



# HOTEL BAR INVENTORY FORECASTING

AI ENGINEER TAKE-HOME PROJECT  
BHARGAV SIMHA



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# BUSINESS PROBLEM

- A growing hotel chain operates bars across locations and is facing frequent stockouts of high-demand items and overstocking of low-demand items. These issues lead to increased operational costs and poor guest experience. The objective is to forecast demand and recommend inventory levels (par levels) to maintain optimum stock.



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# ASSUMPTIONS MADE

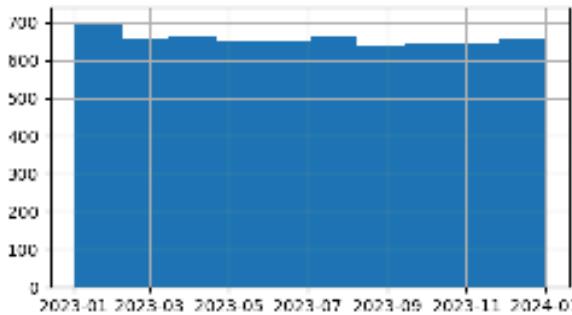
- Historical data is indicative of future demand.
- Data is on daily granularity; weekly seasonality isn't dominant.
- 15% buffer in par level covers natural demand variability.
- One model per item/location is sufficient for prediction accuracy.
- Forecasting horizon limited to 5 days for inventory responsiveness.



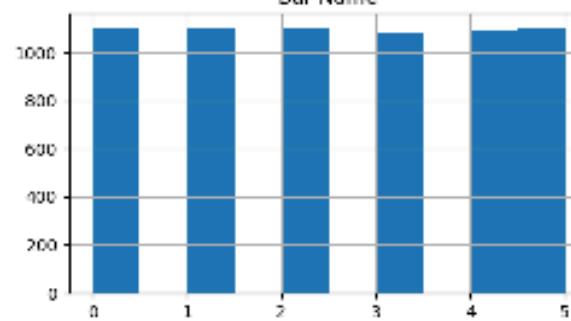
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# Histogram Plot of all columns

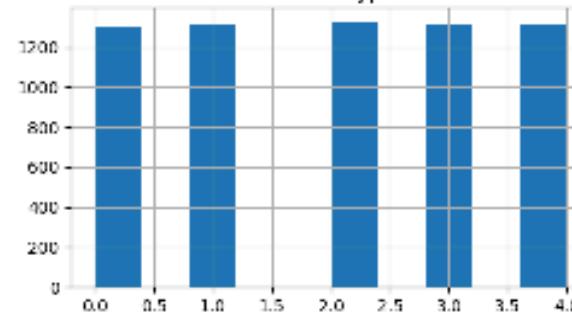
Date Time Served



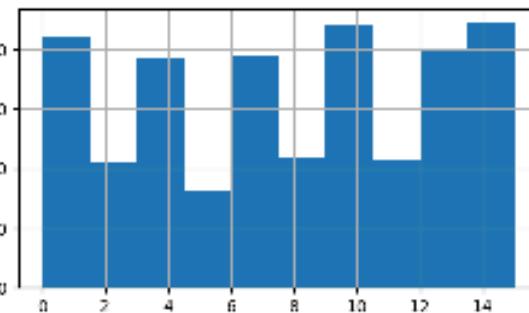
Bar Name



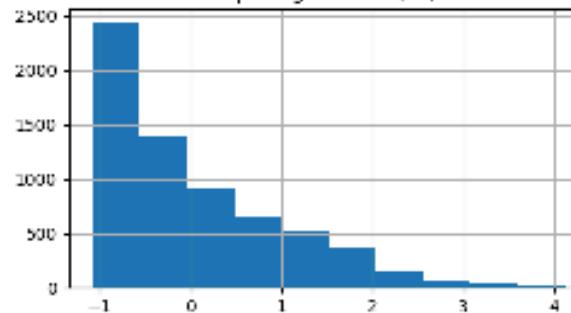
Alcohol Type



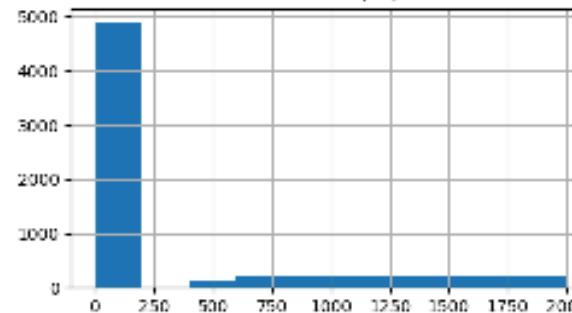
Brand Name



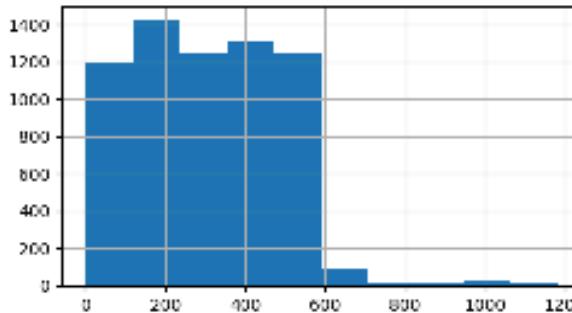
Opening Balance (ml)



