Sales predictor system using Artificial Intelligence

Siddharth Bhorge[1], Mrunal Shinde[2], Sameer Tadavi[3], Prasad Shevale[4], Akash Sonawane[5]
[1,2,3,4,5] *Dept. of Electronics & Telecommunication Engineering, Vishwakarma Institute of Technology Maharashtra, India*

Abstract*—Predicting sales accurately is crucial for businesses to optimize inventory management, plan marketing strategies, and maximize revenue. We propose a neural network-based approach for real-time sales prediction of products. The proposed model leverages historical sales data, pricing information, promotional activities, seasonality indicators, and other relevant factors to forecast future sales volumes. The neural network architecture consists of multiple hidden layers with appropriate activation functions and a linear output layer for regression tasks. Training is performed using optimization algorithms such as Adam, with regularization techniques like dropout to prevent overfitting. The model's performance is evaluated using metrics such as mean squared error (MSE) and mean absolute error (MAE) on separate validation and test datasets. Through experimentation and fine-tuning of hyperparameters, the proposed neural network model demonstrates promising accuracy and generalization ability in predicting sales based on real-time data. This research contributes to the advancement of predictive analytics in retail and e-commerce industries, enabling businesses to make data-driven decisions and improve operational efficiency.

***Keywords*—Artificial Intelligence, Sales Prediction, Machine learning**

I. INTRODUCTION

In today's rapidly evolving marketplace, businesses face the challenge of accurately forecasting sales to optimize resource allocation, enhance customer satisfaction, and maximize profitability. Traditional methods of sales prediction often fall short in capturing the dynamic nature of consumer behavior and market trends. However, recent advancements in machine learning and neural network technologies offer promising solutions for real-time sales forecasting, leveraging the wealth of data available in the digital era. This research explores the application of neural network models in predicting sales for products based on real-time data. Neural networks are computational models inspired by the structure and function of the human brain, capable of learning complex patterns and relationships from large-scale datasets. By harnessing the power of neural networks, businesses can gain insights into consumer preferences, market dynamics, and competitive trends, enabling informed decision-making and strategic planning. The proposed approach utilizes a multi-layer neural network architecture, comprising input, hidden, and output layers, to analyze historical sales data, pricing information, promotional activities, seasonality indicators, and other relevant features. The neural network learns from past sales patterns to generate forecasts of future sales volumes, providing valuable insights into demand forecasting and inventory management. Key technologies used in this research include optimization algorithms such as Adam, which efficiently update the neural network parameters during training, and regularization techniques like dropout, which prevent overfitting by randomly dropping connections between neurons. Additionally, evaluation metrics such as mean squared error (MSE) and mean absolute error (MAE) are employed to assess the accuracy and generalization ability of the neural network model on validation and test datasets.

II. LITERATURE SURVEY

This paper proposes a novel approach to sales prediction in e-marketing using artificial neural networks. By leveraging customer feedback from e-commerce platforms, the proposed model enables marketers to identify potential customers and forecast future sales volumes with greater precision. Moving forward, further research is warranted to explore additional factors influencing sales prediction accuracy and to refine the proposed model for broader applicability across diverse product categories and market segments.[1]

The authors have proposed an AI-based sales forecasting approach tailored for food and beverage (F&B) outlets, addressing their reliance on experience-based methods. Leveraging over 5 years of hourly sales data from a fast-food franchise in Germany, the model incorporates various factors including promotions, weather, holidays, and economic indicators. Results demonstrate significant improvement over heuristic forecasts, reducing errors

by 22% to 33%. While requiring managerial input for predictor selection and real-world testing, this approach promises practical benefits for F&B businesses, enhancing operational efficiency and environmental sustainability..[2]

This review explores various intelligible predictive models aimed at improving future sales forecasts. Recent advancements in forecasting techniques, particularly those utilizing machine learning, offer enhanced capabilities in handling large datasets and ensuring accuracy. Among these techniques, the linear regression model stands out for its ability to provide high levels of forecasting accuracy. Sales forecasting entails the estimation of sensible sales targets through comprehensive analysis, considering various external factors such as economic conditions and demand trends, as well as internal factors like marketing strategies and product attributes..[3]

