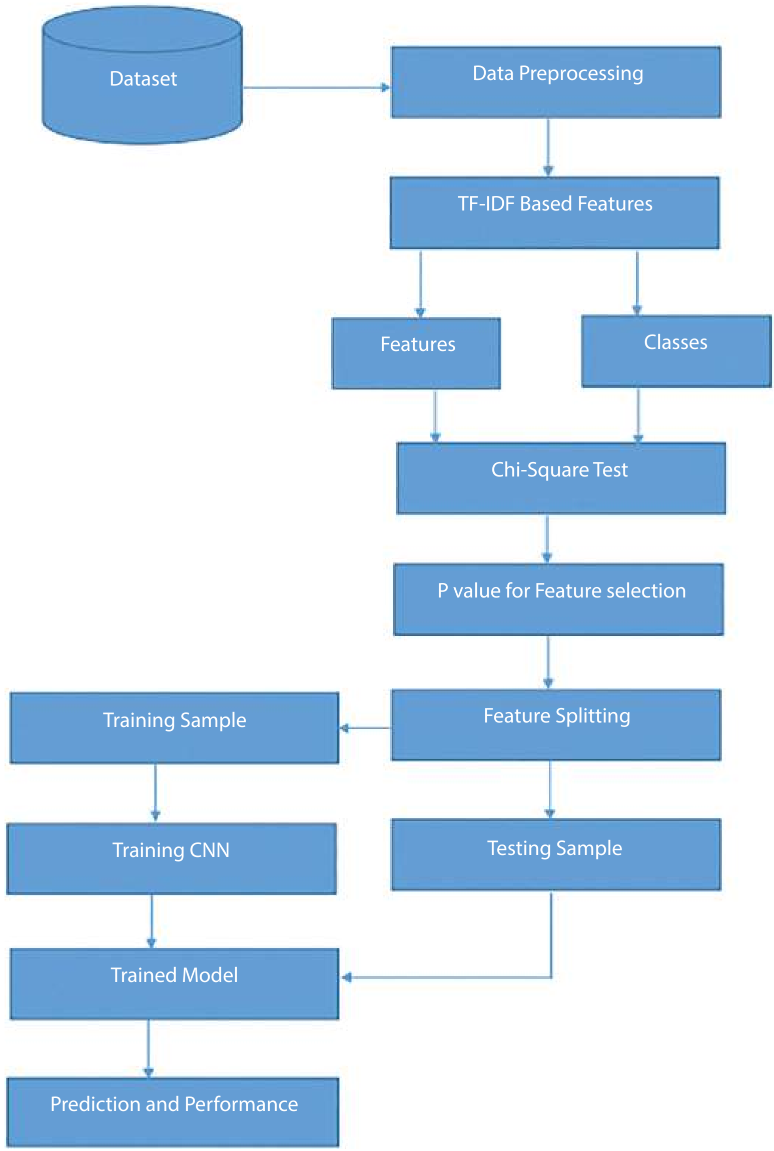

Figure 24.4 Proposed text classification model.

and special characters are removed from the social media data. Next, the TF-IDF vectorizer is used to convert text into a vector form. Next, the vector is tested against the class labels of the dataset for finding relevance scores in terms of p values. Further, the p value is used for identifying the most relevant tokens from the entire TF-IDF–based vector. After feature selection, the dataset is split into two parts; first, 70% of randomly selected samples are treated as training samples, and the next 30% of samples are used for testing or validation of the model.

Further, the deep neural network architecture as discussed previously has been used. This algorithm and the training sample are used for training, and the validation samples are used to test the proposed model. During this validation process, the trained algorithm predicts the type of sample input and is compared with the actual class labels. Finally, based on experiments conducted, the performance of the classifier and feature representation technique has been measured. The achieved performance in different experiments is discussed in the next section.

24.4 Results Analysis

The different social media text feature selection techniques have been implemented using Python technology. Additionally, using a common classification algorithm, the performance of feature selection techniques has been measured in terms of training and validation accuracy and loss.

Moreover, for evaluation of efficiency training time, the memory utilized has also been calculated. First, we measured the accuracy of the classifier with the combination of feature selection techniques. The accuracy of the classifier is basically the measurement of correctness, which is calculated using the following equation:

$$A = \frac{S_C}{S_T} * 100$$

Where S_C are correctly classified samples and S_T is the total samples to classify.

Figure 24.5(a) shows the training accuracy of the different combinations of feature selection approaches and classifiers. The X-axis of this figure shows the epoch cycles and the Y-axis shows the accuracy (%). The training accuracy of TF-IDF–based features is higher as compared to other implemented approaches. Using this evaluation, we have found in the classification of social media text that the text keywords are playing an essential role. Next, Figure 24.5(b) shows the validation accuracy of the text classification models. According to the obtained results we found, the combination of

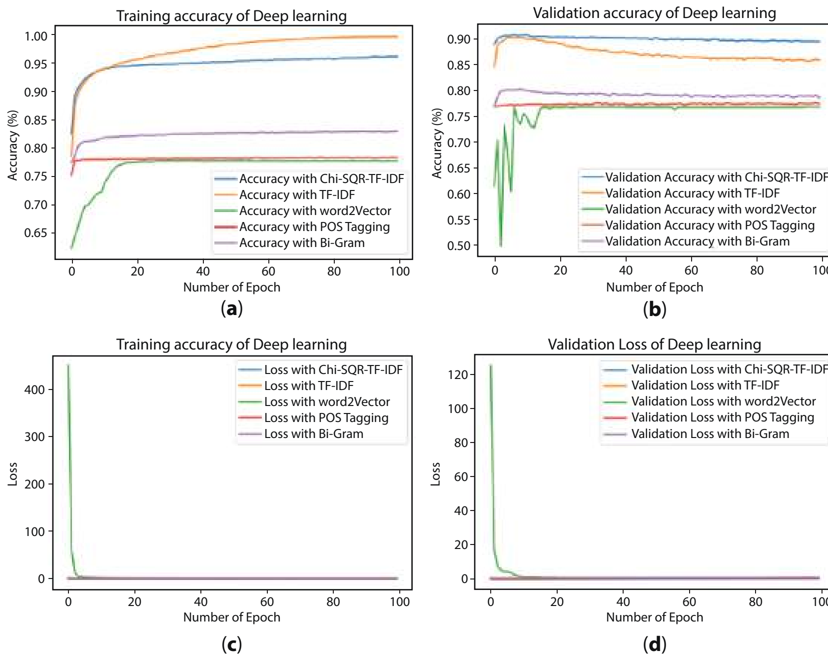

Figure 24.5 Performance of different feature selection technique with CNN classifier in terms of (a) training accuracy, (b) validation accuracy, (c) training loss, and (d) validation loss.

TF-IDF–based feature and refinement using the Chi-square test provides higher accurate results as compared to other implemented techniques.

Next, we have measured the loss of text classification model. The loss value shows the distance of the predicted values with the actual consequences. That will help the classifier to optimize their training and validation performance. In this given experiment, we utilized the categorical_crossentropy function. This function is used for multi-class classification where two or more output labels exist. The output is assigned a one-hot category encoding value in the form of 0s and 1s. According to ML, the loss value is needed to minimize the increasing number of training cycles. The loss of the implemented text classification models is demonstrated in Figure 24.5(c and 5d). According to the obtained results, most of the implemented methods are providing low loss values and reduce the number of training cycles. Finally, we measured the efficiency of the models in terms of training time and memory usage. The training time is the amount of time required to train an ML algorithm with the extracted features; additionally, the memory is the space utilized during the training of

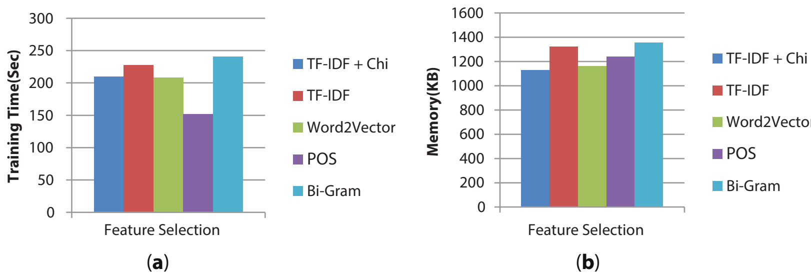

Figure 24.6 Efficiency of the feature selection techniques in terms of (a) training time and (b) memory usage.

the algorithm. Figure 24.6(a) shows the training time of the ML algorithm and Figure 24.6(b) shows the memory usage of the algorithms.

The training time is measured in terms of seconds (Sec) and the memory usage is given in kilobytes (KB). According to the results, the memory usage and training time of Bi-Gram–based feature extraction and classification take very fewer amount of time as compared to other implemented feature selection techniques. Based on all the measured performance parameters, the proposed model extracts features based on TF-IDF, filtered using the Chi-square test and then classified using CNN, and provides accurate and efficient social media text classification.

24.5 Conclusions

ML-based applications are higher data consumers from different sources. Among different sources of data, social media is one of the most popular data sources. This data is large, growing, distributed, and contributed by the entire world. Due to this, in applications of disaster management, disease outbreaks, and fake news detection, it plays an essential role. In this context, social media text is analyzed and key insights are captured from social media data for social welfare. In this paper, social media text classification is studied. The text classification requires data transformation from unstructured data to structured data, thus we need feature selection techniques. The feature selection techniques help to improve the quality of learning data, minimize resource consumption, and enhance the classification accuracy by identifying the essential insights from the data.

However, there are a number of text feature selection techniques available, but the nature of social media text is different from large text classification or document classification problems. Therefore, which feature selection method that will be useful in a target application is needed to be analyzed. In this context, the proposed work involves a comparative performance study in order to classify the social media text. The fake news detection dataset obtained from Kaggle is used for experimentation. The consequences demonstrate the selection of appropriate feature selection techniques for text classification that can highly influence the accuracy of ML applications. The representation of the text for classification also influences the performance of the classifier. Thus, the implementation of different feature selection approaches has been carried out and the extracted features are classified with the help of the CNN algorithm. Based on the fake news dataset, the experiments have been conducted and performance has been evaluated. In experiments, we found that the features extracted from text contain the keywords but the potential keywords will help to improve classification accuracy. In this context, the TF-IDF and Chi-square test–based feature selection perform better than other implemented techniques. In the near future, the work involves analyzing the techniques of social media image classification techniques.

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25

4G Versus 5G Communication Using Machine Learning Techniques

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Abstract

Consistent with customer demand and new use cases, mobile communication technology has evolved over the years, reaching a tipping point with the advent of 4G and 5G. This abstract provides a synopsis of 4G and 5G technology, outlining their main characteristics, benefits, and potential consequences. Faster data speeds, lower latency, and increased multimedia capabilities were delivered by long-term evolution (LTE), often known as 4G, which revolutionized mobile communication. 4G enables seamless video streaming, high-quality audio calls, and extended worldwide coverage, and it is the backbone of modern mobile communication. Download speeds in the hundreds of megabits per second (Mbps) and latency reductions of 30 to 50 milliseconds (ms) are noteworthy advancements. 5G, on the other hand, is the newest mobile communication technology that promises latency levels as low as one millisecond (ms) and data rates in the multi-gigabit range. We are entering a new era where augmented reality experiences, movie streaming, and file downloads are all made easier and faster. Game consoles, driverless cars, and real-time medical procedures all rely on incredibly low latency. The Internet of Things (IoT) and smart city applications rely on 5G since it enables huge device connections and can accommodate up to one million devices per square kilometer. A revolutionary change in connectivity possibilities is marked by the transition from 4G to 5G.

***Keywords*:** 5G technology sustainability management building environment, machine learning

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Premanand Singh Chauhan, Rajesh Arya, Rajesh Kumar Chakrawarti, Elammaran Jayamani, Neelam Sharma and Romil Rawat (eds.) Information Visualization for Intelligent Systems, (349–370)

25.1 Introduction

The fifth generation of cellular communication technology, also known as 5G, and the fourth generation, sometimes known as 4G, are both generations of the same technology. The following is an overview of the fifth generation (5G) and a comparison to the fourth generation (4G): The fourth generation, abbreviated simply as 4G, refers to the generation of cellular communication technology that came before it. In comparison to its predecessor, known as 3G (Third Generation), it was released in the latter part of the 2000s with the intention of providing faster data transfer rates and more dependable connections. Long-term evolution (LTE), the technology that serves as the basis for 4G, has been subjected to a number of improvements that aim to boost its overall performance and effectiveness. Important characteristics of 4G are as follows [1].

Increased Download and Upload Speeds: 4G is capable of providing download and upload speeds that range from several megabits per second (Mbps) to hundreds of Mbps, making it perfect for high-quality video streaming, online gaming, and the downloading of huge files. Latency, which is the delay that occurs during data transmission, has been drastically cut down [2]. When compared to networks of earlier generations, 4G networks often have lower latency, which is vital for real-time applications such as video conferencing and online gaming. Enhanced Multimedia: 4G makes it possible to have improved multimedia experiences, such as video calling in high definition and video streaming without the need for buffering. 5G (fifth generation): As of September 2021, the most recent and cutting-edge cellular communication technology is known as 5G, also known as the fifth generation [3]. It makes considerable gains in data speed, capacity, latency, and overall network performance in comparison to its predecessor, 4G, which served as the basis for its development. It is the goal of 5G to create a communication infrastructure that is both more connected and efficient so that it can support emerging technologies like the Internet of Things (IoT) and enable new innovations. 5G has the following features Data Transfer Rates of a Gigabit: The data transfer rates that 5G is expected to achieve are in the order of gigabits per second (Gbps), making it substantially faster than 4G. This lightning-fast speed opens the door to possibilities for immersive virtual reality, streaming video in 4K or 8K, and other applications that require a lot of data [4]. Reduced Latencies With 5G, latency will be further reduced to a few milliseconds, making it nearly impossible to detect in real-time applications. This is absolutely necessary for applications such as driverless vehicles, remote surgery, and other mission-critical uses of the Internet of Things. Massive Capacity: 5G is capable of managing a substantially higher amount of data. Advantages of 5G above 4G are as follows Downloads are made easier, video streaming is rendered more seamless, and web surfing is sped up thanks to the greatly increased data transfer rates that 5G makes possible. Reduced Latencies: The decreased latency that 5G networks provide is very necessary for the operation of real-time applications such as online gaming, autonomous vehicles, and industrial automation. Enhanced Connectivity: The capacity of 5G networks to connect a large number of devices in a concentrated space makes them perfectly suited for usage in both smart cities and smart households. This makes 5G networks excellent for use in smart cities. Protecting Against the Uncertainty of the Future The cutting-edge technology of 5G lays the foundation for emerging innovations and applications that call for increased data capacity and performance. While 4G continues to be generally used and reliable for most mobile communication needs, 5G is fast being deployed internationally and will become the standard for future mobile communication due to its revolutionary possibilities. While 4G continues to be widely used and reliable for most mobile communication needs, 5G. Users will enjoy even more significant benefits from this next-generation technology as the infrastructure and coverage for 5G continue to expand [5]. The shift from 4G to 5G technology represents a giant leap toward a future that is more data-driven and connected than ever before. Not only can 5G improve user experiences, but it also gives businesses access to capabilities that have never been seen before. It paves the way for disruptive applications that rely on rapid data transfer and better device connectivity, which has the potential to change industries such as healthcare, manufacturing, transportation, and entertainment [6]. Although 4G is still widely used and continues to offer dependable mobile connectivity, the enhanced capabilities of 5G have established it as the technology that will be utilized in the future. Users and industries will experience improved connectivity as well as the development of novel apps that take advantage of the full potential of this fifth-generation technology as 5G continues to be deployed and its coverage area expands. The transition from 4G to 5G in mobile communication is a paradigm shift since it brings together higher speeds, lower latency, and increased connectivity, all of which converge to reinvent the possibilities of the digital era [7].

25.2 Literature Review

In recent years, there has been a growth in interest in a number of various fields that are related to energy, including smart grids, smart homes, and energy efficiency, to name a few of these sectors. The author of reference claims that "Smart Buildings", sometimes commonly abbreviated as "SBs", are aware of the grid in addition to themselves. The firm foundation of SB and SG's connection with one another is a communication that takes place in the here and now. Flexibility in meeting the many different requirements of the market. According to the authors of [12], the basic properties of an SB that distinguish it from structures of prior generations are its responsiveness, adaptability, and resilience. These are the characteristics that set it apart from the structures of past generations. Both adaptability and versatility are absolutely necessary in this day and age. The authors of [13] made it very clear that in order for SBs to function appropriately, they need to have sufficient knowledge and grasp of both the local population as well as the environment that is surrounding them. This is required in order for SBs to achieve their desired level of success. People who live in an SB that has been adapted to suit their environment will have a better overall experience as a result of this, which will assist in improving the quality of life in these homes. In addition, an SB is not a collection of a number of distinct configurations, but rather it is its own self-contained, fully operational system in its own right. Because of this, the many interior spaces of an SB are able to communicate with one another, which ultimately leads to an environment that is more consistent. According to what is mentioned in the source material which can be found at [8].

25.3 Data and Methodology

Machine learning allows computers to "learn" new tasks and get better at them over time without human intervention or code. In several fields, they are essential for pattern recognition, prediction, and decision-making support. A detailed breakdown of some well-known machine learning techniques is provided here.

A. Machine Learning

Neural networks mimic the structure and function of the human brain by using hierarchical structures of interconnected nodes. Deep learning allows the model to automatically learn hierarchical representations through the use of neural networks with numerous layers. Image and audio recognition, NLP, and complicated pattern identification are some of its most common applications.

B. Structural Vector Machines (SVMs)
Using the input space as a guide, support vector machines (SVMs) supervised learning method locates the hyperplane that best divides the input space into classes. It works well in spaces with several dimensions. Use: Typically employed for categorization tasks, particularly in cases with intricate decision limits. Depending on the needs, features, and properties of the data and tasks at hand, one can choose from a variety of machine learning algorithms that offer distinct tools for tackling different kinds of challenges. Progress in machine learning is being propelled by persistent research that, in tandem with technological advancements, is constantly improving and broadening the capabilities of these techniques. The approach used to compare 4G and 5G technologies is crucial for the research to be robust. Using a methodical and thorough methodology, the study seeks to offer a thorough and impartial assessment of these mobile communication technologies. Getting a feel for the current research and methods used to compare 4G and 5G by perusing a mountain of information. This not only helps find gaps in current knowledge but also guarantees a solid basis. Outlining the study's goals and questions to help direct the investigation. This guarantees that the approach is in line with particular objectives, which in turn permits targeted and pertinent data gathering and analysis.

C. Approaches to Collecting Data:
Using suitable data gathering techniques, which could involve numerical measurements like latency comparisons, data transfer speeds, and metrics for network performance. A more complete picture can be painted with qualitative data derived from expert opinions and user experiences. Choosing the Sample: Methodical sample selection with consideration of user demographics, network providers, and geographic areas. This makes the study more applicable to a wider range of situations and increases its external validity. Key Performance Indicators: To evaluate and contrast 4G and 5G technologies in an objective manner, it is necessary to define and use appropriate performance criteria. Data rates, latency, dependability, and coverage analysis may be required for this.

To mimic real-world use, we use real-world testing scenarios. In doing so, reflecting the real-world performance of 4G and 5G technologies in a variety of contexts. Quantitative Evaluation: Applying rigorous statistical methods to correctly decipher the gathered data. Finding the key distinctions between 4G and 5G can necessitate the use of regression analysis, comparative statistical testing, or other similar methodologies. Professional Advice: In order to confirm results and comprehend technical intricacies better, we are asking for the opinions of professionals in the field, engineers, and stakeholders. The study's legitimacy and the usefulness of the context are enhanced by the expert judgments. Important Moral Factors Taking into account ethical concerns, making sure the study is still valid, and protecting the privacy of participants are all part of conducting research ethically.

A strong foundation for comparing 4G and 5G technologies is sought after by the research, which intends to incorporate these aspects into the methodology. The research is of higher quality as a whole since multiple elements were carefully considered and a systematic method was used, which increases the reliability and validity of the findings.

Methodology: When comparing 4G and 5G technologies, we will apply a structured methodology to evaluate their important aspects based on four basic criteria: speed, latency, capacity, and use cases. This will allow us to make a direct comparison between the two. We are going to conduct an analysis of the relevant literature and in order to acquire precise and up-to-date knowledge on both technologies, technical specifications and industry reports are required. Review the data that is currently available to determine the maximum download and upload speeds for 4G networks. 5G: Conduct research to determine the maximum download and upload speeds that can be achieved by 5G networks. Analyze the speed metrics to evaluate the degree to which 5G is an upgrade on 4G in terms of speed. Investigation of latency statistics for 4G networks, which is commonly measured in milliseconds. 5G: In order to evaluate possible improvements, look at latency measures for 5G networks [9].

When compared to 4G, 5G has a lower latency than it had previously, as seen by the following comparison of its latency data. The capacity to: 4G: Determine the data capacity of 4G networks by calculating the maximum number of connected devices that may be supported in one square kilometer. 5G: Determine the data capacity of 5G networks by calculating the maximum number of connected devices that can be supported in one square kilometer. Analyze the capacity measurements to determine the degree to which 5G is superior to 4G in terms of available bandwidth. Case Studies: 4G: Conduct research into the established use cases and applications that make heavy use of 4G technology. Some examples of these include mobile data, video streaming, and voice calls. 5G: Investigate use cases and applications that have been documented and that make use of the increased capabilities of 5G, such as augmented reality, virtual reality, driverless vehicles, and enormous deployments of the internet of things [10].

When compared to the capabilities of 4G, the range and variety of use cases that can be enabled by 5G is significantly greater. Results and a Concluding Statement: The comparison of 4G and 5G will produce objective findings based on their comparative speeds, latency, capacity, and use cases when it is conducted using the technique that was mentioned above [9]. Because of these findings, a thorough explanation of how 5G outperforms 4G in terms of data transfer rates, reductions in latency, increases in capacity, and support for cutting-edge applications will be provided. In conclusion, it will be emphasized that 5G is the next-generation mobile communication technology, which will provide users with a game-changing experience and unlock the possibilities for innovative use cases across all industries. The investigation will emphasize the most important advantages of implementing 5G, thereby establishing it as the technology of the future for mobile communication and networking [11].

25.4 4G and 5G Methodology

Using machine learning techniques to make a comparison between 4G and 5G can be difficult because both technologies are not intrinsically dependent on data patterns and do not require predictive modeling. This makes it difficult to draw meaningful comparisons between the two. On the other hand, we can apply machine learning to analyze data on the performance of the network, anticipate the behavior of the network, or evaluate the user experience in a specific setting. Using techniques for machine learning, here is one method by which we might approach the comparison: Network performance prediction is the gathering of historical data on network performance parameters (such as signal strength, throughput, and latency) for both 4G and 5G networks. Utilize machine learning regression methods such as linear regression and random forest regression to make performance predictions for a network based on contextual parameters such as the time of day, location, and load on the network. Analyze the prediction ability of the models for 4G and 5G, and decide which technology to use based on your findings. Offer improved performance of the network under a variety of circumstances [12].

A. User Experience Assessment

Collect information from users regarding their experiences with mobile communication on 4G and 5G networks (for example, through user evaluations and surveys). Techniques from the field of natural language processing (NLP) should be applied to the task of analyzing text data in order to derive user sentiment and important aspects of their experiences. Utilize classification techniques based on machine learning, such as Support Vector Machines and Naive Bayes, to categorize user experiences as either positive, neutral, or negative for both 4G and 5G networks. Compare the classification findings to gain an understanding of the overall user satisfaction and to identify any discrepancies between the user experiences provided by 4G and 5G networks [13].

B. Network Transition Analysis

Conduct research on the data gathered from network handover and transition events between 4G and 5G for users whose devices are capable of operating on both networks. Users can be categorized according to the transition patterns they make using various machine learning clustering techniques, such as K-Means and DBSCAN. In order to understand how users switch between 4G and 5G networks and discover patterns of network usage, it is necessary to compare the clustering results. Forecasting the Amount of Coverage: Collect information regarding the network coverage and signal strength of 4G and 5G networks in various parts of the world. The network coverage zones for both technologies can be predicted with the use of machine learning algorithms. When comparing the results of the coverage projection, you can find areas that have greater coverage for both 4G and 5G [14].

When comparing 4G and 5G technologies, it is vital to keep in mind that the applicability of machine learning is restricted due to the characteristics of these technologies. Tasks that require recognizing patterns in data and making predictions are particularly well-suited for machine learning. The contrast that was just shown is founded not on conventional examples of machine learning in action but rather on data analysis and user input. Because of this, machine learning can be helpful in certain elements of the comparison; however, in order to conduct a complete examination of the technological differences between 4G and 5G, it is necessary to have an understanding of both of their underlying architectures and the performance characteristics of each [15]. It is important to highlight 5G's characteristics and improvements while comparing 4G and 5G technologies to emphasize their importance and influence. This emphasis clarifies how 5G advances mobile communication. Key 5G features and their relevance:

C. Higher Data Rates

Relevance: 5G offers multi-gigabit data rates. Users may access data-intensive apps and services faster with better download and upload speeds. The better user experience, especially for HD video streaming and real-time online gaming, is relevant.

D. Low Latency:
Relevance: 5G reduces latency to 1 ms. Remote surgery, driverless vehicles, and augmented reality require this. Time-sensitive and mission-critical applications can use low latency for quick response.

Massive Device Connectivity:
The 5G network can connect one million devices per square kilometer. IoT and smart city applications require multiple devices to connect seamlessly. The scalability and efficiency of 5G networks make them relevant for numerous IoT situations.

E. Slice the Network:
Relevance: 5G network slicing allows virtualized, customized networks for individual applications or user groups. Optimizing network resources, assuring service quality, and addressing diverse service and industry needs are particularly important with this functionality.

F. Better Reliability and Coverage:
Relevance: 5G improves network dependability and coverage for a stronger connection. This is especially important in remote or difficult places where earlier generations struggled to retain connectivity. Improved coverage makes the network more inclusive and accessible.

G. Energy Savings:
Relevance: 5G networks optimize resource use with energy efficiency. This is relevant to network sustainability and environmental impact reduction. Energy efficiency improvements support worldwide greening efforts.

H. Dynamic Spectrum Sharing:
Relevance: 5G allows dynamic spectrum sharing for more efficient spectrum use. This helps optimize spectrum use, accommodate varied services, and meet bandwidth demand. Highlighting these capabilities and developments can help the debate focus on how 5G transforms 4G. Each feature highlights 5G's role in current communication and industry innovation.

25.5 4G and 5G Algorithm

Since I am a text-based AI, I don't have the ability to generate graphical plots even if I wish I did. Although I was unable to offer you a comparison chart, I will do my best to explain the most important differences between 4G and 5G. When using 4G, you can achieve download speeds of up to 100 Mbps and upload speeds of up to 50 Mbps. The 5G standard makes it possible to achieve download speeds of up to 10 Gbps and upload speeds of up to 1 Gbps. Waiting time. Approximately 30 milliseconds is considered to be the normal delay for 4G. Real-time applications like virtual reality and autonomous vehicles require an extremely low latency, which 5G can give down to as little as one millisecond. This is a crucial feature of 5G. Up to 2,000 users can be supported via 4G. Devices are distributed across one square kilometer. As a result of its ability to support a significantly greater number of connected devices — up to one million per square kilometer — 5G is well suited for the Internet of Things (IoT) and locations with a high population density [16]. Detailed explanations of 4G and 5G algorithms improve clarity and transparency about their mechanisms.

Algorithms for 4G include OFDM.
The reduce interference and improve spectral efficiency, 4G modulation uses OFDM, which divides the signal into narrowband orthogonal sub-channels. Relevance: OFDM boosts data transmission rates, especially in difficult wireless situations, enabling 4G's high-speed data.

Multiple Input MIMO: Multiple Output
MIMO allows several data streams to be transmitted and received using multiple antennas. MIMO exploits spatial diversity in 4G to improve data speed and signal reliability in urban situations with signal reflections and barriers.

Adaptive Modulation and Coding:
Explanation: AMC optimizes data transmission in different signal environments by dynamically adjusting modulation and coding algorithms. The enhanced dependability and throughput, this method optimizes resource consumption and adapts to channel conditions.

5-G Algorithms:
SCMA: Sparse Code Multiple Access
SCMA allows several users to share a time-frequency resource in 5G using distinct signature sequences. Relevance: SCMA improves spectrum efficiency, increasing device connectivity and resource use.

NOMA: Non-Orthogonal Multiple Access
NOMA lets several users share a time-frequency resource with varied power levels for simultaneous transmissions. NOMA improves spectrum efficiency and supports enormous device connectivity, which is essential for 5G networks to accommodate IoT devices' diversified needs.

Beamforming:
Explanation: 5G uses massive MIMO beamforming to focus radio signals, improving signal strength and minimizing interference. Relevance: Beamforming improves coverage, capacity, and dependability, especially in densely populated locations, boosting 5G network performance. Allocating Resources with Machine Learning 5G uses machine learning algorithms to optimize power, bandwidth, and frequency. Relevance: Machine learning helps networks self-optimize, adapt, and improve efficiency. Deciphering these algorithms clarifies the conversation and helps explain 4G and 5G technology. This deep exploration increases transparency, allowing stakeholders to understand the technological challenges of 4G to 5G.