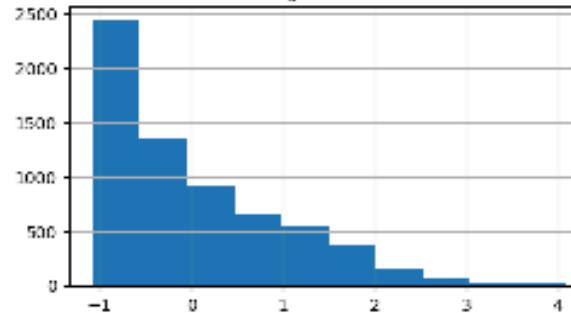
Purchase (ml)



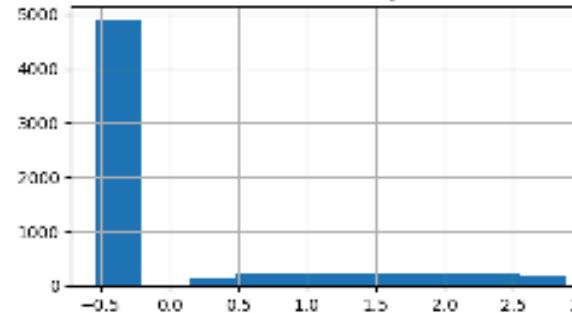
Consumed (ml)



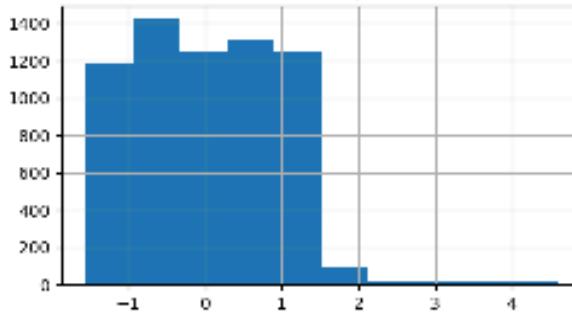
Closing Balance (ml)



Purchase Quantity (ml)