Recent literature underscores the pivotal role of Artificial Intelligence (AI) in advancing sales forecasting, offering heightened precision and efficiency compared to traditional methodologies. While conventional techniques such as time series analysis provide a foundation, they often fall short in capturing the intricacies of dynamic market conditions. Comparative studies highlight AI's superiority, with neural networks frequently outperforming regression and Support Vector Machine (SVM) models. However, challenges persist, including issues with data quality and model interpretability. Future research directions focus on hybrid approaches integrating AI with traditional methods, alongside the integration of real-time data sources for more dynamic forecasting. Overall, AI-based sales forecasting holds immense promise for enhancing decision-making processes and resource allocation within businesses..[4]

The abstract introduces a framework for sales prediction in e-commerce, leveraging historical data to enhance customer service. Challenges include language complexity, feature integration, and missing values. The proposed framework consists of two phases: feature extraction from product attributes and reviews, followed by tensor decomposition for multi-source learning. Experimental results demonstrate a 73% improvement over baseline methods, indicating the efficacy of the proposed approach in accurately estimating product sales on e-commerce platforms.[5]. The proposed system highlights the significance of sales prediction for retail businesses like Big Mart. Traditional forecasting models face limitations in handling nonlinear data, leading to the adoption of Machine Learning (ML) techniques. ML enables efficient processing of vast datasets like the Big Mart dataset, facilitating accurate sales predictions. The study proposes a prediction model incorporating Grid Search Optimization (GSO) for parameter optimization. Results indicate the superiority of the proposed model in surpassing others, enhancing proactive inventory management and meeting consumer demand effectively.[6]

The paper addresses the impact of COVID-19 on offline retail and proposes a B2C model transformation using historical sales data and behavior analytics. Employing RFM analysis, XGBoost, and Random Forest algorithms, it develops sales prediction and product recommendation models, achieving significant accuracy improvements and offering practical insights for business transformation in similar situations.[7]

The paper highlights the significance of accurate sales prediction in the era of online shopping dominance and the challenges faced by traditional retailers in revenue growth. It proposes leveraging AI-driven forecasts to optimize product offerings and increase sales, emphasizing the need for accessible tools and expertise for efficient purchase management. Addressing the evolving business landscape and customer expectations, the study underscores the importance of sales forecasting for maintaining optimal inventory levels and ensuring business profitability in a competitive market.[8]

The case study introduces AI-based sales forecasting for food and beverage (F&B) outlets, addressing challenges of reliance on experience-based heuristics. By leveraging machine learning (ML) techniques and diverse data sources like sales history, weather conditions, and regional events, the approach improves predictive accuracy. Using 5 years of sales data from a German fast-food franchise, the model outperforms heuristic forecasts, reducing errors significantly. While requiring managerial involvement initially, this method offers practical benefits for F&B businesses, enhancing operational efficiency and planning. Key elements include extreme gradient boosting, real-time API integration, and feature importance analysis tailored for small and medium businesses in the restaurant industry.[9]

The study analyzes phytosanitary treatment sales in Morocco's Souss Massa region, aiming to forecast agricultural product sales for supply chain

optimization. Utilizing data from Microsoft Dynamics AXAPTA ERP system, including sale dates, farming type, and regional details, machine learning techniques are employed for forecasting. Evaluation of regression models, notably Gradient Boosting Regressor, yields promising results with low Mean Absolute Error (MAE) and Root Mean Square Error (RMSE), contributing to agricultural sales prediction considering regional and climatic factors.[10]

"Intelligent Sales Prediction Using Machine Learning Techniques" explores the application of machine learning in sales forecasting. It discusses the development of predictive models to forecast sales using various machine learning techniques. The study aims to optimize sales prediction accuracy and effectiveness in business operations.[11]

III. METHODOLOGY

The implementation of the system includes several modules to develop the foundation of the AI system, structure for prediction and user visibility on the higher level.

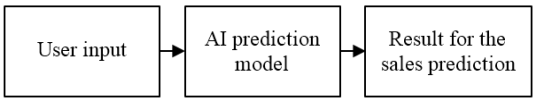

Fig.1 System Architecture for the AI sales predictor.