Frequency Bands:
4G: Primarily utilizes frequency bands lower than 6 GHz and runs at those speed. 5G: Uses a wider range of frequency bands, including both lower frequencies (sub-6 GHz) and higher frequencies (millimeter-wave), which enables both greater coverage and capacity. These frequency bands include both lower and higher frequencies. These frequency bands encompass a wide range of frequencies, from the lowest to the highest. The Scope of Coverage 4G provides coverage across a wider geographic area than its predecessors do. The utilization of higher frequency bands enables 5G to provide more localized coverage, which is especially beneficial in metropolitan areas. Effective Use of Energy 4G has the potential to be relatively power-efficient for a variety of different applications. 5G will introduce technology that will improve energy efficiency [17], but higher data rates may potentially lead to an increase in power consumption. Case Studies: 4G is suitable for general data and voice transmission, as well as video streaming and certain Internet of Things applications. It is now feasible to implement cutting-edge applications such as augmented reality, virtual reality, streaming video in resolutions of 4K and 8K, remote surgery, autonomous vehicles, and smart cities thanks to 5G technology. You can make a comparison graphic using this data that illustrates the significant distinctions between 4G and 5G in regard to the aforementioned factors

by using the information that you have gathered. If you want to represent these disparities in a clear and concise manner, you may think about making a bar chart or a radar chart. Without a doubt! To make a quantitative comparison between 4G and 5G in terms of important factors.

The numerical calculations section for 4G and 5G provides examples to help explain the computations. Examples of 4G numerical calculations include throughput calculations utilizing Modulation and Coding Scheme (MCS).

Consider a 4G LTE connection with these parameters:
B: 20 MHz
64-QAM modulation
Coding Rate: 0.8
Transmission Time Interval: 1 ms
Formula for 4G LTE throughput (T):
$T=B\times\log 2 - (1+SINR)\times CR\times TTI$
SINR = Signal Power Interference + Noise Power.
SINR = Interference + Noise Power Signal Power

Assume 30 dB Signal Power and 20 dB Interference + Noise Power.

SINR = 30/20 = 1.5
Now, Substituting values into throughput formula:
$T= 20 \times \log 2\ (1+1.5)\times 0.8\times 1= 20 \times \log 2\ (2.5)\times 0.8$
$T \approx 20 \times 1.322 \times 0.8 \approx 21.14$ Mbps
Thus, this 4G connection has 21.14 Mbps throughput.

5G Numerical Calculations: Throughput Calculation with Massive MIMO and Beamforming

This 5G connection has these parameters:
B: 100 MHz
Massive MIMO: 64 antennas
Beamforming Gain: 12dB
256-QAM modulation
Code Rate (CR): 0.9 TTI: 0.5 ms
Formula for 5G throughput with Massive MIMO and Beamforming:
$T=B\times\log 2 - (1+SINR)\times CR\times TTI$
SINR=Effective SIL+Beamforming Gain
Say Effective SINR is 15 dB.

SINR=15+12=27
Substituting values into throughput formula:
T = 100 × log 2 (1 + 27) × 0.9 × 0.5
=100×log 2(1+27)×0.9×0.5 899.14 Mbps
This 5G connection has 899.14 Mbps speed.

These examples show how bandwidth, modulation, coding rate, and antenna topologies affect 4G and 5G throughput during numerical calculations.

Data Transfer Speed (Mbps):

4G: Speed_4G = 100 Mbps (download) + 50 Mbps (upload)

5G: Speed_5G = 10,000 Mbps (download) + 1,000 Mbps (upload)

Latency (milliseconds):
4G: Latency_4G = 30 ms
5G: Latency_5G = 1 ms
Network Capacity (devices per km^2):
4G: Capacity_4G = 2,000 devices/km^2
5G: Capacity_5G = 1,000,000 devices/km^2

You can use a bar chart to visually compare the differences by representing these data as bars on the chart. If you want to demonstrate the improvement in a manner that is more quantitative, you can also make use of formulas to compute the percentage rise or reduction that occurs between 4G and 5G for each metric. The following is an illustration of one possible method for calculating the percentage improvement in data transfer speed:

Percentage Increase = ((Speed_5G - Speed_4G) / Speed_4G) * 100

In a similar fashion, you can apply similar formulas for various characteristics and then design a chart or Table 25.2 that displays these values in order to demonstrate the differences between 4G and 5G in a mathematical and graphical manner. There are many various applications for machine learning algorithms that can be used to improve and boost the performance of 4G and 5G wireless communication technology. These generations of wireless communication technology are referred to as 4G and

5G, respectively. The applications of machine learning that can be made to 4G and 5G networks include the following examples: Radio Resource Management:

In both 4G and 5G networks, machine learning methods have the potential to be utilized in order to optimize the distribution of radio resources (such as frequency bands and power levels). This has the potential to improve the efficiency of the spectrum as well as the performance of the network as a whole. The application of machine learning can be of assistance in finding interference sources within the network and minimizing the consequences of such interference sources. In order to improve signal quality and decrease the amount of interference, it is feasible for algorithms to make dynamic adjustments to the settings.

A. Beamforming and Antenna Optimization

Techniques like as beamforming and huge MIMO (multiple-input, multiple-output) are required for 5G communications. Algorithms that learn from experience can enhance beamforming patterns and antenna configurations, leading to improvements in both coverage and capacity. Algorithms powered by machine learning have the ability to forecast and identify probable defects or anomalies in network equipment. This paves the way for proactive maintenance and cuts downtime. Network Slicing The fifth-generation wireless standard, 5G, introduces the concept of network slicing, in which the network is partitioned into virtual slices to accommodate various use cases. The use of machine learning can assist in the process of efficiently allocating and managing these slices in response to real-time demand.

B. Quality of Service (QOS) Management:

A consistent user experience can be maintained through the use of ML algorithms' ability to dynamically alter QoS parameters based on the conditions of the network and the demands of the user. Effective use of energy through the use of intelligent on/off switches that are controlled by machine learning, the network's energy usage may be intelligently optimized, hence reducing costs associated with running the network. Optimization of the Handoff The use of machine learning allows for the prediction and optimization of handover decisions made between various cells or base stations to maintain continuous connectivity even while the user is moving. Protection of Networks: A network can be protected from potential vulnerabilities caused by cyberattacks by utilizing machine learning for anomaly identification, intrusion detection, and network security monitoring. Traffic Prediction and Management: Machine learning algorithms have the ability to forecast traffic patterns and manage network resources in accordance with those forecasts, thereby increasing overall network efficiency. These uses of machine learning are not restricted to just 5G; in fact, many of them can also be used to improve the functionality and effectiveness of 4G networks. The primary distinction lies in the fact that 5G's higher data rates, reduced latency, and increased capacity will make it possible to implement more complex use cases for machine learning applications. vi. Chalange In Hadware Equipment:

The upgrade from 4G technology to 5G technology presents a number of difficulties in terms of the necessary hardware equipment. The following are some of the most significant obstacles that must be overcome in order to upgrade hardware equipment for 5G frequency bands and spectrum. Test your mettle 5G utilizes a greater variety of frequency bands, some of which have higher frequencies, such as millimeter waves. As a result, new hardware components that are able to function at these frequencies are required. A way out Create new radio frequency (RF) components, such as antennas, transceivers, and other RF devices, that are capable of operating at higher frequencies, as well as providing the required level of coverage and capacity. Massive Multi-Input Multiple-Output and Beamforming:

To overcome this obstacle, 5G will rely significantly on technologies such as massive MIMO (Multiple-Input, Multiple-Output) and beamforming. These will allow for higher data rates and improved coverage. Complex antenna arrays and intricate signal processing are required for these technologies. A way out Develop and produce cutting-edge antenna systems as well as beamforming hardware that is able to deal with the added complication that comes with using numerous antennas and performing spatial processing.

C. Small Cell Deployment

The enhanced capacity of 5G as well as its more targeted coverage in specific locations presents a challenge in that it requires the installation of additional tiny cells in highly populated places. This necessitates the purchase of new hardware in addition to considerable infrastructural adjustments. A way out Create tiny cell hardware that is both compact and energy-efficient, with the goal of minimizing interference and power consumption while maximizing ease of integration into existing urban surroundings. Efficiency in the Use of Energy: The increased power consumption that may result from 5G's faster data speeds and shorter latency is a potential challenge. In order to maintain sustainability, it is essential to ensure that the design of hardware is energy-efficient. The answer is: Components of hardware that are energy-efficient should be designed, and power consumption should be optimized using methods such as dynamic power management and sleep modes. Both in the Backhaul and the Fronthaul:

The higher data rates and capacity of 5G networks provide a challenge in that they require robust backhaul and fronthaul links in order to successfully manage the flow of traffic between base stations and core networks. The answer is Create fiber-optic and wireless backhaul solutions with high speeds and low latency that are capable of meeting the increased data requirements of 5G. The challenge of network slicing in 5G makes it possible to slice the network into virtualized portions that can be used for a variety of purposes. The use of hardware that is able to dynamically assign resources to these slices is required for the implementation of this. A way out is Develop hardware that can allow programmability and flexibility, as these are requirements for dynamic resource allocation and management across several network slices.

D. Cost and Scalability

Test your mettle To upgrade to 5G, considerable financial investments in new hardware and software are required. It might be difficult to strike a balance between lowering costs and increasing scalability while maintaining or improving performance. The idea is to design hardware solutions that strike a reasonable balance between cost-effectiveness and scalability. This will make it possible to manage the financial impact of upgrades without disrupting service. Compatibility and interoperability are both important. Test your mettle In order to make the jump from 4G to 5G, you will need to integrate new gear with the 4G infrastructure that already exists. It can be difficult to ensure compatibility and interoperability between different generations of technology [17]. The solution is to design the necessary hardware and equipment with backward compatibility in mind. This will enable a seamless connection with existing networks while also allowing for a progressive transition to 5G. In a nutshell, the obstacles that must be overcome in order to transition from 4G to 5G in terms of the hardware involve supporting higher frequencies, making it possible to use new antenna technologies, preserving energy efficiency, increasing infrastructure, and ensuring compatibility. It is necessary to find solutions to these difficulties in order to fully fulfil the potential of 5G technology and give users with benefits that were promised, which include faster speeds, lower latency, and more capacity. The Tables 25.1 shows about the about the comparison: 4G vs. 5G., The Tables 25.2 shows about the theoretical 4G vs. 5G, The Tables 25.3 shows live 4G vs. 5G, speed monitor, The Figures 25.1 shows about the Theoretical 4G vs. 5G speed and Figures 25.2 shows about the Live 4G vs. 5G speed.

Table 25.1 The comparison: 4G vs. 5G.

	4G	**5G**
Time delay	10 ms	Smaller than 1 ms
No. of mobile link	Eight billion	Eleven billion
Channel bard band	20 MHz 200 MHz	100 MHz (lower than 6 GHz) 400 MHz (lower than 6 GHz)
Frequency Band	600 MHz to 5.925 GHz	600 MHz (millimeter wave)
Data flow	7.2 Eb/month	50 Eb/month
Peak data rate	1 Gb/s	20 Gb/s
Available channel	3 GHz	30 GHz
Link Density	One million link/km*2	One million link/km*2
Uplink waveform	Use SC-FDMA	Use CP_OFDM

Table 25.2 Theoretical 4G vs. 5G, speed monitor various parameters result analysis.

Network	**Peak speed**	**Average speed**
5G	10	500
4G	4	60

Table 25.3 Theoretical 4G vs. 5G, speed monitor various parameters result analysis.

Network	**Peak speed**	**Average speed**
5G	245.71	62.37
4G	50.56	20.5

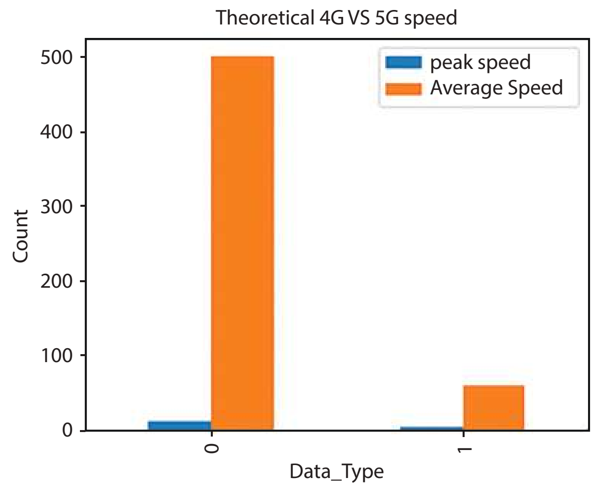

Figure 25.1 Theoretical 4G vs. 5G speed.

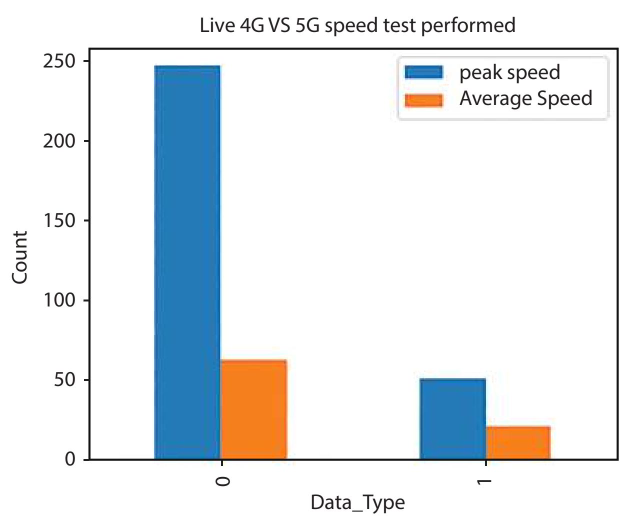

Figure 25.2 Live 4G vs. 5G speed.

25.6 Conclusion

To summarize, both 4G (also known as the fourth generation) and 5G (also known as the fifth generation) are key milestones in the development of mobile communication technologies. There are substantial differences between the two technologies in terms of speed, latency, capacity, and capabilities, despite the fact that both fulfill the objective of providing wireless access. When compared to its predecessor, 3G, the more recent technology known as 4G, also known as long-term evolution or LTE, had significant advancements. It provides faster data rates in addition to improved call quality and enhanced support for multimedia. 4G has become the cornerstone for modern mobile communication, including video streaming, voice calls, and general internet usage. With download rates of several hundred megabits per second (Mbps) and lower latency ranging from 30 to 50 milliseconds (ms), 4G has become the foundation for modern mobile communication. On the other hand, 5G is quickly becoming recognized as the most cutting-edge and game-changing mobile communication technology. It promises huge device connectivity, ultra-fast data transfer rates, and extremely low latency (as low as 1 millisecond). With download rates exceeding several gigabits per second (Gbps), 5G offers up a whole new world of possibilities for connectivity. This new realm of possibilities includes augmented reality, virtual reality, and real-time applications such as remote operations and autonomous vehicles. Because it can support up to a million devices per square kilometer, it is an essential enabler for applications related to the Internet of Things (IoT) and smart cities.

The change from 4G to 5G represents a significant paradigm shift in mobile communication because of the greater capabilities of 5G, which position it as the technology that will be used in the future. Not only can 5G improve user experiences, but it also gives businesses access to capabilities that have never been seen before. It paves the way for disruptive applications that rely on rapid data transfer and better device connectivity, which has the potential to change industries such as healthcare, manufacturing, transportation, and entertainment. While 4G is still widely used and continues to deliver reliable mobile connections, the advanced technology of 5G is laying the framework for future breakthroughs and applications that require more data capacity and performance. Unlocking the potential for creative use cases across industries will need widespread deployment and coverage of 5G technology. This will result in a world that is more linked to one another and driven by data. In conclusion, fifth-generation mobile communication technology, also known as 5G, is the next generation of mobile communication technology. It provides consumers with a game-changing experience and positions itself as the basis for a connected, intelligent, and futuristic digital era. Users and businesses may anticipate an unprecedented variety of apps that take advantage of the full potential of 5G technology as the deployment of 5G grows and the technology matures. Additionally, users and businesses should anticipate an unprecedented level of connectivity, which will result in enhanced.

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26

Design and Development of Programmable and UV-Based Automated Disinfection for Sanitization of Package Surfaces

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Abstract
The global issue corona pandemic has slowed down the lives of human beings. The present device is the design and development of programmable automated UV-C–based disinfection of the package surface which is required for the sanitization of the surface of packets containing products, materials, etc. In this contest of the COVID-19 scenario, the fear of infection through packages handled by several persons before reaching the actual customer will require an automated system that can handle and disinfect a large number of packages. The coming time is very tough for livelihood in the prolonged pandemic environment for the sake of safety and health and assured welfare of the society and this device is designed and developed. The UV-C–based programmable automated system for handling a large number of packages containing a variety of merchandise is not yet reported. The development of code for programming automation of the system and its integration with mechanical systems is challenging and needs an innovative approach that is executed in the present work.

***Keywords*:** Healthcare-associated infections, hospital environmental cleaning, disinfection, ultraviolet light-emitting device, Covid-19

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26.1 Introduction

The burden of both clinical and financial strains is often associated with any chronic condition. During the past few years, this has been an extremely common occurrence. The fact that the method of infection control that is completely foolproof has not yet been created by COVID-19. Based on the findings, it is estimated that in a typical National Health Service hospital with 510 beds, there might be a total of 3,683 HAIS every year, with a cost of Σ11.9 million and 126 details. According to the findings of the study, 4.7 percent of high-risk hospitalized patients in the National Health Service (NHS) have acquired a healthcare-associated infection (HAI), while their stay and 1.7 percent of nursing and doctors and other staff get one annually [1–3].

Patients who are infected and suffering from sickness are typically placed in quarantine and kept in isolation for the purpose of tight monitoring, taking precautions (which may involve significant disinfecting procedures) according to the severity of the situation. Disease sufferers who require treatments (such as biopsy, x-ray, and so on) in a separate location within the hospital present a known logistical challenge. This is because additional housekeeping is required both before and after these patients are treated in the rooms. The severity of this issue is more obvious in radiological settings, where the time required for disinfectant housekeeping might range anywhere from thirty to sixty minutes after each patient has fallen. Because of these delays, patients' workflows have been severely disrupted. According to information provided by the National Health Service (NHS), the number of individuals who have been waiting for a scan for six weeks or longer has nearly tripled between February and March of 2020. In most cases, those who work in radiography care for the housekeeping. Considering that cleaning personnel are not frequently engaged in pervasive medical equipment, the equipment would be expensive if the section were to become the case [4, 5].

It is possible that dispersing the cleaning chemicals throughout the patient room could represent a risk to any electronic circuits that are exposed to them, such as personal computers (PCs), medical equipment, and other similar devices.

Potentially more effective methods of infection management are being developed in response to the needs of technological advancements, including the following: 1.) increased effectiveness, 2.) lessen the amount of time and resources that are required to complete the disinfection removal process, and 3.) lessen the hazards that are incurred by health care professionals (including all staff members) who do not have access to facilities. In light of what was discovered, the third point appears to be particularly important. That had a significant negative impact on the mental health of the personnel who were working under extreme conditions [6].

Using short wavelength ultraviolet–C (UV-C) light, ultraviolet germicidal irradiation (UVGI) is a non-touch disinfection technology that kills microorganisms by destroying their nucleic acids and altering their DNA. This approach is known as UVGI. Besides being effective against whole organisms, UVGI offers numerous additional advantages. Despite a vast body of scientific evidence showing its efficacy against a wide range of viruses, including the coronavirus, the relative cost of labor and consumables, and the absence of determination residuals have all prevented its testing in an andrology environment, as far as the author is aware. Further investigation is required for reasons that will be explained later on, as it is unlikely that any of the UV bases now on the market would be suitable for such a task [7].

We offer three important additions to the field by exploring the viability and efficacy of utilizing UV disinfectant robots in radiology setups in this work. Our first proposal is a UV robot design that allows for precise control over the UV irradiation field [8–10]. With the hope that it will be safe to use around people when used as directed, secondly, we show the outcome of UVGI on inactive microbes from a wide variety of frequently handled surfaces in a hospital radiography room by utilizing an embodiment of the suggested design. Finally, we showcase the effectiveness of sanitizing a radiology room equipped with a CT scan machine in less than fifteen minutes, a two to four reduction from the current time required, in accordance with pertinent contemporary literature [11–13].

26.2 Materials and Methodology

For germicidal activity, TUV disinfection lamps emit short-wave ultraviolet radiation with a radiation peak at 253.7 nm (UV-C). These lamps are composed of a tubular glass envelope and operate on a low-pressure mercury-vapor discharge.

The ozone-forming line at 185 nm is absorbed by the glass. The practical UV-C radiation output is preserved by an internal protective layer (long-life lamps). The base of PL-S lamps already has a specifically designed component that provides a nearly quick starting. From the prior vantage point, the provided warning sign indicates that these bulbs emit UV-C radiation.

The light from these bulbs is dangerous for the skin and eyes. These lamps or tube lights should be installed with the curtains drawn. Regarding the application of TUV, the lamp is employed with the purpose of destroying or rendering inactive various forms of prehistoric life. Air, water, and surface disinfection in healthcare facilities, pharmaceutical and bacteriological research labs, and food processing businesses including bakeries, dairies, and brewers are common examples of typical applications. They have many more applications, including as in the disinfection of pools, air conditioning systems, cold storage rooms, packaging material, and drinking water and wastewater. The last place they are used is in various photochemical reactions. Figure 26.1 indicates the flow chart of the developed machine.

1. Install the driver for the disinfection device by starting the computer or mobile app.
2. Launch the application during installation.
3. To automatically check if the device is connected, the blue LED will light up if the disinfection is linked by Bluetooth.
4. Determine how long the soak should last."

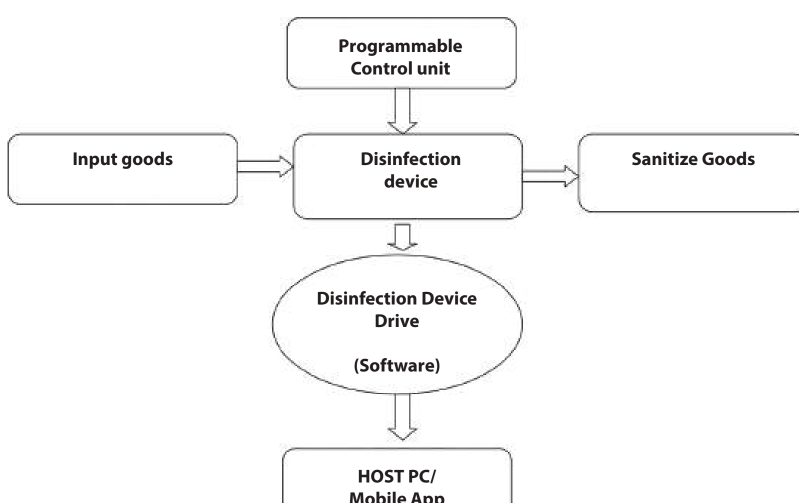

Figure 26.1 Flow chart of developed machine.

5. The system indicates that the disinfection device is active when the activate button is clicked. When the red light starts flashing, it means that the conveyor is ready to receive goods.
6. The procedure of disinfecting input commodities will begin.
7. If the intelligent sensor detects that there are items inside the enclosure, the conveyor will begin to move toward it. If this is the case, the red LED will stop flashing and the UV light will activate.
8. The goods can be soaked in the UVC light for the desired amount of time, allowing the loaded conveyor to continue traveling inside.
9. Meanwhile, from the opposite end, gather the disinfected things. The unit is prepared to receive objects, and the sanitization of the entire commodities will be repeated repeatedly.

26.3 Result and Discussion

Figures 26.2 and 26.3 show the frame and parts fitting of the apparatus. There were different luggage samples such as trolly bags, hand bags, cartons, sample bag carry bags, edible goods, packages, laptop bag, vegetable, milk, and curd packets. Afterward, sanitized samples were tested in microbiological laboratory. From the obtained result, it is viewed that 90% surface was bacteria free; in carton sample, 95% surface was bacteria free; in milk and curd packets sample, 80% surface

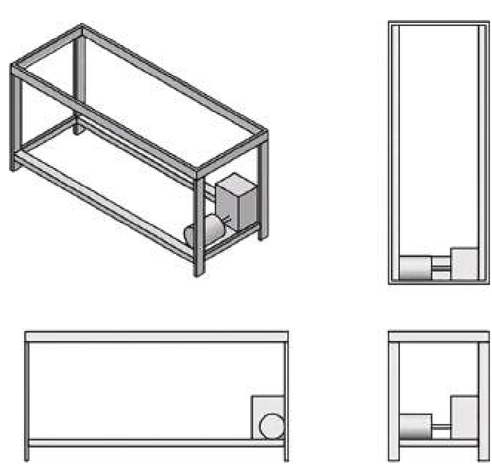

Figure 26.2 Frame and parts fitting.

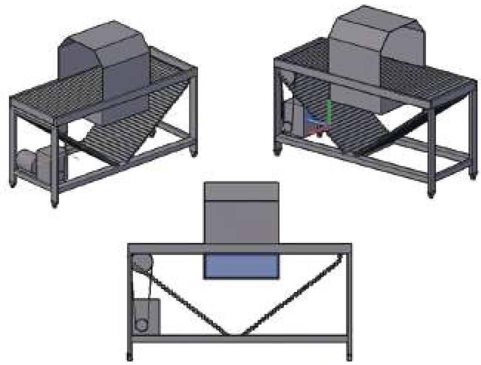

Figure 26.3 3D frame and parts fitting.

was bacteria free; in toffee packet, surfaces were 75% bacteria free; and in edible goods cartons, sample surface was 98% cleaned or bacteria free.

In the Figure 26.4 discussion is the sanitizing process by using UV-C tube lights, mainly used to kill the virus/nanobacteria and gerineaides. 40watt UV-C tube light is used to generate UV-rays of 254 nm of wavelength; when their UV-C rays fall on the skin of germicides or bacteria, they were killed immediately. The sample remains for 26–28 seconds

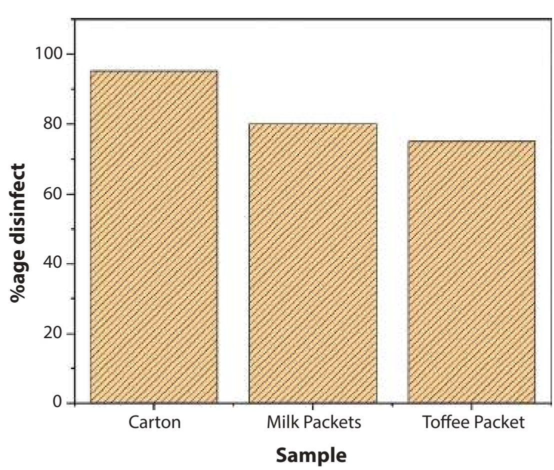

Figure 26.4 Percentage of disinfection.

in contact with UV-C light, and this much time is enough to kill them and make the articles free from bacteria; the ray is harmful to the skin and eyes of human beings, hence the process is conducted under closed enclosure. The material gets sanitized from 360° and gets free of bacteria.

26.4 Conclusion

The goal of this project is to develop an automated disinfection system for packaging surfaces that is both programmable and based on ultraviolet light. During the sanitizing process, less power is consumed, and packets and items can be disinfected quickly. This is important for performance measurement. One goal of infection control techniques is to minimize the microbial burden, and one possible way to do this is by using no-touch surface decontamination technologies that use ultraviolet light. This could lead to a lower incidence of healthcare-associated infections (HAIs). Therefore, these statistics are useful for healthcare facilities considering using this technology in addition to regular manual disinfection; if the aim is to reduce surface bioburden and, by extension, healthcare-associated infections (HAIs), then hospitals should keep up the good work in terms of hand hygiene and environmental disinfection. Overall, compared to manual disinfection alone, Pulsed UV technology proved much more effective at reducing bacterial counts on hospital surfaces.

Funding

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27

Fuzzy-Based Segmentations Performance Analysis for Breast Tumor Detection Using Spatial Fuzzy C-Means Filtering with Preconditions (SFCM-P) Over Bilateral Fuzzy K-Mean Clustering Algorithm (BiFKC)

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Abstract

This study aims to compare the breast tumor detection accuracy of the innovative spatial fuzzy c-means filtering with preconditions (SFCM-P) algorithm with that of the bilateral fuzzy k-mean clustering (BiFKC) algorithm, which is used for disease classification in image feature extraction. There are a total of 40 participants divided into two groups: Group 1 uses SFCM-P to assess the accuracy of breast tumor detection, and Group 2 uses BiFKC. Each group has a sample size of 20, with a pretest power of 80% and an error rate of 0.04. The results show that compared to BiFKC, the innovative SFCM-P–based image feature extraction technique achieves a much higher accuracy of 91.85%. A value of 0.032 ($p<0.05$) was used to determine statistical significance. In conclusion, the accuracy of the image feature extraction system based on BiFKC is much lower than that of the innovative SFCM-P method.

***Keywords*:** Innovative spatial fuzzy c-means filtering, medical treatment, feature extraction technology, bilateral fuzzy k-mean clustering, gray level co-occurrence matrix, ultrasound images

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27.1 Introduction

Several metabolic processes, including protein synthesis, hormone sensitivity, and energy expenditure, are regulated during breastfeeding, which is good for the baby's health. It is crucial to closely monitor the breasts during menopause since their metabolism changes [22]. Cancers of the breast and other sensitive organs can develop in women who do not get enough exercise, sleep, or eat healthily [4, 20, 22]. Medical professionals can better detect breast abnormalities when they combine clinical examinations with computer-aided diagnostic systems [13]. The clinical scanning image can be segmented for additional examination if the algorithm identifies a potentially infected area. Rodriguez-Ruiz *et al.* [11] noted that the physical dissection of breast cancer in order to treat it medically is a laborious procedure. Image analysis for early breast cancer detection is one of the most important clinical trial methodologies. Because no publicly available, high-quality biomedical treatment records exist, it poses a challenge for the producer [8].

