GLOBAL CURRENCY FORECASTER

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1. Introduction:

1.1: Background:

The global economy relies heavily on international trade and investment, leading to frequent transactions involving different currencies. Exchange rate forecasting is essential to anticipate and manage currency fluctuations, which can significantly impact businesses, investors, and policymakers. Forecasting models analyse historical exchange rate data and other relevant factors to predict future currency movements. These models provide valuable insights into potential trends and fluctuations, enabling stakeholders to make informed decisions regarding currency exchange, investments, and risk management.

Accurate exchange rate forecasting is critical for various reasons:

- Businesses use exchange rate forecasts to set pricing strategies, manage currency risks, and plan international transactions.
- Investors rely on exchange rate forecasts to assess investment opportunities, hedge currency exposure, and optimize portfolio allocations.
- Policymakers utilize exchange rate forecasts to formulate monetary policies, stabilize currency markets, and promote economic stability.

1.2: Objective:

The primary objective of this analysis is to develop and evaluate exchange rate forecasting models that provide accurate predictions of future currency movements. By leveraging historical exchange rate data and employing advanced modeling techniques, we aim to enhance the predictive accuracy of our models and provide valuable insights for decision-making processes in the global financial markets.

2. Data Collection:

For the data collection process, we accessed historical foreign exchange rate data from the TraderMade API. The dataset covers the period from May 29, 2023, to April 29,

2024, providing a comprehensive view of daily exchange rate movements for the USD to INR currency pair. The dataset consists of the following key features:

Date: Each record includes the date of the exchange rate data point, allowing for temporal analysis and trend identification.

Open Rate: The opening rate of the USD to INR exchange pair for a given day.

High Rate: The highest exchange rate observed within the trading period on a specific day.

Low Rate: The lowest exchange rate observed within the trading period on a specific day.

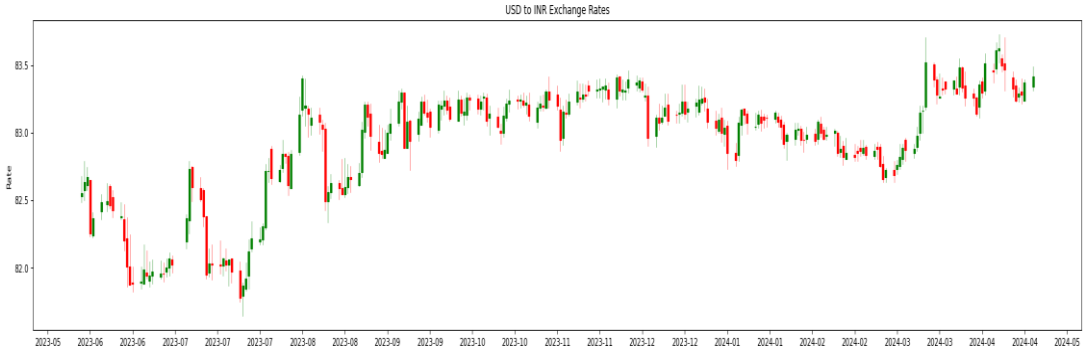
Close Rate: The closing rate of the USD to INR exchange pair for a given day.

By collecting this data, we aimed to gain insights into historical exchange rate movements, identify patterns, and trends that may influence future exchange rate behavior. This dataset serves as the foundation for our analysis and the development of predictive models for forecasting future exchange rate movements between the USD and INR currencies.

3. Data Exploration:

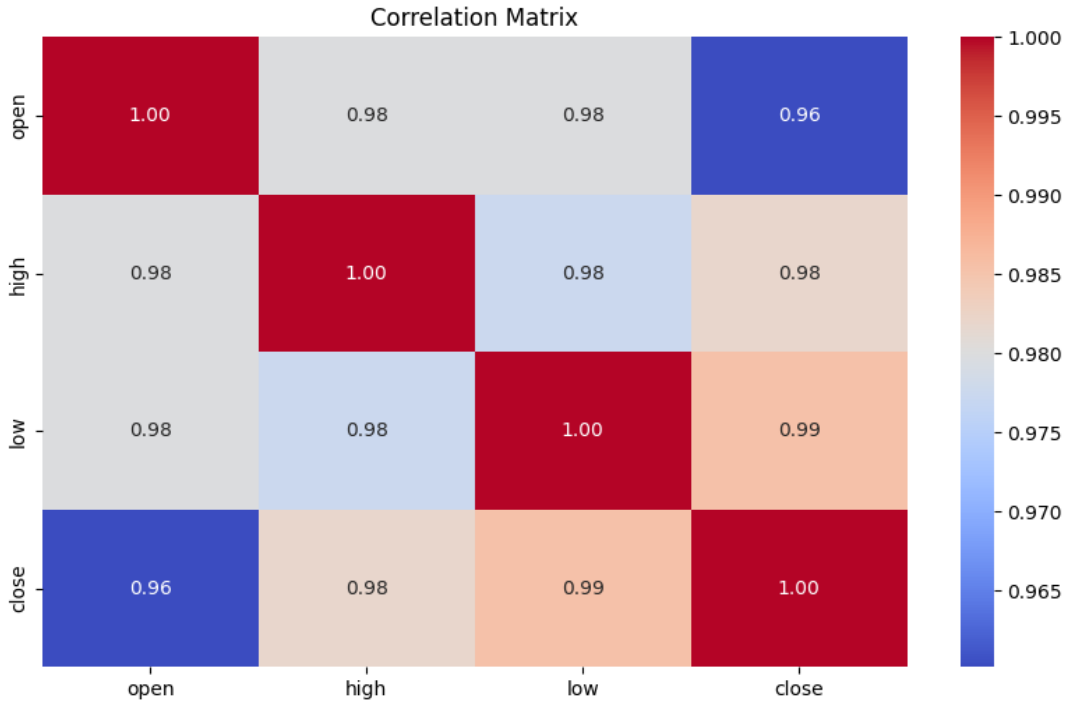
Upon loading the historical foreign exchange rate data, we conducted thorough exploratory data analysis (EDA) to uncover insights into the dynamics of the USD to INR exchange rate. The EDA process involved several visualization techniques to understand the trends, seasonal patterns, and correlations present in the dataset.