A. User Interface:

The AI sales predictor's front-end is designed to be easy and user-friendly, allowing users to effortlessly engage with sales data and predictions. The HTML page has a clean and modern style, with responsive features to enable compatibility across multiple devices. Key features include interactive dashboards, real-time data visualization via graphs and charts, and user input areas for tailoring forecasts to specific parameters such as product categories, time intervals, and geographical regions. The interface also contains an overview area that displays key performance indicators (KPIs) and major trends, allowing users to rapidly understand the sales prospects. Using advanced web technologies such as HTML5, CSS3, and JavaScript, the front-end ensures a smooth and engaging user experience, making the system more adaptive for new users.

B. Data Pipeline and Integration:

The AI sales predictor project's pipeline is a complete procedure that starts with data collection and finishes with real-time analytics. The pipeline begins with data aggregation from several sources, including point-of-sale systems, inventory databases, consumer feedback, and external elements such as weather forecasts and social media trends. The raw data is subsequently cleaned and normalized to ensure correctness and consistency. The next step is to turn the cleaned data into an analysis-ready format. This modified data is put into a centralized data warehouse or cloud storage solution, making it available to AI algorithms. Integration tools and APIs are used to ensure that data flows seamlessly between the front-end and back-end systems. The pipeline also includes real-time data streaming technologies, which allow for constant data upgrades and ensure that the AI models are working with the most up-to-date information available. This rich data pipeline is critical for making accurate and timely predictions, allowing organizations to respond quickly to new trends and market shifts.

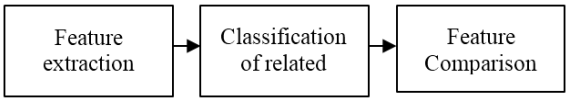

Fig.2 Data pipeline structure of the AI prediction system.

Figure 2 demonstrates the data pipeline of the system, it includes feature classification, extraction and prediction of the important features related to sales.

C. Machine Learning Implementation

The foundation of the AI sales predictor is its machine learning implementation, which is intended to provide precise sales projections and insights. The process starts with choosing relevant machine learning techniques, such as regression models, decision trees, and neural networks, based on the complexity and type of the sales data. These models are trained using past sales data to identify patterns and trends that affect sales success. Feature engineering is an important stage in which relevant features such as seasonal effects, promotional efforts, and economic indicators are found and integrated into the model to improve its predictive potential. The trained models are then validated and evaluated to ensure they are accurate and reliable. Once deployed, these models continue to learn from fresh data and improve their predictions over time. Real-time data integration enables models to constantly change forecasts, offering current insights. Advanced approaches such as ensemble and deep learning may also be used to improve forecast accuracy. The machine learning solution is intended to be scalable, allowing the system to manage vast

amounts of data and deliver predictions quickly, allowing supermarkets to make data-driven decisions and optimize their operations effectively.

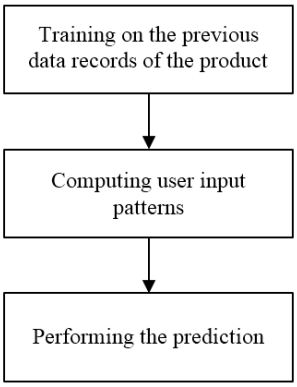

Fig.3 Prediction model design for the AI sales predictor.

Figure 3 represents the structure of the machine learning model responsible for the prediction results generation.

IV. RESULTS & DISCUSSION

The system is developed using machine learning algorithms trained over the product data, which contains different features related to every product. The system has predicted the sales of many different products over the inputs of users. We are getting accurate results on every type of input combination for different categories of products.

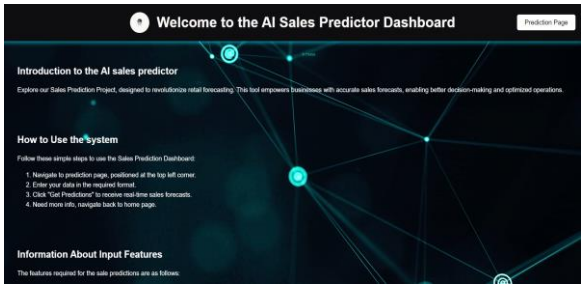

Fig 4.1 Dashboard of the AI sales predictor system.

