Systemwide Variations and Factors Affecting Transit Travel Time Distributions

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Motivation

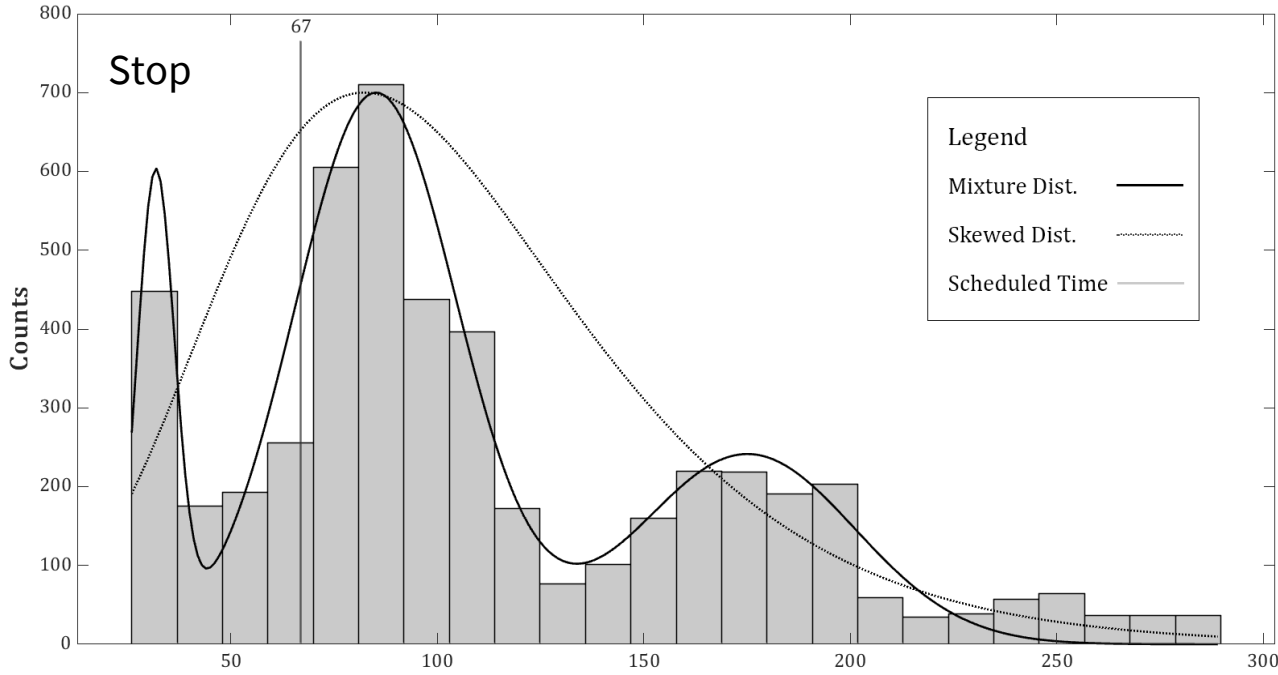
- Reliability is important for transit passenger satisfaction and agency operations.
- Need to improve reliability
- Better understand travel conditions
- Better understand travel time distributions