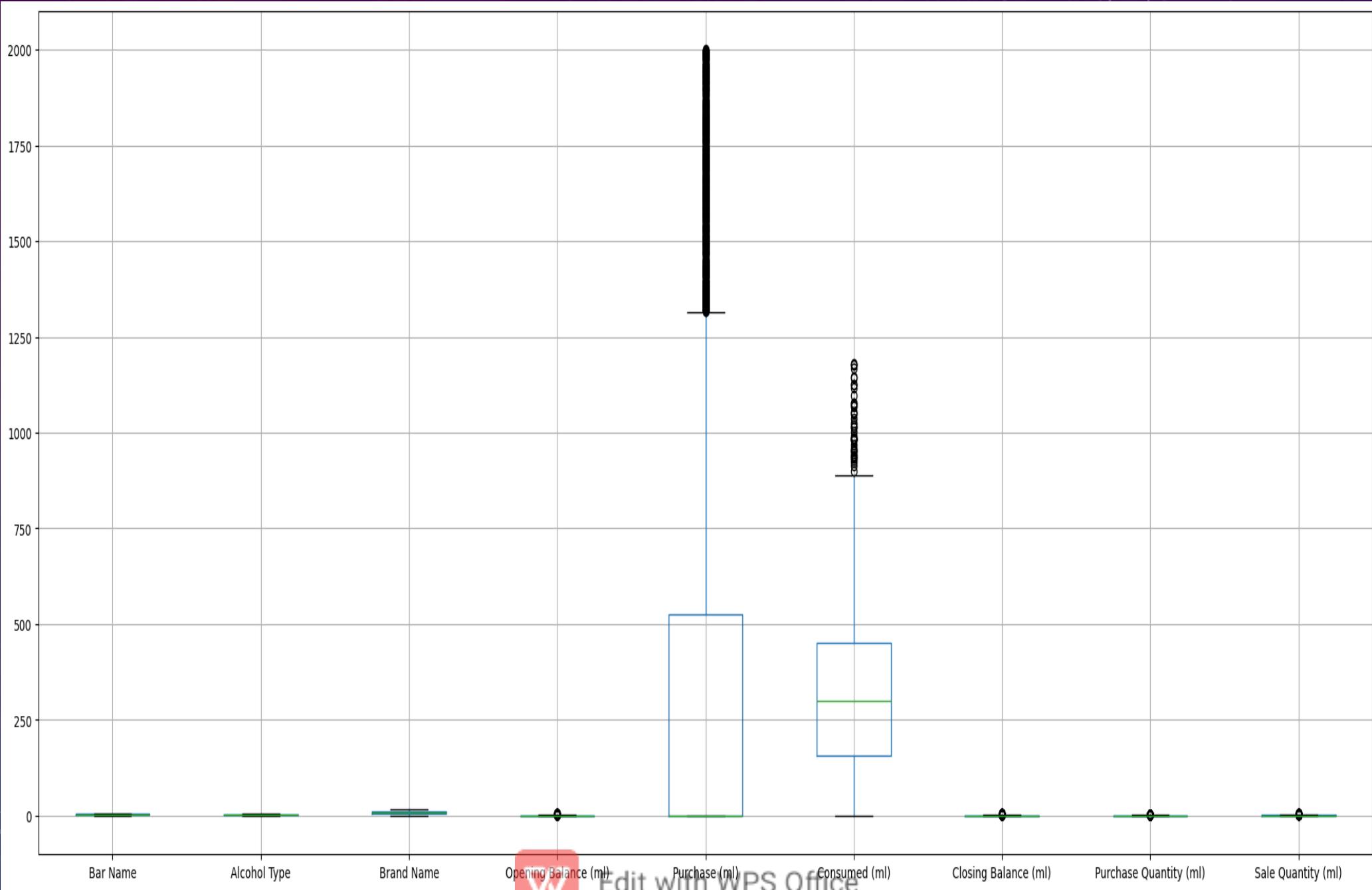


Sale Quantity (ml)