Candlestick Charts: Candlestick charts were used to visualize the daily fluctuations in exchange rates over the entire period. These charts provide a clear depiction of price movements, showing the opening, high, low, and closing rates for each trading day. By examining candlestick patterns, we could identify trends and potential reversal points in the exchange rate.



Line Plots: Line plots were employed to visualize the trend of the exchange rate over time. By plotting the closing rates against the date, we could observe the overall direction of the exchange rate movement and any significant fluctuations or trends.

Correlation Matrices: Correlation matrices were constructed to analyse the relationships between different variables, such as open, high, low, and close rates. By calculating the correlation coefficients between these variables, we could determine the strength and direction of their linear relationships. This helped identify any dependencies or correlations among the exchange rate components.



Through these visualizations, we gained valuable insights into the historical behaviour of the USD to INR exchange rate. We identified trends, patterns, and correlations that provided a foundation for further analysis and model development. These insights informed our understanding of the dataset and guided subsequent steps in the analysis, including model selection and evaluation.

4. Data Analysis:

4.1 Traditional Machine Learning Models:

4.1.1 Decision Tree Regression Model

This model was trained using historical open, high, and low rates to predict closing exchange rates. Evaluation metrics such as R^2 score, Mean Squared Error (MSE), and Mean Absolute Error (MAE) were utilized to assess model performance.

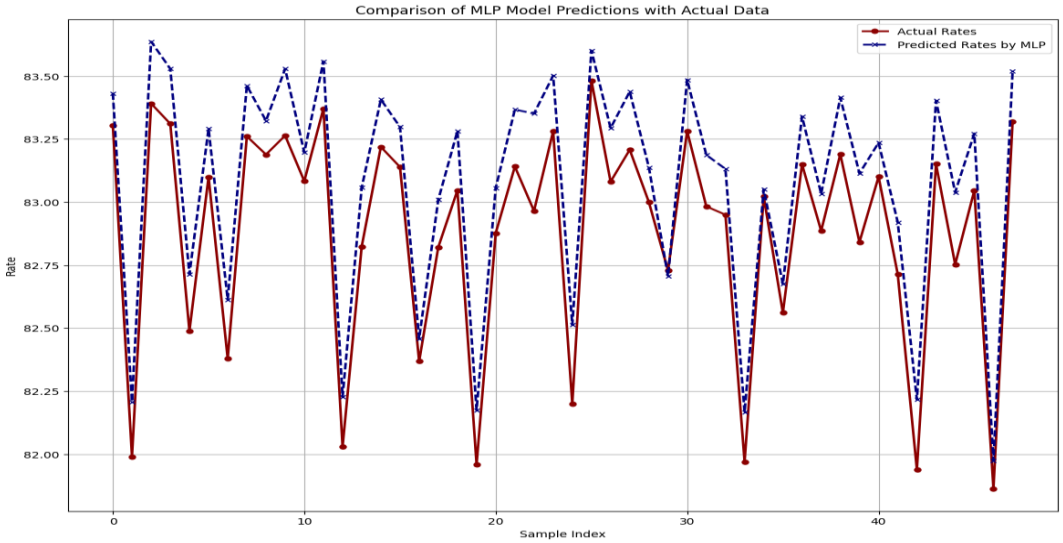
The red line with circular markers represents the actual historical USD-INR exchange rates. The green dashed line with 'x' markers indicates the predicted exchange rates by the Decision Tree model. The shaded grey area highlights the differences between the predicted and actual rates for each point in the dataset. This overlay plot is particularly useful for visualizing the model's performance across different points in the dataset. It can be observed that while there are some points where the prediction closely matches the actual rate (where the red and green lines overlap), there are

areas where the model's predictions diverge from the actual data (evidenced by the width of the grey shaded areas).

