

EXPERIMENT REPORT

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| Project Name | AT2 - Machine Learning as a Service |
| Date | 10/10/2023 |
| Deliverables | kotak_sahil_24707592_forecasting_prophet.ipynb Prophet |

1. EXPERIMENT BACKGROUND

Provide information about the problem/project such as the scope, the overall objective, expectations. Lay down the goal of this experiment and what are the insights, answers you want to gain or level of performance you are expecting to reach.

1.a. Business Objective

The primary goal of this project was to forecast national daily sales revenue for a retail chain. Accurate forecasts help businesses optimize their inventory, streamline operations, and improve customer satisfaction by ensuring product availability. An accurate forecast also aids in financial planning and can guide marketing and sales strategies. Incorrect forecasts, on the other hand, can lead to overstocking or stockouts, both of which have associated costs and can impact customer trust.

1.b. Hypothesis

Given the historical daily sales revenue and considering special events or holidays, we hypothesize that it's possible to predict future sales with reasonable accuracy. Our rationale is based on the belief that sales patterns are influenced by past behavior and special events, and these patterns can be captured and modeled for future forecasting.

1.c. Experiment Objective

The expected outcome of the experiment was to produce a model capable of forecasting the next 7 days of national sales revenue. Our goal was to achieve a forecast that closely mirrors actual sales, with an acceptable margin of error. The possible scenarios from this experiment could be:

- The model provides an accurate forecast, which aligns closely with actual sales.
- The model provides a reasonably close forecast with minor deviations.
- The model's forecast is significantly different from actual sales.

2. EXPERIMENT DETAILS

Elaborate on the approach taken for this experiment. List the different steps/techniques used and explain the rationale for choosing them.

2.a. Data Preparation

For the Prophet model, the data was prepared by aggregating the sales revenue at a daily level. The rationale behind this was that Prophet requires a date (ds) and a corresponding target value (y) for forecasting. Additionally:

- Missing data points were filled to ensure a consistent time frequency.
- We ensured that the data was free from any outliers or anomalies that could adversely affect the forecast.
- While we considered other granularities, daily aggregation was chosen for its balance between detail and manageability.

Steps not executed:

- We didn't delve deep into imputing missing data based on sophisticated methods in this experiment as that was taken care of in the previous experiment building predictive model.
- Data transformation (like log transform) was considered but not applied as Prophet can handle non-stationarity internally.

2.b. Feature Engineering

Prophet automatically handles feature engineering for time-based components:

- Seasonal decomposition for yearly and weekly seasonality was handled internally by Prophet.
- Special events and holidays were explicitly provided to the model as additional regressors. These were deemed important given the domain knowledge that sales might be influenced by events or holidays.

Steps not executed:

- No explicit removal of features was done as Prophet determines the significance of the features internally.

2.c. Modelling

The Prophet model was chosen for this experiment due to its ease of use, capability to handle time series data with trends and seasonality, and its ability to incorporate holidays and special events.

- Hyperparameter tuning was done in a limited capacity. We played with seasonality and changepoint sensitivity to get a better fit.

Models not trained:

- While other time series models like ARIMA or LSTM were considered, we decided to start with Prophet due to its simplicity and the nature of our data.

3. EXPERIMENT RESULTS

Analyse in detail the results achieved from this experiment from a technical and business perspective. Not only report performance metrics results but also any interpretation on model features, incorrect results, risks identified.

3.a. Technical Performance

The Prophet model provided reasonably accurate forecasts, capturing both the trend and seasonality of the sales data. The most underperforming cases were usually around major holidays or events, where sales can be more volatile and harder to predict.

3.b. Business Impact

From a business perspective, the forecasted sales values enable better planning in terms of inventory, staffing, and marketing efforts. Incorrect forecasts can lead to overstocking or stockouts, affecting customer satisfaction and incurring costs. For instance, underestimating sales around a major holiday could lead to stockouts, missed revenue opportunities, and customer dissatisfaction.

3.c. Encountered Issues

- **Data Granularity:** Initially, there was some uncertainty about the granularity at which to aggregate the sales data (daily, weekly, etc.).
- **Handling Missing Data:** While Prophet requires consistent frequency, real-world data might have gaps. We addressed this by imputing missing data.
- **Overfitting:** As with all models, there's a risk of overfitting, especially when the model becomes too sensitive to past events. We tried different changepoint sensitivities to manage this.
- **Event Significance:** Determining which events significantly influence sales was a challenge. Some events might not have a substantial impact on sales, even though they're culturally or socially significant.

For future experiments, it might be worthwhile to delve deeper into hyperparameter tuning, incorporate more external factors, or try other time series forecasting models for comparison.

4. FUTURE EXPERIMENT

Reflect on the experiment and highlight the key information/insights you gained from it that are valuable for the overall project objectives from a technical and business perspective.

4.a. Key Learning

From our experimentation with the Prophet model:

- Prophet effectively captures the yearly and daily seasonality in the sales data.
- Special events or holidays play a crucial role in influencing sales, and incorporating this information improves forecast accuracy.
- The model requires a consistent frequency of data points, and any gaps can affect the forecast.

4.b. Suggestions / Recommendations

- **Further Experimentation:** While Prophet has provided good results, it might be beneficial to experiment with other time series forecasting models or techniques to compare performance.
- **Include Additional Data:** Incorporating other influencing factors, such as marketing campaigns, competitor data, or economic indicators, might enhance the forecast's accuracy.
- **Model Tuning:** There's an opportunity to fine-tune the Prophet model parameters further to potentially improve performance.
- **Deployment:** Given the promising results from the Prophet model, we recommend integrating it into the business process for real-time forecasting. This could be achieved via a REST API (as we've done) to allow seamless access for stakeholders.
- **Monitor and Update:** Post-deployment, it's crucial to monitor the model's predictions against actual sales and recalibrate the model periodically to ensure it remains accurate as new data becomes available.