|| Volume 9 || Issue 5 || May 2025 || ISSN (Online) 2456-0774
INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH
AND ENGINEERING TRENDS

Retail Inventory Demand Forecasting using Machine Learning

Prof. Shantanu Pawar [1],Kaustubh Sagale [2],Abhishek Nighut [3], Sudarshan Thoke[4],Pragati Jadhav[5]

Information Technology, PES Modern College of Engineering (Savitribai Phule Pune University) Pune,India[1,2,3,4,5]

shantanu_pawar_@moderncoe.edu.in[1], kaustubh_sagale_it@moderncoe.edu.in[2], abhishek_nighut_it@moderncoe.edu.in[3], sudarshan_thoke_it@moderncoe.edu. In[4], pragati_jadhav_it@moderncoe.edu.in[5]

Abstract: Retail inventory management is a critical aspect of any retail business, directly impacting profitability, customer satisfaction, and operational efficiency. Traditional methods of demand forecasting, often based on historical sales data and intuition, lack the accuracy needed to optimize inventory levels, leading to either stock outs or overstocking. This project explores the application of machine learning techniques to forecast retail inventory demand more accurately. By leveraging historical sales data, market trends, seasonal patterns, and external factors like promotions and holidays, the machine learning model can predict future inventory requirements. Algorithms such as machine learning are evaluated for their performance in predicting demand. The results demonstrate that machine learning models significantly improve demand forecasting accuracy compared to traditional methods, enabling retailers to maintain optimal inventory levels, reduce costs, and improve customer satisfaction.

Keywords: *C NLP, machine learning, Kaggle*

I.INTRODUCTION:

Efficient inventory management is a cornerstone of success in the retail industry. Retailers must balance the need to meet customer demand with the costs of holding excess stock or facing stockouts. Traditional methods of demand forecasting that rely heavily on historical sales data and heuristic models often fail to capture the complexities of modern retail environments. These models may overlook critical variables such as changing consumer behaviors, promotional impacts, seasonality, and external influences like economic trends or weather conditions, resulting in inaccurate forecasts.

With the growing volume of available data and advancements in computational technologies, machine learning (ML) presents an opportunity to revolutionize demand forecasting. Large datasets and sophisticated algorithms enable ML models to uncover hidden patterns and correlations in data, which traditional methods often overlook. This enables retailers to make more accurate predictions about future demand, adjust inventory levels accordingly, and minimize both excess stock and lost sales due to stockouts.

Moreover, AI enhances inventory management by integrating predictive analytics with automation. By continuously analyzing sales trends, customer preferences, and external factors like weather or market disruptions, AI systems can suggest optimal inventory levels, recommend restocking schedules, and even forecast the success of upcoming promotions. This helps minimize excess stock, reduce holding costs, and prevent lost sales due to stockouts.

In addition, AI-driven tools provide actionable insights through intuitive dashboards and real-time reporting. These systems enable retailers to optimize supply chains, identify inefficiencies, and respond proactively to shifts in demand. The use of natural language processing (NLP) further allows AI to process unstructured data, such as customer reviews and social media trends, to gain a deeper understanding of consumer sentiment and preferences.

Ultimately, integrating AI into retail inventory management transforms it from a reactive process into a predictive and proactive strategy. This empowers retailers to not only meet customer expectations more effectively but also achieve significant cost savings and improve operational efficiency, paving the way for sustainable growth in an increasingly competitive market.

II.LITERATURE SURVEY

According to [1], a thorough analysis of the literature on the use of AI for stock market investments was conducted using 2326 papers from the Scopus database published between 1995 and 2019. Four groups emerged from these studies: portfolio optimization, artificial intelligence-based stock market forecasting, financial sentiment analysis, and combinations of two or more techniques. Each category describes the initial, introductory research and its cutting-edge applications. The review summary shows that this field is getting more attention and having more detailed and comprehensive literature.

According to [2], an autoencoder and 1D DenseNet were used to forecast closing stock prices using 10 years' worth of Yahoo Finance data for ten illustrious stocks and STIs. Less correlation was seen between the computed STIs as a consequence of the autoencoder's initial input of the generated STIs for dimensionality reduction. We then fed these STIs and the data from Yahoo Finance into the 1D DenseNet. The softmax layer, which is part of the 1D DenseNet architecture, predicts closing stock prices for the short, medium, and long term by using the output characteristics from 1D DenseNet as input. Our algorithm offered the user one of three proposed signals—buy, sell, or hold—based on the expected patterns of the stock prices.