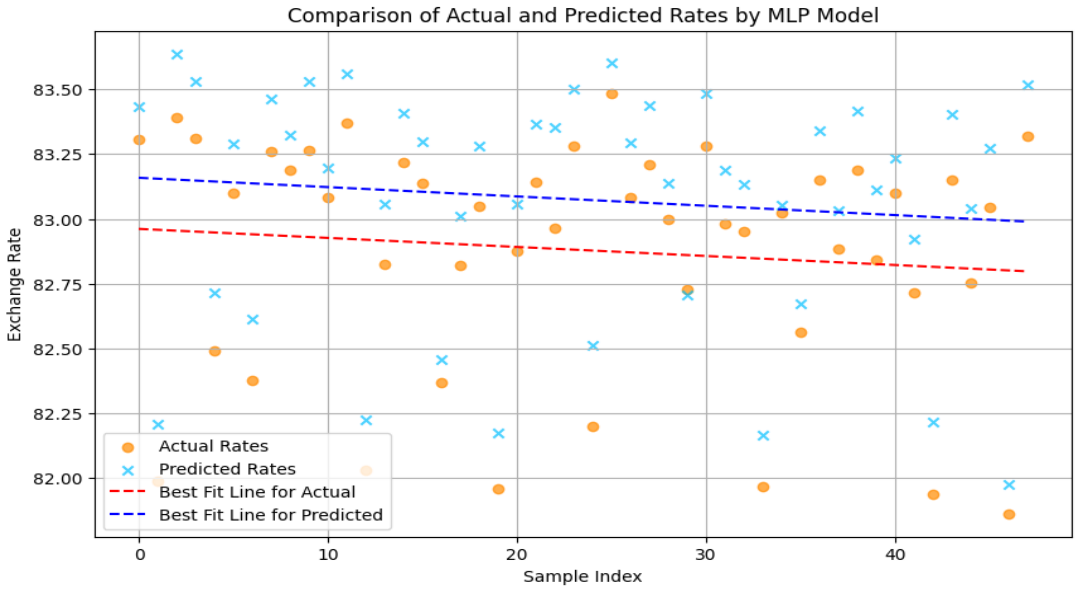
Red circles represent the actual exchange rates at different sample indices. Blue 'x' marks indicate the rates predicted by the Decision Tree model at those same indices. The scatter plot explains each prediction in relation to the actual rate for each sample index. If the model were perfect, all blue 'x' marks would lie directly on top of the red circles. Instead, we can see the spread and how the predictions vary in accuracy. It's a good way to quickly gauge the variance of the predictions and the consistency of the model's performance.

4.1.2 MLP (Multilayer Perceptron) Regressor

The machine learning model, the MLP Regressor, was implemented to predict exchange rates based on historical data. Similarly, we used evaluation metrics to quantify model accuracy.



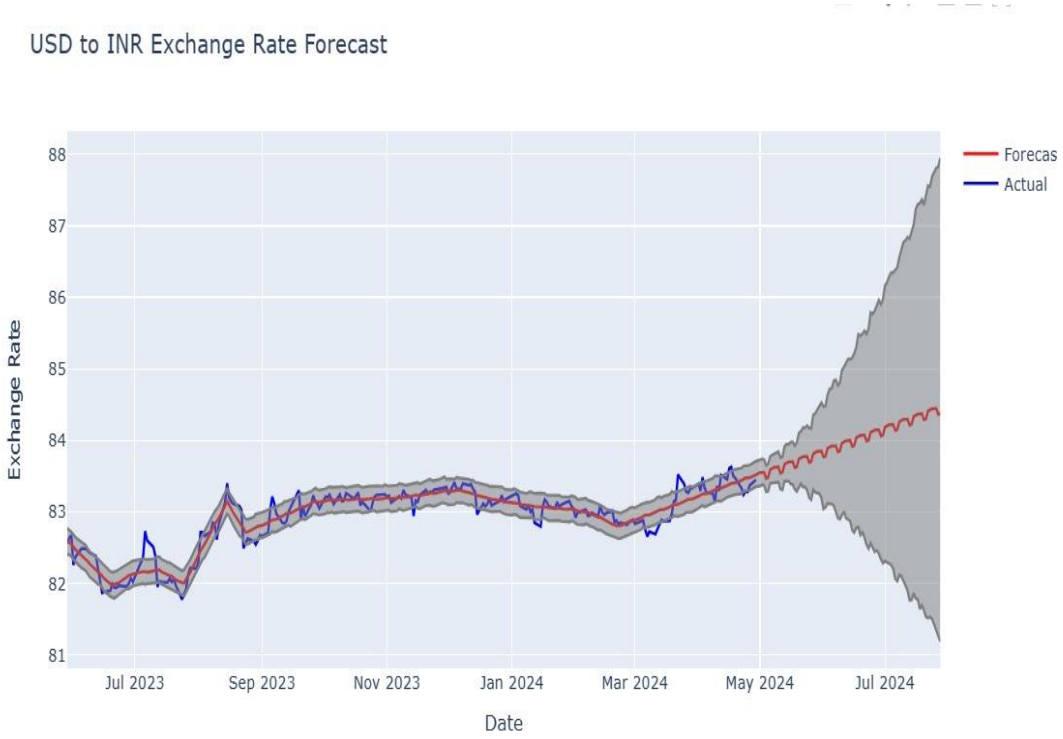
The solid red line with circular markers represents the actual historical USD-INR exchange rates. The dashed blue line with 'x' markers indicates the predicted exchange rates by the MLP model. The plot is meant to give a direct comparison of the MLP model's predictions against the actual rates over a series of sample indices. In this graph, we can see that the MLP seems to capture the overall trend of the actual data. However, there are places where the predicted rates differ significantly from the actual rates. The fact that the model predictions are in a dashed line also gives a visual cue that these are the estimated values rather than the actual recorded values.