There are a grand total of 108 publications available in Google Scholar and 88 articles in IEEE. Advancements in machine learning, deep learning [9], and computer-aided detection and medical treatment technologies have led to the creation of numerous novel algorithms for clinical picture analysis. Wang *et al.* [19] proposed that a CAD system could help with the precise categorization of ultrasound pictures taken for the purpose of breast cancer histology [6]. The use of mammography has increased the success rate of breast cancer screenings. Changing the view location in the CAD system allows for minimal technician interaction while maximizing the delivery of information regarding the breast lesion, similar to ultrasound imaging [16]. The CAD system's sensitive identification based on dissection and cataloging modules, as well as the revealing region of interest (ROI) feature, are necessary for breast corpus recognition. By retaining only the most essential data pieces, the accuracy of breast cancer categorization is enhanced [7]. Determining the medical treatment based on the benign or malignant status of a breast cancer imaged using ultrasound is the main objective of the computer-aided design (CAD) approach [17]. When it comes to early-stage breast cancer [16], when symptoms are nonexistent, mammography is your only bet [5]. Reminding enrolled patients to have further looked out is crucial because about 10% of women who receive a mammogram will have cancer discovered [15]. Referring to studies conducted by Ramalakshmi and Vidhyalakshmi [10] and Thanigaivel *et al.* [18].

Thus, in order to attain the targeted performance, a large amount of training memory is required. This is done in order to compare the innovative spatial fuzzy c-means filtering with preconditions (SFCM-P) in image feature extraction technique for disease classification [12] with the bilateral fuzzy k-mean clustering (BiFKC) algorithm and assess its accuracy in detecting breast tumors.

27.2 Materials and Methods

The research was carried out in the Embedded Systems Laboratory of the Saveetha Institute of Medical and Technical Sciences' Department of Electronics and Communication Engineering at the Saveetha School of Engineering. Two breast tumor detection algorithms are the focus of this study. For the study, 40 participants were selected from the dataset (Kaggle.com) using two different algorithms: Innovative SFCM-P (Group 1) and BiFKC algorithm (Group 2). The statistical parameters used were G-power 80% and alpha 0.05. The algorithms' code is written and executed in MATLAB. The steps of the innovation SFCM-P algorithm for RFC-ConvNet breast cancer identification are outlined in this section. The model's flowchart is displayed in Figure 27.2. Segmentation using the innovative SFCM-P method favors optimistic features extracted from dense features [3]. The model's operation is as follows. Ultrasound picture pre-processing enables the extraction of textural features. In order to make the cancer and edoema areas more visible, normalized Gaussian filtering was employed. A two-dimensional Gaussian distribution can be used for filtering purposes by

$$G_f = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-(x^2+y^2)/2\sigma^2} \tag{27.1}$$

Clustering is done on the image after filtering. Afterwards, detailed information regarding the anatomy and fluid flow of the breast can be obtained by dense feature extraction of ultrasound pictures using a standard database. In order to improve a pre-trained CNN layer, this produces texture features. At three distinct fluid flow sizes, this infectious agent was isolated and propagated.

This study created a rich feature fusion database by extracting all the required features from three distinct types of ultrasound pictures.

Extracting three critical features—(i) textural details, (ii) form, and (iii) agitated deep pixels using gray level co-variance matrix—is the exclusive focus of the gray level co-occurrence matrix (GLCM), a unique matrix computed for every image. In order to convert an image's spatial information into numerical data, feature extraction is used. In order to construct texture-based features, it must first compute matrix element (S) to extract features based on the co-occurrence of gray-level matrices. Based on how often the same intensity location appears in the test image, each feature records a separate dimension. The end product is a wealth of data suitable for DFE (dense feature extraction) studies. Each pixel in the final segmented image is converted into one of eight (0–7) quanta to speed up the calculation. The target data point is always adjacent to the reference data point in the horizontal axis [1]. Each matrix element (M_e), which is the frequency of two distinct intensity patterns, is proportional to the geometric distance d_{geo} between the two points.

$$M_e\left(int_1, int_2 \mid d_r^1, d_t^1\right) = d_{geo} \times f(int_1, int_2 \mid d_r, d_t) \tag{27.2}$$

Each iteration counts the frequency of the intensity pattern in the reference $\left(d_r^1\right)$ and target pixels $\left(d_t^1\right)$ If the initial data point is far from the reference (d_r) and target points (d_t),

$$d_{geo} = \frac{1}{\left(X - d_r^1\right)\left(Y - d_t^1\right)} \tag{27.3}$$

The matrix (X, Y) needs an initial reference point, $C(x+1, y+1)$, and a target point. The frequency of occurrence of this set of data points is recorded as a number across the image. Image intensity patterns are counted and stored based on frequency. Using the below equation, we can estimate the image's sample size and recurrence frequency.

$$C\left(int_1, int_2 \mid d_r^1, d_t^1 = \sum_{r=1}^{X-d_r} \sum_{t=1}^{Y-d_t} \varepsilon_{constant} \right) \tag{27.4}$$

$$\varepsilon_{constant} = \{1; \quad if\ C(x,y) = U, C(x+d_r, y+d_t) = V \tag{27.5}$$

$$\{0; \qquad \text{Otherwise}\}$$

When the reference and adjustment pixel intensities match, the binary value "1" increases. The gray matter (GM) intensity distribution reveals the region's health. For this, FWHM-based thresholding is used.

A. **Statistical Analysis**

The accuracy and response time provided by the innovative spatial fuzzy c-means filtering and the BiFKC method were analyzed using the IBM Statistical Package for the Social Sciences (SPSS) Version 22 tool [21]. The dependent variable is accuracy, while the independent variables are input dataset samples and tests (Seuss, n.d.). The spatial fuzzy c-means filtering model and the BiFKC model both use feature clustering processes, but the former makes use of deep learning and the latter of a different technique. To compare the means, an independent sample t-test was used.

27.3 Results

In comparison to the BiFKC model algorithm-based image feature extraction technique, the system based on the spatial fuzzy c-means filtering model achieved a substantially higher accuracy of 91.85% (two-tailed significance value of 0.032). With a standard deviation of 1.89571, the innovation spatial fuzzy c-means filtering model reaches an average of 87.9915. A mean of 86.4775 and a standard deviation of 2.37025 were produced by the algorithm based on the BiFKC model. Table 27.1 demonstrates that the suggested model (spatial fuzzy c-means filtering models) is evaluated in percentage terms using the true value of epoch time and that it takes various data texts as input. Table 27.2 demonstrates that the accuracy values for the BiFKC model are tabulated for the analysis. The model is trained using the true value of the epoch time for all the input data texts. The percentage is used to determine the accuracy. In comparison to the BiFKC model-based picture feature extraction, which had an accuracy of 90.5%, spatial fuzzy c-means filtering achieved a far higher accuracy of 91.85% (Table 27.3). Group 1 and Group 2 were analyzed using the SPSS tool for group means, standard deviations, and standard errors of accuracy. To illustrate the efficacy of the bilateral fuzzy k-means clustering method and the spatial fuzzy c-means filtering model, an independent sample t-test is administered using SPSS, as shown in Table 27.4. A p-value of less than 0.05 yields a significance value of 0.288. Table 27.5 displays the results of the comparative examination of the various modules suggested in this study, which demonstrate their compatibility with other segmentation methods currently in use.

Table 27.1 Sfcm-p is the spatial fuzzy c-means filtering the accuracy values are tabulated.

Iteration Al	Accuracy of SFCM-P IN (%)
1	85.12
2	85.43
3	85.77
4	85.99
5	86.11
6	86.56
7	86.88
8	87.24
9	87.56
10	87.94
11	83.09
12	88.23
13	88.63
14	88.89
15	89.04
16	89.34
17	89.85
I8	90.32
19	90.99
20	91.85

Figure 27.1 gives the accuracy of the spatial fuzzy c-means filtering and the BiFKC is depicted in the bar chart in Figure 27.1. X-Axis: Groups and Y-Axis: mean accuracy. (SFCM-P is the SFCM-P and BIFKC is bilateral fuzzy k-means clustering). Figure 27.2 gives the operational flow of the proposed RFC-ConvNet using the BiFKC segmentation algorithm and classification implemented the ultrasound, MRI, and mammography images into the pre-trained CNN model. Figure 27.3 shows the similarity index between the detected BT lesion spot region and its ground truth ultrasound images and a comparison between the different types of ultrasound images with final segmentation, testing, and ground truth. Figure 27.4 shows that clinical observation for infectious depth spreads

Table 27.2 The accuracy for the BiFKC model is tabulated.

Iteration Al	Accuracy of Bi-FKC IN (%)
1	82.29
2	82.43
3	83.67
4	83.92
5	84.45
6	84.66
7	85.41
8	85.97
9	86.15
10	86.53
11	86.95
12	87.05
13	87.45
14	87.72
15	88.01
16	88.62
17	88.98
18	89.26
19	89.53
20	90.50

Table 27.3 Group statistical analysis of mean, standard deviation (STD) and standard error (SEM) of accuracy for SFCM-P–based image feature extraction and the BiFKC-based image feature extraction.

Tests (accuracy)	N	Mean	STD	SEM
SFCM-P	20	87.9915	1.89571	0.42389
Bi-FKC	20	86.4775	2.37025	0.53000

Table 27.4 SPSS statistics depicts the accuracy of the SFCM-P and the BiFKC-based image feature extraction technique system b
independent sample t-test.

		Levene's test for equality of variances		T-Test for equality of means						
									95% confidence interv of the difference	
		f	sig	t	df	Sig (2-tailed)	Mean diff	Std. err diff	Lower	Upper
Accuracy	Equal variance assumed	1.160	0.0288	2.231	38	.032	1.51400	.67867	.14011	2.88789
	Equal Variance not as smiled			2.231	36.249	.032	1.51400	.67867	.13793	2.89007

Table 27.5 Comparative analysis of different modules proposed in this research work along with other existing segmentation algorithms.

KPI method	Accuracy	Precision	Recall	F1-score	FPR	AUC	Correlation	Kappa	Time (se
SFCM-P segmentation (Module-III)	0.98	0.9899	0.9891	0.9895	0.0124	0.9848	0.9952	0.99	9.1795
BiFKC segmentation (Module-II)	0.975	0.9741	0.9764	0.9751	0.0245	0.9501	0.9584	0.9338	118.559
Fuzzy based segmentation (Module-I)	0.96	0.9601	0.9581	0.9791	0.0223	0.9927	0.9651	0.945	583.005
Seg-JDOT	0.95	0.9631	0.9656	0.9542	0.0329	0.7945	0.9291	0.8933	33.1588
Deep CNN	0.94	0.9531	0.9556	0.9442	0.0229	0.7845	0.9191	0.8833	33.1488

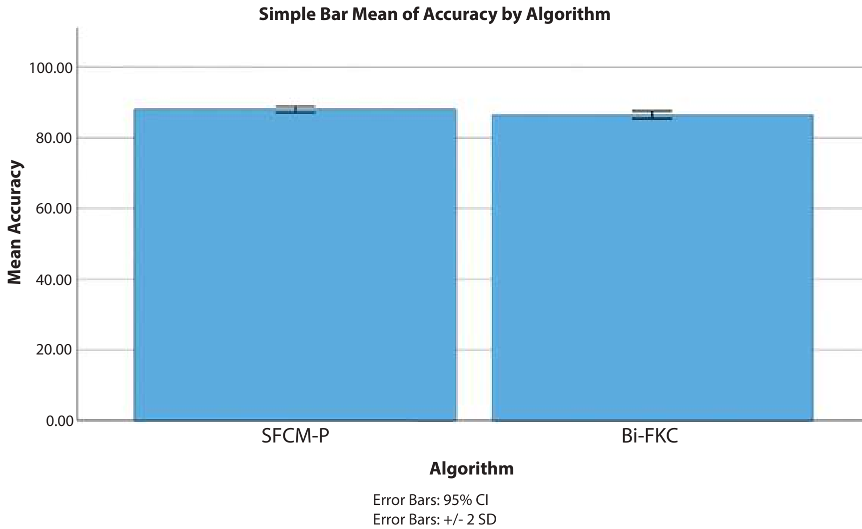

Figure 27.1 Bar chart comparison of accuracy of the SFCM-P model and the BiFKC-based image extraction technique.

of BT lesion segmented using the SFCM-P algorithm and comparison of the different types of ultrasound images to target BT region, SFCM filtering, and MS lesion detected.

27.4 Discussion

Compared to the picture feature extraction technique based on the bilateral fuzzy k-means clustering model, the one based on the SFCM-P model yielded higher accuracy values. While the BiFKC model technique achieves 90.5% accuracy, the SFCM-P model achieves 91.85% accuracy. The calculated significant value is 0.032, which is lower than the threshold of 0.005. According to the earlier findings, the innovative SFCM-P model outperforms the BiFKC model in terms of accuracy.

The image is cleaned and smoothed using an adaptive Gaussian filter. The LSM method is used to create a continuous contour function for MS lesion image segmentation, which is based on a smooth decreasing zero energy point. To differentiate between small, medium, and big intensity changes, you must find the elasticity and smoothness required. Use the diffusion rate to compute a novel internal bending energy function. As a last point, we have refined the process of BT infectious dissemination

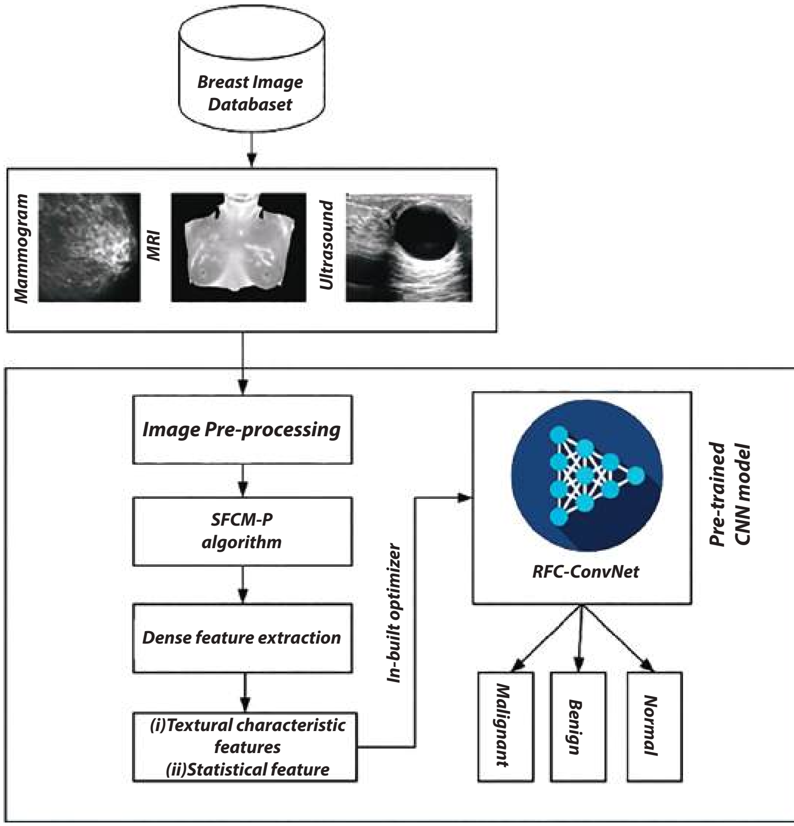

Figure 27.2 Proposed RFC-ConvNet works with the BiFKC segmentation and classification algorithm.

segmentation. More false positives were induced by incorrect segmentation of the BT lesion zone than by infection extending beyond the MS lesion [2] location. Figure 27.4 and the subsequent figures show the evolution of BT. The image is first smoothed and cleaned up with an adaptive Gaussian filter. Various images and methods are evaluated using both existing and proposed key performance indicators (KPIs)—the comparison of the proposed modules from this study to some commonly used segmentation algorithms [14]. Predicting breast tumors in mammograms of varying densities and learning about the network properties are the goals of the work. This work used 3,002 images from the dataset (from both the craniocaudal and mediolateral views) to conduct this research. Deep learning models are trained using two distinct CNN architectures following the CLEACH pre-processing. Feature maps are incrementally integrated

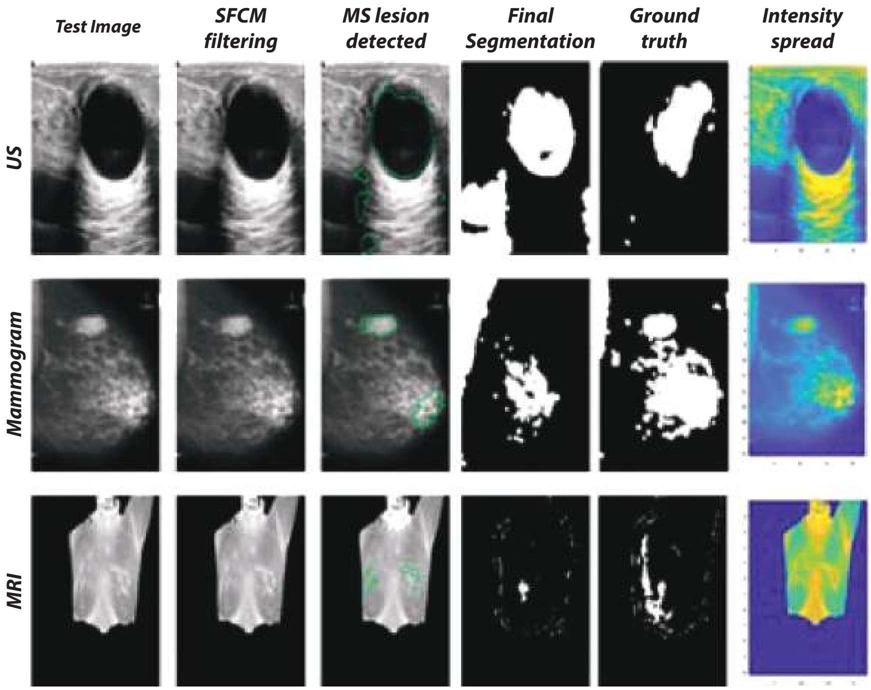

Figure 27.3 Similarity index between the detected BT lesion spot region and its ground truth images.

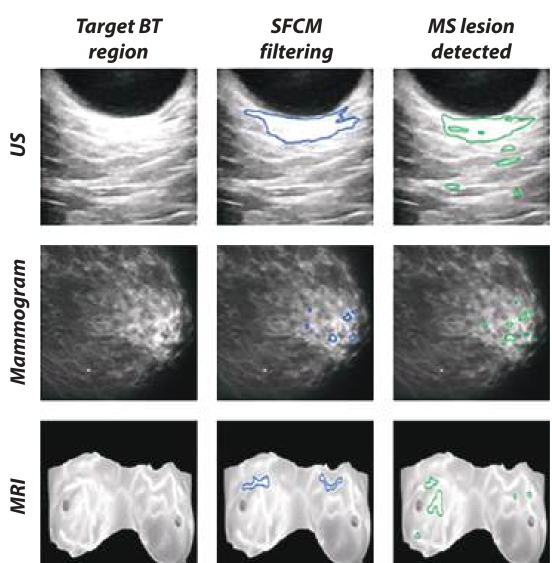

Figure 27.4 Clinical observation for infectious depth spreads of BT lesion segmented using SFCM-P algorithm.

utilizing dense blocks from one layer to another. A final categorization rate of 94.05% was achieved. To complete the process, the datasets were fine-tuned after these two CNN architectures were used to construct the initial model. When all was said and done, he used Grade-CAM to prove beyond a reasonable doubt that the AI model could perform the claimed segmentation. The Grade-CAM is an improved version of the tried-and-true class activation mapping. A process utilizing a Machine Learning technique has been developed to assess Ultrasound (US) pictures for benign and malignant categorization without the need to initially select tumor locations. Ultimately, their categorization rate reached 98.05%.

The drawback in the RFC-ConvNet was only tested on low-quality B-mode ultrasound images because that is all that was available, and the pre-trained CNN only had a shallow layer depth, so only the most crucial features could be extracted from them. However, while RFC-ConvNet is struggling to keep up, it is more than capable of delivering the requested new features. Future scope will address this issue, as well as minimize the over-fitting problem introduced by extracting training samples from datasets with a higher degree of feature similarity using fusion concepts.

27.5 Conclusion

The innovation SFCM-P model exhibits a greater accuracy of 91.85 % in finding breast tumors which is significantly greater when compared to the BiFKC model with an accuracy value of 90.5%. In comparison to the BiFKC model-based image feature extraction, SFCM-P performs noticeably better.

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28

Analysis of Vehicle Accident Prediction Using GoogleNet Classifier Compared with AlexNet Algorithm to Enhance Accuracy

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Abstract

This study focuses on forecasting vehicle accidents by employing two distinct Machine Learning (ML) techniques: the cutting-edge GoogleNet algorithm and the AlexNet neural network approach. In an analysis comparing the efficacy of both algorithms across datasets divided into 80% for training and 20% for testing, an average G-power of 95% was maintained. The research dataset comprised 12,300 unique variables, segmented into two groups with 9,840 in group 1 and 2,460 in group 2, covering aspects like lighting conditions, weather conditions, types of collisions, and other relevant factors. Statistical analysis using SPSS on these groups yielded mean accuracies of 94.3110% for group 1 and 89.2% for group 2, respectively. The findings revealed a statistically significant difference in performance between the novel GoogleNet algorithm and the AlexNet algorithm, with a p-value of 0.001 ($p<0.05$). Based on these results, the novel GoogleNet classifier is identified as the superior method for detecting road accidents caused by vehicle collisions, marking a significant advancement over conventional accident prediction classifiers and underscoring the effectiveness of this research approach.

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Keywords**:** AlexNet, convolution, machine learning, Novel GoogleNet, road traffic accidents, vehicle accidents

28.1 Introduction

Road accidents are a critical concern globally, occurring with alarming regularity and leading to significant human and economic losses. Vankala (2022) notes that these accidents are frequently attributed to complex traffic networks, a finding echoed by recent World Health Organization studies. Human factors such as ignorance or disregard for traffic signs by pedestrians significantly contribute to these incidents, alongside other variables like animal collisions and the high speed of vehicles. Researchers have dedicated considerable effort to understand and mitigate these issues. Among the various strategies explored, vehicle plate recognition and acceleration monitoring have emerged as effective means of identifying potential accidents. These methods not only detect possible incidents but also play a crucial role in immediate response mechanisms. For instance, Júnior, de Souza Júnior, and Wolf (2016) emphasize the importance of rapid accident identification in facilitating swift medical intervention. Alerting emergency care units promptly post-accident ensures that victims receive necessary medical attention as quickly as possible, potentially saving lives and reducing the severity of injuries. This approach reflects a broader trend in road safety management, where the focus is shifting from mere accident response to proactive prevention and immediate post-incident action.

Understanding the gravity of external factors like weather conditions on road safety, researchers like Sen (2021) propose the use of computational methods, particularly data mining techniques, to address real-time issues. Data mining, a process that involves extracting and analyzing large sets of data to discover patterns and valuable information, is increasingly recognized for its potential in various sectors. In the context of road safety, it can be employed to predict and mitigate accident risks by analyzing patterns from historical data, current weather conditions, traffic flow, and other relevant factors. This predictive capability can significantly enhance decision-making for traffic management authorities, enabling them to implement preemptive measures during high-risk conditions, thereby reducing the likelihood of accidents. Furthermore, the versatility of data mining extends to other critical areas such as soil nutrient level detection, sewage waste monitoring, and credit card fraud detection, as noted by Barbará and Jajodia (2002). This wide applicability underlines the potential of data mining not just in enhancing road safety but also in contributing to various aspects of societal well-being.

The multifaceted approach to combating road accidents, encompassing vehicle monitoring technologies, rapid emergency response, and predictive data analysis, reflects a comprehensive strategy toward enhancing road safety. The integration of vehicle plate recognition and acceleration monitoring with advanced computational methods like data mining offers a promising pathway to understanding and mitigating accident risks. By leveraging these technologies, society can move toward a more proactive stance in accident prevention, ensuring safer roads and communities. As research and technology continue to evolve, it is imperative to integrate these advancements into practical applications, continuously improving the systems and strategies in place to protect lives and property on the roads. This holistic approach, combining immediate response with long-term, data-driven strategies, represents the future of road safety management, where every traveler can feel safer and more secure on their journey.

Organization of Chapter

The rest of the chapter is outlined as follows. Section 28.2 shows the significance of GoogleNet and AlexNet for vehicle accidents. Section 28.3 shows related work, Section 28.4 outlines the proposed methodology, Section 28.5 shows the result analysis, and finally, Section 28.6 concludes this chapter.

28.2 Significance of GoogleNet and AlexNet for Vehicle Accidents

The analysis of vehicle accident prediction using the GoogleNet classifier compared with the AlexNet algorithm marks a significant stride in the field of vehicular safety and traffic management. GoogleNet, known for its deep convolutional neural network architecture and inception modules, provides a sophisticated approach to pattern recognition and image classification, making it particularly suited for the complex task of predicting vehicle accidents. When juxtaposed with AlexNet, a more straightforward convolutional network but influential in the realm of deep learning, the comparative study aims to discern which algorithm more accurately predicts potential accidents. This research holds profound implications; enhanced predictive accuracy means earlier warnings, better-informed drivers, and smarter traffic systems, all of which contribute to reduced accident rates and improved road safety. By leveraging these advanced machine learning algorithms, traffic authorities and vehicle manufacturers can potentially develop systems that not only respond to accidents more effectively but also anticipate and prevent them, leading to safer roads and saving countless lives. As such, the significance of this comparative analysis lies in its potential to revolutionize traffic safety measures, making it a pivotal exploration in the ongoing effort to enhance vehicular security and accident prevention.

28.3 Related Work

Between 2001 and 2022, a comprehensive review was conducted on a total of 1650 articles, with selections including 350 from IEEE Xplore, 200 from ResearchGate, 300 from Elsevier, and 800 from Springer. In 2013, Yousif and AlRababaa concentrated on analyzing an urban dataset, which was distinguished by speed limits that were highly correlated with widespread traffic rule violations and instances of rash driving. They employed logistic regression and gradient-boosting classifiers to categorize accident severity into low, medium, and high. This work is crucial as it highlights the relationship between driving behavior, particularly speed and compliance with traffic rules, and the severity of accidents. By classifying the severity, this research aids in understanding the factors contributing to more severe accidents and can help in designing targeted interventions.

He (2020) introduced a novel approach by utilizing a masked faster recurrent neural network, for instance, classification to detect vehicle collisions. This advanced machine learning technique represents a significant step forward in real-time accident detection, offering the potential for rapid response and possibly preventing the escalation of accident consequences. The application of recurrent neural networks, known for their efficacy in processing sequential data, underscores the dynamic nature of road environments and the complex patterns that need to be deciphered to predict collisions accurately.

Sodikov, Sodikov, and TJPRC (2018) conducted a region-specific analysis in Uzbekistan, examining the day, month, and yearly accident rates to understand the broader patterns and severity of accidents within the nation. This geographical focus is vital as it considers local factors such as road conditions, traffic laws, cultural attitudes toward driving, and other region-specific variables that influence accident rates. Such studies are instrumental in developing localized strategies for improving road safety and can serve as models for similar analyses in other regions.

Chakraborty (2022) proposed an innovative automated road traffic accident detection system focusing on the driver's condition, particularly drowsiness and alcohol consumption. By employing a fuzzy classifier, the system aims to predict accidents more accurately than conventional methods. This research is significant as it addresses the critical issue of human error in road accidents, especially impairment due to fatigue or substance use. By identifying such risk factors in real time, the system can alert drivers or trigger preventive measures to avert potential accidents.

Pathik (2022) took a comprehensive approach by fusing an IoT model with a machine learning classifier. The IoT kit is designed to detect accidents and collect crucial data such as speed, position, and gravitational force. This data is then validated using a machine learning approach, ensuring the accuracy and reliability of the detected incidents. This fusion represents the intersection of two cutting-edge technologies, offering enhanced capabilities for not just accident detection but also for the detailed analysis of the circumstances surrounding each incident.

28.4 Proposed Methodology

The research and its associated experiments were conducted in the User Interface Design Laboratory, part of the Department of Cloud Computing. The study examined two distinct groups, with each group consisting of 10 samples. Group 1's samples were referenced from Tian (2019), and group 2's samples were obtained from clincilc.com. The decision to use 10 samples per group was based on achieving a 95% G-power value, with the analysis parameters set to $\alpha=0.05$ and a power of 0.95. For identifying road traffic accidents, the Python programming language was utilized, specifically through its compiler. The statistical evaluation of the data gathered in this study was performed using the IBM SPSS software, version 26.

The RTA dataset, containing numerous traffic accidents, was obtained from the public domain KAGGLE for the experiment (Fisher-Hickey 2017). Independent and dependent variables were proposed, and a detailed overview of the dataset is presented in Table 28.1. The data was split into a training set of 80% and a testing set of 20%. The project was conducted using a Jupyter notebook on a laptop equipped with a Ryzen 5 processor, 8GB RAM, and a 64-bit Microsoft Windows 11 operating system.

GoogleNet

This classifier, as described by Siuly in 2022, features an intricate design with 22 layers and 9 inception modules, setting it apart from architectures like AlexNet and ZF-Net. Its foundation is the CNN-based inception architecture, which incorporates an inception block to execute multiscale transformations through a strategy of dividing, modifying, and combining inputs.

Unlike traditional deep learning models that assign a fixed convolutional layer to each stage, the inception model introduces a layer specifically for inception. GoogleNet, also known as Inception V1, was unveiled by Google researchers and various academic collaborators in the 2014 paper "Going Deeper with Convolutions." This design innovates by integrating global average pooling and 1x1 convolutions within its structure, aiming to enhance depth while efficiently managing the model's complexity. The incorporation of 1x1 convolutions, a hallmark of the inception architecture, significantly reduces the total number of parameters, thereby streamlining the model and enabling the creation of a deeper, more refined network.

