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AI BASED SALES FORECASTING AND PRODUCT DEMAND PREDICTION

[1]MRS.SRAVANTHI,[2]SANE.SRUTHIKA,[3]KURA.SAKETH,[4]KATTA.DURGA VEERENDRA,[5]R.INDRASENA REDDY

[1]Assistant Professor,Department of computer science & engineering (DS),Malla Reddy College of Engineering, secunderabad , Hyderabad.

[2,3,4,5]UG Students,Department of computer science & engineering (DS),Malla Reddy College of Engineering, secunderabad , Hyderabad.

ABSTRACT

Accurate demand forecasting plays a pivotal role in optimizing inventory management and enhancing overall business efficiency, particularly in the retail and ecommerce sectors. In this study, we propose the implementation of the Prophet model, a robust time series forecasting tool developed by Facebook's Core Data Science team, to predict product demand in both retail shops and ecommerce platforms. Leveraging historical sales data, seasonality patterns, and trend information, the Prophet model offers a flexible and intuitive framework for generating accurate demand forecasts at various temporal granularities.

Our methodology involves preprocessing the sales data, including cleaning, normalization, and segmentation based on product categories or SKUs. Subsequently, we train separate Prophet models for each product category or SKU to capture unique demand patterns and dynamics. The model training process incorporates automatic detection of changepoints, enabling the adaptation to shifts in demand trends over time. Additionally, we integrate external factors such as holidays and promotions as informative regressors to enhance forecast accuracy.

To evaluate the performance of the Prophet model, we employ standard metrics such as Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE) on holdout validation datasets. Furthermore, we compare the forecasting performance of the Prophet model with traditional time series forecasting methods to demonstrate its superiority in capturing complex demand patterns and improving forecast accuracy.

Our experimental results demonstrate the effectiveness of the Prophet model in accurately forecasting product demand in both retail and ecommerce environments. By providing reliable demand predictions, our approach empowers businesses to optimize inventory levels, reduce stockouts, minimize excess inventory costs, and ultimately enhance customer satisfaction and profitability. This research contributes to advancing the field of demand forecasting in retail and ecommerce, offering practical insights and methodologies for businesses seeking to improve their forecasting capabilities and operational efficiency.

I.INTRODUCTION

In today's dynamic business landscape, accurate sales forecasting and demand prediction are critical for organizations to optimize inventory management, plan production schedules, and allocate resources effectively. With the advent of artificial intelligence (AI) technologies, businesses have gained new insights and capabilities to enhance their forecasting processes. The AI-based sales forecasting and demand prediction project aim to leverage advanced machine learning algorithms and data analytics techniques to develop a robust system capable of accurately predicting sales trends and customer demand.

This project addresses the challenges faced by businesses in forecasting sales and predicting demand accurately, especially in industries characterized by volatile market conditions and rapidly changing consumer preferences. By harnessing the power of AI, the project seeks to improve the accuracy, reliability, and efficiency of sales forecasting models, enabling organizations to make informed decisions and adapt quickly to market fluctuations.

Key objectives of the project include:

➢ Developing machine learning models trained on historical sales data, market trends, and external factors to predict future sales trends and demand patterns.

➢ Implementing data preprocessing techniques to clean, transform, and normalize the input data, ensuring the quality and consistency of the dataset.

➢ Evaluating the performance of the AI-based forecasting models using metrics such as accuracy, precision, recall, and mean absolute error.

➤ Deploying the trained models into production environments, integrating them into existing business processes and decision-making workflows.

➤ Collecting feedback from users and stakeholders to continuously improve and refine the forecasting models, enhancing their effectiveness and relevance over time.

II.EXISTING SYSTEM

In the existing system, demand forecasting in retail shops and ecommerce platforms may rely on traditional methods or ad-hoc forecasting approaches.

Traditional Methods:

➤ Many retail businesses and ecommerce platforms still utilize traditional forecasting methods such as moving averages, exponential smoothing, or simple regression models.