Orange circles represent the actual exchange rates. Light blue 'x' marks indicate the predicted rates by the MLP model. The dashed red line is the best fit line for the actual rates, showing the overall trend of the actual data. The dashed blue line is the best fit line for the predicted rates, showing the overall trend of the model's predictions. This scatter plot is a more discrete representation of the data points, providing a clearer view of individual predictions. The addition of the best fit lines helps us understand the average trends in both the actual and predicted rates. Ideally, the best fit lines should closely overlap if the predictions are very accurate.

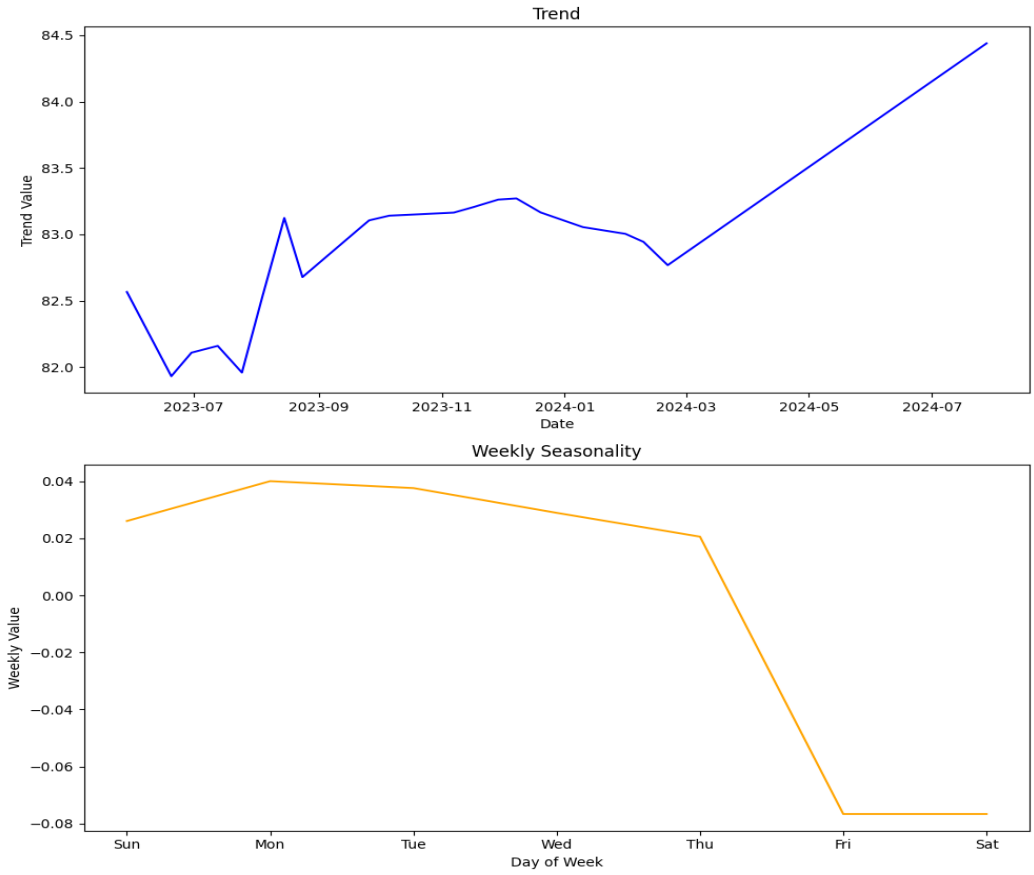
4.2 Prophet Model:

We utilized the Prophet library to develop time series forecasting models. Initially, we fitted a basic Prophet model to historical exchange rate data and then extended it to incorporate additional regressors such as open, high, and low rates for enhanced prediction accuracy. We evaluated the model's performance and visualized the forecasted results.