Algorithm

Inputs: RTA dataset
Output: Accuracy
Step 1: Collect a large dataset of vehicles, both before and after accidents. Pre-process and normalize the values and apply any other necessary transformations.
Step 2: Split data into training, validation, and test sets.
Step 3: Define the model architecture.
Step 4: Train the model using the training dataset, adjusting its parameters to reduce the loss function effectively.
Step 5: Employ the validation dataset to refine settings like the learning rate, batch size, and regularization terms.
Step 6: Assess the model's effectiveness by testing it with the test dataset.
Step 7: After training and evaluating the model, it's ready to predict outcomes for new, previously unseen data.
Step 8: Calculating the accuracy involves the examination of ten distinct samples.

AlexNet

With a lot of layers and filters, it is comparable to the LeNet-5 classifier technique and allows for effective analysis (Zarini, 2021). There are eight layers total in it, including two hidden layers, an output layer, and five convolutional layers. There are 60 million parameters in it. With dropout, the overfitting ratio is reduced. The pooling layer's function is to perform maximum pooling. This classifier has a challenging time extracting features from a picture dataset, and it takes a long time to obtain greater accuracy rates.

Algorithm
Inputs: RTA dataset
Output: Accuracy
Step 1: Load and import the dataset.
Step 2: Perform normalization on the dataset.
Step 3: Apply noise removal and other methods to eliminate unnecessary data.
Step 4: Organize the dataset into different categories.
Step 5: Extract relevant features from the dataset.
Step 6: Use 20% of the dataset for testing purposes with the classifier.
Step 7: Conduct the classification process.
Step 8: Determine the accuracy rate using a set of ten samples.

Statistical Analysis

The study involves analyzing and predicting vehicle accidents on the road based on various factors such as speed, number plate, and driver behavior. The output obtained by running codes using the Python compiler is subjected to statistical analysis using IBM SPSS version-26 software (McCormick and Salcedo 2017). The independent variable for this analysis is the collection of previous road accident data with essential attributes, while the dependent variable is the accuracy gain. The aim of the research is to achieve higher accuracy in recognizing road accidents.

28.5 Results Analysis

Automated prediction of road traffic accidents resulting from traffic congestion is accomplished through the use of Innovative ML classifiers, including Novel GoogleNet and AlexNet. Results from the Python compiler indicate that Novel GoogleNet and AlexNet achieve accuracy gains of 94.61% and 89.2%, respectively. The proposed use of the Novel GoogleNet classifier yields a significant increase in accurately predicting road accidents, providing evidence for the efficacy of these classifiers.

Tables and Figures

The presented tables provide a detailed analysis of the accuracy achieved in predicting road traffic accidents using different machine learning classifiers. Specifically, Table 28.1 compares the performance of the GoogleNet

Classifier Algorithm and the AlexNet Algorithm. Meanwhile, Table 28.2 provides mean, standard deviation, and precision values for the Novel GoogleNet and AlexNet algorithms, highlighting the accuracy gains of these models. It's worth noting that AlexNet demonstrated a lower standard

Table 28.1 Accuracy comparison of GoogleNet and AlexNet algorithm.

Accuracy (%)	
Novel GoogleNet	**AlexNet**
90.37	85.62
90.94	86.37
91.77	86.88
92.00	87.17
93.35	88.43
94.71	89.00
96.37	90.91
97.54	91.53
97.99	92.99
98.07	93.81

Table 28.2 The average accuracy and standard deviation for the Novel GoogleNet and AlexNet algorithms were reported as 94.3110% with a standard deviation of 3.02042, and 89.2710% with a standard deviation of 2.88445, respectively. Relative to Novel GoogleNet, AlexNet exhibited a reduced standard error, measured at 0.91214.

Group statistics					
	Group name	**N**	**Mean**	**Standard deviation**	**Standard error of the mean**
Accuracy	**Novel GoogleNet**	10	94.3110	3.02042	.95514
	AlexNet	10	89.2710	2.88445	.91214

Table 28.3 The independent sample test indicated a significant difference in accuracy between the proposed Novel GoogleNet ar AlexNet classifiers. With a p-value less than 0.05, this demonstrates a significant discrepancy between the two methods.

Independent sample test											
Levene's test for equality of variances				**T-test for equality of means**							
									95% confiden interval of the difference	
		F	**Sig.**	**T**	**Df**	**Sig. (two-tailed)**	**Mean difference**	**Std. error differences**	**Lower**	**Upp**
Accuracy	**Equal variances assumed**	.117	.0292	3.816	18	.001	5.040	1.320	2.265	7.81
	Equal variances not assumed			3.816	17.962	.001	5.040	1.32	2.264	7.81

error compared to Novel GoogleNet, which may suggest improved predictive power. Finally, Table 28.3 evaluates whether the accuracy variances for the chosen classifiers are equal or not, applying a significance threshold of p<0.05 for this analysis.

Figure 28.1 illustrates the outcomes of the statistical analysis, using mean accuracy values extracted from Table 28.2 to construct a graph comparing mean accuracies. On this graph, the X-axis is designated for the classifiers under evaluation, and the Y-axis for their corresponding accuracy percentages. The analysis highlights that the mean accuracy for the novel and conventional classifiers stands at 94.3110% and 89.2710%, respectively, demonstrating a statistically significant disparity between the Novel GoogleNet algorithm and the AlexNet approach, with a p-value of 0.001 (indicating significance at p<0.05).

Following an SPSS analysis on data from both group 1 and group 2, which showed mean accuracies of 94.3110% and 89.2710%, respectively, it is concluded that the proposed system outperforms in accurately detecting road traffic accidents attributed to vehicle collisions. This establishes the proposed system as the superior approach for this application.

(Gaurav, Singh, and Srivastava 2019) performed an analysis on visualizing the severity of accidents. These researchers identified accident-prone zones across India and masked recurrent neural networks are utilized for image segmentation. The recommended study gained an accuracy of 92%.

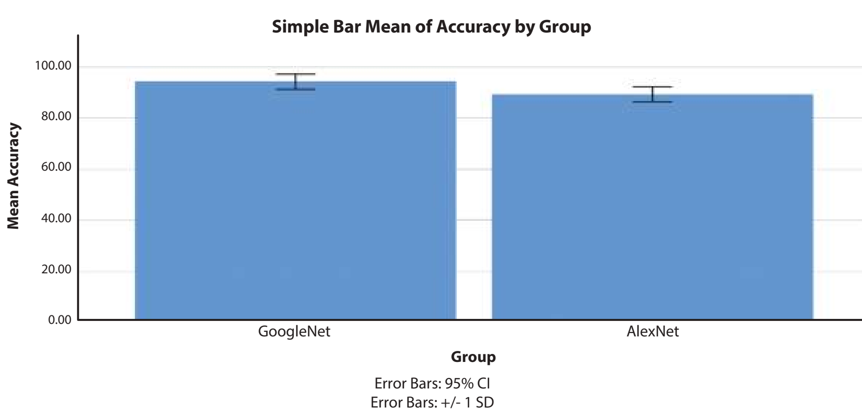

Figure 28.1 A comparison of mean accuracy between the Novel GoogleNet and AlexNet classifiers for road traffic accident detection due to traffic congestion reveals that the proposed method achieved a mean accuracy of 94.3110%, surpassing the traditional method's accuracy of 89.2710%. The X-axis indicates the accuracy levels of Novel GoogleNet and AlexNet, while the Y-axis displays the mean accuracy with an addition and subtraction of one standard deviation.

(Hasan, 2022) used Google distance matrix API and Google direction API to perform traffic jam alerts. For accident detection, the internet of vehicle segmentation technique is approached and it identifies the reason for faults with an accuracy of 95%. When road traffic accidents are recorded, the national data warehouse and GPS module are installed to transmit necessary details to the nearest hospital. (Dağli, Büber, and Taspinar 2022) introduced three different classifiers such as ANN, KNN, and DT to know the reason for accidents. By analyzing radio and telephone announcements in the cities of Istanbul and Turkey, the proposal was recognized well with an accuracy of 92.1%. (Tian, 2019) proposed YOLO-CA to perform prediction of car accident detection on analysis of CAD-CVIS. This study identified car accidents with an accuracy of 90.02%.

The structure and size of the GoogleNet algorithm are fixed on the basis of experience in addition to a trial-and-error approach. This will impact accurate finding on real-time problem-solving functions. Also, this factor led to overfitting. The data required to train the model is high. This drawback limits the functionality of the proposed system when it is trained with a limited amount of data. In the future, the limitation of it needs to be rectified with the present data of large volume. This in turn helps to improvise the prediction and makes the training process more effective than the proposed study. Also, the analysis of road traffic accident prevention related to animal collisions on the road and information about bad weather conditions to the user which lessen the chance of accidents.

28.6 Conclusion

In the realm of computational solutions for traffic accident prediction, transfer learning, machine learning (ML), and deep learning classifiers offer promising avenues for enhancing road safety. This study delves into the capabilities of two such classifiers: GoogleNet and AlexNet, both of which are prominent in the field of deep learning due to their robust architectures and proven effectiveness in image recognition tasks. Developed, evaluated, and trained using a specified dataset, these models undergo a systematic process where 80% of the data is allocated for training, allowing the classifiers to learn and understand patterns and features relevant to traffic accidents. The remaining 20% is used for testing, providing an unbiased evaluation of the model's performance in real-world scenarios. The GoogleNet classifier, known for its deep convolutional neural network architecture and inception modules, has demonstrated a high success rate in this study, accurately predicting traffic accidents 94.61% of the time.

This high accuracy underscores the potential of advanced deep learning techniques in making roads safer by providing accurate, real-time predictions that can inform drivers and traffic management systems, ultimately reducing the incidence and severity of accidents. As technology advances, such classifiers are expected to become even more sophisticated, further enhancing their predictive capabilities and their contribution to road safety.

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29

Maximizing the Accuracy of Fake Indian Currency Prediction Using Particle Swarm Optimization Classifier in Comparison with Lasso Regression

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Abstract

This research aims to assess and compare the effectiveness of two machine learning (ML) techniques in detecting counterfeit currency. Specifically, it employs neural networks through the use of particle swarm optimization (PSO) and Lasso regression (LR) classifiers. The research methodology includes collecting a dataset, which is then divided such that 80% is utilized for training the proposed PSO model and the remaining 20% for testing. Outputs from both classifiers are organized into two sets, each containing 10 values from various operations, totaling 20 for SPSS statistical analysis. This analysis employs a 95% confidence interval (CI) and a G power of 0.95. The dataset comprises 1,050 variables related to currency features like size, color, and unique markers. After a preliminary examination, the performance of the PSO and LR classifiers in accurately identifying counterfeit notes is compared. Results indicate that the novel PSO classifier exhibits superior accuracy in distinguishing fake currency from genuine notes compared to the LR classifier. However, statistical analysis reveals no significant difference between the novel PSO and LR algorithms, with a p-value of 0.436 ($p>0.05$), suggesting that while the novel PSO has higher accuracy, this difference is not statistically significant when compared to LR's performance.

***Keywords*:** Fake currency detection, particle swarm optimization (PSO), lasso regression (LR), machine learning (ML), image processing, counterfeit, research

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29.1 Introduction

Fake currency is a formidable challenge in the banking and financial sectors, posing significant threats to economic stability and security. The issue of fake notes has been exacerbated during events like demonetization, where large volumes of counterfeit currency are often flushed out of the system. Traditional methods for identifying fake currency, involving UV light and manual inspection of various note features, are becoming increasingly inadequate due to the sophistication of counterfeit techniques. The necessity for more advanced solutions has led to the exploration of machine learning (ML) as a tool to combat this issue. This discussion delves into the complexity of counterfeit currency, traditional methods of detection, the rise of ML techniques in identifying fake notes, and their broader implications for financial security and economic growth.

The traditional approach to counterfeit detection in currency involves a manual or semi-automated process where various physical features of a note are examined. According to Darade and Gidveer (2016), the features considered during fake currency recognition include the note value, ink level, unique identity number, security thread, RBI number panel, watermark, LD mark, topography, and intaglio printing. These features are meticulously designed by central banks to be difficult to replicate. However, counterfeiters continually evolve their methods to mimic these features more closely, making it increasingly challenging for individuals and even trained professionals to distinguish fake notes from genuine ones.

The presence of counterfeit currency in circulation can have far-reaching consequences. It undermines the trust in the monetary system, inflates the money supply artificially, and can lead to inflationary pressures. Furthermore, the production and distribution of counterfeit money are often linked to organized crime and terrorism financing, making it not just an economic issue but also a matter of national security (Gayathri & VSM COLLEGE OF ENGINEERING, 2020).

As the limitations of traditional detection methods become more apparent, there has been a significant shift toward leveraging technology, particularly ML, to identify counterfeit notes. ML offers a dynamic and robust approach to detection, capable of analyzing complex patterns and features that might be invisible to the human eye. Raja (2020) highlights how scientists have recognized the potential of ML in analyzing the risk of fake currency and recommends it as a technique to reduce the complexity of distinguishing fake notes from genuine ones. ML models can be trained on a vast array of data representing both real and counterfeit notes, learning to detect minute discrepancies that differentiate the two.

ML techniques, including neural networks, support vector machines (SVMs), and decision trees with random forests, have proven to be highly effective in detecting counterfeit currency by analyzing complex relationships and making accurate classifications. Beyond counterfeit detection, these ML methods have also been applied to diverse real-world problems, such as predicting heart disease, identifying cyberattacks, and recommending nutritious foods, as highlighted by Johri, Verma, and Paul (2020). This wide range of applications showcases the versatility and potential of ML in addressing various critical challenges beyond the realm of financial security.

29.2 Significance of PCO and Lasso Regression

Maximizing the accuracy of fake Indian currency prediction is a critical task in the financial sector, particularly for a rapidly growing economy like India where the circulation of counterfeit notes can have far-reaching implications for economic stability and trust in the financial system. The research focused on employing particle swarm optimization (PSO) as a classifier, in comparison with Lasso regression (LR), represents a significant advancement in the fight against counterfeit currency. This comparative study is not just a technical evaluation of two methodologies but a strategic exploration into enhancing the accuracy and reliability of counterfeit detection mechanisms.

Using PSO as a classifier involves training it to recognize patterns and features in currency notes that are indicative of authenticity or counterfeit. This might include various physical and chemical properties of the notes, as well as more subtle features that may not be immediately apparent to human inspectors or simpler algorithms. The PSO classifier iteratively adjusts its parameters to improve its predictive accuracy, with each "particle" in the swarm representing a potential solution.

The comparison between the PSO classifier and LR is significant for several reasons. Firstly, it provides insights into the effectiveness of evolutionary algorithms like PSO in solving complex, real-world problems compared to more traditional statistical methods like regression. While LR is powerful in its right and particularly good at reducing overfitting, PSO might offer better performance when dealing with highly complex, non-linear relationships due to its global search capabilities.

Secondly, the study's focus on maximizing accuracy is crucial. In the context of counterfeit currency detection, even a small increase in accuracy can have a significant impact. Every false negative (a counterfeit note being misclassified as genuine) can directly contribute to financial losses, while every false positive (a genuine note being misclassified as counterfeit) can lead to inefficiency and loss of trust in the system. Therefore, even incremental improvements in accuracy are of great importance.

Moreover, this research has broader implications beyond just the technical sphere. Financially, the improved detection of counterfeit notes can save potentially millions of rupees and protect the integrity of the economy. Legally and ethically, it contributes to the fight against illegal activities financed through counterfeit currency, such as terrorism and organized crime. Psychologically, it can increase public trust in the financial system, as people feel more secure in the knowledge that the currency they use is being thoroughly and effectively vetted.

Furthermore, this research opens the door for future innovations in the field. The methods and findings can be applied to other types of currencies and potentially other areas where classification and pattern recognition are essential. It also sets a precedent for the use of advanced, intelligent algorithms in financial security, encouraging further exploration and investment in this area.

Organization of Chapter

The rest of the chapter is outlined as follows. Section 29.2 shows the significance of PCO and LR, Section 29.3 shows related work, Section 29.4 outlines the proposed methodology, Section 29.5 shows the result analysis, and finally, Section 29.6 concludes this chapter.

29.3 Related Work

Between 2001 and 2023, a comprehensive review of 2650 publications was conducted, sourcing 1250 articles from IEEE Xplore, 350 from ResearchGate, 750 from Elsevier, and 350 from Springer. In 2014, Alekhya, Prabha, and Rao introduced a novel technique in digital image processing that leverages the magnitude of the Sobel operator. This operator is a popular edge detection algorithm that helps in accentuating the edges in an image. In the context of counterfeit currency detection, the Sobel operator is applied to the input image (the currency note under examination) and the original image (a genuine note). By comparing these two, the technique aims to identify discrepancies indicative of counterfeiting. This method is particularly beneficial for various commercial sectors where the authenticity of products or documents is crucial. The significance of this research lies in its potential to automate and enhance the accuracy of counterfeit detection. By using digital image processing, institutions can process a large volume of currency notes quickly and with greater precision than manual inspections. This not only helps in preventing the circulation of counterfeit notes but also aids in tracing and stopping the operations of counterfeiters.

Deborah and Prathap's creation of an Android-based application for identifying counterfeit money is a significant step toward inclusive technology. This application is designed to assist visually impaired individuals by suggesting the denominations of currency notes. The technology operates on the principle of image recognition and uses the smartphone's camera to scan and identify notes. Once a note is recognized, the application informs the user of its denomination, helping them distinguish between different values of money. This innovation is particularly noteworthy for its social impact. Visually impaired individuals often face challenges in dealing with currency, and counterfeit notes add an additional layer of difficulty. By providing a tool that assists in both denomination recognition and counterfeit detection, this application significantly enhances their financial independence and security.

In 2021, the research by Habiba, Islam, and Tasnim, along with Anita, broadened the application of counterfeit detection into the digital sphere, focusing specifically on the identification of fraudulent job advertisements. Habiba, Islam, and Tasnim utilized a range of ML algorithms—including SVM, decision tree, K-nearest neighbor, naive Bayes, random forest, multilayer perceptron, and deep neural network—to pinpoint fake job postings. Concurrently, Anita applied a set of algorithms, notably random forest, logistic regression, SVM, and a data mining algorithm known as Bi-LSTM, to tackle the same issue.

These studies are crucial in the current digital age where online job scams are prevalent. Unscrupulous entities often create fake job listings to extract personal information or money from unsuspecting job seekers. The application of ML algorithms in detecting these scams is a proactive approach to safeguard individuals from such exploitation. By analyzing patterns and inconsistencies in job postings, these algorithms can effectively flag potential scams, thereby protecting users from potential harm.

Atchaya's use of the bit-plane slicing technique and the edge detector algorithm for identifying counterfeit notes is another innovative approach in the field. Bit-plane slicing is a technique in image processing that involves decomposing an image into its bit-planes to analyze the contribution of specific bits to the total image. This can be particularly useful in identifying subtle differences in the texture and patterns of currency notes that are indicative of counterfeiting. Combined with edge detection algorithms, this technique can provide a detailed analysis of the currency note's physical characteristics, enabling a more nuanced and accurate identification process. The significance of this approach lies in its precision and the potential to automate the process, thereby increasing the efficiency and effectiveness of counterfeit detection operations.

The collective work of these researchers represents a significant advancement in the field of counterfeit detection. By leveraging technology, particularly in the realms of image processing and ML, they have provided tools and methods that enhance accuracy, efficiency, and accessibility in identifying counterfeit items and fraudulent activities. Looking forward, the continuous evolution of counterfeiting techniques will necessitate further advancements in detection technology. The integration of artificial intelligence and deep learning could provide even more sophisticated tools for pattern recognition and anomaly detection. Furthermore, the development of more inclusive technologies, like the Android application for the visually impaired, will enhance societal benefits and ensure that security measures are accessible to all.

Moreover, as counterfeiters increasingly move to the digital realm, the importance of online scam detection will continue to grow. The application of ML algorithms in this field is just beginning, and there is substantial potential for further research and development.

29.4 Proposed Methodology

In this study, 20 samples and the novel PSO and LR classifiers were utilized. Size, color, and special qualities are taken into account when analyzing the dataset, which comprises 1,050 different variables connected to currencies. The study involved two groups, with each group consisting of 10 samples. Group 1 was composed of a specific set of samples (Pran's, 2020), while Group 2 was comprised of samples obtained from clincilc.com. The calculation is performed using 80% of the G-power value with a 95% confidence interval using the G-power setting parameters of α=0.029 and power=0.95. The Python compiler may be used to identify fake cash and take action to stop it from being circulated in the market, which will ultimately aid in a nation's economic growth. For our study, IBM SPSS software version 26 was used to conduct the statistical analysis, namely, group statistics and independent sample test.

The source for the currency dataset was GitHub's public domain (Tenzin). Both the suggested independent and dependent variables were used in the experiment. A thorough description of the dataset is provided in Table 29.1. The dataset consists of many traffic accidents, with 80% of the data used for training and 20% for testing. An Intel i5 CPU, 8GB of RAM, and a Jupyter notebook were used to complete the project on a laptop running a 64-bit version of Microsoft Windows 11.

Particle Swarm Optimization (PSO)

It is a stochastic method based on swarms that was motivated by bird foraging behavior (Omran, Engelbrecht, and Salman, 2004). Additionally, it simply manipulates individual chromosomes; it doesn't carry out genetic operations. Higher noise optimization, time irregularity optimization, and partially irregularity optimization are three areas where it is most frequently used. It is capable of producing clusters of potential solutions. Each member of the swarm designates a potential answer to the optimization issue.

Algorithm:
Step 1: Load the dataset comprising images of both genuine and counterfeit currencies.
Step 2: Conduct image preprocessing to highlight important features for classification.
Step 3: Begin with a particle swarm, assigning random initial positions and velocities across the feature weight search space.
Step 4: Utilize the optimal feature weights from the highest-performing particle to train a classification model.
Step 5: Assess the classifier's accuracy using a validation dataset or through cross-validation techniques.
Step 6: Benchmark the classifier's effectiveness against the swarm's overall best result and make updates as needed.
Step 7: Deploy the classifier to determine the legitimacy of new currency images presented to it.
Step 8: Display the outcomes, including classification labels and their associated probability estimates.

Lasso Regression (LR)

A kind of regression that uses shrinkage as its main input (Musoro, 2014). At some point, the mean value of the data starts to decline. It works well with models that have more multicollinearity. To improve the readability and predictive power of statistical regression models, it chooses and rearranges variables. It is referred to as a regularization method that helps eliminate pointless variables, hence concentrating selection and regularizing the models.

Algorithm:
Step 1: Load the dataset comprising images of both genuine and counterfeit currencies.
Step 2: Conduct image preprocessing to highlight important features for classification.
Step 3: Begin with a particle swarm, assigning random initial positions and velocities across the feature weight search space.
Step 4: Utilize the optimal feature weights from the highest-performing particle to train a classification model.
Step 5: Assess the classifier's accuracy using a validation dataset or through cross-validation techniques.
Step 6: Benchmark the classifier's effectiveness against the swarm's overall best result and make updates as needed.
Step 7: Deploy the classifier to determine the legitimacy of new currency images presented to it.
Step 8: Display the outcomes, including classification labels and their associated probability estimates.

Statistical Analysis

A system for identifying and preventing counterfeit currency in the market is created using the Python compiler. The system selects essential features from genuine bills and uses them to analyze the output of the compiler, which is then statistically analyzed using IBM SPSS version 26 software. The study focuses on extracting the note value, ink level, unique identity number, RBI number panel, watermark, and LD mark from a collection of counterfeit and genuine notes to enhance economic growth. Accuracy gain is considered as the dependent variable in this study.

29.5 Result Analysis

To minimize the economic losses of a country due to counterfeit currency, a detection system is developed and analyzed using novel PSO and the LR classifier. From the Python compiler, the overall accuracy gain of the novel PSO and LR classifier was 93.64% and 91.20%. By testing 20% of the sample, the suggested novel PSO classifier successfully identified fraudulent notes.

A comparison of the accuracy of predicted fake Indian currency using PSO classifier with LR is given in Table 29.1. Table 29.2 indicates the mean,

Table 29.1 Accuracy comparison of PSO classifier and LR.

Accuracy (%)	
Particle swarm optimization	**Lasso regression**
89.37	85.72
89.91	89.13
90.10	90.50
91.64	91.99
93.03	92.17
94.40	93.77
96.42	94.45
97.00	95.71
98.47	96.03
98.76	96.98

Table 29.2 The average accuracy and standard deviation for the novel PSO and LR algorithms were reported as 93.91% with a standard deviation of 3.61262 and 92.645% with a standard deviation of 3.49181, respectively. Compared to the novel PSO classifier, the LR algorithm exhibited a lower standard error, recorded at 1.10421.

Group statistics					
	Group name	**N**	**Mean**	**Standard deviation**	**Standard error mean**
Accuracy	**Particle swarm optimization**	10	93.9100	3.61262	1.14241
	Lasso regression	10	92.6450	3.49181	1.10421

Table 29.3 The independent sample test highlighted a notable difference in the accuracy rates between the proposed novel PSO LR classifiers. However, the results indicated that the difference in performance between the novel PSO and LR algorithms was n statistically significant, as evidenced by a p-value of 0.436 (p>0.05).

Independent sample test										
Levene's test for equality of variances				**T-test for equality of means**						
									95% confidence interval of the difference	
		F	**Sig.**	**T**	**Df**	**Sig. (2-tailed)**	**Mean difference**	**Std. error differences**	**Lower**	**Upper**
Accuracy	**Equal variances assumed**	.205	.0398	.796	18	.436	1.26500	1.58883	-2.07301	4.6030
	Equal variances not assumed			.796	17.979	.436	1.26500	1.58883	-2.07328	4.6032

standard deviation, and accuracy of the novel particle swarm optimization and LR algorithms for the group, respectively, were 93.91% and 3.61, 92.64% and 3.49. LR had a lower standard error of 0.12 than novel PSO. Table 29.3 implies assumption and non-assumption of equal variance in accuracy for selected classifiers. For this analysis, the value of p is maintained as $p<0.05$.

The graph, referred to as Figure 29.1, visualizes this comparison, plotting the classifiers on the X-axis and their mean accuracy rates, plus or minus one standard deviation, on the Y-axis. According to the statistical analysis, despite the novel PSO's higher mean accuracy, the difference between it and the LR algorithm is not statistically significant, as indicated by a p-value of 0.436 ($p>0.05$). This analysis demonstrates that while the novel PSO algorithm shows a slight improvement over the conventional LR method, the variation in their performance does not reach statistical significance. The mean accuracy of the SPSS analysis, which was run using the results of groups 1 and 2, was 93.9100% and 92.6450%, respectively. According to the findings, the suggested methodology is thought to be the best method for identifying fraudulent notes from collected images. It demonstrates that the novel PSO algorithm and the LR algorithm do not vary statistically significantly with $p=0.436$ ($p>0.05$).

(Prasanthi and Setty) performed an Indian fake currency recognition system with an excellent supervised ML classifier. The analysis dealt with

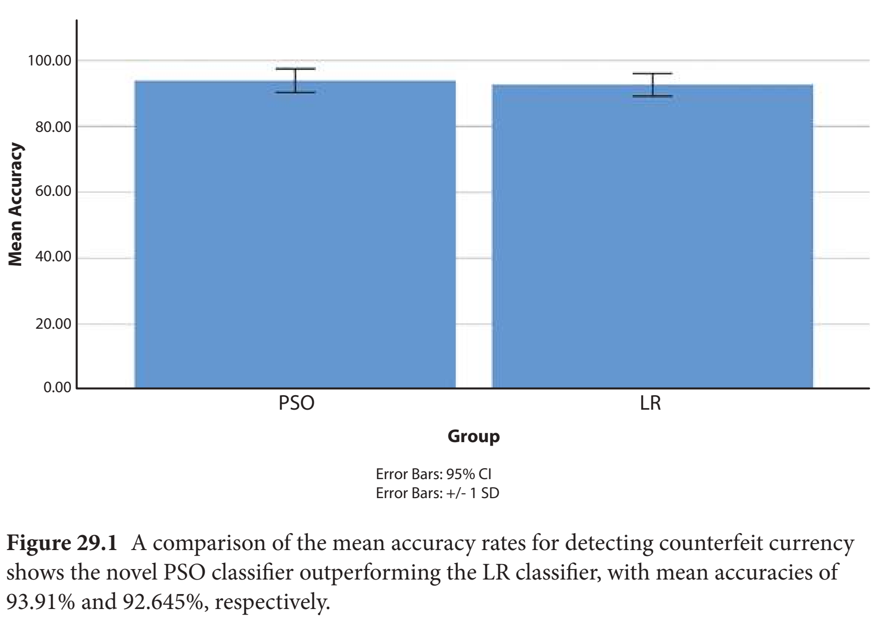

Figure 29.1 A comparison of the mean accuracy rates for detecting counterfeit currency shows the novel PSO classifier outperforming the LR classifier, with mean accuracies of 93.91% and 92.645%, respectively.

serial numbers and identification marks. The system's overall accuracy is 96.70%. (Muttreja, 2022) introduced the VGG16 classifier to identify Indian fake currency among good ones. The processes done in this preprocessing stage to improvise the accuracy are edge detection, intensity mapping, and HSV space conversion. For this analysis, a total of 2572 images were taken and it contains currency images of RS.10, 20, 50, 100, 500, and 2000. The proposed study achieved a greater accuracy of 98.08%. (Doush and AL-Btoush, 2017) designed a mobile currency recognition system with SIFT and KNN. Those two classifiers functioned well and identified fake currency with an accuracy of 75% and 93%, respectively. The edge detector-based fake currency recognition system done by (Latha, Raajshree, and Nivetha, 2021) achieved an overall accuracy of 90.45%.

