Forecasting and Mitigating Disruptions in Public Bus Transit Services

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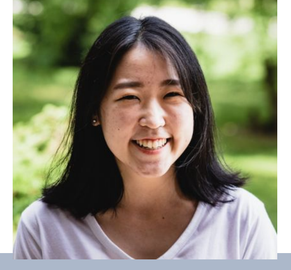


Introduction

1. Vehicle disruptions cause unexpected transit delays. It affects increasing commute time and upsetting traffic patterns.
2. Many models fail to account for bus disruptions.
3. Vehicle stationing methods could be strengthened by applying disruption forecasting results.

Methods

1. Use APC, Disruption, and GTFS data provided by Nashville, TN.
2. Use a data-driven statistical model to predict the likelihood of disruptions based on historical data and real-time information.
3. Optimize vehicle stationing model using a randomized local-search algorithm that selects locations for substitute vehicles based on ridership prediction and disruption data.

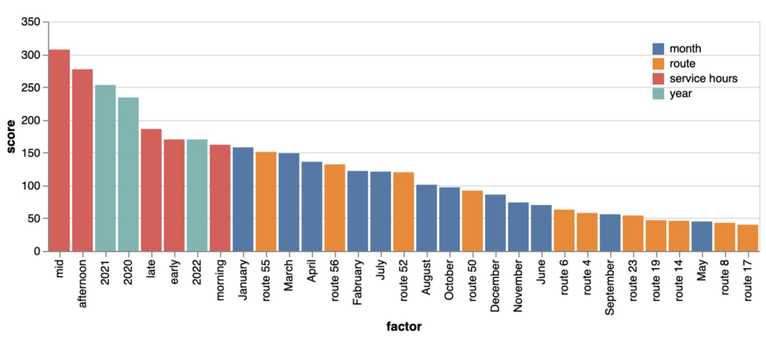
$$O = \sum_{k=1}^{K} (D_k + T_k) + \sum_{s=1}^{S} (L_s)$$

Disruption Forecasting

1. Five independent factors are significant for the predictive performance of the model: passenger capacity, service hours, day of the week, month, and route identification + direction.
2. Measure the performance of the model using the cross-entropy value, with lower values indicating better performance. Among the three models evaluated - logistic regression, XGBoost, and XGBoost calibrated with isotonic regression - the latter demonstrated the best performance.

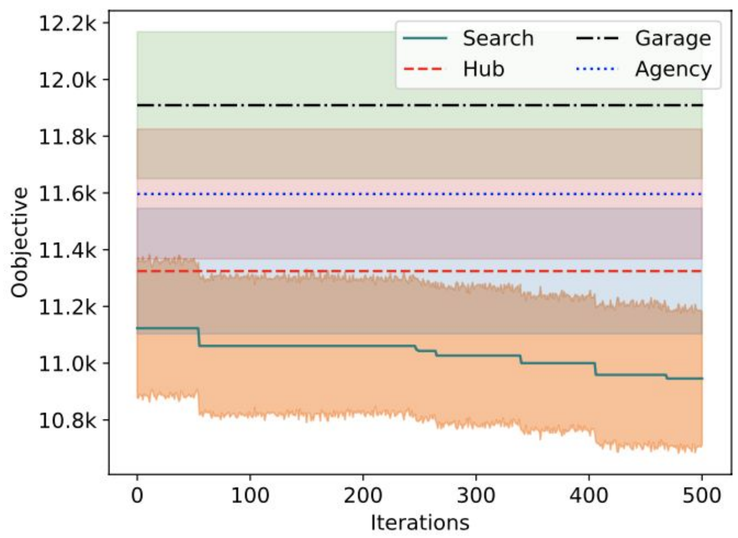
Model	Train Cross Entropy	Test Cross Entropy
Logistic Regression	0.0903	0.0912
XGBoost	0.0872	0.0881
XGBoost + Calibration	0.0870	0.0876

3. Certain routes are more prone to disruptions than others. Disruptions are also more likely to occur during midday and afternoon hours than in the morning, late, or early hours.



Vehicle Stationing

1. The search algorithm-generated stationing plans yield much lower scores compared to other plans.
2. Able to find the minimal objective cost within the first 100 iterations.
3. Without stationing constraints, stationing five buses at the main hub often outperforms these searched plans.



Future Work & Conclusion

1. Disruption forecasting model contributes to a more robust, responsive, and customer-focused public transportation system.
2. Vehicle stationing model can adapt to different scenarios and provide reliable and effective solutions for proactive disruption management.
3. Future work can improve forecast performance even more, modify it for other transit systems, and integrate it with real-world decision support settings.

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