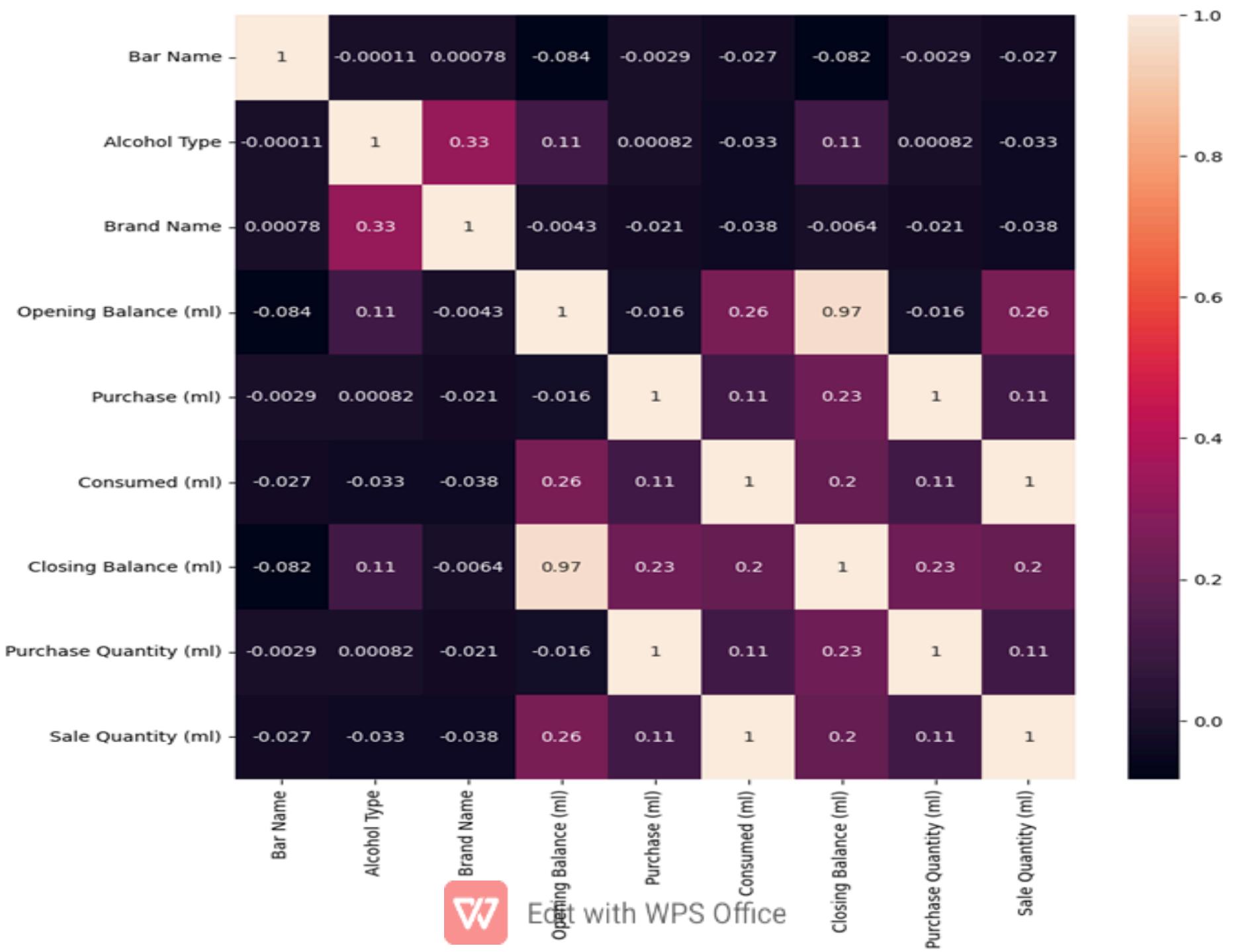


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# Boxplot of All Columns

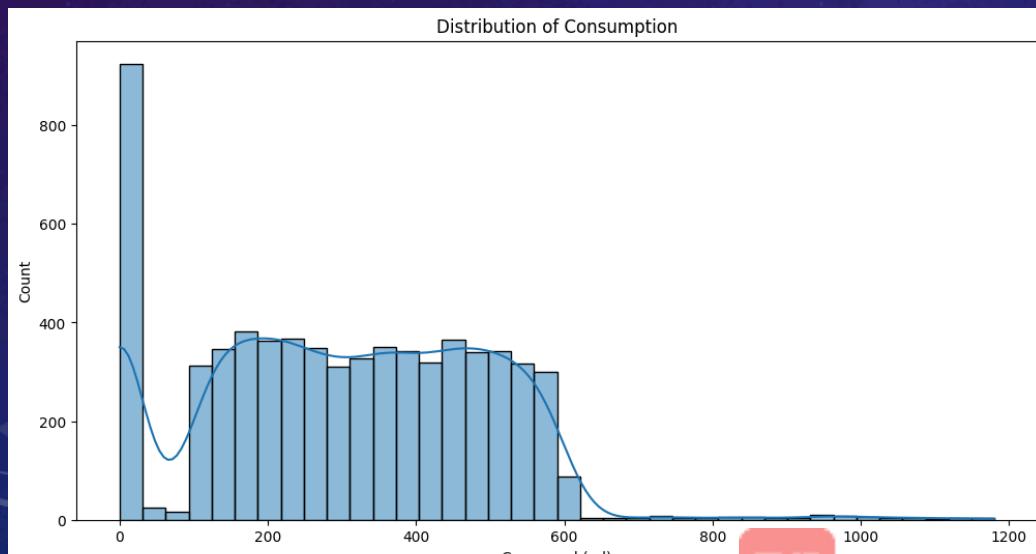
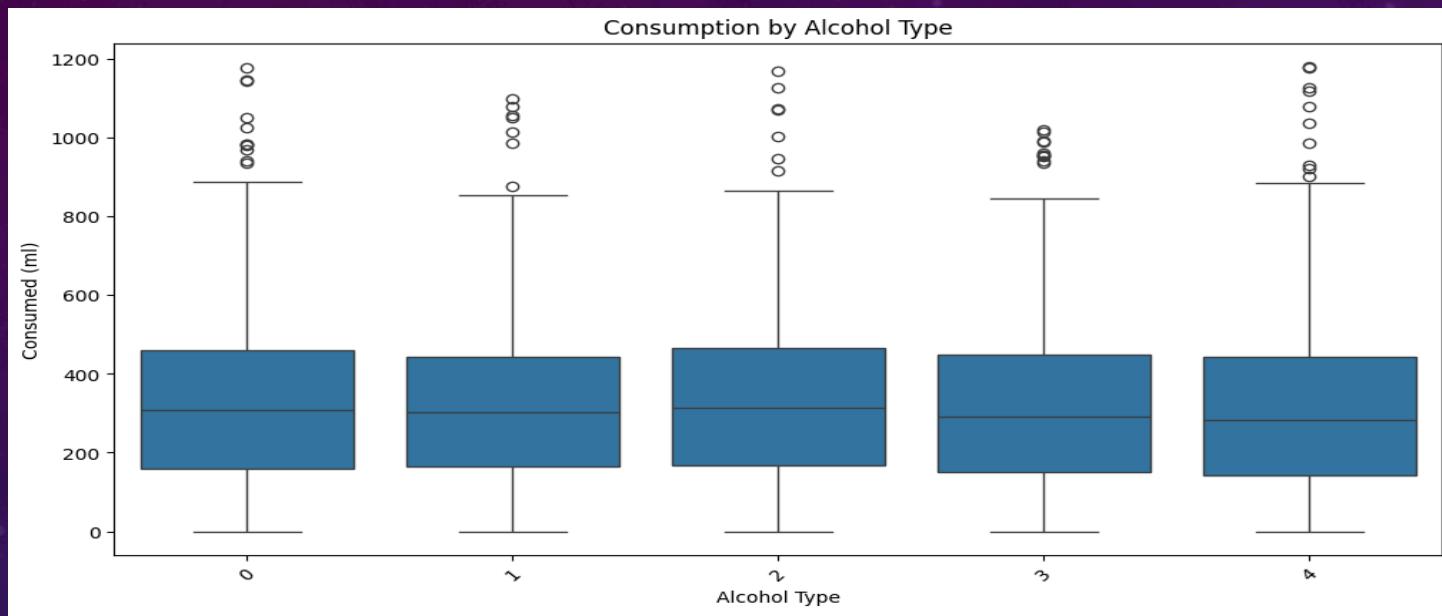


# Correlation matrix in the form of heatmap



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# Few Other Visualization



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# MODELS USED AND RATIONALE

- Multiple models were tested: Linear Regression, Decision Tree, Random Forest, XGBoost, CatBoost, LightGBM.
- Ensemble model (Gradient Boosting + CatBoost + LightGBM) performed best with MAE of ~152.
- Prophet was used for short-term forecast with confidence intervals.



