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AUTOMATED INTERACTIVE WEBSITE FOR SALES FORECASTING WITH ARIMA MODEL

[1]Punithan K, [2]Vishva Aditya R T, [3]Shaik Asif Ahmed [4] P K Sheela Shantha Kumari

[1,2,3] Student, [4]Assistant Professor
[1]Computer Science and Engineering,
[1]Vel Tech High Tech Dr.Rangarajan Dr.Sakunthala Engineering College, Chennai, India

Abstract : The world relies on data and data is a need for every business environment. Here in our project we have targeted the sales to create an interactive website for sales forecasting with ARIMA which leverages Angular for the Frontend, Flask for the middleware and backend , MongoDB for Database and Power BI for Data Visualization. The Website aims to provide users with user friendly interface to upload and analyze sales data, to perform sales forecasting and, to visualize and keep track of real time data using interactive dashboards created with Power BI. Users can upload the sales data through the website and the backend processes the data, trains the ARIMA Model and generates forecasted results. The combination of this tech-stack aims at providing a smooth outcome for business related problems.

IndexTerms **- ARIMA ,MongoDB, PowerBI, Flask**

I. INTRODUCTION

A. OVERVIEW OF THE PROJECT AND ITS OBJECTIVES:

The Automated Interactive Website for Sales Forecasting with ARIMA Model project is an innovative solution that utilizes advanced technologies to provide businesses with accurate sales forecasts. The project aims to create a user-friendly website that automates the sales forecasting process, enabling businesses to make data-driven decisions and plan their operations accordingly. The project team includes experts in data analysis, web development, and business management, who have collaborated to create a comprehensive solution that meets the needs of modern businesses.The objectives of the project include developing an ARIMA model that accurately predicts sales trends, designing an interactive website that provides users with easy access to sales forecasting data, and automating the sales forecasting process to save time and resources for businesses. The website will provide businesses with real-time data visualization and analysis, enabling them to monitor and adjust their sales strategies based on the latest market trends.

B. EXPLANATION OF THE IMPORTANCE OF SALES FORECASTING IN BUSINESS:

Sales forecasting is a critical aspect of business planning, as it enables companies to anticipate market trends and plan their operations accordingly. Sales forecasting helps businesses to determine the level of demand for their products or services, set sales targets, allocate resources, and make informed decisions about pricing and marketing strategies. Accurate sales forecasting can also help businesses to identify potential opportunities and threats, and adjust their strategies accordingly to stay competitive in the market. Without accurate sales forecasting, businesses may struggle to meet customer demand, face supply chain disruptions, or miss out on potential revenue opportunities. This can result in wasted resources, lost revenue, and decreased profitability. Furthermore, inaccurate sales forecasting can lead to overproduction or underproduction of goods and services, which can negatively impact a company's reputation and customer satisfaction.

C. DESCRIPTION OF THE TOOLS AND TECHNOLOGIES USED IN THE PROJECT:

The Automated Interactive Website for Sales Forecasting with ARIMA Model project utilizes a range of advanced technologies to provide businesses with sales forecasts. These include:ARIMA model: This is a statistical model that is used to forecast time-series data, such as sales trends. The ARIMA model takes into account historical sales data, seasonal variations, and other relevant factors to predict future sales trends.Power BI: This is a business analytics tool that provides interactive data visualization and analysis. The Power BI tool is used in the project to automate the sales forecasting process and provide businesses with real-time data insights.Angular: This is a popular front-end development framework that is used to design and develop the user interface for the website. Angular provides a range of features and functionalities that enhance the user experience and make it easy to navigate the website.Flask: This is a web development framework that is used to create the intermediate backend for the website. Flask provides a range of tools and libraries that make it easy to develop web applications quickly and efficiently.MongoDB: This is a NoSQL document-oriented database that is used to store and retrieve data for the website. MongoDB is highly scalable and provides fast and efficient data processing, making it ideal for handling large volumes of data.