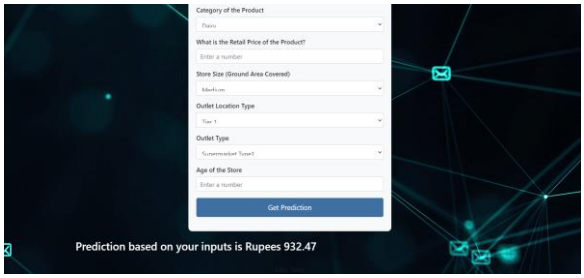

Fig 4.2 Input panel for the AI sales predictor system

Figure 4.1 & 4.2 represents the end results for the AI sales predictor system, the dashboard and the input panel are being demonstrated in the given figures respectively.

V. CONCLUSION

The installation of an AI sales prediction model marks a significant leap in the retail business, giving supermarkets powerful tools for optimizing sales strategies and improving decision-making processes. Businesses may receive real-time insights into sales patterns, inventory management, and consumer behavior by combining an easy-to-use front-end interface, a strong data pipeline, and sophisticated machine learning algorithms. AI-driven forecasts allow supermarkets to quickly adjust to changing market conditions, customize marketing efforts, and optimize operations for better efficiency and profitability. Looking ahead, the breadth of AI sales predictors has enormous opportunity for additional refinement and innovation. Future developments may include improved predictive accuracy through the use of advanced AI techniques, integration with emerging technologies such as IoT devices for real-time data collection, and the expansion of predictive capabilities to cover more aspects of retail operations than just sales forecasting. As AI advances, so will the capabilities of AI sales forecasters, allowing supermarkets to stay ahead of the curve and thrive in an increasingly.

REFERENCES

[1] S. Cheriyan, S. Ibrahim, S. Mohanan and S. Treesa, "Intelligent Sales Prediction Using Machine Learning Techniques," 2018 International Conference on Computing, Electronics & Communications Engineering (iCCECE), Southend, UK, 2018, pp. 53-58, August 2018 doi: 10.1109/iCCECOME.2018.8659115.

[2] Biswajit Biswas, Manas Kumar Sanyal, Tuhin Mukherje, "AI-Based Sales Forecasting Model for Digital Marketing," International Journal of E-Business Research (IJEBR), 19(1):1-14, January 2023 doi: 10.4018/IJEBR.317888.

[3] Omkar Kumbhar , Saurabh Redekar , Prof. S. H. Thengil, "Sales Prediction in Business Using AI and Machine Learning Techniques," International Journal of Advanced Research in Science, Communication and Technology (IJARSCT), Volume 2, Issue 2, May 2022 doi: 10.48175/568.

[4] Groene, N., Zakharov, S. Introduction of AI-based sales forecasting: how to drive digital

transformation in food and beverage outlets. Discov Artif Intell 4, 1 (2024). https://doi.org/10.1007/s44163-023-00097-x.

[5] Nebri Mohamed-Amine, Moussaid Abdellatif, Bouikhalene Belaid, "Artificial intelligence for forecasting sales of agricultural products: A case study of a moroccan agricultural company," Journal of Open Innovation: Technology, Market, and Complexity,Volume 10, Issue 1, 2024,,ISSN 2199-8531, doi: org/10.1016/j.joitmc.2023.100189.

[6] Vahid Sohrabpour, Pejvak Oghazi, Reza Toorajipour, Ali Nazarpour, "Export sales forecasting using artificial intelligence," Technological Forecasting and Social Change, Volume 163, February 2021 doi.org/10.1016/j.techfore.2020.120480.

[7] Ahmadov, Y., Helo, P. "Deep learning-based approach for forecasting intermittent online sales," Discov Artif Intell 3, 45, December 2023 doi:org/10.1007/s44163-023-00085-1

[8] Yuanpu Hu, "Sales Prediction Based on State-of-art Machine Learning Scenarios," International Conference on Financial Innovation, FinTech and Information Technology, January 2023, doi:10.4108/eai.28-10-2022.2328458

[9] Jain, Harshit and Vashi, Dattpalsinh and Kumar Ray, Sumit and Vishal, Vishal, "Sales Prediction Using Machine Learning," Kilby 100: 7th International joint conference on computing sciences, May 5, 2023.

[10] Biswas, B., Sanyal, M. K., & Mukherjee. T, "AI-Based Sales Forecasting Model for Digital Marketing," International Journal of E-Business Research (IJEBR), 19(1), 1-14. January 2023 http://doi.org/10.4018/IJEBR.317888.