➤ These methods often require manual intervention, lack the ability to capture complex demand patterns, and may struggle to incorporate external factors such as holidays or promotions effectively.

Ad-Hoc Approaches:

➤ In some cases, businesses may employ ad-hoc approaches to demand forecasting, relying on spreadsheets, basic statistical tools, or even intuition.

➤ While these approaches may suffice for short-term forecasting or small-scale operations, they are often inadequate for managing large inventories or addressing the complexities of modern retail environments.

III.PROPOSED SYSTEM

The proposed system involves the implementation of the Prophet model for demand forecasting in both retail shops and ecommerce platforms, offering a more advanced and data-driven approach.

Prophet Model Implementation:

➤ The core component of the proposed system is the integration of the Prophet model into the demand forecasting process.

➤ Prophet is a robust time series forecasting tool developed by

Facebook, designed to handle seasonality, trends, and holiday effects automatically.

➢ By leveraging historical sales data and incorporating domain knowledge, the Prophet model generates accurate demand forecasts at various temporal granularities.

Data Preprocessing:

➢ Before applying the Prophet model, the data undergo preprocessing steps to clean, normalize, and segment the sales data based on product categories or SKUs.

➢ This preprocessing ensures that the input data are suitable for training the Prophet model and capturing the unique demand patterns of each product category.

➢ Model Training and Parameter Tuning:

➢ The Prophet model is trained separately for each product category or SKU, allowing for the customization of forecasting models to specific products.

➢ During model training, parameters such as seasonality prior scales, holidays, and changepoints are

automatically determined or manually adjusted to optimize forecast accuracy.

Incorporation of External Factors:

➢ In addition to historical sales data, the proposed system incorporates external factors such as holidays, promotions, weather data, and macroeconomic indicators as informative regressors.

➢ By integrating these external factors into the forecasting model, the system can capture the impact of events and trends that may influence product demand.

Model Evaluation and Validation:

➢ The performance of the Prophet model is evaluated using standard metrics such as Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE) on holdout validation datasets.

➢ Model validation ensures that the forecast outputs are accurate and reliable, providing confidence to stakeholders for decision-making purposes.

By transitioning from traditional or ad-hoc forecasting approaches to the proposed system leveraging the Prophet model, businesses can enhance their demand forecasting capabilities, optimize inventory management processes, and ultimately improve customer satisfaction and profitability in both retail and ecommerce environments.

IV.MODULES

Module 1: Retail Shop Product Demand Forecasting

User Interface:

- The retail shop demand forecasting module provides a user-friendly interface where users can select the product for which they want to forecast demand.
- Users input the desired number of days for which they want to forecast demand, specifying the forecast horizon.

Data Input and Processing:

- The module processes historical sales data for the selected product, including information such as sales volume, dates, and any relevant external factors.
- Data preprocessing techniques are applied to clean and prepare the input data for model training.

Model Training and Forecasting:

- The Prophet model is trained using the preprocessed historical sales data, capturing the seasonality, trends, and other patterns specific to the selected product.
- Forecasting is performed based on the trained model, generating demand predictions for the specified forecast horizon.

Output Generation:

- The module generates a forecast report displaying the predicted demand for the selected product over the specified number of days.
- Additionally, a time series graph is provided to visually represent the forecasted demand trends, aiding in interpretation and decision-making.

Module 2: Ecommerce Platform Product Demand Forecasting

User Interface:

- The ecommerce platform product demand forecasting module offers a user-friendly interface similar to the retail shop module.
- Users select the product they wish to forecast demand for and input the desired forecast horizon in terms of days.

Data Input and Processing:

- Similar to the retail shop module, historical sales data for the selected product are processed, including relevant external factors such as promotions, seasonality, and website traffic.
- Data preprocessing techniques are applied to ensure the input data are suitable for model training.

Model Training and Forecasting:

- The Prophet model is trained using the processed historical sales data, capturing the unique demand patterns of the selected product on the ecommerce platform.
- Forecasting is conducted based on the trained model, generating predictions of product demand for the specified forecast horizon.

