Group 3 – Capstone Final Project

AutoML Model Resources:

We developed three core models in Azure AutoML:

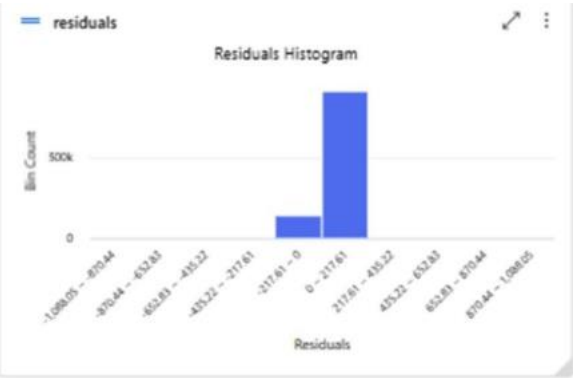
1. Regression (Passenger Volume Prediction)

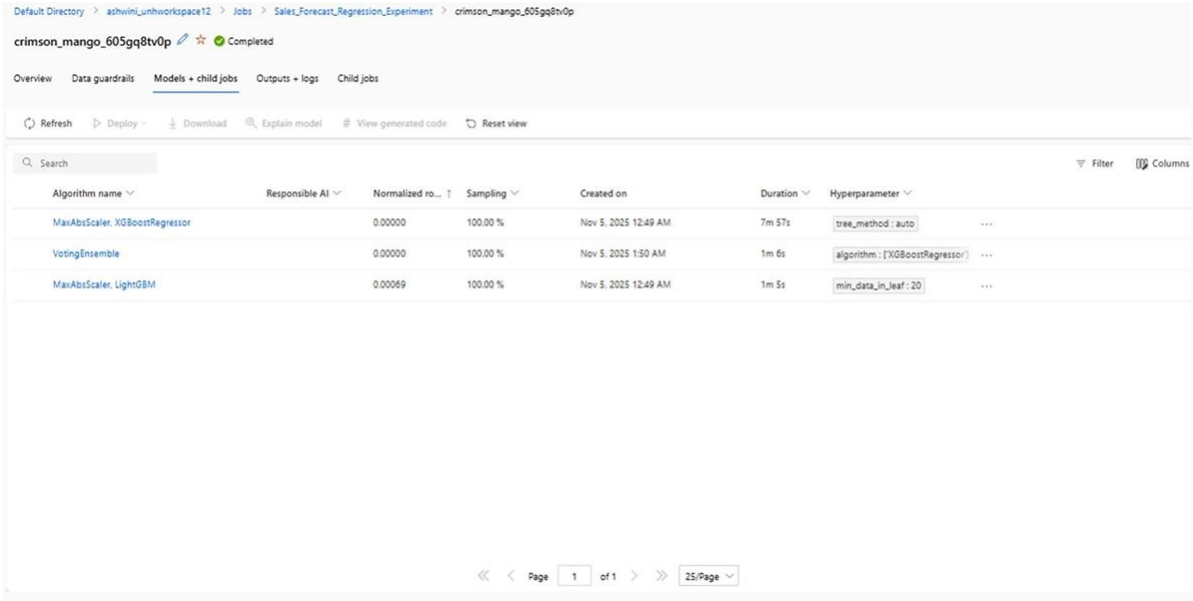
- Dependent variable: Passenger Volume
- Independent variables: EZ Pass, Violation, Month, LaneMode
- Top algorithms: VotingEnsemble, XGBoostRegressor, LightGBM, ElasticNet
- Best NRMSE ~ 0 (very low error), indicating high predictive accuracy

Azure AutoML was used to build multiple regression models to predict the target variable for the Port Authority dataset. The system trained several algorithms and evaluated them based on the Normalized Root Mean Squared Error [NRMSE]-the primary metric selected for this experiment. The AutoML run generated the following top-performing models:
Voting Ensemble (Best Model)

- Performance: NRMSE: 0.00000(best score)
- Training Duration: 1minute 6 seconds
- Sampling :100%
- Key Hyperparameters : algorithm:['XGBoostRegressor',...]