According to [3], in the short term, the market behaves like a voting machine, but in the long run, it behaves like a weighing

machine; therefore, there is room for longer- term market prediction. A promising field is the use of machine learning methods and other algorithms for stock price research and forecasting. In the first section of this essay, we provide a brief overview of stock markets and a taxonomy of stock market prediction techniques. Then, we concentrate on a few scientific developments in stock analysis and forecasting. We examine methods for stock analysis that are technical, fundamental, short-term, and long-term.

We use MS Excel as the best statistical tool for graph and tabular representation of prediction results, focusing on linear regression (LR), three-month moving average (3MMA), exponential smoothing (ES), and time series forecasting, as suggested by [4]. After using LR, we successfully anticipated the stock market trend for the next month and also assessed accuracy in accordance with measures. We gathered data from Yahoo Finance for the stocks of Amazon (AMZN), Apple (AAPL), and Google (GOOG).

According to [5], the stock market organizations have projected their future performance. We selected four groups from the Tehran Stock Exchange for experimental assessments: diversified financials, petroleum, non-metallic minerals, and basic metals. We gathered information for the groupings based on ten years' worth of historical documents. We forecast the values for the next 1, 2, 5, 10, 15, 20, and 30 days. We forecasted future stock market group values using various machine learning techniques. We used artificial neural networks (ANN), recurrent neural networks (RNN), long short-term memory, bagging, random forest, adaptive boosting (Adaboost), gradient boosting, and extreme gradient boosting (XGBoost) (LSTM). We gave ten technical indicators to each of the prediction models' inputs.

According to [6], a detailed analysis of 50 research papers recommends various methods for stock market prediction, including the Bayesian model, fuzzy classifier, artificial neural network (ANN), support vector machine (SVM) classifier, neural network (NN), and machine learning methods. We categorize the collected papers using various prediction and clustering methods. We list and explain the research gaps and difficulties with the current methods, assisting the researchers in improving the upcoming works.

According to [7] Researchers have investigated both linear and machine learning technologies as successful prediction devices over the last two decades. Researchers are moving too quickly to keep up with the rapid advancements in deep learning models. This survey aims to provide an up-to-date evaluation of recent efforts on deep learning models for stock market prediction. Along with classifying the numerous data sources, neural network architectures, and widely used assessment measures, we also consider implementation and repeatability.

According to [8], the long short-term memory neural network with an automatic encoder and the deep long short-term memory neural network (LSTM) with an embedded layer are used for stock market forecasting. We use the embedded layer and the automatic encoder in these two models to vectorize the data so that a long-short-term memory neural network can predict the stock.

According to [9], a thorough analysis of 30 research papers recommends various techniques, including calculation techniques, machine learning algorithms, performance metrics, and top journals. We use research questions to guide the selection of the studies. As a result, these chosen studies are assisting in the discovery of ML methods and their dataset for stock market prediction. We use the most popular ANN and NN techniques to produce accurate stock market predictions. Despite significant effort, the most recent stock market- related prediction methodology has many drawbacks. This study assumes that stock market forecasting is a comprehensive process, with specific parameters for stock market forecasting being considered more accurate.

According to [10], a study was conducted on social media and financial news data to determine the impact of this data on the accuracy of stock market forecasting for an additional ten days. We apply feature selection and spam tweet reduction to the data sets to improve the performance and quality of predictions. Additionally, we conduct trials to pinpoint stock markets that pose forecasting challenges, as well as those heavily influenced by social media and financial news. We evaluate the outcomes of several methods to identify a reliable classifier. Finally, we ensemble certain classifiers and use deep learning to provide predictions with the highest degree of accuracy.

III.RESEARCHE MTHODOLOGY

We first gathered information from a variety of sources, including different web applications, Retail Inventory Demand market data set details, and a few synthetic data sets from diverse sources. The system can predict product market demand by analyzing text data. Any application can evaluate the system's synthesis and real- time text data. The system has training as well as a testing phase for classification. The system uses machine learning algorithms to find the retail inventory demand predictive. Figure 1 shows the proposed system architecture with the machine learning classifier. Evaluate the system based on accuracy and false ratios

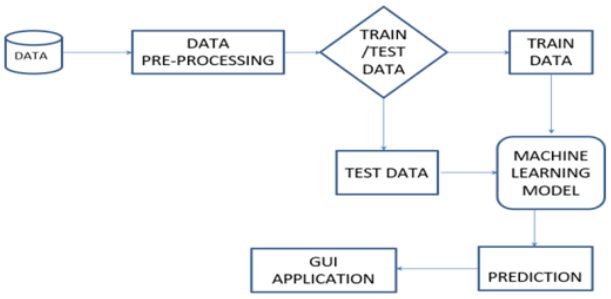

Figure 1: Research methodology of proposed system

Implement Model

Dataset Collection

This research extracts the Retail Inventory Demand dataset from Kaggle and several real-time data sources. We first gather data from aviation firms, analyze, extract, and subject it to machine learning algorithms, and then forecast the outcome based on

accuracy.