Output Generation:

- Similar to the retail shop module, the ecommerce platform module generates a forecast report displaying the predicted demand for the selected product over the specified number of days.
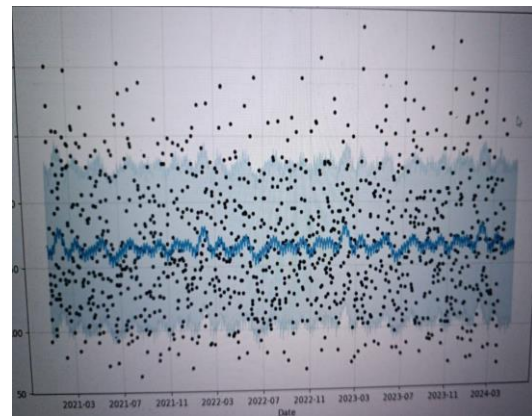
- Additionally, a time series graph is provided to visualize the forecasted demand trends, facilitating understanding and decision-making for ecommerce platform stakeholders.

Integration and Deployment:

Both modules are seamlessly integrated into their respective environments, allowing retail shop owners and ecommerce platform managers to access demand forecasting capabilities directly within their existing systems. The modules are deployed on scalable and reliable infrastructure to ensure robust performance and availability.

Benefits:

- By providing accurate demand forecasts and intuitive visualization tools, both modules empower retail shop owners and ecommerce platform managers to make informed decisions regarding inventory management, procurement, and marketing strategies.

- The ability to customize forecast horizons and select specific products enhances the modules' flexibility and utility for users with diverse business needs and objectives.

- Continuous monitoring and feedback mechanisms enable iterative improvement of the forecasting models, ensuring that the modules remain effective and reliable over time.

The retail shop and ecommerce platform product demand forecasting modules, powered by the Prophet model, offer valuable tools for businesses to optimize their operations and drive growth in competitive market environments. By leveraging advanced forecasting techniques and intuitive user interfaces, these modules empower users to make data-driven decisions and stay ahead of market trends and customer demand fluctuations.

V.CONCLUSION:

In conclusion, the project on product demand forecasting in retail shops and ecommerce platforms represents a significant endeavor aimed at enhancing operational efficiency, optimizing inventory management, and driving business growth in competitive market environments. Through the implementation of advanced forecasting techniques and intuitive software solutions, the project seeks to address the challenges faced by retail businesses and ecommerce platforms in accurately predicting product demand and making informed decisions.

By leveraging technologies such as the Prophet forecasting model, Python programming languages, and associated libraries and frameworks, the project offers a robust and scalable solution for time series analysis and forecasting. The use of user-friendly interfaces, interactive visualizations, and automated data preprocessing pipelines ensures that users can easily interact with the system, interpret forecast results, and derive actionable insights to support decision-making processes.

Furthermore, the project incorporates best practices in software development, including rigorous testing and quality assurance methodologies, to ensure the reliability, performance, and security of the demand forecasting modules. Through unit testing, integration testing, system testing, user acceptance testing, performance testing, and security testing, the project aims to validate the functionality, usability, and scalability of the system, while mitigating risks and ensuring compliance with industry standards and regulations.

Overall, the project represents a holistic approach to demand forecasting, encompassing technical excellence, user-centric design, and adherence to quality standards. By providing accurate and timely forecasts, the project empowers retail shop owners and ecommerce platform managers to make data-driven decisions, optimize resource allocation, and improve customer satisfaction. As a result, the project has the potential to deliver tangible benefits, including cost savings, revenue growth, and competitive advantage, to businesses operating in dynamic and demanding market environments.

In summary, the project on product demand forecasting in retail shops and ecommerce platforms stands as a testament to the power of data-driven decision-making and technological innovation in driving business success. With a focus on accuracy, usability, and reliability, the project sets the stage for future advancements in demand forecasting and business intelligence, enabling organizations to thrive and prosper in an ever-evolving marketplace.

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