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# SYSTEM PERFORMANCE

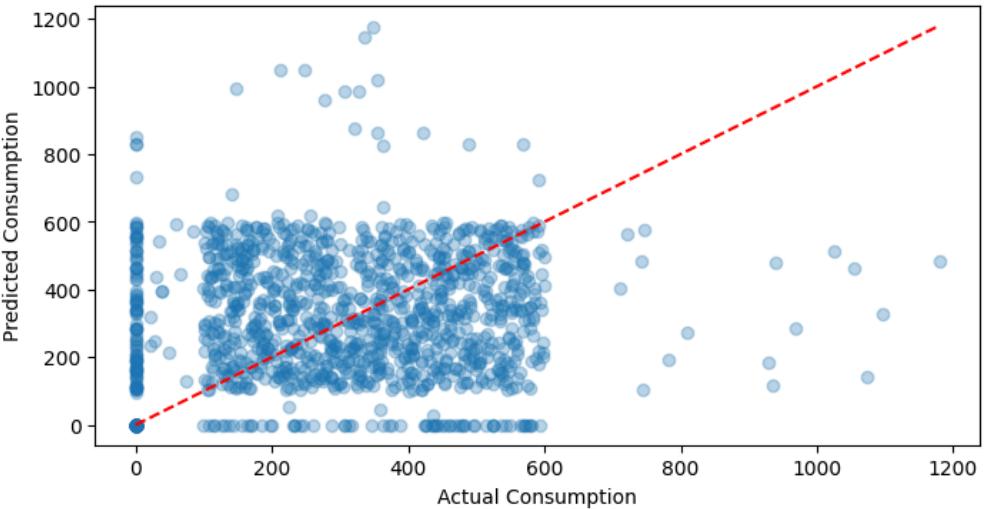
- Ensemble Model MAE: 152.99, RMSE: 184.26, R<sup>2</sup>: 0.072.
- LightGBM, CatBoost followed closely.
- Prophet provided interpretable forecasts with upper/lower bounds.
- Final inventory recommendation: `par\_level = predicted\_demand \* 1.15`.



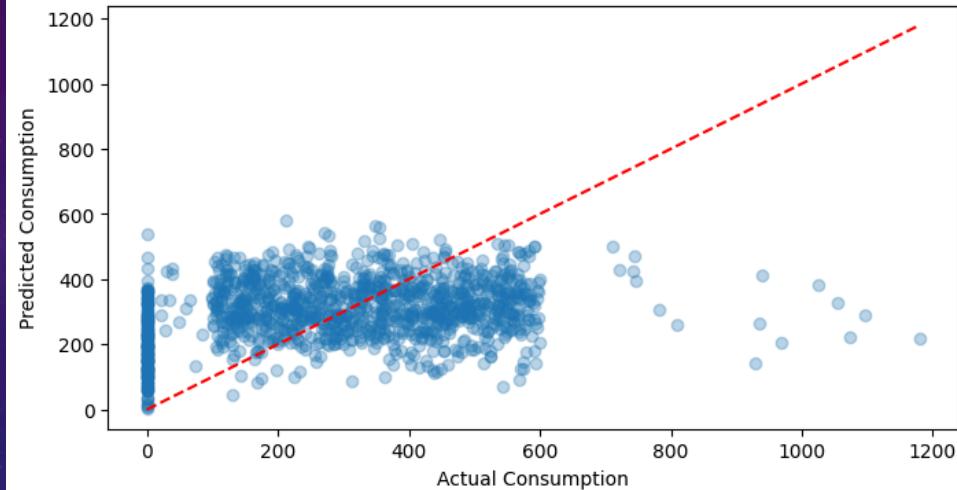
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# MODEL EVALUATION RESULTS