This graph illustrates the historical and forecasted USD to INR exchange rates. The blue line represents the actual historical exchange rates, showcasing the fluctuations over time until the present. The red line indicates the model's forecast, extending from the end of the historical data into the future. The grey shaded area around the forecast signifies the confidence interval, representing the range of possible future values that the model predicts, with the width of the area indicating the level of uncertainty—narrow at the beginning and widening as the forecast extends further out. The forecasted trend suggests a continuation of the recent

actual rate pattern, with slight increases followed by potential variability as indicated by the confidence interval.

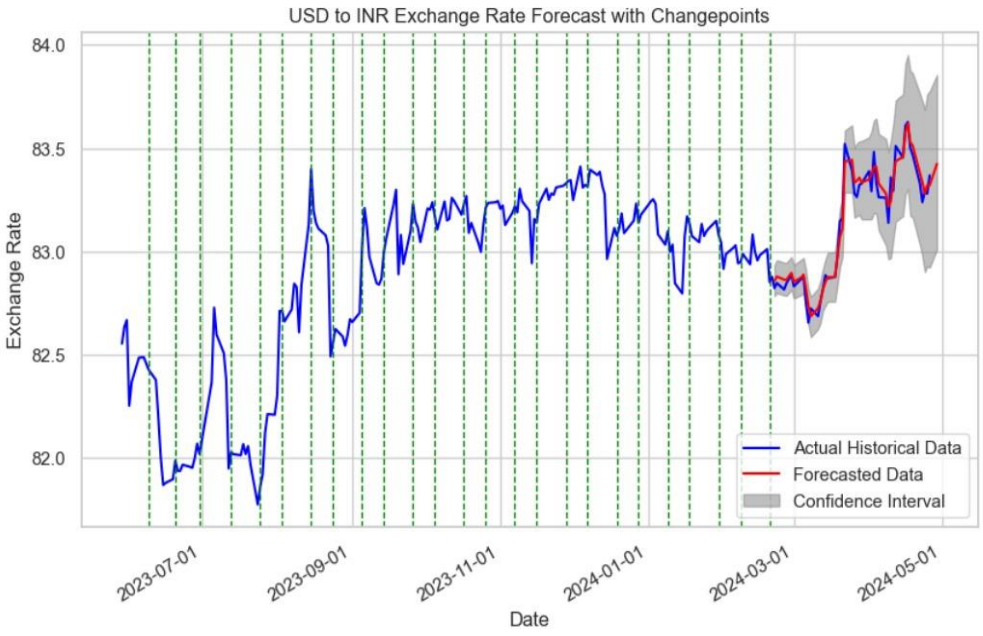


Trend Graph:

This graph shows the trend component of the time series data, which has been extracted by the forecasting model. Initially, the trend appears relatively stable and then starts to incline gradually, suggesting an increase in the time series value over the forecast period. The model has detected that, moving forward, the trend is expected to rise, indicating an upward trajectory in the future.

Weekly Seasonality Graph:

The weekly seasonality graph shows the typical patterns occurring within a week. The plot indicates that the value of the time series tends to drop significantly below the baseline at the beginning of the week, picks back up around Wednesday, and then increases substantially towards the end of the week. This implies that the time series is influenced by weekly effects, with the lowest and highest values typically occurring on specific days of the week.

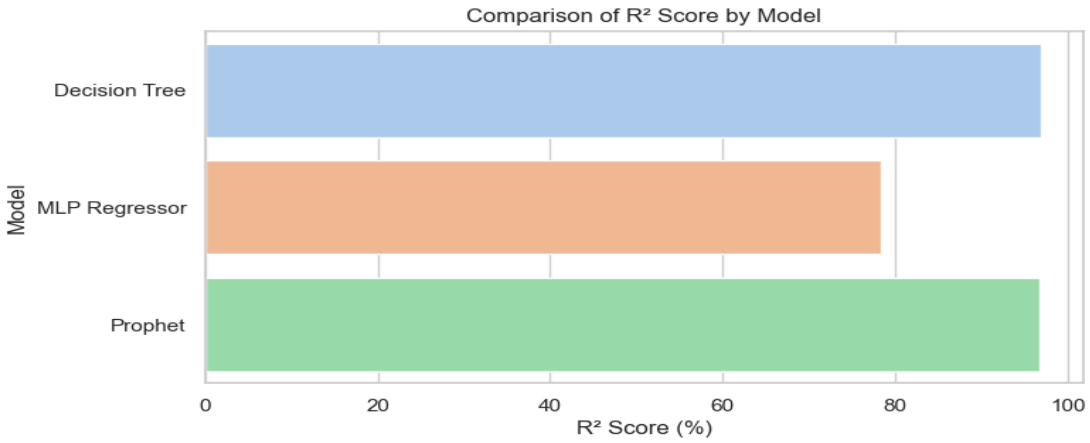


The graph presents a time series forecast for the USD to INR exchange rate, incorporating both historical data and future predictions with changepoints. The historical exchange rate is traced in blue, exhibiting fluctuations over time up to the present. The red line extends from the end of the historical data, representing the model's predictions about future exchange rates. The grey area surrounding the forecast line denotes the confidence interval, indicating the range of probable future values based on the model's estimations. This interval gets wider as the forecast moves further from the last historical point, suggesting increased uncertainty in the long-term predictions. Changepoints, which are not explicitly marked on this graph but are mentioned in the title, are typically points in the series where the model has detected potential shifts in the underlying trend, influencing the model's predictions. The forecast suggests the expectation of a stable or slightly increasing trend in exchange rates shortly after the last observed data point.