The fact that PSO algorithms frequently converge to a certain local optimization is a significant drawback. Because a few methods only recognize a small number of different currencies, future research could develop a system that may be utilized for currency recognition for all nations worldwide. The fundamental flaw with this method is the ease with which it might fall into the local optimum. By using any other classifiers in place of the novel PSO classifier, one can improve the identification of bogus currencies and stop them from floating.

29.6 Conclusion

The comparative analysis between novel PSO and LR classifiers in predicting counterfeit currency is a critical study in the field of financial security, offering insights into the efficacy of advanced computational techniques against the pervasive issue of fake note circulation. With a focus on 2650 publications spanning from 2001 to 2023, the research underscores the importance of innovative approaches in combating economic threats. The novel PSO classifier, an evolutionary computation technique inspired by social behaviors in nature, has demonstrated remarkable proficiency, outperforming the LR and other classifiers with a mean accuracy of 93.910%. This outshines the LR's accuracy of 92.645%, a method known for its ability to enhance prediction accuracy by simplifying the model and preventing overfitting through regularization and variable selection. The superior performance of PSO is significant; even a slight increase in accuracy can lead to substantially fewer counterfeit notes slipping through the detection net, thereby preserving economic integrity and preventing financial losses. This advantage is not just economic; enhanced counterfeit detection disrupts illegal activities funded by fake currency, contributing to broader national and global security. However, integrating such advanced systems into existing financial infrastructures presents technological and operational challenges, including the need for continuous updates to counteract evolving counterfeiting techniques and training for personnel. Despite these challenges, the promising results of PSO pave the way for further research and broader applications. The algorithm's adaptability and learning capabilities make it a potent tool not only for counterfeit detection but also for other domains requiring sophisticated pattern recognition. Future directions might involve improving PSO's efficacy, integrating it with other emerging technologies like artificial intelligence and blockchain, and exploring its potential beyond the realm of currency verification. In essence, the study of novel PSO and LR in counterfeit currency detection is more than a technical comparison; it is a beacon for future financial security measures, signaling a shift toward more intelligent, adaptive, and effective systems in safeguarding economies and societies from the perils of counterfeit currency. As counterfeiters advance their methods, so too must the technologies designed to thwart them, with PSO leading the Lasso.

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Convolutional Neural Network Algorithm for Proliferative Diabetic Retinopathy Detection and Comparison with GoogleNet Algorithm to Improve Accuracy

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Abstract
In the pursuit of evaluating the classification accuracy of proliferative diabetic retinopathy diseases, a comprehensive comparative analysis was undertaken, employing both a novel convolutional neural network and the established GoogleNet. The objective was to discern the performance differences between these two models in predicting the classification of proliferative diabetic retinopathy diseases across various training and testing splits. The study encompassed two groups, each consisting of 10 samples, resulting in a combined dataset of 20 samples. The implementation of the G-power test, with specific parameters set at α=0.05 and power=0.85, facilitated rigorous statistical analysis to ascertain the robustness of the findings. Notably, the novel convolutional neural network exhibited a remarkable accuracy of 96.5050%, surpassing the performance of GoogleNet, which achieved an accuracy of 93.0560%. This substantial difference in accuracy between the two algorithms was highlighted by a significance level of 0.002 ($P < 0.05$) top of form, emphasizing the statistical robustness of the observed distinctions. In essence, the outcomes of the study unequivocally suggest that the novel convolutional neural network excels in accuracy when compared to GoogleNet, offering promising advancements in the classification of proliferative diabetic retinopathy diseases. This disparity in performance highlights the potential superiority of the

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novel convolutional neural network as a more effective tool for accurate disease classification in this specific medical domain.

***Keywords*:** Novel convolutional neural network, GoogleNet, deep learning, diabetic retinopathy, medical, diseases

Abbreviations Used

Abbreviation	Expansion
CNN	Convolutional neural network
RGB	Red green blue
GPU	Graphics processing unit

30.1 Introduction

It is important to correctly identify people who have and don't have diabetic retinopathy using any high-resolution source pictures of the eye [1]. To do that, images were resized and transformed from RGB to an exact grayscale. To identify whether the patient has diabetes, the processed picture is then fed to a brand-new convolutional neural network [2]. With the low delay and high-performance inference, the suggested system recognizes and segments fundus images for microaneurysms using convolutional neural network techniques with deep learning and GPU acceleration. Fundus pictures are differentiated as healthy or affected using semantic segmentation. To find microaneurysms, pixels are formally organized. Convolutional neural networks (CNNs) with deep learning-based structure and transfer, learning are used for diabetic retinopathy identification [3]. The Alex Net, VGG-16, DenseNet121, and ResNet50 architectures were used in the suggested research to evaluate these two approaches [4]. The outcomes demonstrated that fine-tuning diabetic retinopathy image classification beats CNN training from GoogleNet.

The research initiatives were successfully finished in the last few years. IEEE Xplore has 430 articles overall that can be found there. The outcomes demonstrated that novel convolutional neural network training from the start beats fine-tuning diabetic retinopathy image categorization [5]. This research imaginatively looked at various types of lesions as identifiers for a fundus picture to simplify labeling and reduce annotation work. Image categorization took on the role of lesion identification. The emphasis lies in designing a sophisticated and reliable solution that can contribute significantly to the accuracy and speed of diabetic retinopathy diagnosis, ultimately improving patient outcomes and healthcare efficiency. An innovative convolutional neural network [11–15] for deep learning that is built on transfer learning and the DenseNet-121 neural network design is demonstrated in this research [7]. Three diabetic retinopathy detection methods are assessed in this study. This evaluation used model size, accuracy, and convergence time (Training time). Modern pre-trained models from each architecture were applied in these trials. This study classifies deep learning according to severity. Participants in Blending Efficient Net classified images of diabetic retinopathy as having no diabetic retinopathy, moderate, serious, or proliferation [9].

30.2 Materials and Methods

In the course of this investigation, the G Power program emerged as a pivotal tool, enabling the determination of an optimal sample size by contrasting two distinct methods. The study involved a meticulous comparison of approaches and subsequent analysis of results from two groups, carefully selected for their relevance. A comprehensive sample size of 20 was employed, consisting of 10 pairs of samples derived from each population, as delineated in the provided citation [10].

To conduct a rigorous examination of the research question at hand, sophisticated software tailored for scientific studies was employed. Specifically, the novel convolutional neural network and GoogleNet were chosen as the two techniques under scrutiny. The G-Power 3.1 program played a central role in setting up parameters for statistical analysis, with a significance level (α) set at 0.05 and a power of 0.85 to ensure robustness in the findings.

Implementation of these techniques was facilitated through the versatile Python OpenCV software, which provided a powerful platform for executing the prescribed task. The deep learning evaluation, a cornerstone of this investigation, operated seamlessly on the Windows 10 operating system. The hardware infrastructure supporting this endeavor boasted an Intel Core i7 CPU and 4GB of RAM, ensuring computational efficiency and accuracy in the analysis. The utilization of a 64-bit system architecture further enhanced the processing capabilities, contributing to the reliability and precision of the results obtained. The code execution was facilitated using the Python programming language. To complete an output procedure and guarantee precision, the information is being worked on in the

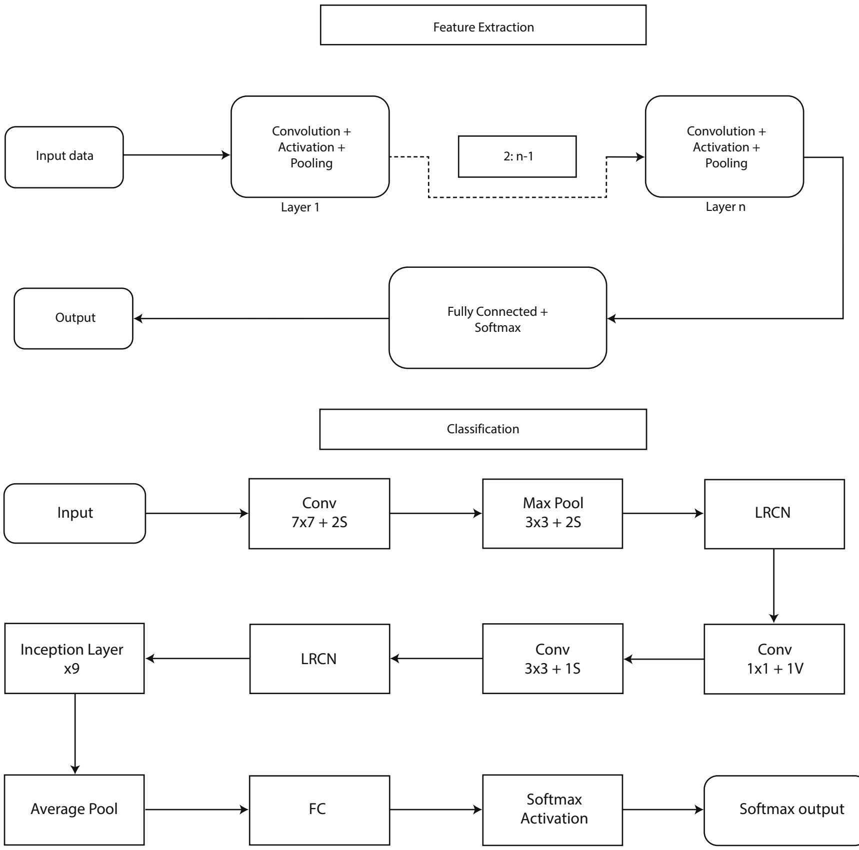

Figure 30.1 Block diagram of novel convolutional neural network algorithm and GoogleNet algorithm.

background while the code is being processed. The dataset was taken from the Kaggle website.

Figure 30.1 introduces block diagrams that elucidate the underlying architectures and processing steps of both CNN and GoogleNet. This visual aid aids in understanding the intricacies of the algorithms, showcasing their respective structures and data flow.

A. CNN Algorithm:

Description:

Deep learning methods for image recognition and other tasks requiring the analysis of pixel data use CNNs, a particular type of network design. For a variety of computer vision tasks, such as picture classification, face identification, and object detection, novel convolutional neural networks are commonly used.

Algorithm:
Step 1: Obtaining a sizable array of patient retinal pictures is the first stage in the data collection process.
Step 2: The gathered retinal images must be preprocessed in step two of the data collection procedure.
Step 3: Convolutional Layers: The CNN will then be given several convolutional layers as the third stage.
Step 4: Pooling Layers: These are inserted after the convolutional layers.
Step 5: Fully linked levels: The CNN must now have fully linked levels added to it.
Step 6: Loss Optimizer and Function: To train the CNN.
Step 7: Training. The loss function and the gathered information are used to train the CNN.
Step 8: Evaluation: After the CNN has been taught, it can be assessed using a validation set.
Step 9: Deployment: Lastly, if CNN's deployment.

B. GoogleNet:
Description:
GoogleNet employs a convolutional neural network (CNN) comprising 22 layers, and it provides the capability to load a network that has undergone prior training on either the ImageNet or Places365 datasets. On ImageNet, images can be categorized into hundreds of different groups, such as "keyboard," "mouse," "pencil," and "animal." Images were categorized into 365 various site groups using the algorithm that was found on ImageNet, including meadows, parks, airports, and foyers. By combining various feature representations, these networks have evolved to symbolize a variety of visual data types. The same concept can also be stated as the height of the time filter times the number of input screens multiplied by the total of the input screen counts plus one.

Algorithm:
Step 1: Data Preprocessing: The first step is to preprocess the data.
Step 2: Inception Module Design: The core building block of GoogleNet is the Inception module.
Step 3: Architecture Establishment: The GoogleNet architecture is formulated by assembling multiple Inception modules in a stacked configuration.

Step 4: Global Average Pooling Layer Integration: Incorporate a Global Average Pooling layer to diminish the spatial dimensions of the feature maps, thereby reducing the overall number of parameters.
Step 5: Culminating Fully-Connected Layer: The concluding layer within the GoogleNet structure is characterized by being fully connected.
Step 6: Network Training: Conduct the training process for the GoogleNet network, utilizing an extensive dataset comprising images and their corresponding labels.
Step 7: Evaluation of Performance: After the training phase, assess the performance of the GoogleNet network by applying it to a validation dataset.
Step 8: Prediction: Subsequently, utilize the trained GoogleNet network to make predictions on new images.

30.3 Statistical Analysis

The quantitative evaluation of GoogleNet and CNN involves a meticulous examination utilizing the statistical prowess of SPSS software. The focal point of this analysis is the comparison of these two deep learning models concerning their performance in diabetic retinopathy image classification. In the context of statistical scrutiny, independent variables encompass the diverse set of diabetic retinopathy images, while the dependent variable under consideration is accuracy, a critical metric for evaluating the efficacy of these models in medical image classification.

To facilitate a comprehensive understanding of their performance, each step of the analysis involves an objective T-test. This analytical approach is crucial for discerning any significant differences in precision between GoogleNet and CNN. The T-test is a powerful statistical tool, providing a robust framework for quantifying the precision of each model, and the results derived from this analysis serve as a quantitative yardstick for comparing the effectiveness of GoogleNet and CNN in diabetic retinopathy image classification.

As the T-test is conducted for each procedure, precision becomes the focal point of scrutiny. This precision-oriented analysis aims to unravel the nuanced distinctions in the accuracy of GoogleNet and CNN when subjected to the task of classifying diabetic retinopathy images. The significance of these statistical comparisons lies in their capacity to offer insights into which model exhibits superior accuracy, thereby influencing decisions regarding the selection of the most effective deep-learning model for diabetic retinopathy diagnostics.

In essence, this analysis not only extends the quantitative evaluation of GoogleNet and CNN but also underscores the methodological rigor employed in scrutinizing their performance. The T-test methodology, coupled with SPSS, adds a layer of statistical robustness to the assessment, elevating the reliability and validity of the findings. Ultimately, this multifaceted analysis contributes to a more nuanced understanding of the comparative precision of GoogleNet and CNN in diabetic retinopathy image classification.

30.4 Results

The experimental procedures encompassed the independent execution of the CNN and GoogleNet algorithms within the Python OpenCV software framework, utilizing a dataset comprising 20 samples. The precision outcomes for each algorithm discerned across the 20 examples, are meticulously detailed, providing a comprehensive overview of their performances.

An accuracy analysis was conducted for two groups: (1) CNN and (2) GoogleNet. For Group 1, consisting of Sample 1, the recorded accuracies ranged between 94.39% and 97.96%. The individual accuracies for Sample 1 were observed at 96.14%, 97.15%, 96.15%, 96.82%, 96.73%, 96.77%, 97.96%, 95.05%, and 97.89%. Meanwhile, in Group 2, represented by Sample 2, accuracies fluctuated between 90.08% and 95.26%. The specific accuracies for Sample 2 were noted at 93.85%, 92.80%, 93.15%, 92.69%, 91.24%, 93.41%, 91.97%, 92.10%, and 95.26%. These accuracy assessments illustrate variations in performance between the CNN and GoogleNet models across distinct samples within their respective groups.

Advancing to Table 30.1, a detailed group statistical analysis is presented, shedding light on the performance of both CNN and GoogleNet. This encompassed computing the mean, standard deviation, and standard error mean for ten samples. In Table 30.1, the statistical assessment of the

Table 30.1 Statistical analysis of GoogleNet and CNN.

	Group		N	Mean	Std. deviation	Std. error mean
Accuracy	1	CNN	10	96.5050	1.13141	.35778
	2	GoogleNet	10	93.0560	2.58007	.81589

performance of CNN and GoogleNet in a group context uncovered that CNN demonstrates a superior average accuracy when juxtaposed with GoogleNet. This inference is derived from the computation of the mean, standard deviation, and standard error mean across 10 samples.

Significantly, the mean precision values for CNN and GoogleNet were recorded as 96.505% and 93.0560%, respectively. A thorough comparative evaluation accentuates CNN's superior mean accuracy values, a result attributed to its smaller standard deviations (1.13141 for CNN and 2.58007 for GoogleNet).

The results of the Independent Sample T-test, which compares CNN and GoogleNet, are detailed in Table 30.2, providing insights into the significance of the observed differences. These results indicate a slight advantage of CNN over GoogleNet, underscored by a significant contrast in accuracy between the two algorithms, as evidenced by significance values of 0.002 ($P<0.05$). For CNN, the mean, standard deviation, and standard error mean are 96.5050, 1.13141, and 0.35778, respectively contrast, for GoogleNet, the corresponding values are 93.0560, 2.58007, and 0. 81589. To complement the tabulated data, Figure 30.2 serves as a visual representation, displaying pre-processed images from both CNN and GoogleNet. This figure offers a comparative view of their raw, processed, and segmented forms, providing valuable insights into the image processing methodologies employed by each algorithm.

Figure 30.3 extends the graphs that are employed to facilitate a comprehensive comparison of the categorization, loss values, and analysis of the two algorithms. This visual representation accentuates CNN's categorization accuracy of 96.5050%, distinctly outperforming GoogleNet's accuracy of 93.0560%. Notably, CNN's standard deviation is marginally lower than that of GoogleNet. The X-axis is dedicated to the CNN vs. GoogleNet Classifier, while the Y-axis illustrates mean recognition success (+/-1SD), providing a clear graphical representation of the observed differences.

Figure 30.3 illustrates a comparison between CNN and GoogleNet classifiers based on their mean accuracy. The mean accuracy of the CNN classifier significantly surpasses that of the GoogleNet classifier. Furthermore, the standard deviation of the CNN classifier is notably superior to that of the GoogleNet classifier. The X-axis represents the CNN versus GoogleNet classifiers, while the Y-axis denotes the mean accuracy of detection with a range of +/-1 standard deviation.

Table 30.2 Independent sample T-test: CNN is significantly better than GoogleNet with p-value 0.002 ($p < 0.05$).

		Levene's test for equality of variances		**T-test for equality means with 95% confidence interval**						
		f	**Sig.**	**T**	**df**	**Sig. (2-tailed)**	**Mean difference**	**Std. error difference**	**Lower**	**Uppe**
Accuracy	Equal variances assumed	10.898	0.002	3.871	18	0.002	3.44900	.89089	1.57731	5.320
	Equal variances not assumed			3.871	12.338	0.002	3.44900	.89089	1.51380	5.384

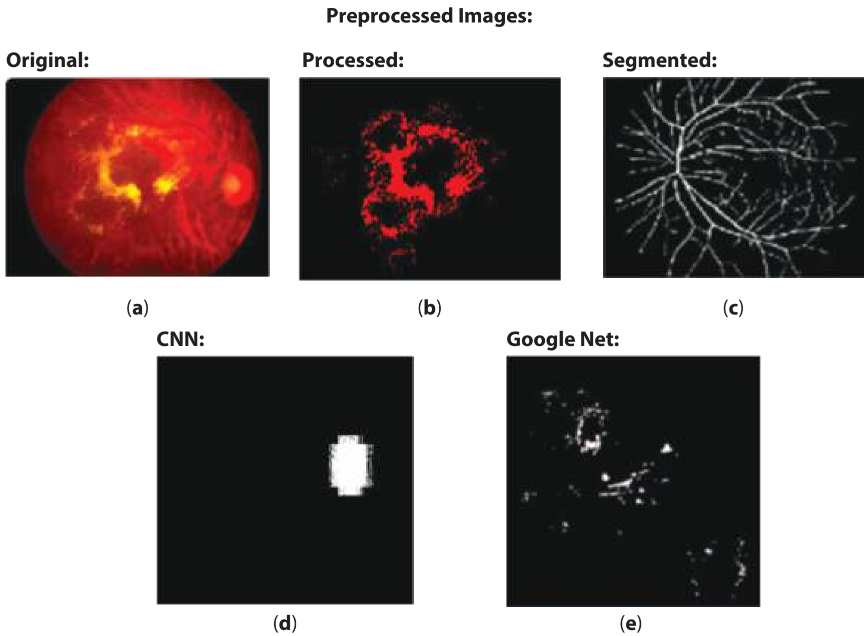

Figure 30.2 Preprocessed images with novel CNN and GoogleNet.

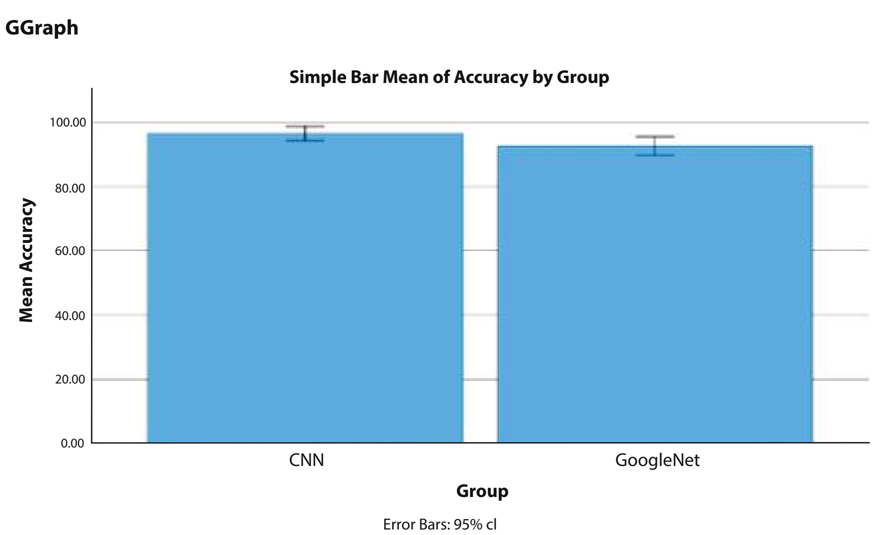

Figure 30.3 Simple bar mean of accuracy.

30.5 Discussion

The discussion section delves into the significant disparities in accuracy between the convolutional neural network (CNN) and GoogleNet, with pronounced significance values of 0.002 ($P < 0.05$). This underscores the clear superiority of CNN, boasting an accuracy of 96.5050% in contrast to Google's 93.5560%. The robust statistical foundation supports the conclusion that CNN outperforms GoogleNet in the context of the conducted experiments, solidifying the credibility of the findings [6].

Shifting the focus to the broader context of diabetic retinal disease, a pervasive complication of diabetes with the potential to cause vision impairment, the research employs sophisticated methodologies. Convex Hull is utilized for the identification and removal of optical discs, while filter-based techniques are harnessed for the extraction of retinal arteries. Additionally, fuzzy C-means is employed for the recognition of exudates. These techniques collectively contribute to the accurate identification and understanding of diabetic retinopathy, providing valuable insights into the multifaceted nature of the disease.

The utilization of Support Vector Machines (SVM) for the classification of fundus images further exemplifies the research's commitment to employing advanced techniques. The dataset, comprising 49 training and 89 testing fundus images, draws from the DIARETDB1 database and Hospital Serdang in Malaysia. The classification process involves categorizing diabetic retinopathy diseases into distinct stages, which span a spectrum ranging from mild and intermediate to severe and proliferative diabetic retinopathy diseases (NPDR). This categorization is essential for providing a nuanced understanding of the disease progression, as it allows healthcare professionals to differentiate between varying degrees of severity and tailor appropriate interventions based on the specific stage of diabetic retinopathy that an individual may be experiencing. The stages, from mild and intermediate to severe and proliferative, provide a comprehensive framework for clinicians to assess the extent of retinal damage and make informed decisions regarding the most suitable course of treatment or management for patients with diabetic retinopathy. Even in the face of variations in illumination, the system excels, achieving remarkable detection rates of 98% and 100% for exudates, blood vessels, and hemorrhages. These high detection rates underscore the efficacy of the employed methodologies in accurately discerning pathological features associated with diabetic retinopathy.

However, the discussion section is candid in acknowledging a limitation in the form of the time-intensive training required for CNN, particularly when dealing with extensive databases. This recognition provides a nuanced perspective on the challenges associated with implementing deep learning models in large-scale applications. The forward-looking stance of the research is encapsulated in the future objectives, which center around enhancing the system's scalability. The aim is to accommodate additional features while concurrently mitigating the time required for training datasets. This acknowledgment of limitations and proactive identification of future goals contribute to the ongoing dialog within the scientific community, paving the way for continuous advancements in the field.

30.6 Conclusion

The focal point of this research revolves around the pivotal task of classifying proliferative diabetic retinopathy diseases, employing two powerful deep learning models, namely, convolutional neural network (CNN) and GoogleNet. The outcome of this investigation reveals compelling insights into the performance of these models, with GoogleNet achieving a commendable accuracy score of 93.5560%, while CNN emerges as the standout performer with an impressive precision score of 96.5050%.

Delving into the statistical analysis, it becomes evident that there is a noticeable disparity in accuracy between GoogleNet and CNN. GoogleNet records an accuracy of 93.0560%, which falls short when juxtaposed against the substantially higher accuracy of CNN at 96.5050%. The statistical rigor applied to these findings further strengthens the credibility of the results, with significance values of 0.002 ($P < 0.05$) signifying a significant difference in the performance of both algorithms.

The superiority of CNN in achieving a higher accuracy score is particularly noteworthy in the context of diagnosing proliferative diabetic retinopathy diseases. This finding underscores the efficacy of CNN in discerning intricate patterns and features within retinal images, contributing to a more accurate and reliable classification of diabetic retinopathy stages.

Beyond the specific outcomes of this research, the implications extend to the broader landscape of medical diagnostics and deep learning applications. The success of CNN in outperforming GoogleNet highlights the importance of selecting appropriate models for specific medical image classification tasks. This insight can guide future endeavors in the development and refinement of deep learning models tailored to the nuances of diabetic retinopathy detection and classification.

In conclusion, the extended findings of this research illuminate the nuanced dynamics of employing CNN and GoogleNet in the classification of proliferative diabetic retinopathy diseases [8]. The robust statistical evidence, coupled with the superior accuracy of CNN, not only contributes to the understanding of diabetic retinopathy diagnostics but also informs future directions in leveraging deep learning for enhanced medical image analysis and classification.

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31

Conversational AI – Security Aspects for Modern Business Applications

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Abstract
Conversational artificial intelligence (CAI), commonly known as chatbots or virtual assistants, has seen significant adoption across various domains, ranging from customer support to personal assistants. As these CAI systems become more pervasive, the need for robust security measures becomes increasingly crucial. However, implementing CAI presents challenges. Ensuring naturalness and context in responses, addressing data privacy and security concerns, and dealing with ethical considerations are vital aspects. Integrating CAI into existing systems and scaling it for high user volumes also pose complexities. Looking to the future, developments in CAI are anticipated to focus on refining NLP techniques for better context awareness and incorporating multimodal interactions combining text and speech. The integration of AI with IoT devices for smart automation and the enhancement of emotional intelligence in AI responses are also areas of active research. This research chapter investigates the security threats associated with CAI systems and proposes mitigation strategies to safeguard against potential attacks. We analyze the vulnerabilities, potential risks, and attack vectors that

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malicious actors may exploit in CAI environments. Furthermore, we present various security mechanisms to enhance the resilience of these systems, thereby fostering trust in the deployment and usage of CAI. The work explores the security landscape of CAI, identifying potential threats and vulnerabilities.

***Keywords*:** Conversational AI, natural language processing, security and privacy

Abbreviations Used

Conversational AI	CAI
Natural language processing	NLP
Machine learning	ML
Natural language understanding	NLU
Automatic speech recognition	ASR
Amazon Web Services	AWS
Artificial intelligence markup language	AI-ML

31.1 Introduction

Conversational artificial intelligence (CAI) has emerged as a powerful technology, transforming human-computer interactions by enabling natural language processing (NLP) and conversations. The widespread integration of CAI in diverse applications has raised concerns about the security and privacy implications associated with these systems. Table 31.1 shows the CAI Aspects.

CAI has proven to be a game-changer for businesses, offering a wide range of applications across various sectors. Leveraging NLP and machine learning (ML), CAI enables businesses to interact with their customers, employees, and stakeholders in a more personalized and efficient manner. Table 31.2 represents CAI for business applications.

31.2 CAI – Security Threats

a) **Security Threats in** CAI **Systems:** Analyze the security threats and attack vectors specific to each type of CAI system:

Table 31.1 CAI aspects [16–20].

Aspect	Details
Components	The key components that make up a CAI system, including NLP, speech recognition, dialog management, etc.
Use Cases	Real-world applications of CAI in different domains, such as customer support, healthcare, and education.
Advantages	The benefits of using CAI, such as improved customer experience, efficiency, and accessibility.
Challenges	Common challenges and limitations faced in the development and deployment of CAI systems.
Security and Privacy	An overview of security threats and privacy concerns related to CAI and mitigation strategies.
Future Trends	Emerging trends and technologies that are likely to shape the future of CAI.
Examples	Notable examples of successful CAI implementations and their impact on various industries.
Ethical Considerations	Ethical considerations surrounding the use of CAI, including bias, fairness, and transparency.

i. Chatbots:

- User Impersonation Attacks
- Eavesdropping and Data Interception
- Injection Attacks
- Contextual Manipulation
- Denial-of-Service (DoS) Attacks

ii. Virtual Personal Assistants:

- Voice and Speech Spoofing
- Unauthorized Access to Personal Information
- Misinterpretation of Voice Commands

Table 31.2 CAI for business applications [21–24].