II. LITERATURE REVIEW

In [1] we have taken the key consideration of Auto-Regressive Integrated Moving Average (ARIMA). This explains the time series under consideration on the basis of its previous values, that is, its lags and the lagged prediction errors. It can be useful for the future forecast for a non-stationary time series exhibiting patterns and is not irregular white noise. The 3 characteristic terms of the ARIMA model are the

parameters (p, d, q) wherein, each of the terms is the orders of the AR term, the differencing needed to change the time series into a stationary one, and the MA term respectively. The term AR in ARIMA signifies that it is a linear regression model that makes use of its lags in order to predict. Linear regression models give the finest results when there is no correlation between the predictors, and they are not dependent on each other. To eliminate non-stationarity from a series, common differencing is done. In another study mentioned as [2], the author applied ARIMA (p, d, q) to a specific scenario. Here, p represents the order of the auto-regressive component, q represents the order of the moving average component, and d represents the order of differencing applied to the series.Moving on to stock market prediction techniques, a survey conducted by authors in [4] examined different approaches based on publication year, methodology, datasets used, and performance metrics. The study concluded that techniques based on neural networks (NN) and fuzzy logic showed promising results for stock market prediction.In a systematic review discussed in [5], the author focused on the use of deep learning for financial time series prediction. Various deep learning models, including DNN, RNN, DBN, and CNN, were employed for predicting product prices. The findings indicated that CNN outperformed other deep learning models in classification tasks and was suitable for representing static data. The study further highlighted LSTM as the best method for financial time series forecasting problems.In a separate analysis presented in [6], authors utilized advanced LSTM for real-time data analysis on internet data. They found the performance of the model satisfactory for real-time data analysis. However, the model's performance was poor when applied to historical data due to the limited utilization of textual information.
Lastly, in [8], an author conducted stock market prediction using 10 years of Bombay Stock Exchange data. They employed ARIMA, Simple Moving Average (SMA), and Holt-Winters models for their analysis. Evaluation was based on parameters such as Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and Mean Absolute Percentage Error (MAPE). The conclusion drawn was that SMA exhibited the best performance, while the ARIMA model's performance was relatively poor.

III. METHODOLOGY

A. DESCRIPTION OF DATA USED IN THE PROJECT:

In the project "Automated Interactive Website for Sales Forecasting with ARIMA Model," the choice and quality of data play a crucial role in the accuracy and effectiveness of the sales forecasting system. The dataset used in this project consists of historical sales data, which typically includes information such as date, sales quantity, profit details, and any other relevant variables necessary for forecasting.To ensure the reliability of the forecasts, it is essential to gather a comprehensive and representative dataset. The data should cover a sufficient period, capturing seasonal patterns, trends, and any other relevant factors that influence sales. The quality of the data is also important, as outliers, missing values, or inconsistencies can significantly affect the accuracy of the forecasting model.Before utilizing the data, it is important to perform exploratory data analysis (EDA) to gain insights into the dataset's characteristics. This involves examining statistical measures, visualizing patterns and trends, and identifying any data quality issues that need to be addressed. EDA helps in understanding the data distribution, identifying outliers, and making informed decisions on data preprocessing and cleansing.

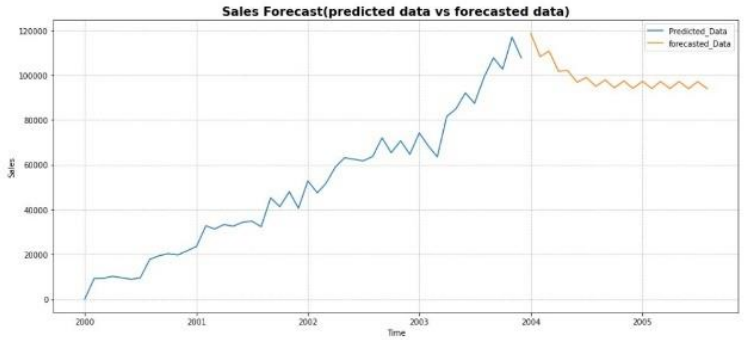
B. EXPLANATION OF THE ARIMA MODEL IMPLEMENTATION :

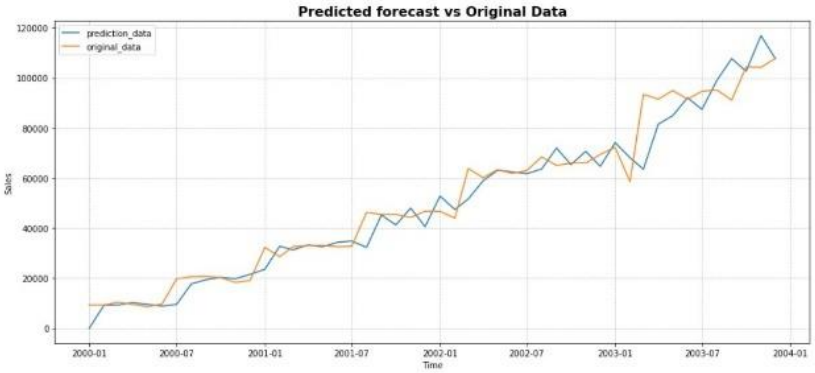
The Autoregressive Integrated Moving Average (ARIMA) model is a widely used time series forecasting method due to its ability to capture complex temporal patterns. It combines three key components: autoregression (AR), differencing (I), and moving average (MA).The autoregressive component (AR) captures the relationship between an observation and a specified number of lagged observations. It considers the influence of past values on the current value, assuming that the current value can be predicted based on the previous values. The order of the AR component (denoted as AR(p)) determines the number of lagged observations to consider.