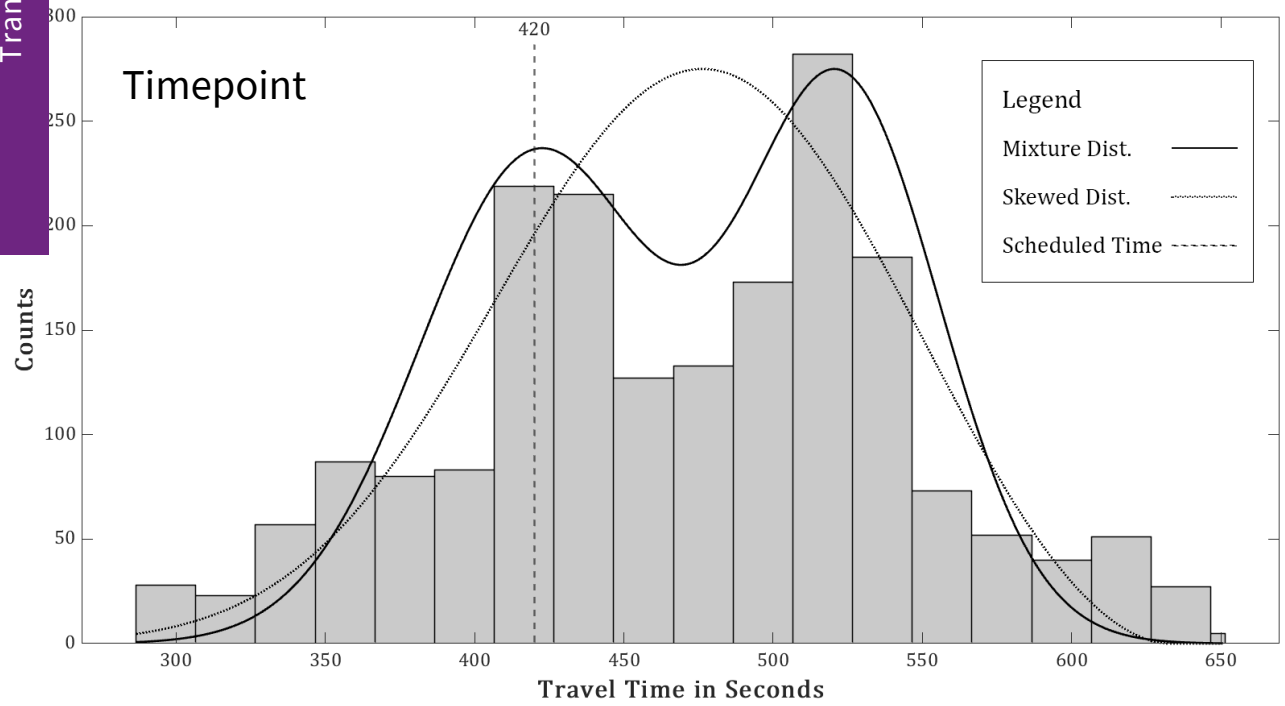
Literature Review

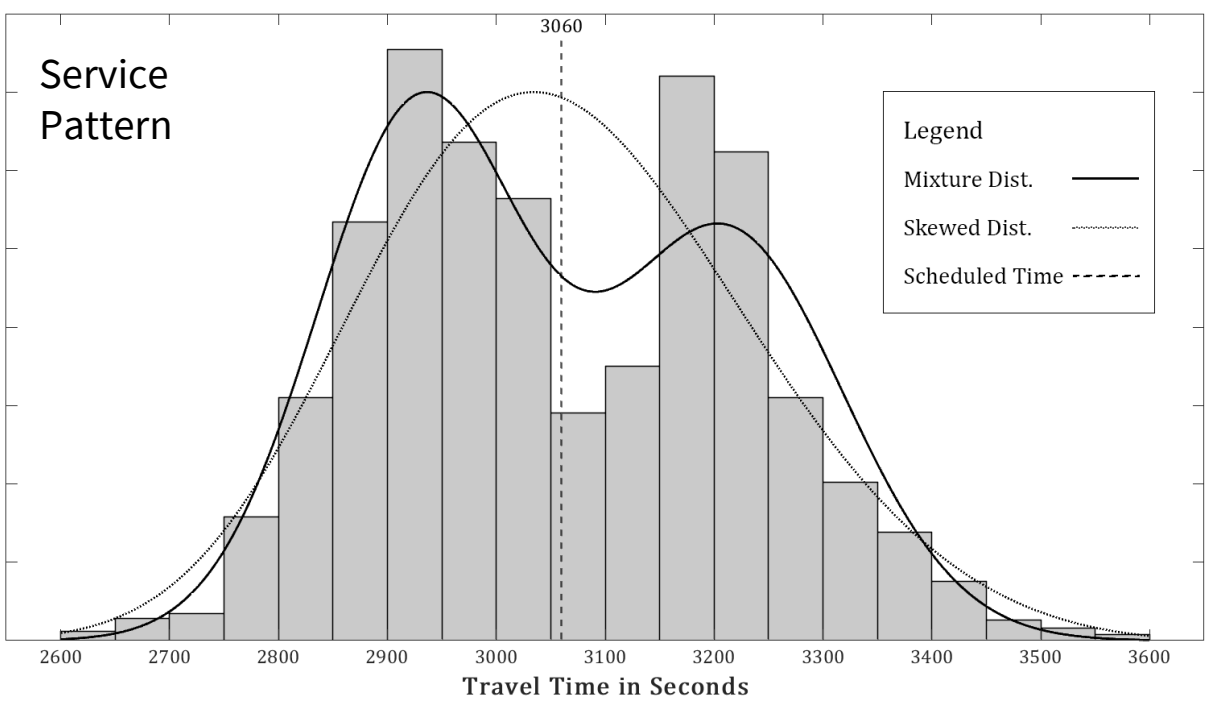
- Many regarding parametric travel time distributions
  - Normal Distribution
  - Skewed Distribution
  - Gaussian Mixture Distribution
- Many work depends on travel time distributions
  - Transit system simulation
  - Transfer coordination
- Need:
  - Systemwide analysis
  - Less aggregated analysis
  - Non-parametric analysis