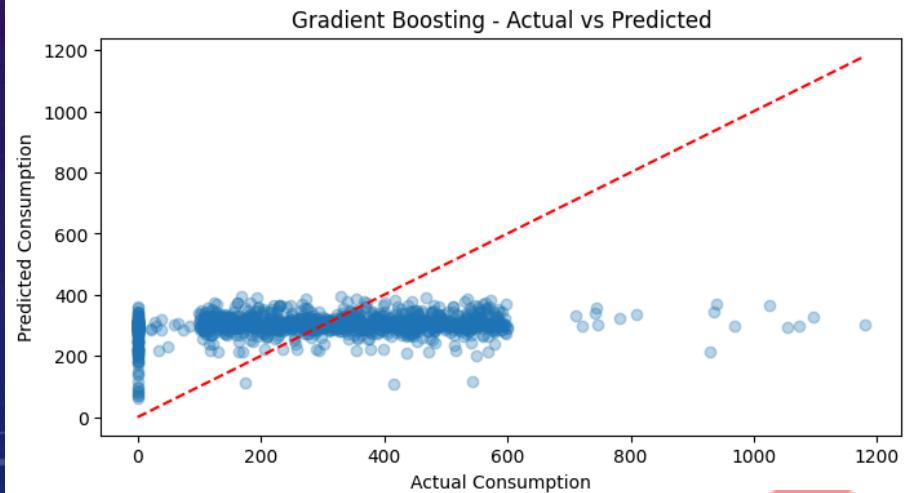
Decision Tree - Actual vs Predicted



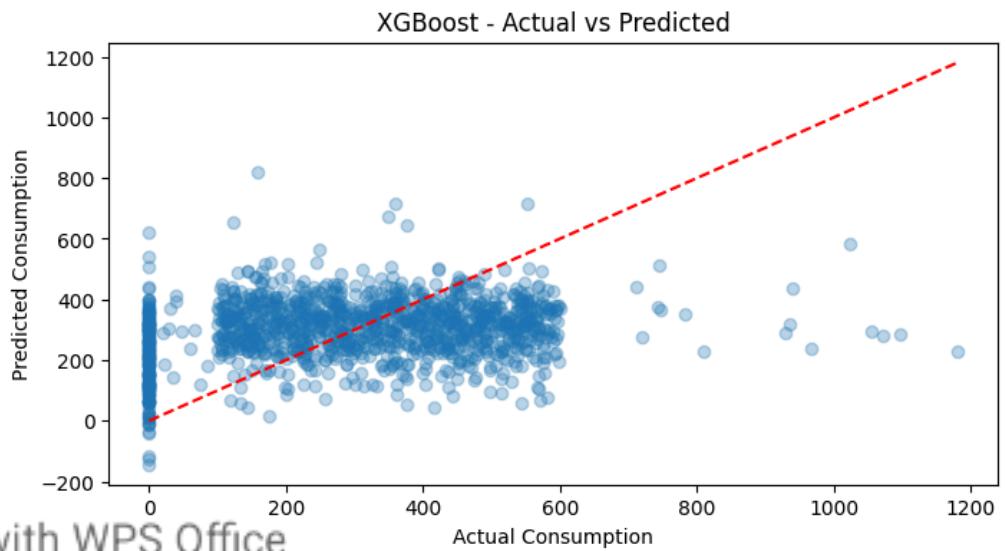
Random Forest - Actual vs Predicted



Gradient Boosting - Actual vs Predicted

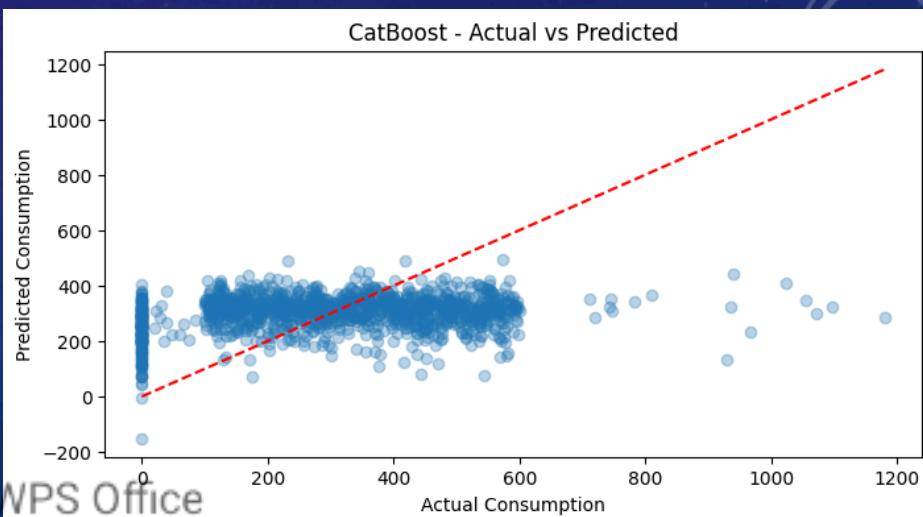
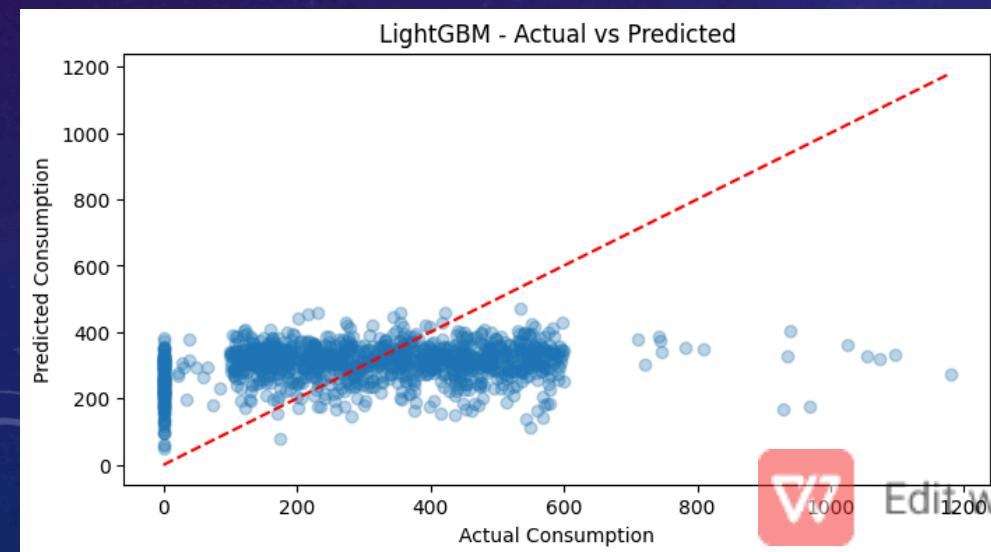
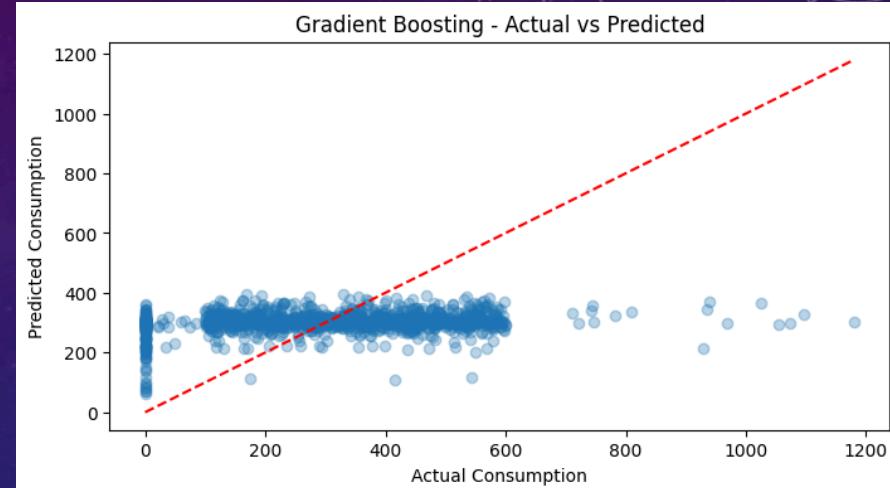
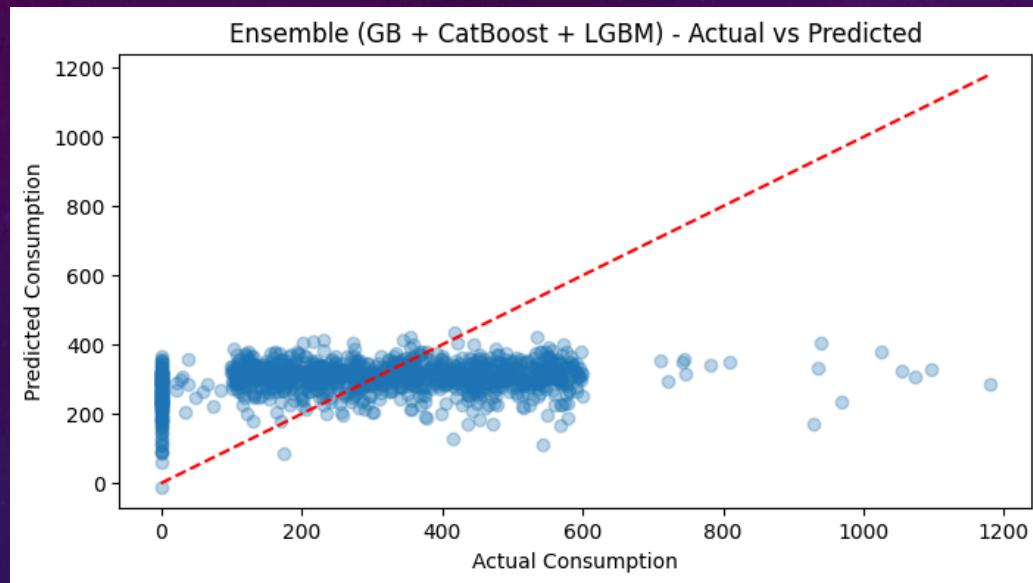


XGBoost - Actual vs Predicted



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# FEW MORE MODEL BUILDING EVALUATION



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# REAL-WORLD INTEGRATION

- Daily predictions help managers decide restocking needs.
- System connects to POS data, runs forecasts, and suggests quantities.
- Alerts for low inventory days can be triggered.
- Performance can be tracked using MAE and forecast errors.
- Improvements: retrain weekly, include event/calendar effects, more granular SKUs.