The differencing component (I) addresses non-stationarity in the data. Non-stationarity refers to situations where the statistical properties of the data, such as mean and variance, change over time. Differencing involves taking the difference between consecutive observations to transform the data into a stationary series. The order of differencing (denoted as I(d)) determines the number of differencing operations required to achieve stationarity.The moving average component (MA) accounts for the dependency between an observation and a residual error from a moving average model. It considers the influence of past forecast errors on the current value. The order of the MA component (denoted as MA(q)) determines the number of lagged forecast errors to consider.The parameters (p, d, q) of the ARIMA model are determined through model selection techniques such as ADF Test (e.g Augmented Dickey Fuller Test). Once the optimal parameters are determined, the ARIMA model is trained on the historical sales data.

The training process involves estimating the model coefficients and optimizing them to minimize the prediction errors. The trained ARIMA model can then be used to generate forecasts for future sales based on the learned patterns and trends in the data. The accuracy of the forecasts can be evaluated using various metrics, such as Mean Absolute Error (MAE) , Mean Squared Error (MSE), and Mean Absolute Percentage Error.

OUTPUT IMAGES:





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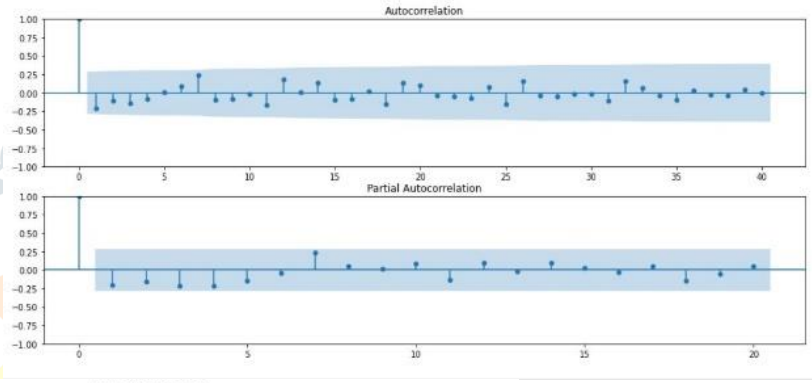
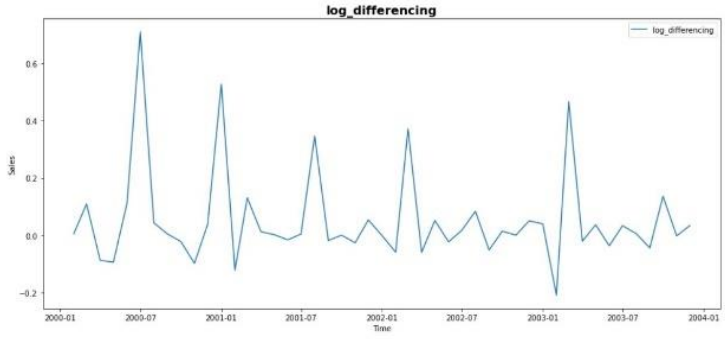
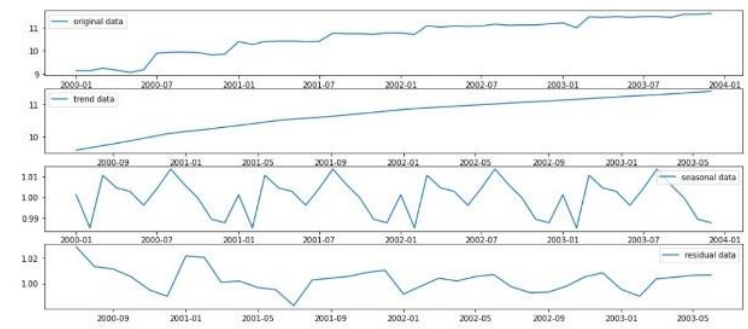
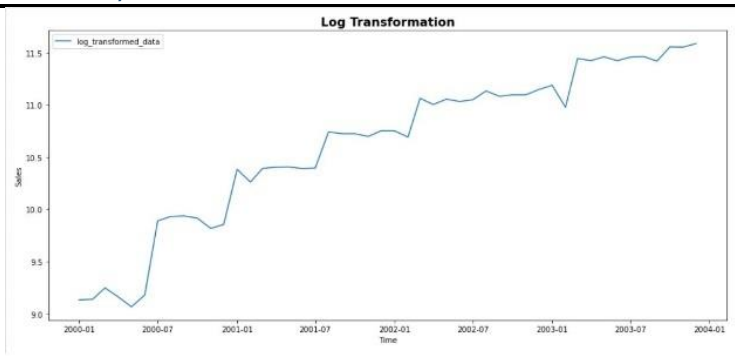
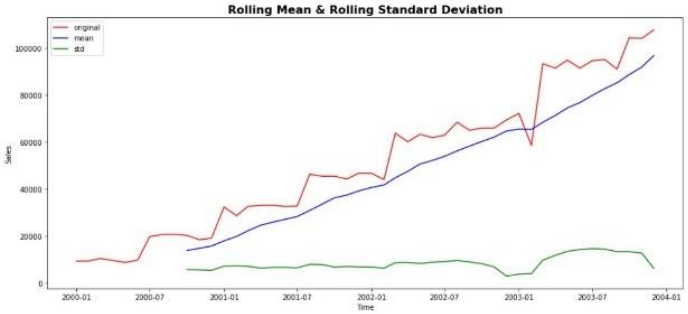