Application	**Use cases**	**Benefits**	**Examples**
Customer support and service	- Virtual assistants and chatbots: Provide instant responses to customer queries 24/7.	- Improved customer service with round-the-clock support. - Reduced workload for human agents. - Faster response times.	- Chatbot on a company website.
	- Automated ticketing: Generate and manage support tickets.	- Streamlined ticketing process. - Efficient ticket routing and resolution. - Enhanced issue tracking.	- AI-powered ticketing system.
Sales and marketing	- Lead generation: Qualify leads and initiate initial conversations.	- Increased lead conversion rates. - Time-saving for sales teams. - Targeted lead nurturing.	- AI-powered lead generation chatbot.
	- Personalized recommendations: Offer product recommendations based on preferences.	- Enhanced cross-selling and upselling. - Improved customer engagement and loyalty. - Higher sales revenue.	- AI-driven product recommendation engine.
E-commerce and retail	- Product search and recommendations: Assist customers in finding products and alternatives.	- Improved customer experience and satisfaction. - Increased conversion rates. - Reduced bounce rates.	- E-commerce chatbot with product search functionality.
	- Order tracking: Provide real-time updates on orders.	- Enhanced customer communication and transparency. - Reduced customer inquiries. - Improved order fulfillment process.	- AI-based order tracking system.

(*Continued*)

Table 31.2 CAI for business applications [21–24]. (*Continued*)

Application	Use cases	Benefits	Examples
Human resources	- Candidate screening: Automate initial screening of job applicants.	- Time-saving for recruiters. - Efficient candidate shortlisting. - Improved hiring process.	- AI-powered candidate screening tool.
	- Employee onboarding: Guide new employees through the onboarding process.	- Enhanced employee experience. - Reduced onboarding time and costs. - Consistent onboarding process.	- Virtual assistant for employee onboarding.
Internal communications and productivity	- Team collaboration: Facilitate team communication and task management.	- Improved team collaboration and productivity. - Efficient task allocation and tracking. - Simplified project management.	- AI-driven team collaboration platform.
	- Personal productivity: Assist employees with schedule management.	- Enhanced time management. - Reminder system for important tasks. - Increased individual efficiency.	- AI-based personal productivity assistant.
Voice interfaces and virtual meetings	- Voice-enabled devices: Enable interaction with business services using voice commands.	- Hands-free interaction with business applications. - Improved accessibility for users. - Enhanced user experience.	- Voice-activated virtual assistant.
	- Virtual meetings: Schedule and manage virtual meetings.	- Streamlined meeting scheduling. - Automated meeting reminders. - Improved meeting organization.	- AI-powered virtual meeting scheduler.

(*Continued*)

Table 31.2 CAI for business applications [21–24]. (*Continued*)

Application	**Use cases**	**Benefits**	**Examples**
Data analytics and business intelligence	- AI-driven insights: Provide real-time business intelligence.	- Faster data analysis and insights. - Accurate data-driven decision-making. - Improved business performance.	- AI-driven business analytics platform.
	- Data visualization: Present complex data in an easy-to-understand manner.	- Enhanced data comprehension and communication. - Improved data-driven storytelling. - Quick identification of trends and patterns.	- AI-powered data visualization tool.
Feedback and surveys	- Customer feedback: Collect feedback through interactive surveys.	- Valuable insights into customer satisfaction and preferences. - Enhanced customer engagement and loyalty. - Data-driven improvements to products and services.	- AI-driven customer feedback survey system.
	- Employee feedback: Conduct employee feedback sessions.	- Improved employee satisfaction and retention. - Effective employee performance evaluations. - Opportunities for organizational improvements based on employee feedback.	- AI-assisted employee feedback mechanism.

iii. Automated Messaging Systems:

- Phishing Attacks
- Spamming and Malicious Content Distribution
- Link Manipulation

iv. Agent-Assisting Bots:

- Data Leakage from User Conversations
- Insider Threats from Authorized Agents
- Failure to Maintain CAI Context

v. AI-Powered Solutions:

- Adversarial Attacks on ML Models
- Model Inference Attacks
- Model Stealing and Copycat Attacks

b) **Vulnerabilities in** CAI **Systems:** Discuss the specific weaknesses and potential vulnerabilities that exist in each type of CAI system, including implementation flaws and architecture-related risks.

CAI tools are software solutions that facilitate the development and deployment of CAI applications, such as chatbots, virtual assistants, and voice-based interfaces. These tools provide a user-friendly and efficient way for businesses and developers to create and manage CAI experiences without the need for extensive coding or AI expertise. Table 31.3 highlights for CAI tools.

Table 31.3 CAI tools [25, 26].

Tool name	Description	Platform	Features	Pricing
Dialogflow	A Google Cloud–based development suite for creating CAI interfaces.	Web-based	- Natural language understanding (NLU) - Speech-to-text - Text-to-speech - Integration with Google Assistant and other platforms	Free tier pay-as-you-go

(*Continued*)

Table 31.3 CAI tools [25, 26]. (*Continued*)

Tool name	Description	Platform	Features	Pricing
IBM Watson	IBM's AI platform offering various tools for building chatbots and virtual assistants.	Cloud-based	- Watson assistant - Watson Discovery - Watson speech to text - Watson Text to Speech	Free tier pay-as-you-go
Microsoft Bot Framework	An open-source framework by Microsoft for building CAI agents.	Web-based	- Bot Builder packages for various languages - Integration with Azure services - Channel connectors	Free pay-as-you-go
Rasa	An open-source AI framework for developing context-aware chatbots and assistants.	On-premises, Cloud-based	- Open-source NLU and core components - Customizable pipelines - Scalable and flexible	Open-source
Wit.ai	A NLP platform by Facebook for building CAI apps.	Web-based	- NLP API for extracting intents and entities - Integration with Facebook Messenger	Free tier pay-as-you-go
Amazon Lex	Part of Amazon Web Services (AWS), a service for building CAI interfaces.	Cloud-based	- Automatic speech recognition (ASR) - NLU - Integration with AWS services	Pay-as-you-go

(*Continued*)

Table 31.3 CAI tools [25, 26]. (*Continued*)

Tool name	Description	Platform	Features	Pricing
Botpress	An open-source chatbot platform with a visual interface and powerful features.	On-premises, Cloud-based	- Flow builder for creating complex dialogs - NLU - Integration with various channels	Open-source
SnatchBot	A user-friendly platform for building chatbots with a drag-and-drop interface.	Web-based	- Drag-and-drop bot builder - Integration with multiple messaging channels - Analytics	Free tier pay-as-you-go
ChatterBot	A Python-based open-source library for building chatbots using ML algorithms.	On-premises	- Trained on large datasets for language generation - Simple and customizable	Open-source
Pandorabots	A platform for building and deploying chatbots and virtual agents using AI-ML (artificial intelligence markup language).	Web-based	- AI-ML-based chatbot development - Integration with various channels - Customizable	Free tier pay-as-you-go

31.3 Literature Review

Table 31.4 shows the comparative study of CAI techniques.

Table 31.4 Comparative study of techniques.

Topic	Research	Key findings	Contributions	Referenc
NLP in CAI	- Sequence-to-Sequence Learning with Neural Networks (Sutskever *et al.*, 2014) - BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding (Devlin *et al.*, 2018) - Knowledge Graphs in NLP (Bordes *et al.*, 2017)	- Sequence-to-sequence models for dialog generation. - Contextual understanding with BERT. - Incorporating knowledge graphs into NLP models.	- Improved dialog generation. - Enhanced contextual understanding. - Knowledge integration in NLP.	[1–3]
Dialog Management and Reinforcement Learning	- End-to-End LSTM-based Dialog Control Optimized with Supervised and Reinforcement Learning (Williams *et al.*, 2016) - Reinforcement Learning for Personalized Dialogue Generation (Zhao *et al.*, 2018) - Dialogue State Tracking with Deep Learning (Henderson *et al.*, 2014)	- Effective dialog management using LSTM and reinforcement learning. - Personalized dialog generation with RL. - Dialog state tracking with deep learning.	- Improved dialog flow and turn-taking. - Personalized responses in CAI. - Accurate dialog state tracking.	[4–6] [9–11]
Ethical Considerations and Fairness in CAI	- On the Dangers of Stochastic Parrots: Can Language Models Be Too Big? (Bender *et al.*, 2021) - Ensuring Inclusivity and Fairness in Language Models (Abend *et al.*, 2021)	- Potential dangers of large language models. - Addressing biases and ensuring inclusivity in language models.	- Awareness of risks in using large language models. - Promoting fairness and inclusivity in AI systems.	[7, 13]

(*Contin*

Table 31.4 Comparative study of techniques. (*Continued*)

Topic	Research	Key findings	Contributions	Referenc
Multimodal CAI	- End-to-End Multi-Turn Response Selection with Graph-based Candidate Generation and BERT-based Candidate Ranking (Hori *et al*., 2019)	- Effective multimodal dialog generation using graphs and BERT.	- Improved context awareness in multimodal conversations.	[8, 13]
Transfer learning and few-shot learning	- A Joint Many-Task Model: Growing a Neural Network for Multiple NLP Tasks (Yu *et al*., 2016) - The Impact of Transfer Learning on Few-Shot Task-Oriented Dialogue Systems (Rasa *et al*., 2021)	- Effective transfer learning for multiple NLP tasks. - Few-shot learning for task-oriented dialog systems.	- Generalization across multiple NLP tasks. - Improved performance with few-shot learning.	[9, 10]
Real-world applications of CAI	- Chatbots in Mental Health: Detecting Emotional Distress in Text-Based Conversations (Shick *et al*., 2019) - Personalized Recommender System with Sequential Deep Learning for Cross-Sell and Upsell at Scale (Xiao *et al*., 2018) - Real-Time Emotion Classification of Customer Conversations Using Multilingual BERT (Srivastava *et al*., 2021) - Dialog-Based Intelligent Tutoring Systems: A Meta-Analysis (D'Mello *et al*., 2017)	- Detection of emotional distress in mental health conversations. - Personalized recommendations using deep learning. - Real-time emotion classification in customer conversations. - Meta-analysis of dialog-based intelligent tutoring systems.	- Improved mental health support with chatbots. - Enhanced personalized recommendations. - Real-time emotion analysis in customer support. - Insight into intelligent tutoring system effectiveness.	[11, 12, 14 15]

31.4 Mitigation Strategies

Strategies to mitigate the security threats include:

a. Secure Authentication and Authorization: Implementing strong authentication mechanisms to prevent unauthorized access.
b. Encryption and Data Security: Employing end-to-end encryption and data masking techniques to protect sensitive information.
c. Intent Verification: Ensuring that user queries match intended intents to prevent context manipulation.
d. Continuous Monitoring and Auditing: Regularly monitoring system activity and conducting audits to detect potential breaches.
e. User Awareness and Education: Educating users about potential security risks and promoting safe usage practices. Table 31.5 displays the CAI techniques.

CAI, while offering numerous benefits and transformative potential, also faces several challenges and issues. Table 31.6 focussed on CAI issues.

31.5 CAI Models

CAI models utilize various algorithms to process natural language, understand user intent, and generate appropriate responses. Below are some of the key algorithms commonly used in CAI models:

i. **NLP:** It is a fundamental component of CAI models. It involves algorithms for tokenization, part-of-speech tagging, named entity recognition, and syntactic parsing. NLP helps in understanding the structure and meaning of user input.
ii. ML **Algorithms:** CAI models often incorporate ML algorithms, such as:
   - **Supervised Learning**: Used for intent classification and entity recognition, where the model learns from labeled training data to make predictions on new data.

Table 31.5 CAI techniques.

System type	Description	Main features	Use cases	Examples
Chatbots	Chatbots are software applications designed to conduct conversations with users via text-based messaging interfaces. They are widely used in customer support, virtual assistants, and various online platforms.	NLU, contextual responses, integration with messaging apps	Customer support, information retrieval, E-commerce assistance	IBM Watson Assistant, Google Dialogflow, Microsoft Bot Framework
Virtual personal assistants	Virtual Personal Assistants are AI-powered applications that assist users in managing tasks, organizing schedules, and providing personalized recommendations. They often utilize both text and voice-based interactions.	Voice recognition, task automation, personalization	Schedule management, reminders, Smart home control	Apple Siri, Amazon Alexa, Google Assistant
Automated messaging systems	Automated Messaging Systems are systems that automate the process of sending messages or notifications to users. They may use predefined message templates or respond to specific user actions or events.	Message templates, event-triggered responses, opt-in/opt-out management	Transaction notifications, appointment reminders, marketing campaigns	Twilio, Mailchimp, HubSpot
Agent-assisting bots	Agent-Assisting Bots work alongside human agents to provide support and assistance in handling customer queries. They often use AI to suggest responses or provide relevant information to agents.	Real-time suggestions, knowledge base integration, sentiment analysis	Customer service centers, help desks, support ticket systems	LivePerson, Zendesk, Intercom
AI-powered solutions	AI-powered Solutions refer to a broader category of CAI systems that leverage advanced AI techniques, including NLP, ML, and deep learning, to enable intelligent interactions with users. These solutions may include various applications such as chatbots, virtual assistants, and more.	Advanced NLP, contextual understanding, adaptive learning	Healthcare diagnostics, personal finance, language translation	OpenAI GPT-3, Salesforce Einstein, BERT (Bidirectional Encoder Representations from Transformers)

Table 31.6 CAI issues.

Language understanding and context	**Security and privacy concerns**	**User trust and transparency**	**Training data and model performance**
Difficulty understanding natural language and context.	Storing and processing user data raises privacy concerns.	Users may find it challenging to trust AI systems.	Requiring large and diverse training datasets for robust performance.
Misinterpretation of ambiguous user inputs.	Risk of sensitive information being compromised.	Lack of transparency in AI decision-making.	Optimizing models for efficiency.
Handling diverse language variations and slang.	Potential data breaches and privacy violations.	Lack of understanding of how AI decisions are made.	Ensuring model generalization to new and diverse inputs.
Real-time contextual understanding during multi-turn conversations.	Providing helpful error messages and graceful error recovery.	Ethical considerations regarding biased decision-making.	Obtaining quality training data for accurate learning.

- **Unsupervised Learning:** Used for tasks like topic modeling and text clustering to discover patterns and insights from unlabelled data.
- **Reinforcement Learning:** In certain cases, CAI models employ reinforcement learning to optimize responses through trial-and-error interactions with users.

iii. **Seq2Seq Models (Encoder-Decoder Architectures):** These models use recurrent neural networks (RNNs) or transformer-based architectures to convert input sequences (user queries) into fixed-length vectors (contextual embeddings) and then decode them into appropriate responses.

iv. **Transformer-Based Models:** Transformers have gained popularity in CAI due to their parallel processing capabilities and ability to handle long-range dependencies.
v. **Memory-Augmented Neural Networks:** These models integrate external memory to store and retrieve context information, enabling better long-term conversation understanding and maintaining conversation history.
vi. **Dialog Management:** For multi-turn conversations, dialog management algorithms keep track of user context, handle turn-taking, and manage conversation flows, ensuring coherent and contextually appropriate responses.
vii. **Language Generation Techniques:** Models leverage techniques like beam search, nucleus sampling, or temperature scaling during response generation to balance creativity and relevance in generating responses.
viii. **Pre-training and Fine-tuning:** Many CAI models are pre-trained on large corpora of text data using unsupervised learning and then fine-tuned on domain-specific datasets to adapt to particular use cases.
ix. **Intent and Entity Recognition Techniques:** Intent recognition algorithms classify user queries into specific intents, while entity recognition identifies key pieces of information within the user input, such as dates, locations, or names.

31.6 Future Research Directions

Identify potential areas for future research and development in CAI security, including the integration of AI-driven threat detection and advanced user authentication methods. Future research directions for addressing CAI threats encompass a broad spectrum of areas that aim to enhance the security, privacy, and trustworthiness of these systems. Some key research directions include:

i. **Adversarial Robustness:** Developing robust CAI models that can withstand adversarial attacks, including input perturbations, adversarial examples, and context manipulation. Research should focus on techniques such as adversarial training and data augmentation to improve model resilience.

ii. **Privacy-Preserving Conversations:** Exploring techniques to ensure end-to-end encryption and privacy-preserving conversations in distributed CAI systems, particularly in sensitive domains like healthcare and finance.
iii. **Contextual Understanding:** Advancing the understanding of long-term context and memory retention in multi-turn conversations. Improving context management is crucial for accurate responses and preventing context-based attacks.
iv. **Explainability and Transparency:** Investigating methods to make CAI systems more explainable and transparent to users. Research should focus on generating human-interpretable explanations for AI decisions, enhancing user trust.
v. **Fairness and Bias Mitigation:** Addressing bias in CAI models to ensure fairness and inclusivity in responses. Developing techniques to detect and mitigate biases in language generation is essential to prevent discriminatory behavior.
vi. **Zero-Shot and Few-Shot Learning:** Exploring ways to enable CAI systems to learn from limited data or new domains quickly, reducing the reliance on extensive training datasets.
vii. **Multi-modal Conversations:** Advancing CAI to handle multi-modal inputs, combining text, speech, images, and other modalities for more enriched and contextually aware conversations.
viii. **Human-AI Collaboration:** Investigating methods to foster seamless human-AI collaboration, where CAI systems work alongside humans to achieve shared goals, while also respecting user preferences and boundaries.
ix. **Continual Learning:** Exploring continual learning approaches that allow CAI systems to continuously improve and adapt to changing user preferences and emerging threats.
x. **User-Centric Security Measures:** Conducting research on user-centric security mechanisms, such as user-driven privacy controls and permissions, empowering users to manage their data and interactions.
xi. **Federated Learning for Privacy:** Investigating the potential of federated learning approaches to train CAI models

on decentralized data sources while maintaining data privacy and security.

xii. **Incorporating Ethical Guidelines:** Integrating ethical guidelines and principles into the design and development of CAI systems to ensure responsible use and ethical decision-making.

xiii. **Real-World Deployment Studies:** Conducting large-scale deployment studies of CAI systems in real-world settings to understand their vulnerabilities, user perceptions, and actual security risks.

xiv. **World Models:** Understanding and generating contextually coherent and meaningful conversations, taking into account user preferences.

31.7 Conclusion

The importance of implementing robust security measures to enhance the trust and adoption of CAI systems in various domains is emphasized. The development and adoption of CAI have revolutionized human-computer interactions, offering a seamless and natural way for users to interact with machines. However, these advancements have not come without challenges, and various threat issues associated with CAI must be carefully addressed to ensure the security, privacy, and trustworthiness of these systems. The identified threat issues encompass a wide range of concerns, including language understanding and context, data bias and fairness, security and privacy vulnerabilities, user trust and transparency, and potential ethical implications. Addressing these issues requires a holistic approach, involving collaboration between researchers, developers, policymakers, and end-users. To mitigate language understanding challenges, further advancements in NLP and deep learning techniques are necessary, focussing on better context comprehension and handling ambiguous user inputs. Additionally, ensuring the fairness and inclusivity of CAI systems demands careful curation of training data, bias detection, and bias mitigation strategies. The security and privacy concerns surrounding CAI systems necessitate robust encryption, authentication mechanisms, and secure data handling practices. Adequate user education and transparency in AI decision-making can help build user trust and encourage broader acceptance of these technologies. Efforts should also be directed toward continuous evaluation and improvement of CAI models, including ethical considerations, ensuring compliance with data protection regulations, and conducting rigorous adversarial testing to identify vulnerabilities.

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32

Literature Review Analysis for Cyberattacks at Management Applications and Industrial Control Systems

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Abstract
One of the most frequently discussed methods for protecting online supply chain management network (OSCMN) access and connection through compromised, peer-to-peer networks and research on cyber terrorism for the logistics industry (CTLI) is cyberattack and vulnerability (CAV) on industrial control systems (CICS). In order to combat cybercrime in the supply chain (CCSC), this study examines peer-reviewed literature and provides a thorough overview of the most popular CICS security applications. Our findings suggest that a counter message and post against cybercriminal and agent (CCA) events on social networking sites be designed to direct and inform normal users so that they can cut themselves off from dangerous users. This pertinent systematic study sheds some light on prospective prospects in CICS and CCSC research, instruction, and practices, such as CICS security in OSCMN, CICS security for machine learning (ML), and automated approaches.

***Keywords*:** CAV, OSCMN, industrial engineering products illicit sale (IEPIS), cybercriminal staffing (CCS), CCIE, CICS

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Abbreviations Used

CICS	Cyberattacks on Industrial Control Systems
CCSC	Cybercrime in the Supply Chain
ML	Machine Learning
DSSCT	dos-attack security Supply Chain Threat
CCA	Cybercriminal and Agents
CCS	Cybercriminal Staffing
OSCMN	Online Supply Chain Management Network
CTLI	Cyber Terrorism for Logistics Industry
CAV	Cyber Attack and Vulnerability
CCIE	Criminals for Communication in Industrial Engineering
DWCLI	Hidden Web Criminals Attacks on Logistics Industry
DNMIE	Hidden-net Market for Industrial Engineering
IEPIS	Industrial Engineering Products Illicit Sale
NN	Neural Network
BP	Back-Propagation
NLR	Narrative Literature Reviews
ML	Machine Learning
DM	Data Mining
NB	Nave Bayes
SVM	Support Vector Machine
MLP	Multilayer Perceptron
ELA	Ensemble Learning Algorithm
RF	Random Forest
LR	Logistic Regression
GBM	Gradient Boosting Machines
DNN	Deep Neural Network
LDA	Latent Dirichlet Analysis
CISC	Cyber Information Security and Cryptography
GBT	Gradient Boosted Trees
KNN	K-Nearest Neighbor
ICSTD	Industrial Control Systems Threat Dataset

ICSNA	Industrial Control Systems Network Analytics
TOR	The Onion Router
HAD	Hierarchical Aggregation/Disaggregation and Decomposition/Composition
ANN	Artificial Neural Network
QA	Quality Assessment
RQ	Research Questions
QQ	Qualitative and Quantitative
PoW	Proof-of-Work
IT-3	Iterative Dichotomiser 3
KMC	K-Means Clustering
DFR	Deep-Full-Range
PCA	Principal Component Analysis
RBFNN	Radial Basis Function Network
PSO	Particle Swarm Optimization
IIDS	Industrial Intrusion Detection System
GA	Genetic-Algorithm
ICSS	Industrial Control Systems Security
IE	Impact Evaluation
SA	Sentiment Analysis
IoT	Internet of Things

32.1 Introduction

In terms of functionality and design patterns, CAV on industrial control systems (CICS) technology is an advanced ICSS (Industrial Control Systems Security) technique to identify terrorist activities [10] on the hidden web [10–15] CCAs-CICSs on logistics sector (DWCLI) [8]. To determine potential CAVs on contemporary OSCMN, their primary causes, and defense mechanisms. In order to create alerts to ICSS agencies with account data and locations, the OSCMN is traced by ICSS agencies in order to track shared contents utilized by CCA for DoS-attack security [49] supply chain threat (DSSCT) on social networks. The primary actions carried out by CCA [1] include cybercrimes and CAVs that result in significant losses.

In order to exploit the hardware and applications that manage industrial processes and protect industrial automation infrastructures, CCAs are progressively weaponizing [16] the settings used for industrial automation. Containing cyber incidents can be challenging due to a lack of skilled labor and overlapping IT [20] and industrial automation systems. The severe effects of breached industrial automation and applications include ransomware, statistics and facts loss, altering the chemical composition of a municipal water supply, swapping authentic camera video for fakes, and disruption of transportation networks.

ICSS agencies are continuously assessing new techniques to provide proof of soundness for the detection and blocking of CCA activities [1–4] and to evaluate the proposed schema on a large dataset on CCA-CCS [16–19] and DSSCT-related OSCMN environments. Since the launch of the first fundraising by virtual currency (FVC) CICS [5]. New CICS systems have evolved with open E-transaction modes such as Bitcoin [30, 32, 33] for anonymous transactions at OSCMN channels [5–9, 21]. CICS technology has recently been the focus of a growing count of technical studies [12], and its unique trust and ICSS qualities have piqued the interest of analysts, developers, and industry practitioners. Certainly, CICS has grown more and more popular all over the world. Instead of only gaining popularity, it has had a long-lasting effect on the world [3]. For instance, it has been used commercially, affected world currency markets [6], and promoted the growth of illegal DWCLI trading platforms. Additionally, it has contributed to the growth of malware [10] and other CAV against merchants and associated OSCMN enterprises that are financially motivated. The segments are striving to integrate the core ideas into their current business operations after realizing the benefits of a trustless, decentralized digital money [6] system with temporal irreversibility [4, 23]. Due to the special characteristics of the CICS innovation, its use is tempting in a number of industries, including finance, transportation, the medicinal sector, smart settlements, and, most importantly, CCSC-CCA events [34]. Beyond the usage of digital money for CCA-CCS payments, a paradigm is emerging. The CICS might lay the groundwork for crucial elements of Internet ICSS infrastructures and allow for a new generation of abstraction-layer federated apps. In order to comprehend how evolving solutions might aid in reducing new threats, it is crucial to locate previous studies on the use of CICS to the challenge of CCSC. Finding out what analysis has previously been done in relation to CICS and CCSC requires mapping out pertinent publications and academic works. This study concentrates on the current literature on the use of CICS as a contributing platform for CCSC apps [7], such as those in sectors of business connected to statistics, privacy, ICSS, integrity, and accountability, as well as its usage in interconnected channels like the OSCMN [14]. Our primary objective is to establish a community-driven project to advance greater comprehension of CICS and CCSC by analyzing the connections among the two often-addressed domains. To do this, we will conduct a critical analysis of the previous research on CICS-CCSC and then apply our results to fresh contexts.

32.1.1 Available Research and Findings

To the best of our view, there appear to be very few narrative literature reviews (NLRs) in regard to the application of CICS to the problem of CCSC. [47] published a research article on cyberspace by CCA in the field of CICS and CCSC. In addition to providing a thorough analysis of the current CICS-enabled approaches [51] to access control, facts and resource provenance, and integrity assurance in OSCMN channels [1], the authors of this paper discuss the difficulties and problems associated with using ICSS services in a centrally organized layout in a variety of app contexts. This study, in our opinion, provides a good starting point for other analysts who are interested in CICS-based network and service ICSS. As far as we can tell, there do not seem to be many narrative literature reviews (NLRs) about using CICS to solve the CCSC problem. The authors [36] released a study on cyberspace in the CICS and CCSC fields by CCA [47]. Apart from offering a comprehensive evaluation of the existing CICS-enabled methods [51] for integrity assurance, facts and resource provenance, and access control in OSCMN channels [1], the authors of this paper also address the challenges and issues related to employing ICSS services in a centrally organized layout in diverse app scenarios. We believe that our study offers other analysts interested in CICS-based network and service ICSS a solid place to start. Aside from that, there have been a few published analyses of CICS and its broader effect, which we shall examine below in order to compare and contrast the writers' selected issues with our own study.

The authors [36] conducted an NLR to discover published research findings on the broad concept of CICS technology [16]. They focused on articles regarding CICS technology rather than legal, economic, or regulatory studies. They found that, in addition to the standard subjects of ICSS and privacy, 82% of the articles discuss FVC projects. The scope of CICS applications has expanded since 2018; hence, our study will examine the particular research that has been done on CCSC and CICS applications.

In particular, in relation to OSCMN and other peer-to-peer communication channels, [54] did an NLR on the utilization and adaptation of CICS [11]. They also discussed the possibility of using the CICS to identify statistics and facts of abuse without the need for a centralized monitoring system. However, the overall impact of CICS on CCSC was not taken into account. The core of our examination into how CICS may influence CCSC concerns is an impact evaluation of real scenarios, which is something they recommend future research should incorporate.

None of the earlier studies specifically looked at how the CICS platform may be utilized to enhance CCSC products, although they all addressed issues related to the technology's more general use. The background of the CICS study is rather recent, and it is developing quickly. Therefore, a comprehensive synopsis of current scientific efforts, especially in the fields of CICS and CCSC, is needed to drive future research activity.

32.1.2 Research Objectives

This study's objectives include reviewing prior research and its conclusions as well as outlining research initiatives in CICS applications for the CCSC [49]. We generated three RQs (research questions), as indicated in Table 32.1, to help focus our efforts.

32.1.3 Contributions

The NLR adds to available research by providing the supplement for anyone interested in CICS and CCSC to advance their research: Figure 32.1 shows the focused RQ.

- We found 51 observational studies on CICS and CCSC up until early 2023. Other analysts and ICSS agencies might

RQ1: To Present the OSCMN Applications focused on ICSS?	CICS's has been the most discussed topic among ICSS agencies to detect their activities and channels used by CCAs and Recruiters at OSCMN platform.
RQ2: What are the Disparate CCA-CCIE techniques and methods?	OSCMN is the collection of multiple platforms (WhatsApp, Facebook, twitter, Instagram etc.), where cyber offenders search for target to make him isolate among his relatives, in this way they encourage target to follow CCA ideologies.
RQ3: What is List of datasets covering CTLI -related statistics?	Millions of statistics are continuously generating at OSCMN platform,the analysts and ICSS agencies are tracking vulnerable contents and creating automated system to detect malicious activities when matched with statistics and Facts collected from OSCMN-CCA channels.

Figure 32.1 RQ.

utilize this collection of studies to narrow their attention to CICS. Next, we selected 35 observational studies that meet our predetermined criteria for quality. These results might serve as great benchmarks when evaluating a similar idea. In order to convey CICS and CCSC research, thoughts, and concerns, we carried out a thorough IE of the statistics and facts featured in the subset of 35 observational studies.

- We provide a meta-IE for enhancing the ICSS of current and OSCMN-IE technologies in terms of CICS implementation strategies. We set standards and provide representations to motivate more effort in this field.

32.2 Literature Survey

The author in [55] developed a stratification model that includes events that are man-made, external, natural, and unnatural. They have developed a novel ICSS-IE method that predicts the uncertainty of susceptible events. CTLI [8] has the power to completely destroy a civilization and profoundly impact its people. Much study has been done in the past several decades to learn more about the causes of CTLI and how to set up an effective CTLI system to reduce the risk of CCA-CAV. Additionally, data mining (DM) techniques and machine learning (ML) algorithms have been applied to enhance comprehension of the different parts of a CCA-CAV.