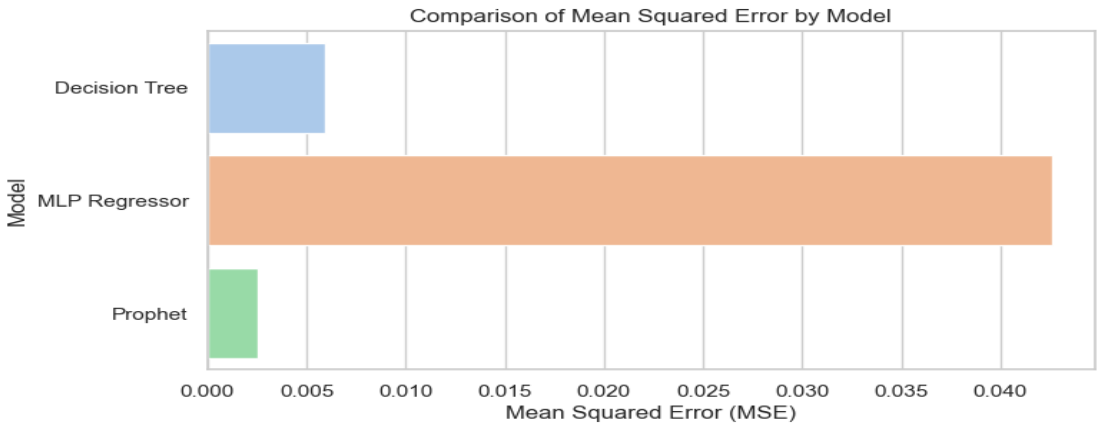
5. Results:

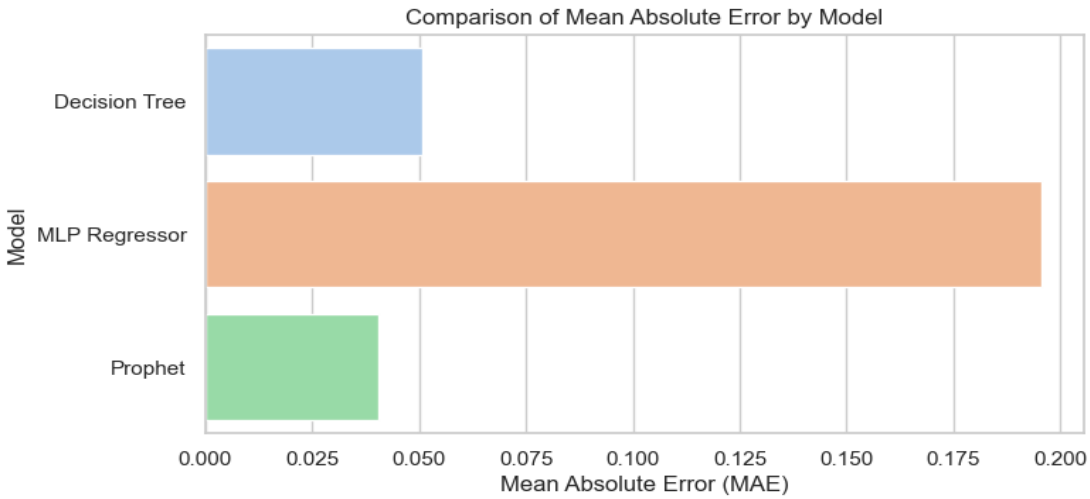
From the analysis, the three different models (Decision Tree, MLP Regressor, and Prophet) were used to predict USD to INR exchange rates. The Decision Tree model had an impressive R^2 Score of approximately 96.97%, indicating a high level of accuracy in the predictions. The Prophet model closely followed with a similar R^2 Score

of around 96.81%. On the other hand, the MLP Regressor had a lower R^2 Score of approximately 78.34%.