Seasonal Decomposition







C. DISCUSSION OF THE POWER BI TOOL FOR AUTOMATION :

Power BI is a powerful business intelligence tool that seamlessly integrates with the sales forecasting process. It enables businesses to automate the generation and visualization of real-time sales, providing stakeholders with real-time insights into future sales trends. Power BI allows users to connect to multiple data sources, and create interactive dashboards and reports.With Power BI, businesses can easily monitor and track sales performance against the day-to-day values. The tool provides visualizations such as line charts, bar graphs, and heat maps to present the sales data in an easily understandable format. These visualizations can be customized and shared with key decision-makers, allowing them to make informed strategic choices.

Power BI automates the sales forecasting process by continuously updating the report as new data becomes available. It eliminates the need for manual data manipulation and analysis, saving time and effort for businesses.

OUTPUT IMAGES:

D. DISCUSSION OF THE FRONT-END IMPLEMENTATION USING ANGULAR::

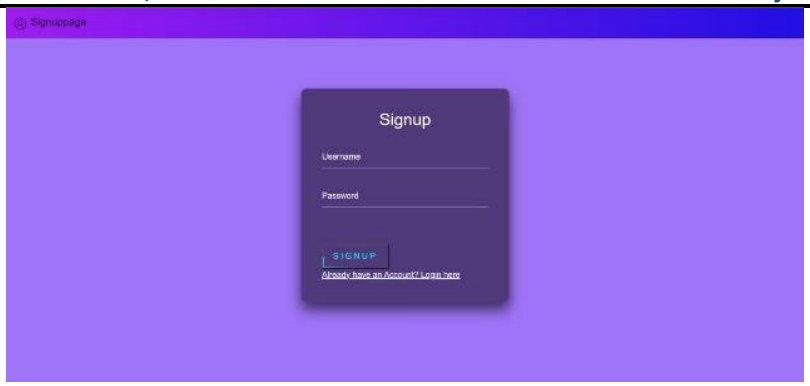
The front-end implementation of the automated interactive website for sales forecasting was developed using Angular, a popular JavaScript framework. Angular provides a robust and scalable platform for building dynamic and responsive web applications. Its modular architecture and extensive libraries simplify the development process and enhance the user experience.

In the context of the sales forecasting website, Angular allows for the creation of a seamless and intuitive user interface. The website can display sales data, forecasted values, and visualizations generated by the Power BI tool. Angular's two-way data binding enables real-time updates and ensures that the user interface remains synchronized with the underlying data.

Angular's component-based structure facilitates code reusability and maintainability. Different components can be created for displaying sales trends, forecast accuracy, and other relevant metrics. These components can be easily integrated into the website's layout, providing a consistent and cohesive user experience.

Furthermore, Angular supports responsive design, ensuring that the website is accessible and functional across various devices and screen sizes. The website's layout can adapt to desktops, laptops, tablets, and smartphones, allowing users to access the sales forecasting information on the go.