Mixture Distributions

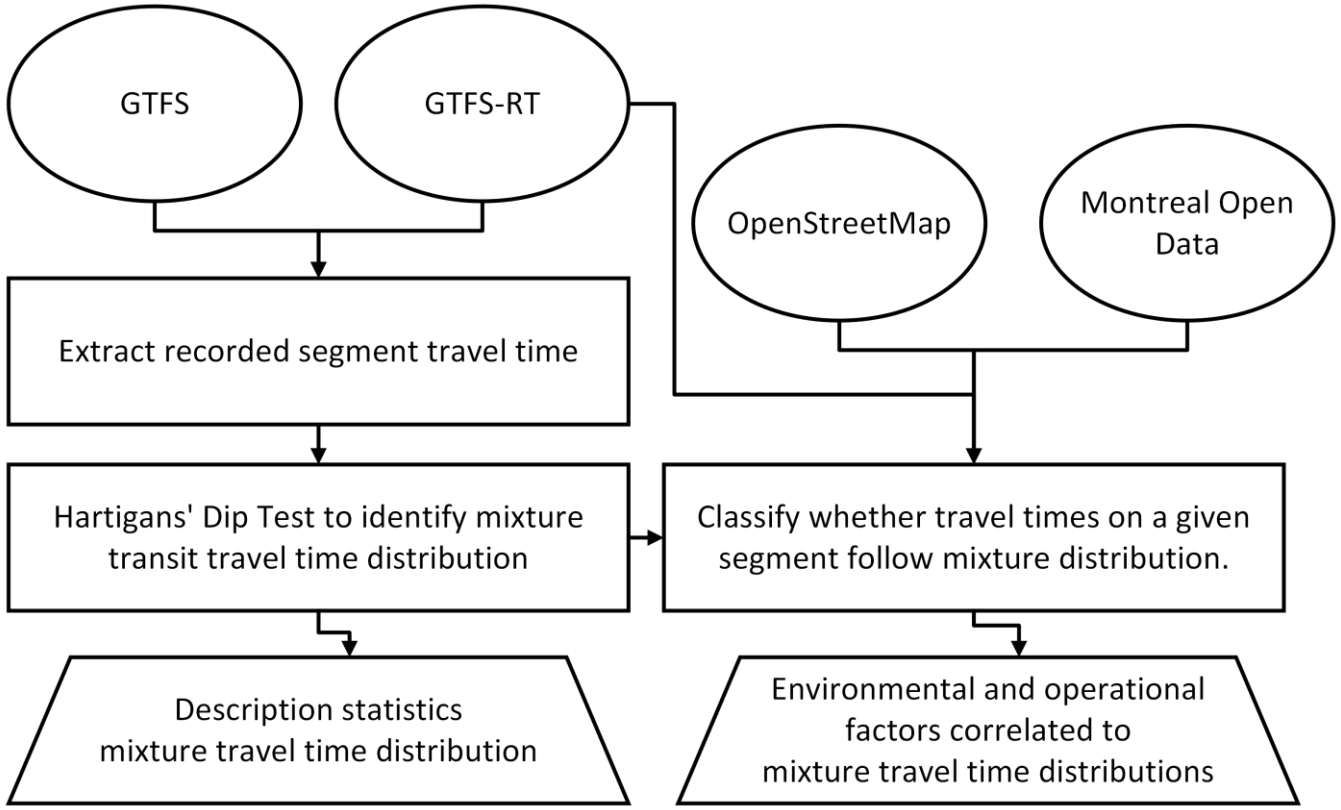
Different underlying travel time distributions happening with different probabilities