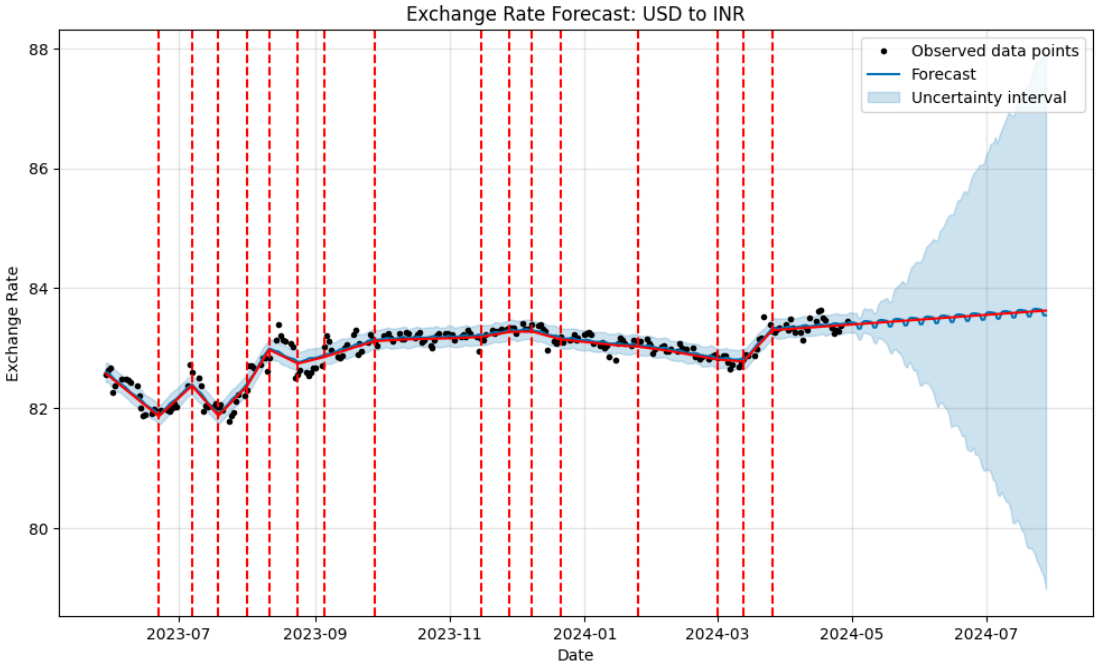


In terms of error metrics, the Prophet model had the lowest Mean Squared Error (MSE) and Mean Absolute Error (MAE), suggesting it was the most precise and consistent in its predictions. The Decision Tree model, despite its high R^2 Score, had slightly higher errors compared to the Prophet model.

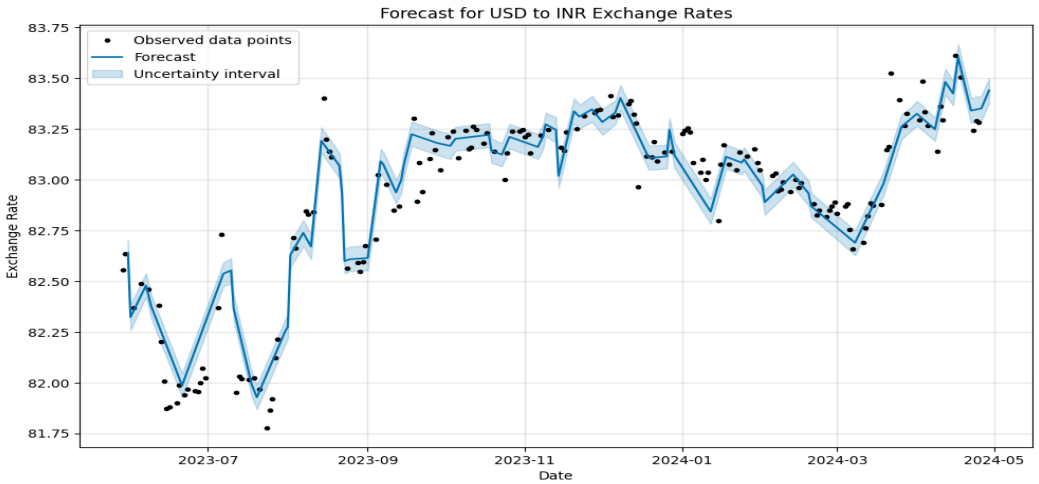




Visualizations were created to compare the performance of these models, and they likely showed that while all models captured the trend of the data to some extent, the Prophet model was particularly effective in forecasting with the added advantage of providing confidence intervals to express forecast uncertainty.