Azure AutoML automactially selected VotingEnsemble as the best-performing regression Model because, it achieved the lowest NRMSE(0.00000) and combined the strengths of multiple high-preforming algorithms.
The VotingEnsemble combines predictions from multiple top models (XGBoost and LIGHTgbm), resulting in higher overall accuracy and model Stability.





2. Classification (Eligibility / Traffic Behavior)

- Dependent variable: Eligibility / category
- Independent variables: Time/Month, Average Speed, Passenger Carrier
- Top algorithms: SeasonalNaive, SeasonalAverage, ExponentialSmoothing, Prophet, LightGBM, XGBoostRegressor
- Best NRMSE ≈ 0.05216; ensemble models moderate performance

Azure AutoML was used to develop a classification model to predict the target class for the Port Authority dataset. The AutoML experiment automatically trained and evaluated multiple classification algorithms using AUC (Weighted) as the primary evaluation metric.

Models Evaluated:

Azure AutoML tested a wide range of classification models, including:

- XGBoost Classifier (with StandardScaler, MaxAbsScaler, and SparseNormalizer)
- LightGBM
- Random Forest
- Extreme Random Trees
- Voting Ensemble

Each model was trained using 100% of the available data with optimized hyperparameters generated by AutoML.

Best Model Selection:

- Multiple models achieved an AUC (Weighted) score of 1.000, indicating excellent class separability.
- Among these, StandardScalerWrapper with XGBoostClassifier was selected as the best-performing model based on:

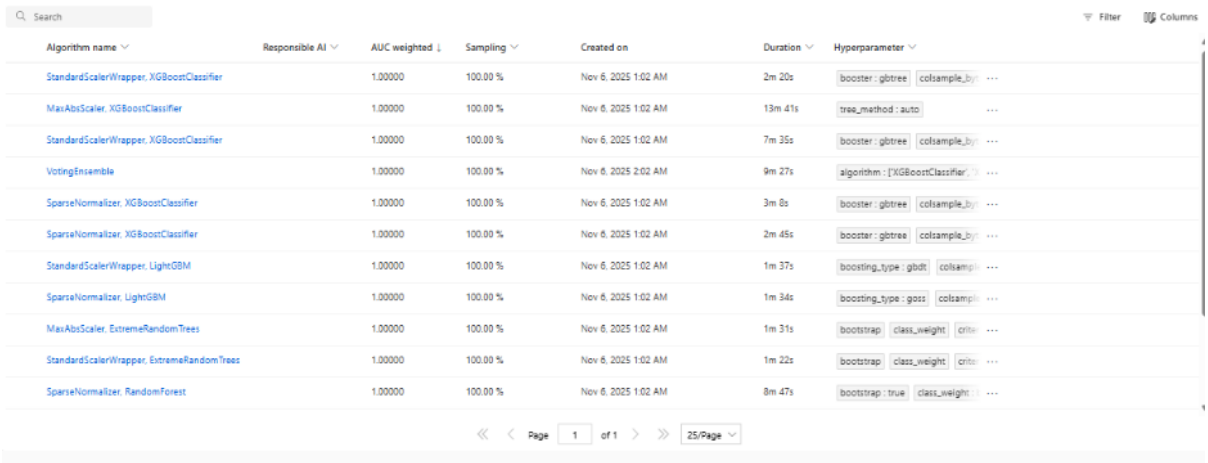
- Highest AUC (Weighted)
- Consistent performance across runs
- Efficient training duration

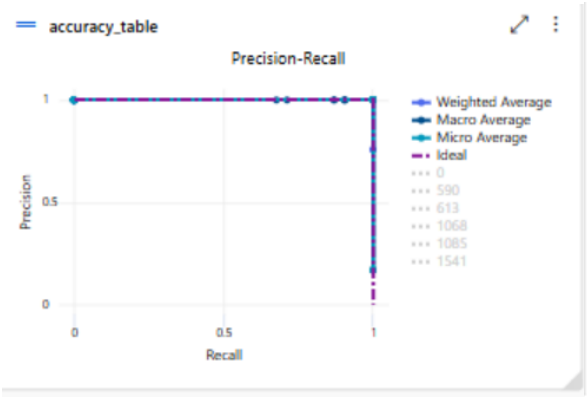
Model Performance:

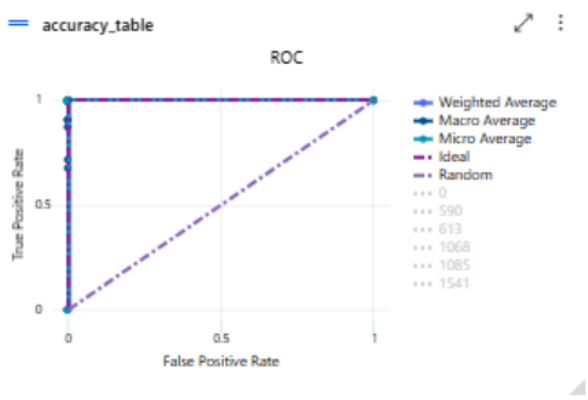
- The perfect AUC score demonstrates the model's ability to accurately distinguish between classes.
- Ensemble and tree-based models further confirmed the robustness and stability of predictions.
- The use of different scaling techniques (StandardScaler, MaxAbsScaler, SparseNormalizer) improved model performance on sparse and high-dimensional data.

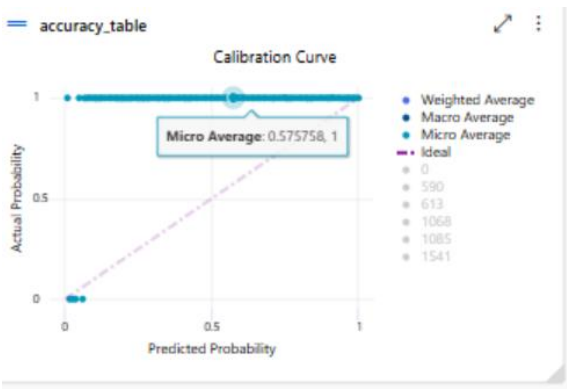
Conclusion:

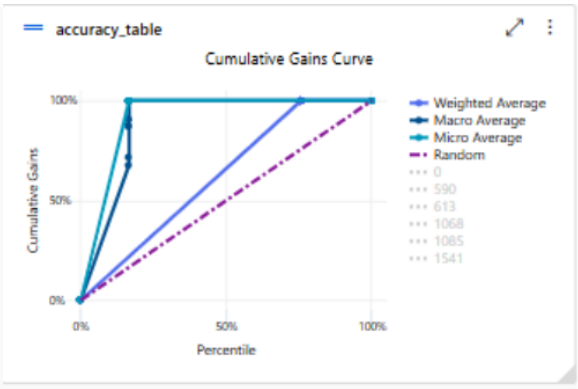
The Azure AutoML classification experiment successfully identified XGBoost-based models as the most effective for this dataset. The selected model shows excellent predictive performance, making it suitable for reliable classification tasks within the Port Authority project.