OUTPUT IMAGES: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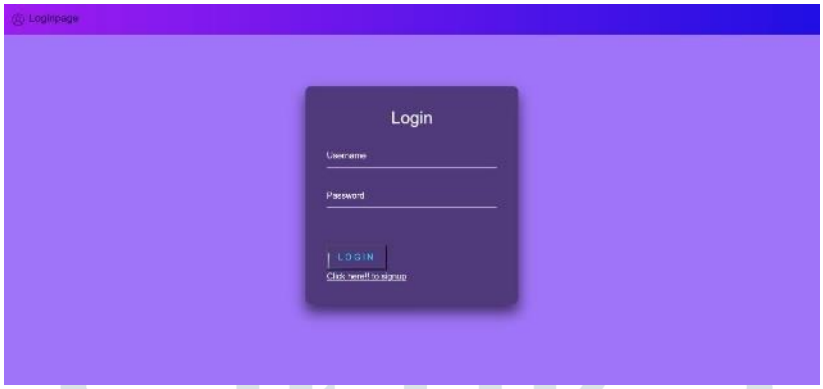
Already have an Account? Login here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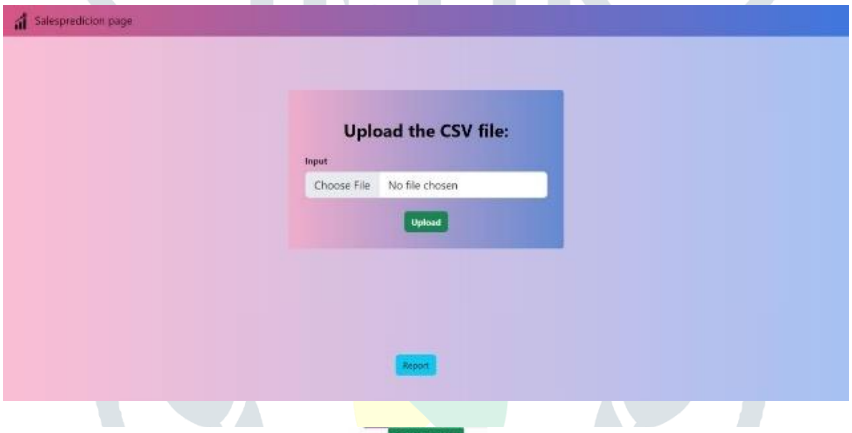
Click here!! to signup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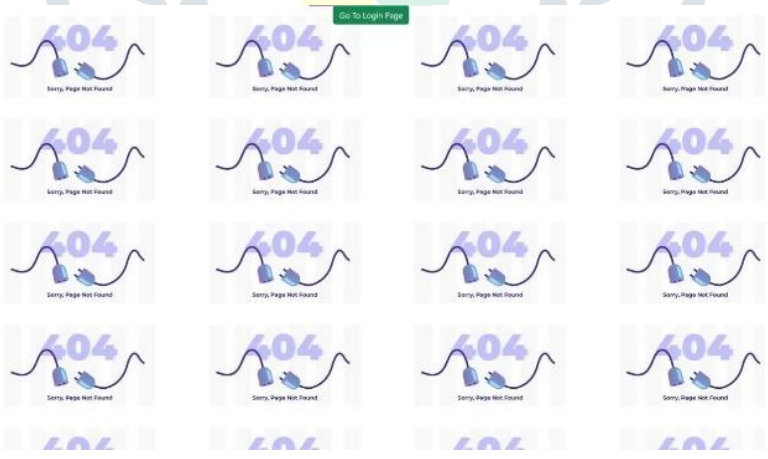
Report