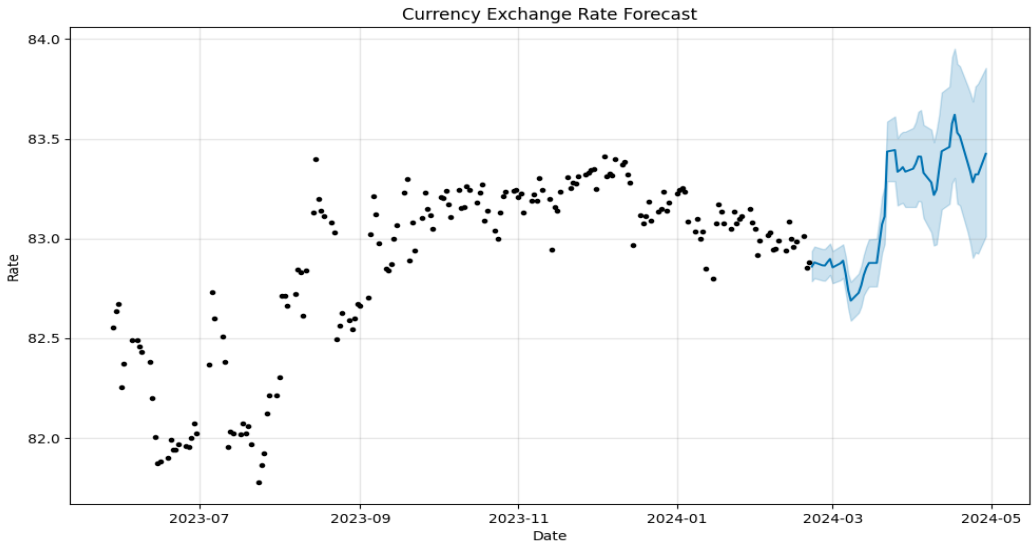


This graph displays a forecast for the USD to INR exchange rate, with historical data in black dots and the forecast trend in a blue line. Red dashed vertical lines may represent identified changepoints or significant dates, and the blue shaded area indicates the forecast's uncertainty interval, which widens over time, showing increasing uncertainty in the future exchange rate prediction.

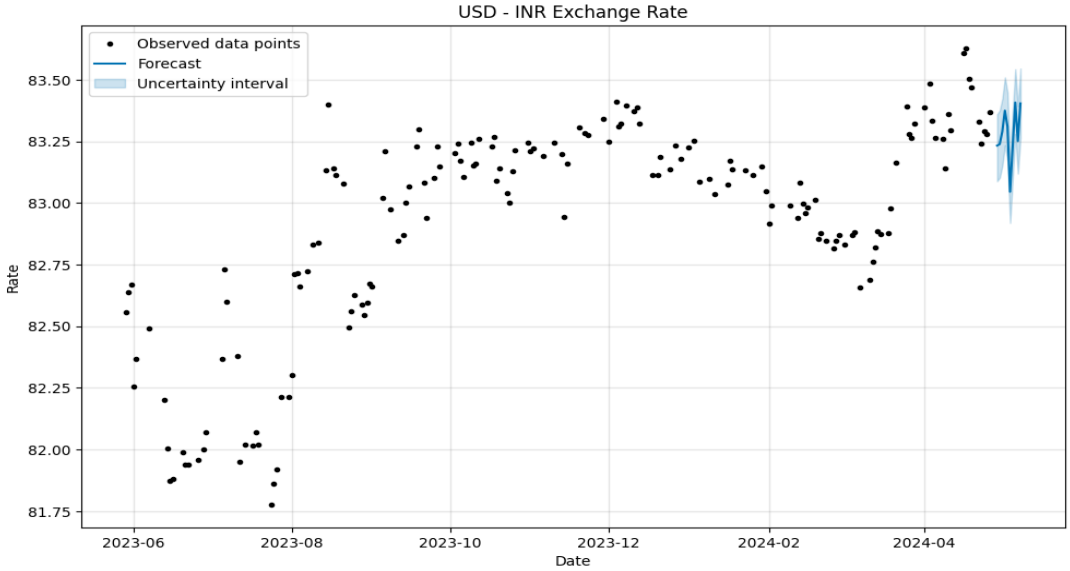


The graph shows historical and predicted USD to INR exchange rates. Black dots

represent actual past rates, the solid blue line indicates the forecasted future rates, and the light blue shaded area represents the confidence interval around the forecast, highlighting the range of potential future values. The forecast suggests an uptrend in exchange rates, with the actual rates closely following the predicted path, albeit with some volatility.



This graph shows a time series of USD to INR exchange rates, with black dots representing observed historical data and a blue line forecasting future rates. As the forecast progresses, the blue line becomes a shaded area, representing the increasing uncertainty of future rate predictions. The graph suggests relative stability in the past rates, with a notable prediction of increased volatility or uncertainty soon.



The graph illustrates historical currency exchange rates and a forecast into the future. The black dots represent actual historical exchange rate data, showing the rate's movement over time. The blue line indicates the model's prediction of future exchange rates, and the light blue shaded area around this line represents the confidence interval, suggesting greater variability or uncertainty in the rate as time advances. The trend indicates an expected increase in the exchange rate following the historical data trend.

These findings would suggest that for forecasting USD to INR exchange rates, the Prophet model might be the preferred choice due to its balance of high accuracy and low error rates, along with its ability to account for uncertainty in future predictions.

6. Conclusion:

The conclusion of the report on global currency forecasting emphasizes the effectiveness of the three examined models—Decision Tree, MLP Regressor, and Prophet—in predicting USD to INR exchange rates. It particularly highlights the superior performance of the Prophet model, which not only achieved a high accuracy with an R^2 score comparable to the Decision Tree model but also exhibited the lowest error rates, making it the most precise and consistent. This model's capability to provide confidence intervals adds an additional layer of value by expressing the forecast uncertainty, which is crucial for stakeholders making informed decisions in volatile financial markets. The analysis reaffirms the importance of advanced forecasting models in managing economic risks associated with fluctuating exchange rates and underscores the need for continuous model evaluation and data analysis to adapt to changing market dynamics.