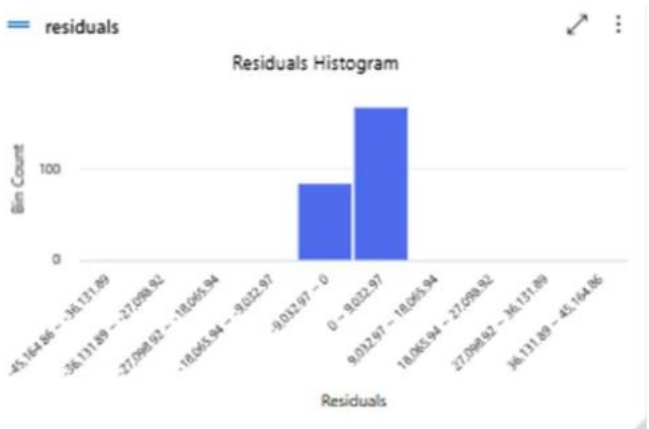


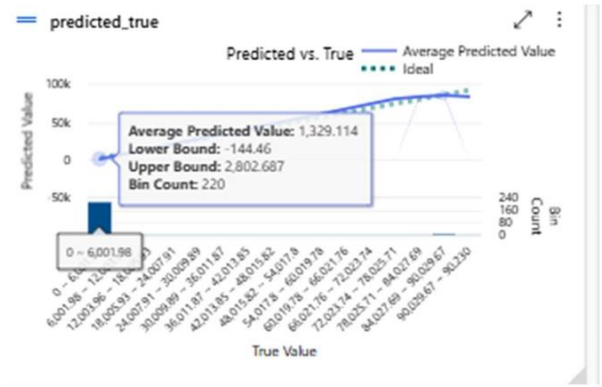


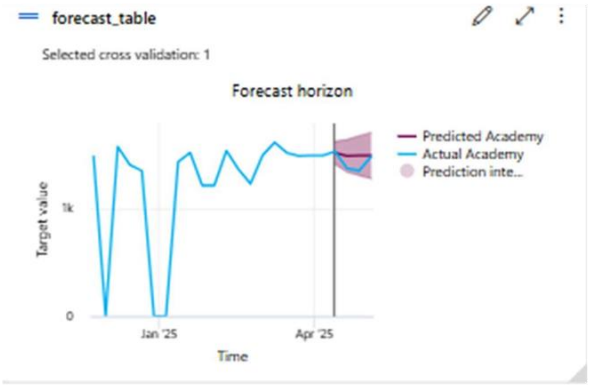
3. Time Series (Passenger Volume / Eligibility Over Time)

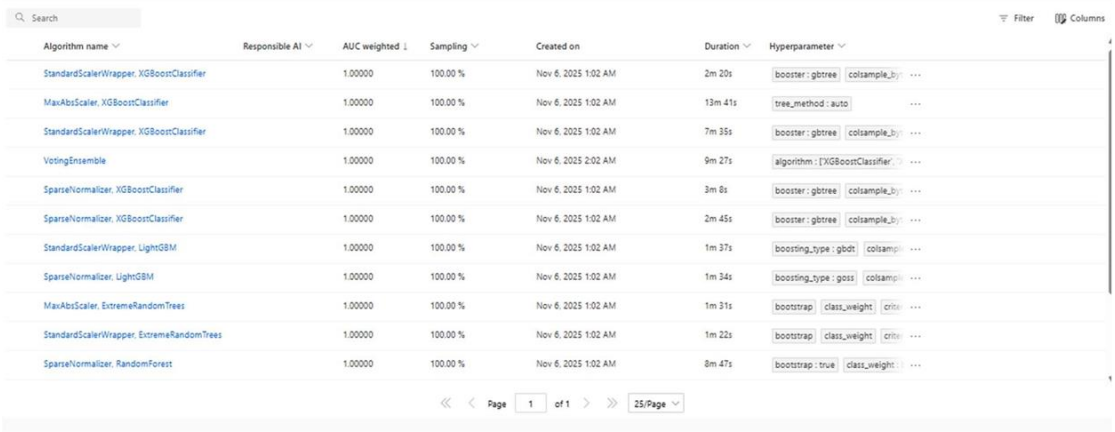
- Uses lagged demand, average speed, and carrier information
- Algorithms: XGBoostClassifier, LightGBM, ExtremeRandomTrees, VotingEnsemble
- Top models achieved AUC = 1.000 on classification tasks (perfect separation) Azure AutoML was used to train multiple time-series forecasting models to predict future facility usage patterns. The system tested classical statistical forecasting models, machine learning regressor with time-window features, and ensemble approaches. All models were evaluated using Normalized Root Mean Squared Error (NRMSE) as the primary metrics: Below is the best performing model of me series: Seasonal Naïve (Best Model)
    - NRMSE: 0.05216 (lowest error, best model)
    - Duration: 44 seconds
    - Sampling: 100%

  Seasonal Naïve: This model achieved the lowest error (NRMSE=0.05216) and showed the strongest ability to capture repetitive seasonal trends in Port Authority traffic/usage data.









Azure outputs (predicted vs true plots, residual histograms, ROC and precision-recall curves) confirmed stable models and strong seasonality structure.