[39] developed a visual analytical method for effectively recognizing related elements, such as CCA-class, events, and places, based on a 2D arrangement. A bioinformatics sequence comparison that has been modified to incorporate the CCA's historical operations is shown in the study. The strategy, according to the study, reveals connections between several OSCMN channels that are challenging to find using conventional techniques. The author in [5] presented an ELA that categorizes and predicts CCA class using four different classifiers: NB (Nave-Bayes), K-NN (K-nearest-neighbor), IT-3 (Iterative Dichotomiser 3), and decision stump. The comparison between individual models was demonstrated by the authors.

A counter-CTLI system based on neural networks (NNs) was developed by the author in [2]. The analysts gathered data and facts that might be utilized to assess the suitability of AI methods for counter-CTLI using a game designed by psychologists and criminologists. After investigating NN, the analysts discovered that they had a 60% success rate in identifying dishonest and illegal activity.

The latent themes within the content of a DWCLI page were discovered using the latent Dirichlet analysis (LDA) [36, 40] method. LDA is a generative framework that analyzes each document and entraps switchable terms to find themes in a corpus of text. Finding endangered issues may help identify important community members. Using LDA to identify terrorized themes and extract key members of a class, a study was carried out to enhance ICSNA by integrating LDA into DWCLI sites. By applying the method, you may assess a member's degree of experience and classify them as significant or expert, based on the nature of the problem. This analysis is conducted on a single forum and is limited to DWCLI websites that use English as a CCIE language.

An idea of a concealed threat intelligence IE schema is put out in the DNMIE-Threat Intelligence [44] IE Schema, which was released by the CISC [43, 48]. We conducted an empirical study on the Web of a number of international extremist groups to observe how skilfully their ideologies were disseminated. Studies have been conducted on SA, opinion mining, the affected IE of user comments on Web forums, and the identification of user roles and their relationships. A web-text-content-based stratification process was presented by the author in [8] to identify unlawful TOR (The Onion Router) [45] DNMIE activity. They employed LR, SVM, and NB as three different supervised classifiers using a 2-text representation.

"Query Probing", an automated deep web stratification technique that pulls data from deep web statistics and Facts sources, was first presented by the author. Furthermore, it is widely used in "Visible Form Attributes" and supervised machine learning methods. To assess private contacts, the author in [41] developed a technique for automatically labeling threads that are likely to result in private communications. The social relationships and economics of the underground forum were examined through these investigations. Within the framework of IIDS, this research addresses the use of a hybrid HAD (hierarchical aggregation, disaggregation, and decomposition) algorithm approach for NN training. In order to contextualize this use and highlight the place of the proposed technique in the literature, it included previous works that used genetic algorithms [37] to train NN for the Industrial Intrusion Detection System's objective.

A vulnerability detection model based on the artificial fish swarming algorithm and a BP (back-propagation)-NN (AFSA) was developed by the author in [51]. By lowering sample training time, increasing stratification accuracy, and optimizing BP-NN weights, the method improves the accuracy of stratification. The principle components analysis (PCA) method is used to handle the real dataset, and the particle swarm optimization (PSO) algorithm is used to improve BP-NN, according to a method developed by the author in [48]. After optimization, the BP-NN is employed in the IIDS system.

A method for MLP-based IIDS that may be used in an offline manner for vulnerability identification was described by the author in [49]. This work uses a multilayer perceptron (MLP) NN classifier in a flow-based IIDS to distinguish between benign and malicious communications. The modified gravity search method is a new heuristic methodology to optimize the connection weights of the NN-anomaly detector. An IIDS based on ANN trained by GA (genetic algorithm) was proposed by the author in [30]. Their approach had a very high detection rate since it encoded the data in a binary manner using a network audit dataset.

In a similar analysis, [54] presented a hybrid classifier that combines PSO [52, 55], RBFNN (radial basis function network), and Kernel-PCA (KPCA). KPCA is used to reduce the dimensionality of the original sample facts and statistics. The PSO technique, which is used to optimize the RBF-NN's characteristics, is the basic classifier of the RBF-NN. The authors provide a low-weight deep-full-range (DFR) system that leverages IIDS and DL for encrypted traffic stratification in order to detect novel threats.

An IIDS for real-time statistics, fact processing, and IE based on a diversified DL architecture with DNNs was proposed by the author in [9]. They used the proposed DNN model to gather real-time information on hosts and networks in order to identify threats and vulnerabilities. To evaluate the DNN against other conventional ML techniques, they ran a variety of experiments. NSL-KDD and UNSW-NB15, two free, publicly accessible datasets, were employed in the research. The findings showed that in the binary stratification scenario, the DNN performed better than other models.

Based on the DL technique, the author in [9] proposed a one-dimensional invasion Internet traffic model for the IIDS using convolutional neural networks (1DCNN). As an intrusive Internet traffic model for the IIDS, serializing TCP/IP packets over a predetermined duration allowed the 1D-CNN to be used for supervised machine learning on flow statistics and facts. Normal and aberrant network traffic is categorized and tagged for supervised machine learning in the 1D-CNN. The experiments used the publicly accessible UNSW-NB15 dataset. The findings demonstrate that, compared to other frameworks, the 1D-CNN performs better in binary stratification. The detection accuracy obtained by a UNSW-NB15-1D-CNN was 0.9091.

The author in [5, 18] used ICSNA (industrial control systems network analytics) models and metrics based on ML approaches to study link forecasts in a CCA network. They looked at ML techniques that used a supervised ML strategy based on GBM (gradient boosting machines) to improve hidden link forecast performance in a large dataset. The tests offered quantified evidence of the mathematics and ML models' relevance and performance for ICSNA and hidden network forecasting using a real domain-related dataset.

The author in [31] applied ML as an "active defense" against CAV to elaborate suspicious pattern tracing and intelligence from the DWCLI. Furthermore, they developed a way to detect the attributes of these forums, concentrating on the current scenario with numerous forums abounding on the DWCLI. The demonstration revealed that the NN-based tool "doc2vec" performs well as a natural language processing and attribute extraction approach in ML. Based on the number of datasets utilized in the demonstration, MLP showed a high stratification performance of 90% or more. This demonstrated that doc2vec's vectorization appropriately depicts the characteristics of the postings.

For the purpose of filtering network traffic and identifying malicious network activity, [37] presented a hybrid IDS technique. The platform uses both linear and ML algorithms in addition to a protocol analyzer. The techniques use these properties to recognize new types of threats, whereas the linear technique filters and extracts distinctive CAV traits and attributes. The author in [47] proposed using principal component analysis (PCA) and statistics gain to detect vulnerability. MLPs, instance-based ML algorithms, and support vector machines (SVM) were used.

The legal frameworks in several nations listed by [46] describe the prohibited CCA offenses. LE (law enforcement) organizations are tasked with preventing crime and CCAs. Several IE and forecasting techniques are offered by analysts to the entities doing the study. The author of the [26] study used 39 different categories of crime information from the USA. Employing GBT and SVMs, a model separating offenses into two categories—blue/white collar crime and violence.

Each factor's importance in predicting crime was evaluated [10]. The research used crime statistics and facts to predict crime in predefined Indian locations based on the kind, timing, and placement of crimes. The KNN forecast algorithm was selected for use. This method was used to anticipate illuminated e-threats. A big data and ML architecture was developed using violence statistics and facts gathered by [47] from ICSNA-networks. The numbers were gathered through the internet and mobile crime reporting programs, as well as geographic statistics. Based on the gathered data and facts, the NB algorithm was utilized to produce predictions for violence.

These projections seek to identify probable crime hotspots so that they might be avoided. To predict CCA-CAVs in India, socioeconomical, geographical, and factual data from previous years' incidence were used.

The data and facts used by [11] to assess cybercrime were obtained from the ICSNA Network. The methods were contrasted using the F-measure value, which represents the level of precision and accuracy. With a precision of 82%, the RF strategy was found to be the best fit for the situation. A model that examined cybercrime was used to automatically identify cyber threats.

Real-time crime data and information from online news sources were used in the screening algorithm provided by [38]. The methods used for stratification were SVM, multinomial NB, and RF. CCA and non-CCA were the two groups into which the statistics and facts were split. The fact that it now provides news is the most important feature.

Statistics and facts from hacking cases in India were classified using ML models. The tool reduced time spent on IE and manual reporting, according to [22], and was 98% accurate in anticipating crimes. Table 32.1 represents the comparative study of available literature reviews.

Table 32.1 Comparative study of literature reviews.

Ref	Focus
[6]	Study of social engineering techniques used in modern business and industrial cyber security.
[7]	A thorough analysis of the literature on threat-security awareness in relation to industrial IoT (Internet-of-Things)
[8]	The Marine Industry's Use of Cyberattacks: A Systematic Review of Recent Developments and Forecast Trends
[9]	A reference architecture for web security measures for Industry-4.0 is available in the available literature.
[10]	A Comprehensive Analysis of Water Infrastructure Security
[11]	Cyber-physical system model-based cybersecurity engineering: a comprehensive mapping analysis.
Proposed Work	Narrative Literature Review for Cyberattacks on Industrial Control Systems by Hidden Web Cybercriminals

32.3 Research Techniques

To respond to the RQ, we employed the NLR and adhered to the recommendations made by [53]. In order to thoroughly examine the NLR, we made an effort to go through the planning, conducting, and reporting phases of the review in stages.

32.3.1 Analysis of Observations

To highlight observational research, keywords were added to the search modules of an e-publication database. The platforms that were looked up in the Digital Library are shown in Table 32.2. The keyword was found in order to help find research choices that would support the RQ's conclusion. The only Boolean operators accessible were AND and OR. The following were the search phrases used:

> ("CCA- CCS" OR "Industrial Engineering Products Illicit Sale (IEPIS)" OR "Fundraising") AND "CCSC"
> ("CCA Networks" OR "Fundraising" OR "CCA- CCIE") AND ("CCSC" OR "Cyber threat" OR "DWCLI crime" OR "DWCLI-crime" OR "OSCMN -threat")

The title, phrases, or synopsis were used in the searches, depending on the search platforms. We undertook the scans and analyzed the research that had been published up to that date, January 10, 2023. With the use of inclusion and exclusion constraints, these searches produced results that were refined. The snowballing [46] procedure was used. Up until there

Tables 32.2 E-Publication database's IE.

Google-Scholar
IEEE-Xplore E-Library
Science-Direct
ACM
Springer

were no more articles that fit the inclusion criterion, there were forward and backward snowballing cycles.

32.3.2 Parameters for Manuscript (Inclusion and Exclusion) IE

Studies that might be included in this NLR include case studies, technical CICS applications that are now in use, and a discussion on how CICS integration is helping to build current cyber vulnerability mitigation strategies. They must be authored in English, have received critical analysis, or both. Because Google Scholar has a tendency to produce articles of lower quality, any discoveries will be scrutinized for compliance with these standards. This page will only reference studies in their most current iteration. The below figures provide paper selection criteria and Review Criteria list the main inclusion and exclusion criteria.

32.3.3 Outcome Identification

A total of 797 studies were discovered from the first phrase scans on the above sites. The overall count of studies was lowered to 697 after duplicate studies were eliminated. There were 85 publications remaining to examine after evaluating the study versus the inclusion and exclusion factors. After reading all 84 articles, the addition and removal criteria were reapplied, resulting in the production of 39 papers. A further document was discovered via snowballing forward (7) and backward (5), bringing the total count of articles in this NLR to 54.

32.3.4 IE-Qualitative

The quality of observational research is assessed, making it possible to assess the papers' relevance to the RQ as well as any signs of investigation bias and the accuracy of the facts and figures used in the demonstration.

Inclusion	Exclusion
Paper needs to include empirical statistics and Facts on the deployment and use of CICS.	Papers focusing on general discussion or relating to business promotion.
Statistics about CICS or OSCMN crime, Extremism and propaganda IE.	A Grey literature containing blogs, posts, News and government documents
Must be the peer-reviewed work that has been published in a reputed conference proceedings or the journal.	Non-English papers

Figure 32.2 Observational studies filtering technique.

Review Process	Details
CICS	The paper must be focused on the design of CICS domains towards a certain issue.
Context	The study aims and findings must be placed in perspective. This will enable authentic research interpretation.
CICS application	In order to address RQ- RQ1 and RQ2, the research would have adequate details to show the approaches in an accurate manner in relation to a precise circumstance.
ICSS context	In order to aid in answering RQ3, the article must clarify why the ICSS threat exists.
CICS performance	Comparisons of disparate CICS applications will be possible if the performance of CICS is evaluated in the environment in which it is used.
Statistics and Facts acquisition	Details on how the information was gathered, measured, presented, and assessed must be included in order to ascertain its correctness.

Figure 32.3 Review criteria.

The IE procedure was based on that of [45]. To analyze their efficacy, 7 papers were selected at random and subjected to the following quality IE process: Figure 32.2 is focused on the observational studies technique, and Figure 32.3 shows the review criteria.

Afterward, this reliability verification list was used for all other observational research that was discovered. As demonstrated in the above figures, 12 studies were removed from the NLR because they did not comply with the checklist standards.

32.3.5 Statistics and Facts Extraction

In order to evaluate the authenticity of the statistics provided in the article and to examine their completeness, figures and facts were extracted from all articles that successfully underwent quality assessment (QA). The technique for identifying facts and statistics was first tested in six research studies. Later, it was expanded to include all research studies that accessed the standard IE phase. Each study project's data and information were collected, categorized, and entered into a spreadsheet. The facts and statistics were grouped according to pertinent criteria: background metrics and facts pertain to details about the study's goal. The writers' conclusions and suggestions are QA and factual. In a study, data from experiments and research are referred to as quantitative facts. From the first-term searches on each platform to the final selection of observational research, Figure 32.1 displays the number of articles picked at each stage of the workflow, including the rate of article stratification.

32.3.6 Statistics and Facts IE

To achieve the purpose of resolving the RQ, we have collated the statistics contained in the qualitative and quantitative (QQ) statistics and Facts sections. For the publications that had gone through the final statistics and data extraction process, we additionally conducted a meta-analysis.

32.3.6.1 Publications

However, the concept of CICS—which is associated with CTLI [24]—was initially proposed in the 1990s; observational research studies weren't published until 2018. This might highlight the innovative CCSC applications from CICS [25, 36]. The number of observational studies published per year is displayed in Table 32.3. The application of CICS in the CCSC setting is becoming more and more common [42]. Considering that the number of publications in 2020 was just half of what has been published up to January 2023, we expect a significant number of research studies on the use of CICS in real-world scenarios to be published in the future. Figure 32.4 shows the paper processing and stratification procedure.

The IE of phrases is used throughout all 55 papers to identify similar themes across the chosen observational studies. Table 32.4 shows the frequency of various terms in each of the observational trials. The 4th most frequent phrase in the dataset, after "DWCLI-crime" and "IEPIS", following the author's phrases "CCA-CCS" and "Fundraising", is "CCSC", as seen in the table. This reflects a growing emphasis on OSCMN's CICS adoption [52].

Table 32.3 Research publications.

Year	Publications
2019	7
2020	12
2021	10
2022	18
2023	9
2024	4

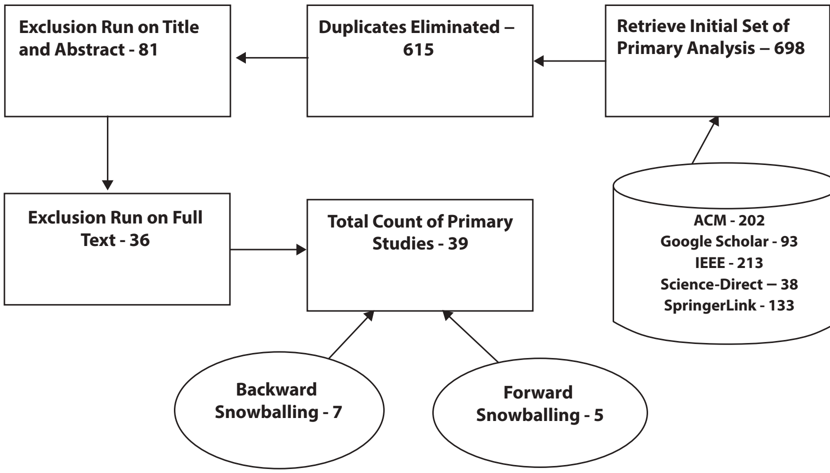

Figure 32.4 Paper processing and stratification.

32.4 Observational Values

All observational study papers were reviewed in their entirety, and the relevant QQ data and facts were collected and condensed into the tables above. Every observational study had a subject or topic that connected to the way CICS addressed a particular problem. Table 32.4 also includes a list of each paper's emphasis.

Each study's focus was more precisely split into two major categories to provide a more direct explanation of the observational research topic. In order to compile evaluations focused on IEPIS [41], financing, cyber CCA, extremism, CCS, funding, CCA-CCIE, and CICS-IE [48], the networks class [13] was created. The percentage of unique domains in the 30 primary studies that were approved for inclusion in the statistics and Facts IE are shown in Figure 32.2.

Based on themes identified in observational research, 35% of the review on CCSC domains [27, 28] of CICS is associated with the ICSS of OSCMN. With 16% of all issues, IEPIS is the second most worried domain. At 10%, propaganda is the third domain that causes the most worry. Ten percent of the ratio is accounted for by the fourth and fifth most searched websites, respectively. Instead of depending on a vulnerable central source of data, end users can use the CICS apps to authenticate with another organization or service. The fifth most often asked question is about CCS and how CICS can effectively gather data on a distributed network to prevent malicious material and virus modifications [27]. The final three trending topics are

Table 32.4 Keywords in IE.

Keywords	Number
OSCMN	2148
IEPIS	1457
CICS	218
CTLI	186
CCS	1269
CCA- CCIE	1237
CICS- IE	786
DSSCT	799
CCIE	779
CCA	528

CCA-CCIE, CICS-IE, cyber-CCA, and illegal crime and extremism (keywords) [33, 44]. On our list, there are [30, 35, 36, 52], and [55], each making up 3% of the total.

32.5 Analysis

First keyword searches show that there are a lot of articles on CICS. With just 16 years of existence, CICS is undoubtedly still in its infancy. The majority of the recommended observational subjects use solid statistics and facts, but few practical implementations demonstrate theories or concepts for solutions to modern challenges. In the subsequent simple research, a few of the most useful ICSS strategies show cutting-edge methods for resolving a variety of issues concerning CTLI and propaganda [55] sharing at OSCMN. The solutions typically necessitate significant technological changes to the system, such as vulnerable [39] content analysis and tracking engines.

The time and effort needed to update the system to automatic CCA event detection [5] within a framework that is currently available make it difficult to test empirical principles over an extended length of time in a controlled setting to determine if the CICS framework is more effective

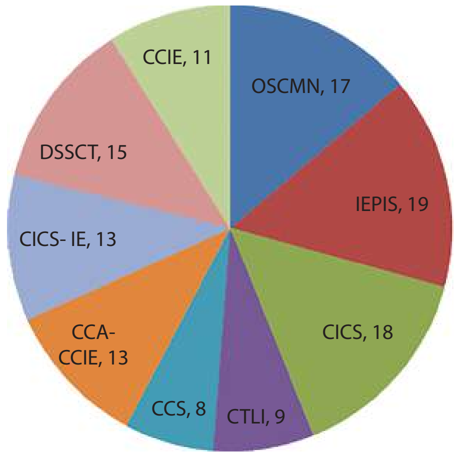

Figure 32.5 Observational studies theme chart.

than traditional ICSS. Among the significant outliers were the design problems of OSCMN and its demonstration with alternative consensus techniques. They took advantage of the well-known ICSNA platform to carry out their development and demonstration. The ones that had been put out seemed to be the most workable and prepared for implementation. Highly flexible analytics of content linkages and their impact [42] and a centralized person for identifying and mapping dangerous material origins [55] are made possible by ICSNA. Regarding Figure 32.5 illustrates the observational studies theme chart.

The Checklist of Credibility CICS was able to come to a consensus by giving each connected node a value [50]. Theoretically, a hybridized CICS that employs both proof-of-stake and proof-of-credibility may be more robust to CCSC than a proof-of-work system (PoW). This demonstrates that using POW tactics alone is not a guarantee of criminal detection. The democratic method of CICS provides it with power, sturdiness, and constant appeal. Because of this, basic examinations generally have shown that using CICSs that are already in place is essential.

32.5.1 What are the OSCMN Applications Focused ICSS- RQ1?

It is important to remember that the scope of this systematic research is restricted to the CICS CCSC architecture, and other potential or current uses, such as business, e-health, or logistics, are not taken into account. It

OSCMN	Content filtering and suspicious activity alerting deployment is required to guide users.
Unidentified CCIE	CCIE with unknown or unrelated user must be firstly verified for authenticity of his/her identity.
OSCMN Channel Automation	Suspicious and offensive related account and propaganda-based content should be identified and blocked.

Figure 32.6 Most recent IE ICSS-focused CICS applications.

is noteworthy, therefore, that throughout the process of stratification that was employed to choose the most important research, the analysts discovered that papers pertaining to finance, and e-health were common. The selection method concentrated on research that includes ICSS at its heart, even if each of these studies may have tackled ICSS dangers and problems in its own unique way. There are several opportunities to enhance OSCMN's ICSS, especially as it is linked to over 50% of all CCSC-CICS applications that have been published. This may be because OSCMN is widely used as a communication tool for idea expression and sharing personal information, and there is a rising need for OSCMN solutions [29]. Similarly, demand for OSCMN solutions to address ICSS issues may have been spurred by publicly disseminated ICSNA figures and information regarding risks orchestrated by the exploitation of such communication channels and applications [36]. The most current IE CICSS-focused CICS apps are displayed in Figure 32.6.

32.5.2 Analysis of Disparate CCA-CCIE Techniques and Methods-RQ2?

The solutions to CCSC [48] issues are not found in CICS and comparable technologies. They simply serve to strengthen current initiatives in the fields of code languages [53] and secure communication [25]. Figure 32.7 provides information on the threat analysis patterns.

The plurality of ICSS approaches relies on a particular, reliable source to validate facts. The platform is susceptible to attack, as several hostile actors

- Patterns of CCIE [2].
- Location of User activity
- User behavior
- CCA- CCS, funding and propaganda related contents [6].
- Banned organization by ICSS agencies related account keywords.
- Identification of Code Name used in OSCMN.
- Triggering and violent words [35].

Figure 32.7 Patterns of threats analysis.

may focus their efforts on a single target to launch attacks, activate malware [45], introduce harmful statistics and facts, or extract facts via theft or extortion. CICSs have an advantage over existing ICSS techniques since they are decentralized and do not rely on the authority or confidence of a single organization or network participant. Because each node, or member, has a complete copy of all the historical information accessible, and because further statistics and facts are only added to the chain of previous expertise by attaining a common agreement, the platform does not necessitate trust.

This can be done in a variety of ways, but the fact remains that a class with many representatives who have direct access to statistics will be far more secure than one with a single leader and a large count of members who rely on the leader for information, especially given the possibility of bad actors within the class or even the representatives themselves. We show how CICS was applied to enhance CCSC in OSCMN using the most ICSS-focused CICS applications exposed in RQ1.

32.5.3 Availability of Datasets with CTLI-Related Statistics- RQ3

Many major studies concur that actors (CCAs) sway users by learning about their personal information and connections, employing a variety of mind-washing strategies, and drawing them into an uncontrollably powerful hidden world (CCA activities) [5]. That is, new methods for verifying the signature, fingerprint, and pattern of malevolent actors used by OSCMN [17] who exhibit questionable communication behavior as reported by ICSS agencies. The channel demonstrates how there are alternatives to moving in that give recipient networks more clout when it comes to voting. Additionally, a node's future voting power over the strong faith and chain's operations increases with its mining investment.

In one study, the prospect of depending on several CICS levels for authentication and transaction confidence between connecting layers is investigated. Although some polls recommend CICS as an ICSS strategy, they do not specify if an existing CICS should be utilized or whether one has to be built from scratch. In a similar vein, different research rejects content filtering entirely while supporting the article's fascinating recommendations for ICSS techniques without ever looking at the CICS. No other method has been demonstrated in extensive testing to be able to increase securely with the amounts of connected user traffic, with the exception of a PoW consensus process that compensates recruiter miners.

CCSC Datasets	Ref.	Details
Power System Datasets	[55]	Electric Transmission System Normal, Disturbance, Control, CICS Behaviors
Gas Pipeline Datasets		Logs of Threats
Gas Pipeline and Water Storage Tank		CICSs and normal network behavior from 2- laboratory scale industrial control systems; a water storage tank and a gas pipeline.
WUSTL-IIOT-2018		An ICS-SCADA Intrusion Dataset

Figure 32.8 CCSC datasets.

The information on the various datasets related to CCSC (DWCLI) utilized for research and IE is shown in Figure 32.8 above.

32.6 CICS -CCSC Future Scope

We suggest the following CICS-CCSC research directions for further inquiry in light of the results of this IE and our observations:

CICS for OSCMN-ICSS: Despite recent studies demonstrating that almost all of the articles on CICS-CCSC in the literature note that the ICSS of OSCMN structures could be revitalized if it is endorsed with CICS, according to industry reports, ICSS in OSCMN connections is desperately needed, and it has been given top priority for improvement and implementation.

However, little is known or addressed about the variables that affect choices regarding the adoption of this procedure and OSCMN policing, in addition to how and in what ways it can be consistently applied to confront prevailing OSCMN-ICSS risks and threats in a contextually relevant manner, enabling the formation of prospective SVM for lightweight CICS-based solutions.

There are millions of active users on OSCMN channels, and information is exchanged by people from different countries as well as information gathered from a range of sources. Artificial intelligence (AI) [47] and its variants are tools for evaluating and understanding recorded data and facts in order to arrive at solid arguments in ICSS issues. Even though AI may be used with scattered channels, misleading Internet Explorer would be produced if malevolent third parties intentionally or inadvertently incorporated unlawful or tainted data and facts based on hostile inputs. CICS has the potential to be used in a variety of internet settings due to its broad use. By guaranteeing the reliability, accuracy, and validity of information and facts via characteristics like decentralization and factuality.

The solutions to these issues are essential for further investigations into CICS-CCSC via OSCMN channels. Releasing datasets and open-source software to the public and engaging with the community The CICS-CCSC research community is split between scholars and developers. Academics must work to overcome this gap by providing the business community and entrepreneurs with additional open-source programs, tools, and datasets. Since there is a large audience interested in CICS-IE, universities should really actively involve the communities in the design, validation, and maintenance of their research results.

32.7 Future Work

The investigation discovered new studies on the potential benefits of CICS systems for CCSC problem solving. According to the first keyword searches for this research and current ICSNA sources, CICS brings with it an insane range of workable solutions for banking, logistics, E-Health, CCSC, CCAs'-CCS, fundraising, IEPIS, and propaganda escalation. This study's main focus was on IE for CTLI-CCIE and CCS activities. On their own, the CCA activity detection and alerting handle any issue pertaining to CCSC. Solutions for CICS and CCSC have expanded and enhanced earlier efforts to strengthen ICSS and ward against CCA.

Potential subjects for CCSC research outside of OSCMN's purview are identified in this study. As the Internet becomes closer to being utilized extensively for daily tasks, there is an increasing necessity to secure its assessment centers and encryption. The OSCMN-ICSS research, which used CICS applications, often mentioned the variety of online communication modalities that are available to support the dispersed network. For the purposes of this investigation, it was not feasible to quantify such data and facts because of the differences in solutions adopted by each class of analysts. Future research in CICS-based OSCMN networks may compare the automated malicious activity-stopping method and OSCMN Channels mode vulnerability IE. It may also standardize statistics and facts.

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33

Fractal Natural Language Semantics and Fractal Machine Learning Engineering: Cultural Heritage Generative Management Systems

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Abstract
Cultural heritage generative management systems (CH-GeMS) are systems supporting the management of the actor and process interactions through the continuous production and adaptation of value through self-organization, learning, and coevolution of such interactions. CH-GeMS are an improvement of cultural heritage management systems based on AI-driven generative models.

Keywords**:** Generative management systems, cultural heritage, knowledge framework, fractal natural language semiotics

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33.1 Introduction

Such learning capacities are enabled by the following “CH-duality”, characterized as the coevolution of a “past-present phase” with a “present past phase”.

The dynamics of CH-GeMS over space and time is given by iterative feedback between

- the “CH-GeMS **past-present phase**”, (called “**knowledge framework**” in [20]) consists of the following sequence:
  - “CH-GeMS past input process” (*commitment*)
  - “CH-GeMS -past matching process” (*realization*)
  - “CH-GeMS -past output process” (*use*);

- the “CH-GeMS **present-future phase**”, (called “**valorization framework**” in [20]) consists of the following sequence:
  - “CH-GeMS future input process” (*monitoring*)
  - CH-GeMS -future matching process” (*conservation/restoration*)
  - “CH-GeMS future output process” (*fruition*).

The description of the learning interactions generated by this CH duality expands over an expanding four-level hierarchy which lets emerge a “fractal natural language semiotics” approach which naturally could be mapped to a “fractal machine learning engineering” methodology.

33.2 Frameworks, Directions, and Domains

Despite their diversity in forms, styles, and purposes, the landscape elements together constitute a “cultural sign” [1]. In addition, the cultural heritage contributes to territorial diversities by forming “tessellations”, which are essential to the distinctiveness, individuality, and individuality of the locations. Additionally, the cultural legacy that has been established throughout time and geography expresses culture and identity in an increasingly powerful way. Although cultural diversity symbolizes the persistence of identity codes, it is part of an evolutionary process including multiscale (local to global) events with qualities that are physical and intangible, natural and technological, and spatial and temporal [2].