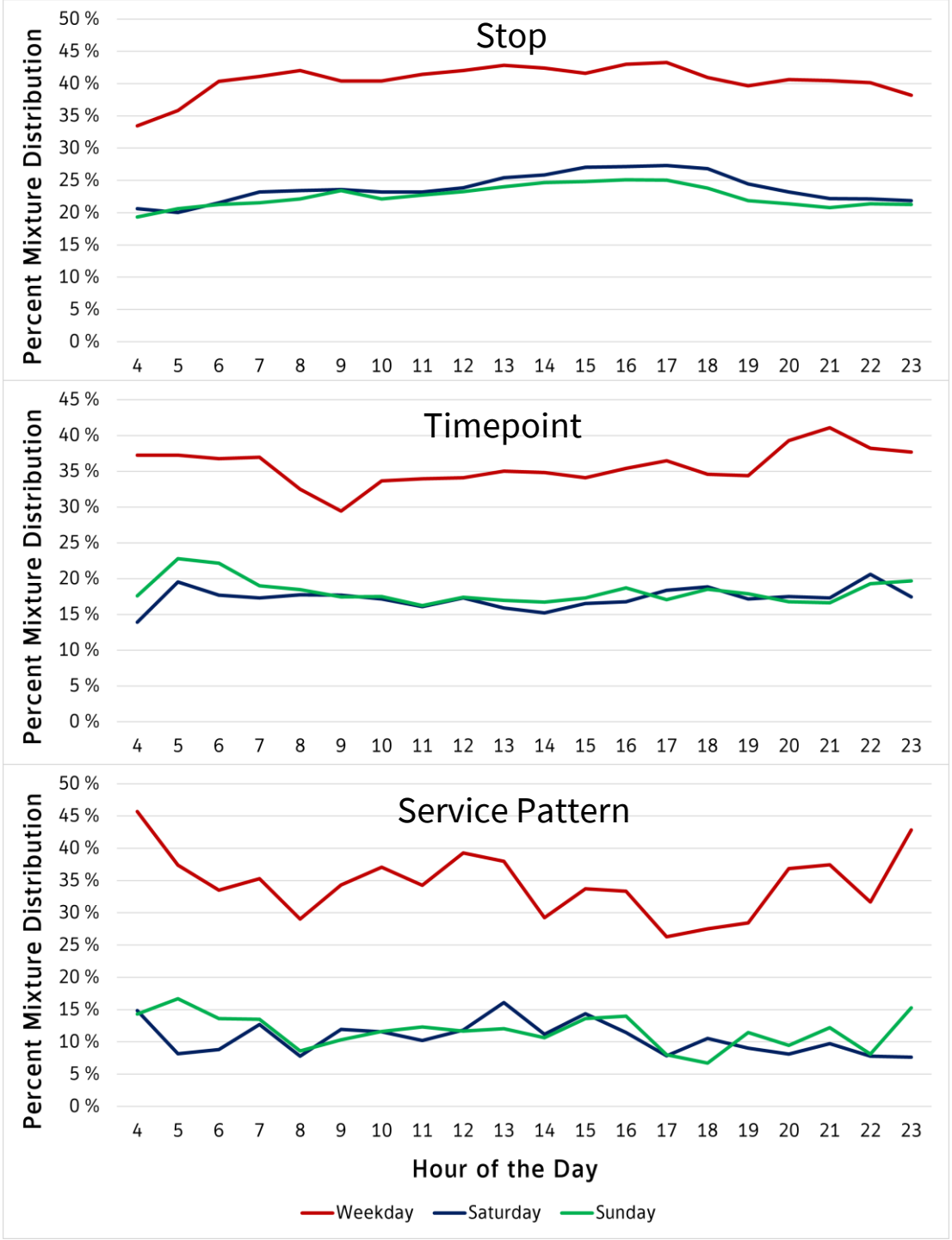


Research Framework



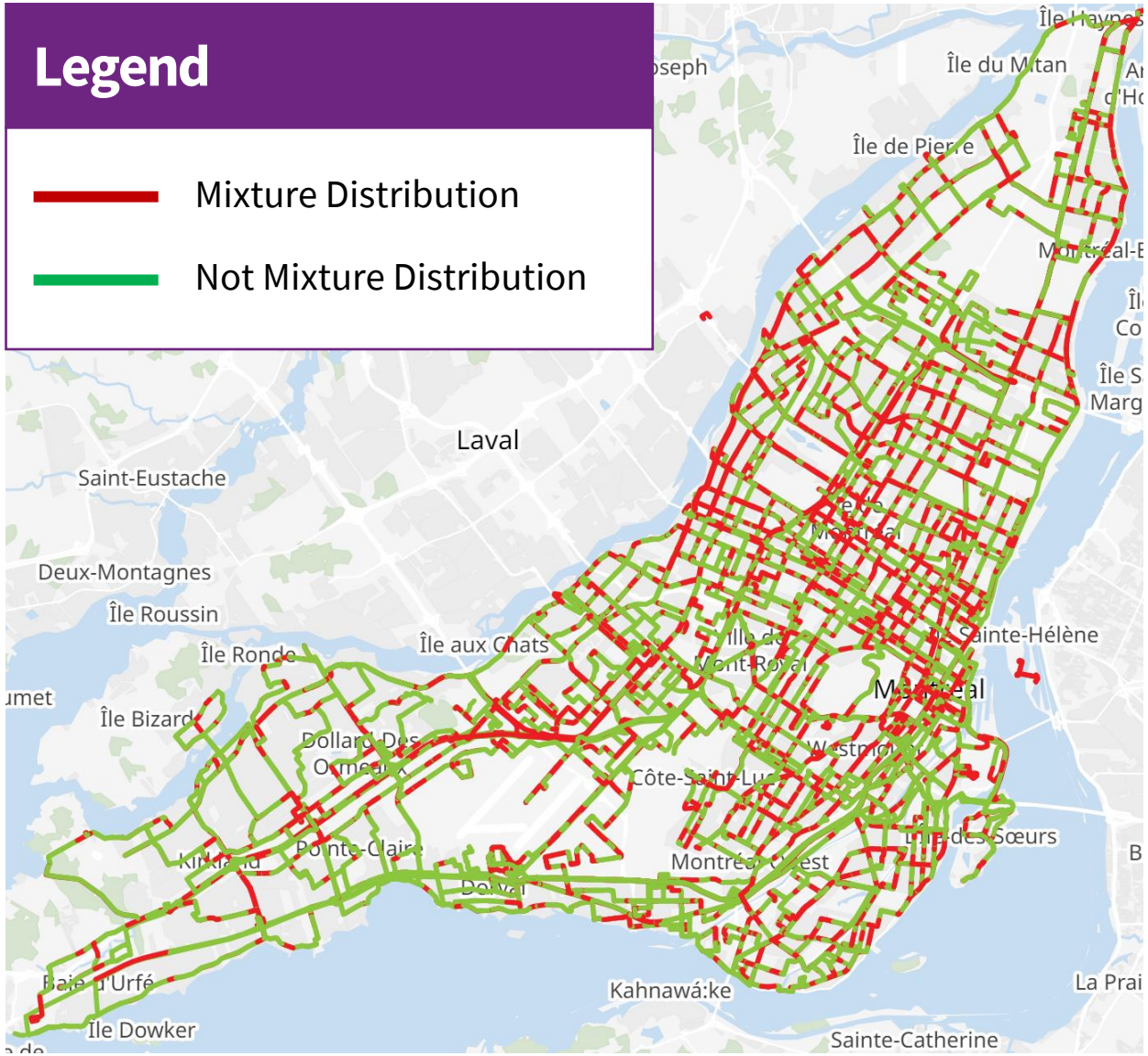
Temporal Variation

- Many segments in the system follow mixture distributions
- Temporal variation is relatively stable
- Slight reduction during rush hour for timepoint and route levels
- Weekends have less mixture distributions



Spatial Variation

- Similar observations at all three levels
- Densely populated areas have more mixture distribution
- Major transportation corridors have more mixture distribution



Classification

- Models:
  - Logistics Regression (Linear)
  - Classification Tree (Non-Linear)
  - Random Forest (Non-Linear)
  - K-Nearest Neighbours (Similarity)
- Dependent Variable:
  - Does a given segment follow mixture distribution or not?