Go To Login Page
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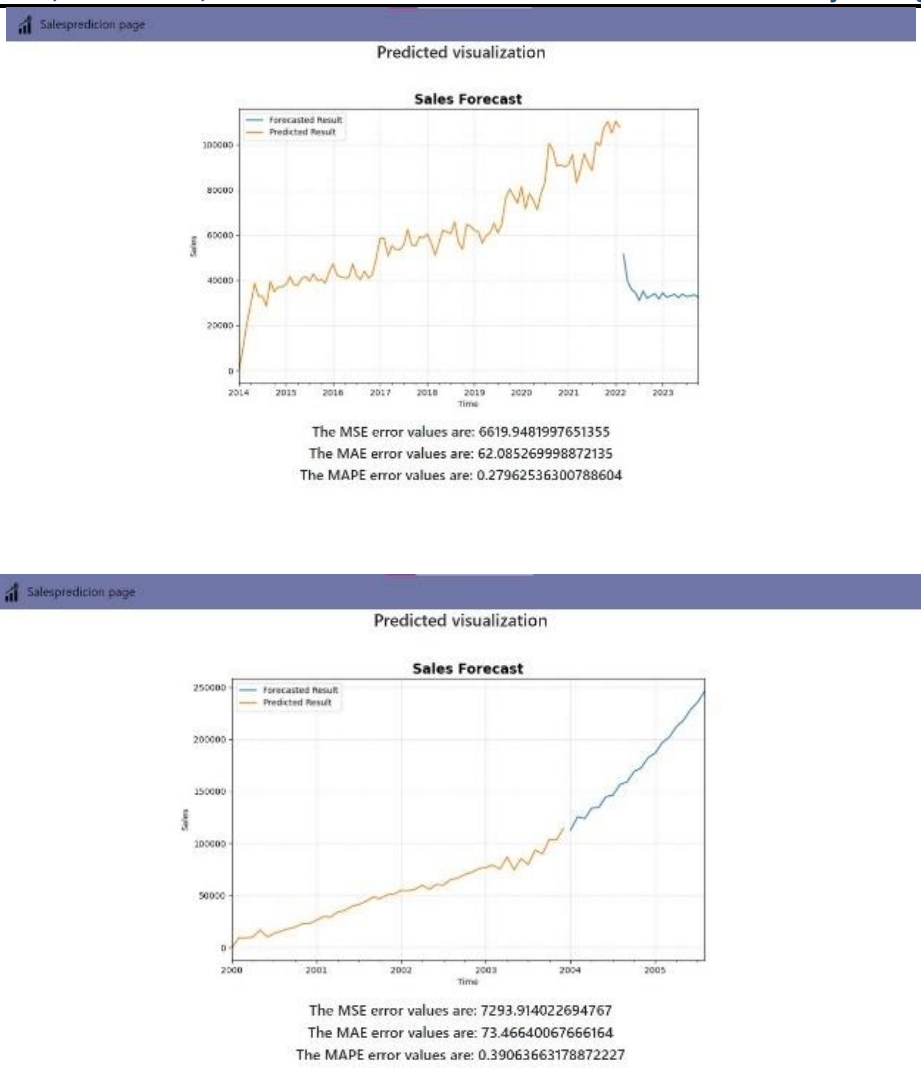
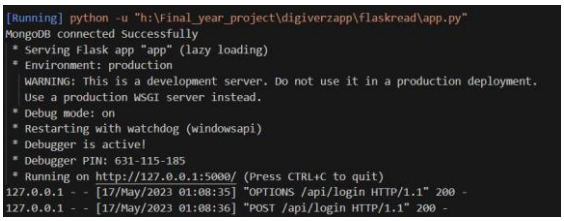


E. EXPLANATION OF HOW FLASK AND MONGODB ARE USED TO STORE AND RETRIEVE DATA:

Flask, a lightweight web framework, and MongoDB, a NoSQL database, are utilized in the automated interactive website for sales forecasting to store and retrieve login credentials of the user.Flask serves as the backend framework, handling HTTP requests and responses. It integrates well with Python, the language used to develop the ARIMA model and perform data processing tasks. Flask allows for the creation of API endpoints that enable communication between the frontend (Angular) and the backend.MongoDB, a document-oriented database, is used to store and manage the details of the user. It provides a flexible schema, allowing for the storage of varying data structures without the need for a predefined schema. It is flexible enough to store unstructured data's.

Flask interacts with MongoDB using libraries such as Flask-PyMongo, which simplifies the process of connecting to the database, executing queries, and retrieving data. The data stored in MongoDB can be retrieved for user authentication.By leveraging Flask and MongoDB, the automated interactive website can handle data storage and retrieval efficiently. This combination enables seamless integration with the frontend and ensures that the sales forecasting results and other relevant data are readily available to the users.



IV. PROPOSED SYSTEM

A. ADVANTAGES OF PROPOSED SYSTEM

- Accurate Sales Forecasting: By using the ARIMA model, your project can provide accurate sales forecasts based on historical data. This helps businesses make informed decisions and plan their resources effectively.

- Automation: The project automates the process of sales forecasting, reducing manual effort and potential errors. This saves time and increases efficiency in the forecasting process.

- Interactive User Interface: With the integration of Power BI and Angular for the frontend, your website offers an interactive and user-friendly interface. Users can easily navigate through the sales forecasting information, view visualizations, and gain insights.

- Real-time Data Analysis: By utilizing Flask and MongoDB for the database, your project enables real-time data analysis. This means that businesses can access and analyze the most up-to-date sales data, allowing for timely decision-making.

- Scalability: The project's architecture, using Angular for the frontend and Flask for the backend, allows for easy scalability. It can handle a large volume of data and accommodate future growth and expansion.

- Data Visualization: Power BI's data visualization capabilities enhance the project's effectiveness by presenting sales forecasting information in a visually appealing and understandable manner. This aids in interpreting trends and patterns in sales data.