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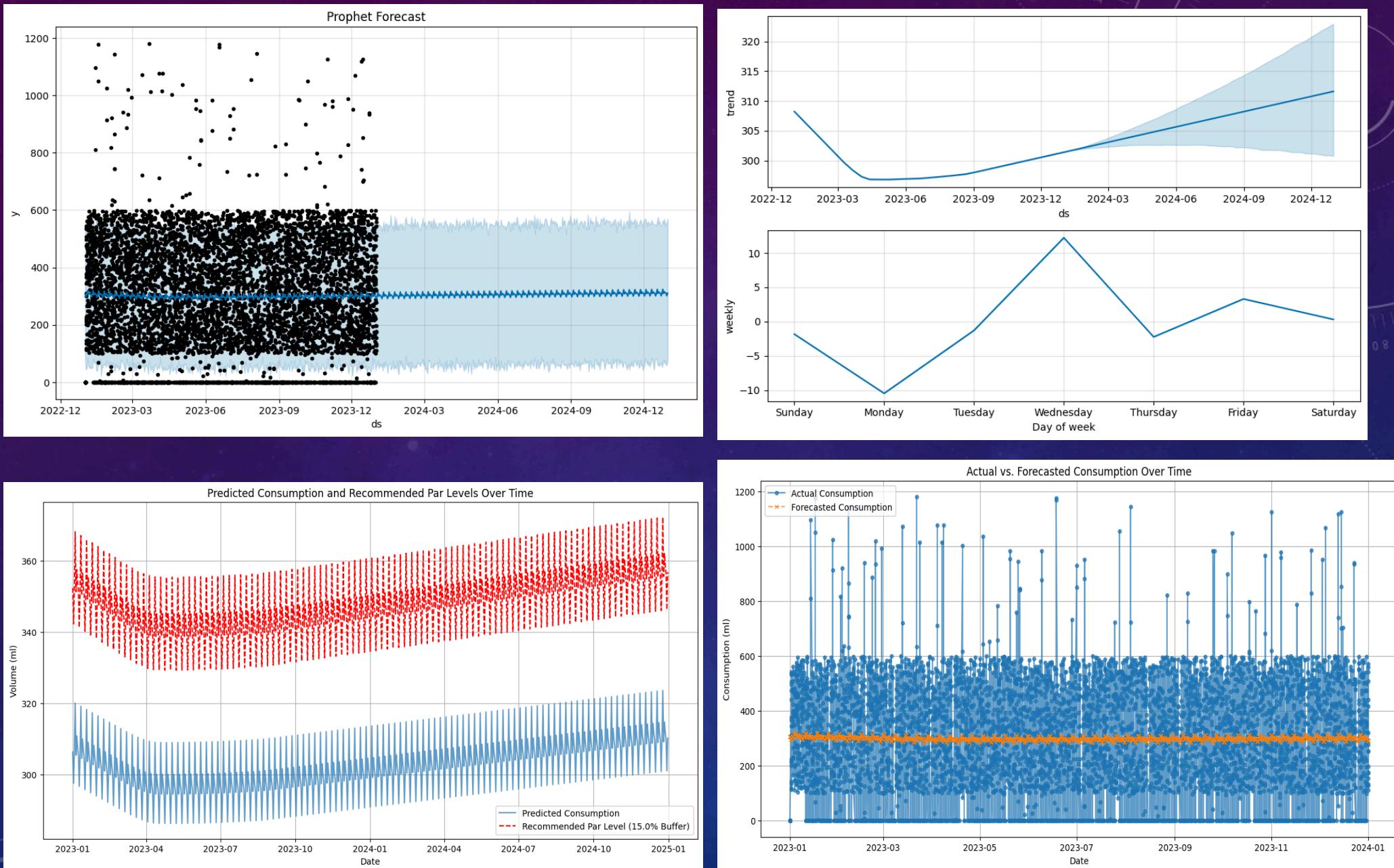
# POTENTIAL SCALING CHALLENGES

- Real-time demand shifts and external factors can reduce accuracy.
- Data latency might affect timely recommendations.
- Need to automate retraining and monitoring in production.
- Integrating with multiple locations requires scalable pipelines.



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# Prophet Forecasting Images



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# CONCLUSION & FUTURE TRENDS

- Forecasting and inventory recommendations help reduce stockouts and overstocking.
- Ensemble models and Prophet enable robust demand prediction with uncertainty.
- Future trends: Incorporating real-time data, external factors like events, AI-driven dynamic par levels.
- Continuous retraining and feedback loops will improve system accuracy.



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# CHALLENGES FACED DURING THE PROJECT

- Handling noisy and incomplete historical data required careful preprocessing.
- Balancing model complexity and interpretability was important.
- Low R<sup>2</sup> scores indicate inherent variability and difficulty in demand prediction.
- Choosing appropriate forecasting horizon to balance responsiveness and stability.
- Integrating multiple models and tuning ensemble parameters required experimentation.



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