The relationships between landscapes, heritage, and culture (LHC) take place within and between two frameworks:

- The first is the knowledge framework, which corresponds to a space-time linked to the needs, production, and use of the LHC objects under consideration. It may be influenced by LHC objects as they emerge from a valuation framework.
- The second is the valuation framework, which corresponds to a space-time linked to the observation, preservation, and realization of the LHC objects as they emerge from a knowledge framework.

The intricacy of the research perspectives stems from the way that LHC interact in two ways:

- Heritage landscapes, which operate in a bottom-up manner by referring to the tangible or virtual contexts of cultural heritage, along with the products and procedures that are linked to social, economic, and knowledge objectives that characterize one or more landscapes' cultures (as manifestations of a shared cultural background); and
- landscapes' cultures, which operate in a top-down manner by referring to conceptual, cognitive, and socioeconomic paradigms that (implicitly or explicitly) facilitate the processes pertaining to heritage landscapes.

Moreover, the management of such interactions occurs within and across the information and the operational domains giving rise to a coevolution of two management ***dimensions***:

- the ***information management*** of the information about the elements and the **LHC** interactions and
- the ***operative management*** of policies and processes and the adherence to, and the demonstration of adherence to laws, regulations, and policies associated with the **LHC** interactions.

To handle adaptive behaviors (e.g., availability of resources and error detection), these management systems have to take into account complex events which have to be decomposed w.r.t. more elementary interactions within and across the above directions, frameworks, and dimensions, as illustrated in the figure below, and by updating data, simulations, and models w.r.t.

- the *pre-matching* of these interactions and
- the *post-matching* of these interactions.

Working within and across these directions, frameworks, and dimensions requires a *transdisciplinary approach* with competences, methodologies, and technologies of both exact and human sciences (e.g., mathematical, computational, physical, and natural sciences, together with economic, social, historical, geographical, and philosophical sciences).

This paper deals with the **learning interaction system** of **LHC** through the above two directions, two frameworks, and two dimensions.

More precisely the following descriptive elements are considered: the *components* (characteristics of cultural objects, processes acting on them, and objectives of such processes) and their specific *tools* and *contexts*. Such elements are, in some cases, instances of only apparently contradictory aspects concerning

a) the *characteristics* of the cultural objects (tangible and intangible, social and environmental, and spatial and temporal) relative to the *knowledge framework* and the *valorization framework* together with their *landscape contexts* and *supports* to handle such objects;
b) the *knowledge framework processes* (requirements, creation, and utilization) and the *valorization framework processes* (monitoring, conservation, and fruition) acting on the cultural objects, together with their *competence contexts* and *methodologies* and *technologies* to activate such processes;
c) the *knowledge framework objectives* and the *valorization framework objectives* (education and entertainment, cohesion and competitiveness, research, and innovation) realizable by processes mentioned in (b) jointly with their *cultural contexts* and *visions* connected to such objectives.

The main contributions of the paper are in

- a unified approach to the knowledge framework and the valorization framework of the LHC interaction system as a set of dynamical relations and feedback loops among

characteristics of cultural objects, processes, and objectives together with their tools and contexts,
- a unified approach to the matching mechanisms underlying both the query-answer information management (search engine) and the demand-supply operative management (governance and compliance system) of the **LHC** interactions,
- a unified approach to the design of adaptive information management and adaptive operative management systems,
- a revisited approach to the design of such systems, based on generative artificial intelligence.

Moreover, the novelty, from a methodological point of view, of the proposed unified approach enables effective use of the obtained results, from a design point of view, at multiple scale levels (e.g., local, regional, and national) by a variety of stakeholders (e.g., general audience, public organizations, and private companies) and for multiple uses (e.g., paradigms investigation, information search, and decision-support).

33.3 CH-GeMS Architecture

33.3.1 Material: "Landscapes, Heritage, and Culture" Interaction System

The elements and their interactions of LHC are analyzed as a complex adaptive and multiscale dynamical system where the global behavior cannot be simply obtained by summing up the behavior of its subsystems since

- cultural objects associated with a (local) heritage landscape ought to be considered in relationships with those of other heritage landscapes in order to adopt a (global) landscape's culture and vice versa;
- a landscape's culture suggests guidelines for the management (at a local level) of other heritage landscapes.

The present section contains a description of the typologies and mechanisms of the interactions to be considered in a model of a LHC search engine and of a "governance and compliance" system. To this aim, the following four-level hierarchy is introduced:

- classes of *elements* of the model, consisting of the following: *components* (characteristics of cultural objects, processes, and objectives) together with their *tools* (technologies, methodologies, and visions) and *contexts* (landscapes, competences, and cultural contexts) (§2.1.1);
- *interaction networks*, consisting of networks of interactions among instances of elements in one, two, or three of the above classes (§2.1.2);
- *networks of networks*, which characterize dynamic connections among the above interaction networks (§2.1.3).
- *networks of networks of networks* which characterize variations among the above networks of networks generated by "life learning mechanisms" (§2.1.4).

33.3.1.1 Components, Tools, and Contexts

LHC, when considered from the knowledge framework or valorization framework, interact through the following classes of components; and to each of them, specific tools and contexts can be associated:

A) *The characteristics* of the cultural objects consist of three main classes of attributes, each of them with specific *support* and *landscape contexts*. Such attribute classes are the following:
   - *spatial,* corresponding to the various types of products/procedures related to a set of geographic territories;
   - *temporal,* corresponding to the various types of products/procedures related to time intervals;
   - *tangible,* corresponding to the various types of products/procedures related to tangible cultural objects;
   - *intangible,* corresponding to the various types of products/procedures related to intangible cultural objects;
   - *social,* corresponding to the social inspirations and/or motivations behind cultural objects;
   - *environmental,* corresponding to the environmental inspirations and/or motivations behind cultural objects;

B) *The processes that* act on the cultural objects, associated with specific *methodologies* and technologies derived from different *competence contexts* are to be developed. Such process classes are the following:

- *requirements*: the knowledge framework processes as emerging from the interaction between the demand agents (human commitment, nature predisposition, etc.) and supply agents (artists, land communities, etc.);
- *creation*: the knowledge framework processes as emerging from the realization of cultural objects corresponding to the various types of knowledge products/procedures associated with the interactions mainly among human beings, nature, and technology;
- *utilization*: the knowledge framework processes as emerging from the use of the (cultural) objects within the space-time corresponding to the knowledge framework;
- *monitoring*: the valorization framework processes as emerging from the identification and monitoring of cultural objects;
- *conservation*: the valorization framework processes as emerging from the preservation, corresponding to the various types of products/procedures associated with the diagnosis, preservation, restoration, and conservation of cultural objects;
- *fruition*: the valorization framework processes as emerging from the fruition of cultural heritage objects corresponding to the various types of products/procedures associated with fruition needs.

C) For each of the two frameworks (knowledge and valorization), the *objectives*, concerning the processes, belong to three classes and the choice among them is coherent to appropriate *cultural contexts* and represents specific *visions* of stakeholders. Such classes are the following:

- *cohesion* and *competitiveness* corresponding to the various types of products and procedures associated with decision making with respect to both the expectations and constraints of social cohesion and of market's *competitiveness*;
- *research* and *innovation*, corresponding to the various types of products and procedures associated with the expectations and constraints of both research (including investigation) and innovation;
- *education* and *entertainment*, corresponding to the various types of products and procedures associated with

both the expectations and constraints of education and entertainment.

33.3.1.2 Interaction Networks

The coevolution of heritage landscapes and landscape's cultures is enabled by the composition of basic interactions occurring among two or more elements of the classes described in the previous subsection. Such coevolution is based on query-answer mechanisms through the available information on these elements and on demand-supply mechanisms among involved stakeholders as explained in the following section.

For illustration purposes, let us consider explicitly the following types of networks.

A) Interaction Network of Cultural Objects' Characteristics

The interactions concerning the cultural objects' characteristics consist of all the possible relations generated by one or more of the following ones:

- spatial-temporal: cultural objects characterizing one or more time intervals are analyzed and presented in the perspective of one or more landscapes (and vice versa);
- tangible-intangible: properties of tangible cultural objects can be a "root starting point" for properties of intangible ones (and vice versa);
- social-environmental: corresponding to the various types of inspirations and/or motivations behind cultural objects coming out from the society and/or environment.

These types of interactions relative to the cultural objects' characteristics, together with their tools and contexts, are interconnected according to the adaptive demand/supply matching and define the LHC *Interaction Network of Cultural Objects' Characteristics.*

B) Interaction Network of Processes

The interactions concerning the various kinds of processes acting on cultural objects' characteristics consist of all the possible associations of information query-answer and operative demand-supply of services as illustrated below.

- in one direction from the needs of knowing, since it has been identified, recognized, and understood the identity value of a culture product/procedure, the interaction with the process of valorization arises by means of an enriCH-GeMS ent of the semantic and pragmatic descriptors of the valorization products/procedures with semantic and pragmatic descriptors associated with the knowledge products/procedures;

- in the other direction from the needs of valorization, since it has been identified, recognized, and understood the knowledge value of a culture product/procedure, the interaction with the process of knowledge arises by means of an enrichment of the semantic and pragmatic descriptors of the knowledge products/procedures with semantic and pragmatic descriptors associated with the valorization products/procedures. The processes of the knowledge and the valorization frameworks are represented by the following Table 33.1.

The interactions of the processes within and across the knowledge and the valorization frameworks are represented by the following hexagon, as shown in Figure 33.1.

These types of interactions relative to the processes, together with their tools and contexts, are interconnected according to query-answer and demand-supply matchings and define the LHC *Interaction Network of Processes*.

C) Interaction Network of Objectives

The interactions concerning the objectives enabling the above processes consist of all the possible associations of information query-answer and operative demand-supply generated by elements of the following pairs:

Table 33.1 Processes of the knowledge and the valorization frameworks.

	Pre-processes	**Processes**	**Post-processes**
Knowledge framework	Requirements: 1	Creation: 2	Utilization: 3
Valorization framework	Monitoring: 1*	Conservation: 2*	Fruition: 3*

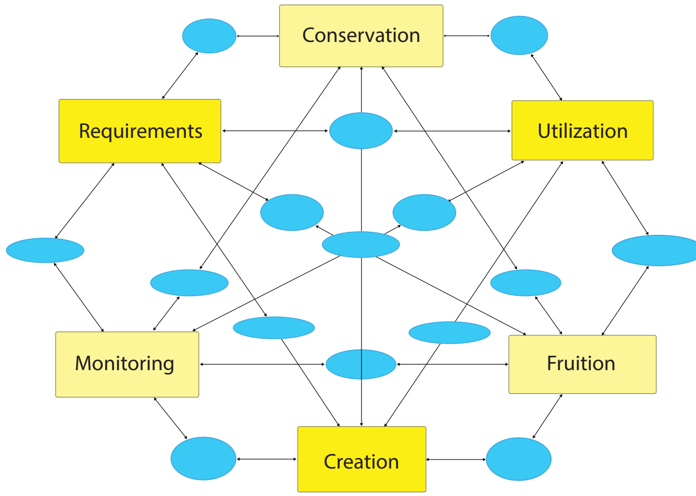

Figure 33.1 The hexagon of LHC processes interactions.

- the cohesion-competitiveness interaction consists of the impact of the issues of social cohesion on the economical-financial competition for what concerns the products/procedures associated with heritage, culture, and landscapes (and vice versa);
- the research-innovation interaction concerns in one direction the transfer of research into innovative products/procedures and, in the other direction, the identification of open problems raised by the realization and/or management of innovative products/procedures that can become research themes;
- the education-entertainment interaction concerns the impact of the expectations of the education objectives on the opportunities offered by the entertainment, relative to LHC and (and vice versa).

These types of interactions relative to the objectives, together with their tools and contexts, are interconnected according to query-answer and demand-supply matchings and define the LHC *Interaction Network of Objectives*.

33.3.1.3 Networks of Networks

The connections across the interaction networks of cultural objects' characteristics, processes, and objectives, within and across the knowledge framework and the conservation framework, characterize the information and the operative management of LHC.

More precisely, the proposed **LHC search engine** is based on the learning coevolution:

The "top-down search":

- the information search of the processes, methodologies, and competences best adapted for the realization of the objectives relative to a vision with respect to a cultural context;
- the information search of cultural objects' characteristics, supports, and land contexts more appropriate for enabling given processes, methodologies-technologies, and competences;
- the information search of cultural objects' characteristics, technologies, and land contexts best adapted for the realization of the objectives relative to a vision with respect to a cultural context;

and the "bottom up search";

- the information search of objectives, visions, and cultural contexts fitting with given selected processes, methodologies, and competences;
- the information search of processes, methodologies, and competences best fitting with selected cultural objects' characteristics, supports, and land contexts;
- the information search of the objectives, visions, and cultural contexts fitting with selected cultural objects' characteristics, supports, and land contexts.

Analogously, the proposed **LHC "governance and compliance" System** is based on the learning coevolution of the following:

Governance:

- the operative choice of the processes, methodologies, and competences best adapted for the realization of the objectives relative to a vision with respect to a cultural context;
- the operative choice of cultural objects' characteristics, supports, and land contexts more appropriate for enabling given processes, methodologies-technologies, and competences;

- the operative choice of cultural objects' characteristics, technologies, and land contexts best adapted for the realization of the objectives relative to a vision with respect to a cultural context;

and Compliance:

- the operative evaluation of the objectives fulfillment with respect to the enabled processes and the adopted methodologies and competences;
- the operative verification of the adequacy of the enabled processes and the adopted methodologies and competencies with respect to the selected cultural objects' characteristics, supports, and land contexts;
- the operative evaluation of the objectives fulfillment with respect to the selected cultural objects' characteristics, supports, and land contexts as shown in Figure 33.2.

The LHC x-management system, i.e., search engine (for x = information) and (for x = operative), can be considered as a complex adaptive

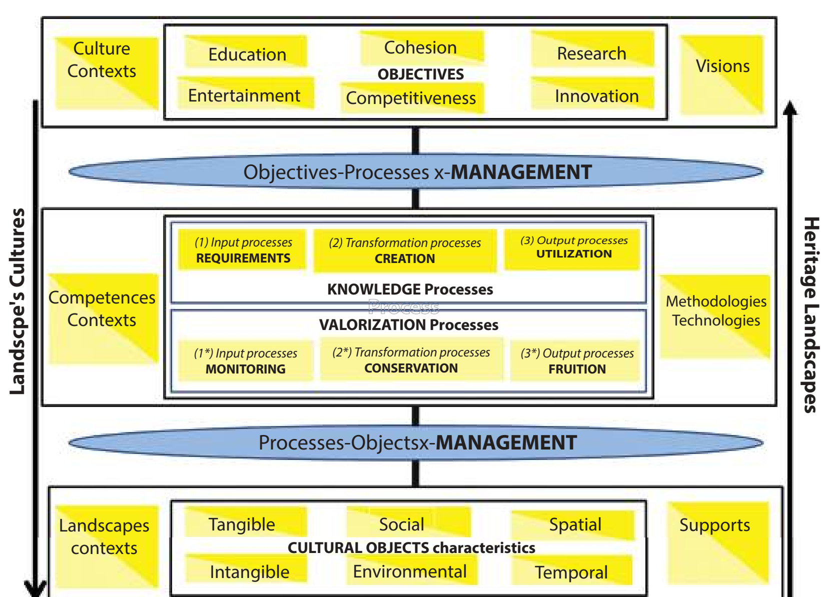

Figure 33.2 The landscapes, heritage, and culture x-management system.

learning system where interrelated information query-answer and operative demand-supply interactions occur at four complexity levels:

- for each framework, the interaction networks inside each of the classes of elements: the characteristics of cultural objects, the processes, and the objectives.
- for each framework, the networks of networks coupling two or more of the above interaction networks;
- the interconnections across networks of networks within the "knowledge framework" and networks of networks within the "valorization framework";
- the evolution of the networks of networks as induced by adaptation/learning mechanisms acquired over space and time, giving rise to networks dynamic interactions of networks of networks.

33.3.1.4 Networks of Networks of Networks N^3

The adaptation/learning mechanisms within and across the networks of networks acquired over space and time give rise to networks dynamic interactions of networks of networks, as shown in Table 33.2.

33.3.2 Services Dualities and Dynamic Data–Driven Simulations

The section introduces the main methodologies for the analysis, design, and management of the LHC. More precisely:

Table 33.2 Networks dynamic interactions.

N^3	**Learning pre-processes**	**Learning processes**	**Learning post-processes**
Learning Knowledge framework	Learning Requirements: L-1	Learning Creation: L-2	Learning Utilization: L-3
Learning Valorization framework	Learning Monitoring: L-1*	Learning Conservation: L-2*	Learning Fruition: L-3*

- the query-answer and demand-supply mechanisms giving rise to dualities of services associated with such matchings are presented in § 2.2.1 and
- the adaptive behavior of dynamical relations and feedback loops associated with such services are analyzed in § 2.2.2 by the dynamic data–driven applications simulations approach to the coevolution of data, simulations, and models.

33.3.2.1 Services Dualities

The general form of interaction between two elements of query-answer and demand-supply matchings can be related to the well-known double-entry bookkeeping system ("partita doppia") in accounting, invented by the Italian mathematician Luca Pacioli in the year 1494, called double-entry because each transaction is recorded in at least two accounts: each transaction results in at least one account being debited and at least one account being credited, with the total debits of the transaction equal to the total credits.

Moreover, the matching of demand and supply roles can be realized by a mediation mechanism of web services, as considered in interaction protocols, according to the following correspondence:

- "demand to be matched by" as "send request";
- "demand matched by" as "receive answer";
- "supply to be matched by" as "send answer";
- "supply matched by" as "receive request".

The evolution in time in a demand role or a supply role, of each stakeholder, is to be seen with respect to multiple stakeholders, at their turn in a supply role or a demand role, satisfying a matching event. Such evolution includes the iteration of the following phases:

- demand to be matched by a supply before a matching event,
- demand matched by (the) supply at a matching event,
- demand to be matched by a supply after a matching event;

and dually:

- supply to be matched by a demand before a matching event,
- supply matched by (the) demand at a matching event,
- supply to be matched by a demand after a matching event.

Consequently, the informative and operative learning interaction mechanisms are specified, respectively, as shown in Figure 33.3, and Figure 33.4 shows about the operative demand-supply learning interaction mechanism.

Moreover the same information entity i can play a query role Qi or an answer role Ai. Analogously the same operative entity i can play a demand role Di or a supply role Si. So the management "i&j" of the dual roles of two

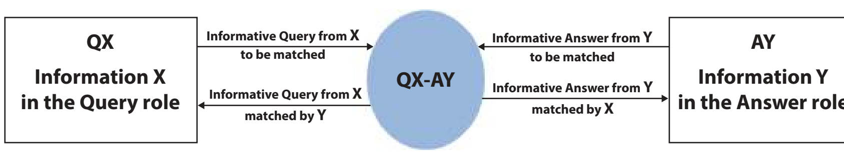

Figure 33.3 Informative query-answer learning interaction mechanism.

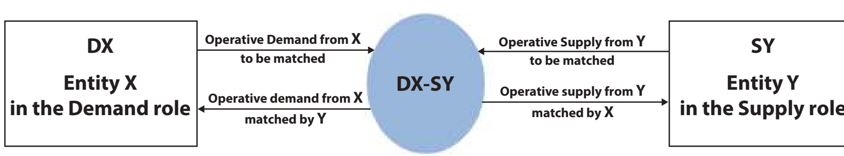

Figure 33.4 Operative demand-supply learning interaction mechanism.

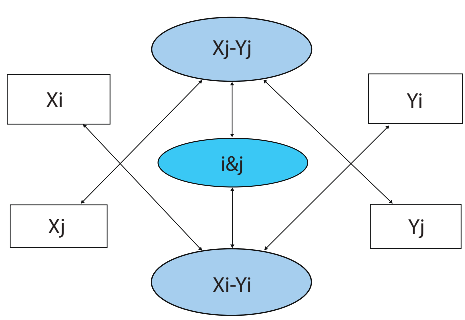

Figure 33.5 Management of the dual roles of two entities i and j.

Table 33.3 Demand-supply mechanism.

	Information management	Operative management
X	Information query	Operative demand
Y	Information answer	Operative supply

entities i and j w.r.t. the query-answer or the demand-supply mechanism can be summarized in the network in Figure 33.5, above, where X,Y vary according to the following Table 33.3.

33.3.3 Dynamic Data–Driven Applications Systems

The realization of the adaptive query-answer matching and demand-supply matching in LHC information and operative, respectively, management systems, which as seen in the previous subsection are based on the same interaction pattern, requires a software architecture enabling such a behavior.

The adaptive behavior of such matchings can be realized following the DDDAS [11] "dynamic data–driven applications simulations" paradigm, where

- applications (or simulations) and measurements become a symbiotic feedback control system;
- additional data are dynamically incorporated into an executing application and the application dynamically steers the measurement process;
- capabilities allow more accurate analysis and prediction, more precise controls, and more reliable outcomes.

Such a paradigm [5–9] entails the ability to incorporate additional data [14–19] into an executing application [22, 23] - these data can be archival or collected online; and in reverse, the ability of applications to dynamically steer the measurement process. This paradigm offers the promise of improving modeling methods, and augmenting the analysis and prediction capabilities of application simulations and the effectiveness of measurement systems (see, e.g., [11]).

Each of the matching mechanisms is, thus, realized according to the following figure where the adaptive matching could be realized by a kind of "DDDAS components", as an appropriate integration of the web services technologies and the DDDAS paradigm (e.g., in the same direction as the "autonomic components" [10]), toward "intelligent agents" in the Generative Artificial Intelligence paradigm as shown in Figure 33.6.

Such a vision suggests an interesting possibility to consider the proposed model of the informative and operative management of LHC interactions as a distributed intelligence system for LHC.

Such kind of *adaptive learning search engine* (i.e., adaptive learning information management system), having access to the dynamically updated

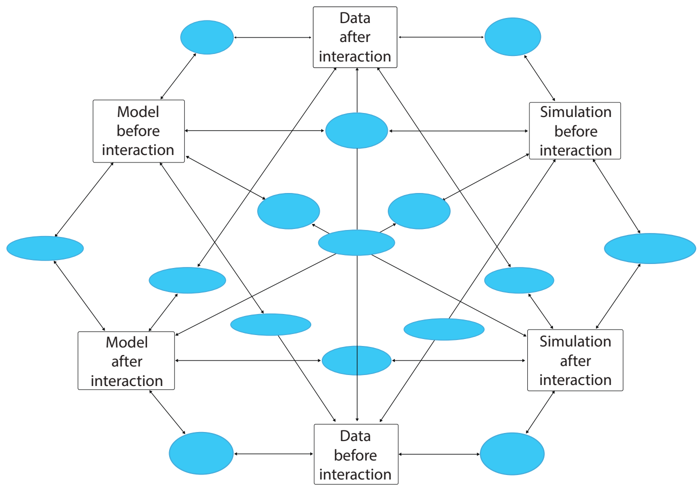

Figure 33.6 Dynamic data–driven application systems for LHC learning interactions.

knowledge of the properties of the elements and their interactions, allows, in particular, the following:

For the top-down search:

- the information search of the competences contexts, processes, and methodologies adaptively fitting the realization of the objectives relative to a vision and a cultural context: the landscape contexts, cultural objects, and supports being considered as parameters;
- the information search of landscape contexts, cultural objects, and technologies adaptively fitting processes, methodologies-technologies, and competences contexts: the cultural contexts, objectives, and visions being considered as parameters;
- the information search of landscape contexts, cultural objects, and technologies adaptively fitting the objectives relative to visions and cultural contexts: the competences contexts, processes, and methodologies-technologies being considered as parameters;

For the bottom-up search:

- the information search of the objectives relative to visions and cultural contexts adaptively fitting the processes and

the adopted methodologies-technologies and competences: the landscape contexts, cultural objects, and supports being considered as parameters;
- the information search of the competences contexts, processes, and methodologies-technologies adaptively fitting the selected landscape contexts, cultural objects, and supports: the considered cultural contexts, objectives, and visions being considered as parameters;
- the information search of the objectives relative to visions and culture contexts adaptively fitting the selected landscape contexts, cultural objects, and supports: the competences contexts, processes, and methodologies-technologies being considered as parameters.

Analogously, such kind of "governance and compliance" *adaptive learning system*, having access to the dynamically updated elements and their interactions, allows the following:

For governance:

- the choice of the competences contexts, processes, and methodologies best adapted for the realization of the objectives relative to a vision and a cultural context, the landscape contexts, cultural objects, and supports being considered as parameters;
- the choice of landscape contexts, cultural objects, and technologies more appropriate for enabling given processes, methodologies-technologies, and competences contexts, the cultural contexts, objectives, and visions being considered as parameters;
- the choice of landscape contexts, cultural objects, and technologies best adapted for the realization of the objectives relative to visions and cultural contexts, the competences contexts, processes, and methodologies-technologies being considered as parameters;

For compliance:

- the fulfillment evaluation of the objectives relative to visions and cultural contexts with respect to the enabled processes and the adopted methodologies-technologies and competences, the landscape contexts, cultural objects, and supports being considered as parameters,

- the adequacy verification of the competence's contexts, enabled processes, and adopted methodologies-technologies with respect to the selected landscape contexts, cultural objects, supports, the considered cultural contexts, objectives, and visions being considered as parameters;
- the fulfillment evaluation of the objectives relative to visions and culture contexts with respect to the selected landscape contexts, cultural objects, and supports, the competences contexts, processes, and methodologies-technologies being considered as parameters. Figure 33.7 shows the distributed augmented (human-artificial) intelligence systems. From what is presented, up to now, it is possible to consider the CH-GeMS.

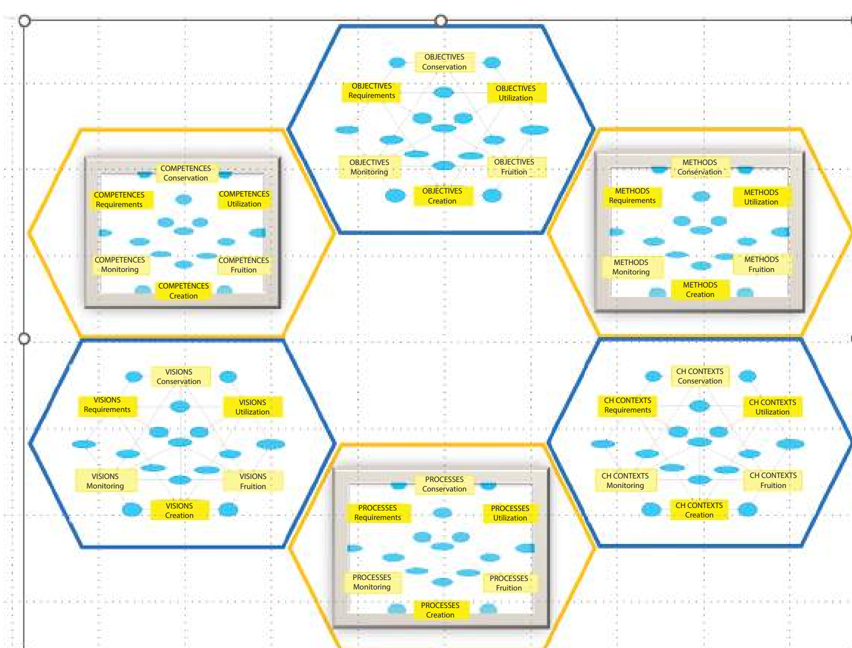

Figure 33.7 Distributed augmented (human-artificial) intelligence systems.

33.4 Conclusions

The interactions between heritage landscapes and landscape's cultures enable higher "values" of cultural heritage that is a productive function connected to the territorial platform and local identity; so, it is a not transferable factor of development, strictly related to an endogenous fruition of sustainable activities as cultural tourism, industrial innovation, and high-quality education. Furthermore, the interaction between heritage landscapes and landscape's cultures is a platform for innovative approaches, such as cultural planning and cultural economy, requiring appropriate general frameworks for strategic management and development policies that can be tuned to specific territorial systems.

For this purpose, the main result of the research we described in the present paper deals with a model of an interaction system oriented to the governance and compliance of heritage, culture, and landscapes based on an inter-quality paradigm. Recognizing to LHC G&C interaction System the properties of complex adaptive learning system, a conceptual architecture for its implementation, as an extension of the knowledge grid paradigm and dynamic data–driven application systems.

The general approach here proposed allows considering the result of our research from the point of view of governance as a "*project generator*" and from the point of view of compliance as an "*operating process*". A crucial point to be emphasized is that the development of specific projects as instances of the LHC G&C approach we have proposed requires appropriate international, national, and regional frameworks.

On this subject, we can observe, for example, that the interdisciplinary "Cultura e Territorio" Project [4] of the Italian National Research Council (CNR), Cultural Heritage Department, has been the first application generated by the proposed approach. Such a project aimed to develop tools for integrated management of the preservation-fruition cycle of heritage, culture, and landscape, including the scientific contribution of almost all other CNR departments and the participation of other main stakeholders coming from government institutions, national and local public administrations, scientific institutions, and public and private companies. Furthermore, it could contribute to the compliance of the guidelines formulated by the *UNESCO* World Heritage Centre about the aspects of the management of the preservation-fruition cycle [12, 13].

The stakeholders (e.g., government institutions, national public administrations, local administrations and communities, professional sectors, scientific institutions and cultural organizations, production entities such as public and private companies, and foundations) involved in the governance and compliance of LHC have, according to their institutional finality, different visions [3]. These different visions have to interact and be integrated in order to realize a conscious, shared, and participated "Learning Governance and Compliance model".

The UNESCO trilogy: World Heritage, Sustainable Development and Artificial Intelligence is pivotal for the research agenda proposed in this paper by adopting Generative Deep Learning methodologies and systems [24].

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