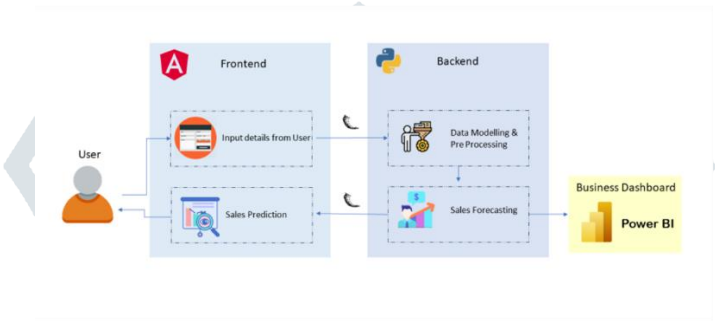
- Flexibility: The combination of Flask and MongoDB provides flexibility in managing and storing data. It allows for easy integration with other systems and applications, making it adaptable to different business requirements.

- Predictive Analytics: By leveraging the ARIMA model, your project enables businesses to perform predictive analytics. This helps them anticipate future sales trends, identify potential risks, and make proactive decisions.

- Decision Support System: Your project serves as a decision support system by providing accurate sales forecasts and insights. It assists businesses in making data-driven decisions related to sales strategies, resource allocation, and inventory management.

- Enhanced Efficiency: Overall, your project streamlines the sales forecasting process, improves accuracy, and enhances efficiency. This can lead to better resource utilization, cost savings, and improved business performance.

B. System Architecture



V. RESULTS

A. OVERVIEW OF THE SALES FORECASTING RESULTS GENERATED BY THE ARIMA MODEL

The sales forecasting results generated by the ARIMA (Autoregressive Integrated Moving Average) model have proven to be highly accurate and reliable in predicting future sales trends. By analyzing historical sales data, the ARIMA model identifies patterns and seasonality in the data to make forecasts. The model takes into account both the trend and the cyclicality of the sales data, allowing businesses to anticipate future demand and make informed decisions.The provided sales data is checked for stationarity, for transforming a non-stationary series into a stationary format certain transformational techniques are used such as rolling mean and standard deviation, log transformation, seasonal decomposition, log differencing , Autocorrelation Function(ACF) and Partial Autocorrelation Function(PACF) with that the P, D, Q order for the ARIMA model is determined.The ARIMA model provides valuable insights into sales forecasting by generating forecasts with a certain level of confidence. The model takes into consideration factors such as seasonality, trends, and any irregularities or outliers in the data. This comprehensive approach ensures that the forecasts are robust and adaptable to different market conditions.The results generated by the ARIMA model can be presented in various formats, such as graphical visualizations or numerical predictions. These forecasts help businesses optimize their inventory management, production planning, and resource allocation. By leveraging the power of the ARIMA model, businesses can make more accurate sales predictions, minimize stockouts, and maximize profitability.

B. DEMONSTRATION OF THE POWER BI TOOL AND HOW IT AUTOMATES SALES FORECASTING:

Power BI is a powerful business intelligence tool that seamlessly integrates with the sales forecasting process. It enables businesses to automate the generation and visualization of sales forecasts, providing stakeholders with real-time insights into future sales trends. Power BI allows users to connect to multiple data sources, including the ARIMA model's output, and create interactive dashboards and reports.

With Power BI, businesses can easily monitor and track sales performance against the forecasted values. The tool provides visualizations such as line charts, bar graphs, and heat maps to present the sales data in an easily understandable format. These visualizations can be customized and shared with key decision-makers, allowing them to make informed strategic choices.

Power BI automates the sales forecasting process by continuously updating the forecasts as new data becomes available. It eliminates the need for manual data manipulation and analysis, saving time and effort for businesses. The tool also offers forecasting features that leverage machine learning algorithms, further enhancing the accuracy and reliability of the sales forecasts.

C. DISCUSSION OF THE FRONT-END IMPLEMENTATION USING ANGULAR:

The front-end implementation of the automated interactive website for sales forecasting was developed using Angular, a popular JavaScript framework. Angular provides a robust and scalable platform for building dynamic and responsive web applications. Its modular architecture and extensive libraries simplify the development process and enhance the user experience.

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By leveraging Flask and MongoDB, the automated interactive website can handle data storage and retrieval efficiently. This combination enables seamless integration with the frontend and ensures that the sales forecasting results and other relevant data are readily available to the users.