Input Variables

- Temporal
  - Time of the day
  - Day of the week
- Spatial
  - Segment length
  - Land use
  - Has bus lanes
  - Number of turns
  - Traffic lights
- Operational
  - Passenger loads
  - Delays
  - Service frequency
  - Number of stops

Logistics Regression

- Less likely to have mixture dist.
  - Weekends
  - Turns
  - Long segments
- More likely to have mixture dist.
  - Service frequency (driver behaviours, vehicle to vehicle interactions…)
  - Traffic lights
  - SD of bus load
- The odds are similar
  - Land use
  - Other streetscape variables
  - Bus lane

	Stop	Timepoint	Service Pattern
Intercept	**-0,24**	**1,14**	-0,01
Saturday	**-0,84**	**-1,11**	**-1,56**
Sunday	**-0,80**	**-1,00**	**-1,48**
Early AM	**0,04**	**0,32**	-0,08
AM Peak	**0,10**	**0,06**	**-0,18**
PM Peak	-0,02	-0,05	**-0,43**
Evening	0,01	0,05	-0,12
Late Evening	**0,05**	**0,19**	-0,18
Service Frequency	**0,16**	**0,21**	**0,29**
Number of Stops	-	**-0,06**	**0,01**
Number of Streets	**-0,07**	**-0,17**	-0,01
Number of Lights	**0,17**	**0,07**	0,00
Speed Limit	0,00	**0,00**	**0,02**
Bus Lane	0,00	**0,00**	0,00
Oneway	**0,00**	**0,00**	0,00
Pop. Density	**0,03**	**0,02**	0,02
Length - Residential	**-2,09**	**-0,47**	0,00
Length - Collector	**-1,78**	**-0,59**	**-0,08**
Length - Secondary	**-0,96**	**-0,34**	**-0,03**
Length - Primary	**-0,53**	-0,03	**0,04**
Length - Motorway	**0,08**	**0,04**	**0,04**
Land Use - Mixed	**0,00**	**0,00**	**-0,01**
Land Use - Downtown	**0,00**	0,00	**-0,01**
Land Use - Residential	0,00	**0,00**	0,00
Land Use - Industrial	**0,00**	**0,00**	**-0,01**
Average Load	**-0,07**	**0,22**	0,02
SD Load	**0,13**	**-0,15**	**0,07**
Average Delay	**0,08**	**-0,11**	-0,04
SD Delay	0,00	**0,01**	0,00
Percent Boarding	**0,00**	**-0,01**	**-0,02**

Model Comparisons

		Stop			Timepoint			Service Pattern	
		False	True		False	True		False	True
KNN	False	0,78	0,22	False	0,81	0,19	False	0,73	0,27
	True	0,22	0,78	True	0,18	0,82	True	0,26	0,74
	Accuracy		0,78	Accuracy		0,81	Accuracy		0,73
		False	True		False	True		False	True
Tree	False	0,72	0,28	False	0,76	0,24	False	0,68	0,32
	True	0,28	0,72	True	0,24	0,76	True	0,31	0,69
	Accuracy		0,72	Accuracy		0,76	Accuracy		0,68
		False	True		False	True		False	True
Forest	False	0,80	0,21	False	0,85	0,15	False	0,73	0,27
	True	0,20	0,80	True	0,17	0,83	True	0,25	0,75
	Accuracy		0,80	Accuracy		0,84	Accuracy		0,74
		False	True		False	True		False	True
Logistic	False	0,65	0,35	False	0,71	0,29	False	0,95	0,05
	True	0,39	0,61	True	0,31	0,69	True	0,81	0,19
	Accuracy		0,63	Accuracy		0,70	Accuracy		0,58

Limitation + Next Steps

- Add additional details such as traffic signal timing and demand variation to the models
- Distinguish traffic light delays
- Detours are not considered
- Distinguish the cause relating to each underlying distributions, traffic lights, dwell time, weather, collisions…
- Nudge slower travel conditions to faster ones
- Investigate more detailed passenger experiences and impacts

Thank you!
Questions?

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Photo credits: Yuxuan Wang