Pre-processing and normalization

The data may contain a significant amount of redundant information and gaps. Data preparation is carried out to handle this portion. Numerous data preprocessing techniques exist, such as data cleansing, data transformation, and data reduction.

Feature extraction and Selection

From the data input, this procedure retrieves a variety of features. We then standardize the extracted features using a feature selection threshold, eliminating redundant and unnecessary features for training. We use the normalized data with relational characteristics to extract a variety of hybrid attributes, and then select an optimization strategy for training.

Classification

Upon successful execution of the module, the training module receives the selected features as input, generating comprehensive background knowledge for the system. Once we have the training model, we can input the testing data into it to obtain the classification prediction. The testing stage includes preprocessing of the testing text, vectorization, and classification of the testing text. The module testing evaluates the system's predictive performance using machine learning methods.

Types of Forecasting Methods

Traditional Forecasting Techniques: The author examines statistical techniques such as ARIMA (AutoRegressive Integrated Moving Average), Exponential Smoothing, and moving averages, emphasizing their constraints in intricate and ever- changing retail settings.

Machine Learning Approaches: An overview of machine learning techniques that have shown promise in improving demand forecasting is provided.

Supervised Learning: Regression models, decision trees, support vector machines (SVM), k-nearest neighbors (KNN), and neural networks.

Unsupervised Learning: Clustering algorithms for segmenting products or stores with similar demand patterns.

Reinforcement Learning: Discusses its potential for optimizing long-term inventory strategies.

IV.CHALLENGES AND LIMITATIONS

Data Quality and Quantity: While high- quality data is essential, real-time data may be limited or deficient.

Scalability: Machine learning models must be scalable across several product categories and geographic regions.

Interpretability: Numerous sophisticated models, such as deep learning, function as black-box systems, making them difficult to analyze.

V.CONCLSUION

The Retail Inventory Demand Forecast Utilizing Machine Learning project illustrates the potential of machine learning to revolutionize inventory management within the retail industry. Through the use of machine learning models such as Cosine similarity, we developed a predictive system capable of reliably forecasting inventory needs based on past sales data, seasonal trends, and other significant variables. The findings demonstrate that machine learning models, especially those designed for time series data, may markedly enhance the precision of demand projections relative to conventional approaches. Our models empower retailers to make more educated choices on stock replenishment, therefore mitigating both overstock and understock challenges. This increased forecasting capacity may result in superior resource allocation, cost reductions, heightened customer satisfaction, and eventually enhanced operational efficiency.

VI.REFERENCES

[1]Ferreira, Fernando GDC, Amir H. Gandomi, and Rodrigo TN Cardoso. "Artificial intelligence applied to stock market trading: a review." IEEE Access 9 (2021): 30898-30917.

[2]Albahli, Saleh, et al. "AEI-DNET: a novel densenet model with an autoencoder for the stock market predictions using stock technical indicators." Electronics 11.4 (2022): 611.

[3]Shah, Dev, Haruna Isah, and Farhana Zulkernine. "Stock market analysis: A review and taxonomy of prediction techniques." International Journal of Financial Studies 7.2 (2019): 26.

[4]Umer, Muhammad, Muhammad Awais, and Muhammad Muzammul. "Stock market prediction using machine learning (ML) algorithms." ADCAIJ: Advances in Distributed Computing and Artificial Intelligence Journal 8.4 (2019): 97-116.

[5]Nabipour, Mojtaba, et al. "Deep learning for stock market prediction." Entropy 22.8 (2020): 840.

[6]Gandhmal, Dattatray P., and K. Kumar. "Systematic analysis and review of stock market prediction techniques." Computer Science Review 34 (2019):100190.

[7]Jiang, Weiwei. "Applications of deep learning in stock market prediction: recent progress." Expert Systems with Applications 184 (2021): 115537.

[8]Pang, Xiongwen, et al. "An innovative neural network approach for stock market prediction." The Journal of Supercomputing 76.3 (2020): 2098-2118.

[9]Kumar, Deepak, Pradeepta Kumar Sarangi, and Rajit Verma. "A systematic review of stock market prediction using machine learning and statistical techniques." Materials Today: Proceedings (2021).

[10]Khan, Wasiat, et al. "Stock market prediction using machine learning classifiers and social media, news." Journal of Ambient Intelligence and Humanized Computing (2020)