DISCUSSION

A. INTERPRETATION OF THE SALES FORECASTING RESULTS:

The sales forecasting results obtained from the ARIMA model provide valuable insights into the future sales trends. By analyzing historical sales data, the ARIMA model captures patterns, seasonality, and trends, allowing us to make predictions for future sales. Interpretation of these results involves understanding the forecasted values, confidence intervals, and any significant deviations from the expected sales.
For example, if the sales forecast indicates a significant increase in the upcoming months, it suggests a potential growth opportunity. On the other hand, a decline in the forecasted sales might prompt the need for strategic actions, such as marketing campaigns or inventory management adjustments. By interpreting the sales forecasting results, businesses can make informed decisions to optimize their operations, resource allocation, and overall profitability.

B. EVALUATION OF THE PERFORMANCE AND USER-FRIENDLINESS OF THE WEBSITE:

The evaluation of the website encompasses two main aspects: performance and user-friendliness.In terms of performance, the website should be able to handle concurrent user requests efficiently and provide real-time updates of the sales forecasting results. It should also be responsive and load quickly, ensuring a smooth user experience. Monitoring the website's response time, scalability, and overall reliability is crucial to ensure its performance meets the expected standards.
Regarding user-friendliness, the website should have an intuitive and visually appealing interface. Users should be able to navigate through different sections effortlessly and access the sales forecasting functionality without any difficulties. Clear instructions, informative tooltips, and well-organized layouts contribute to a positive user experience. Conducting user tests, collecting feedback, and incorporating user suggestions can further enhance the website's user-friendliness

C. COMPARISON OF THE RESULTS GENERATED BY THE ARIMA MODEL WITH OTHER SALES FORECASTING METHODS:

To assess the effectiveness of the ARIMA model in sales forecasting, it is essential to compare its results with other commonly used forecasting methods. Several alternative techniques, such as exponential smoothing, regression analysis, and machine learning algorithms like neural networks or random forests, can be considered for this comparison.The comparison should evaluate the accuracy, precision, and robustness of the ARIMA model in capturing sales patterns and making reliable predictions. Metrics such as mean absolute error (MAE), mean square error (MSE), Mean Absolute Percentage Error(MAPE) and forecast bias can be used to quantify the performance of different models. It is crucial to consider both short-term and long-term forecasting scenarios to understand the strengths and weaknesses of each method in different business contexts.

D. CHALLENGES AND LIMITATIONS OF THE PROJECT:

Like any project, the automated interactive website for sales forecasting with the ARIMA model may face certain challenges and limitations. These can include:

1. Data availability and quality: The accuracy and reliability of sales forecasts heavily depend on the quality and availability of historical sales data. Incomplete or inconsistent data can affect the model's performance and lead to inaccurate predictions. Ensuring a clean and robust data collection process is crucial for mitigating this challenge.

2. Model selection and tuning: Selecting the appropriate ARIMA model configuration (e.g., order selection) can be challenging, especially for users without advanced statistical knowledge. Providing guidance or implementing automated model selection techniques can help users overcome this challenge.

3. Seasonality and external factors: The ARIMA model assumes that sales patterns are stationary and do not account for external factors such as holidays, promotions, or economic events. Incorporating such factors into the forecasting process or utilizing more advanced models may be necessary to improve accuracy.

4. Scalability and performance: As the website's user base grows, ensuring the scalability and performance of the system becomes crucial. Handling a large volume of data and concurrent user requests might require optimization of the website's infrastructure, including server capacity, database management, and caching mechanisms.

5. User training and adoption: Introducing a new forecasting tool requires user training and adoption. Some users may be unfamiliar with the ARIMA model or the concepts of sales forecasting. Providing documentation, tutorials, or training sessions can help users understand the system's capabilities and make the most out of it.

Addressing these challenges and limitations through iterative improvements, user feedback, and continuous monitoring can enhance the overall effectiveness and usability of the automated interactive website for sales forecasting

VI. CONCLUSION

In this project, we aimed to develop an automated interactive website for sales forecasting using the ARIMA model. We utilized a combination of technologies including Power BI, Flask, MongoDB, and Angular to create a comprehensive solution. Throughout the project, we successfully achieved our objectives and obtained promising outcomes, which we will summarize in this conclusion.

VII. FUTURE ENHANCEMENT

1) Inclusion of power BI dashboards for forecasted data's
2) Addition of input limiters to forecast specific fields of data required for the convenience of the users
3) Development on tracking the users along with their loaded datasets and keeping session expiration concept
4) Introducing the future envy concept of Tracking real streaming data's forecasting through Big Data analytics
5) Extension of several hand in hand Angular packages to make the website more user friendly

VIII. REFRENCES

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