A Deep-Learning Approach for Transportation Network Companies Trip-Demand Prediction Considering Spatial-Temporal Features

Yi Hou, Venu Garikapati, Joshua Sperling, Alejandro Henao, and Stan Young

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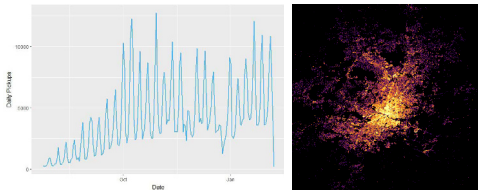
STUDY QUESTIONS

Unique questions explored in this study:

- What are the most relevant variables (e.g., time of day, weather, and zip code) affecting transportation network company (TNC) trip demand?
- How can TNC trip demand be predicted in small and mid-sized cities?

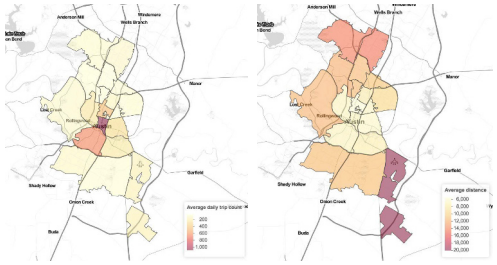
RIDEAUSTIN DATASET



By the numbers:

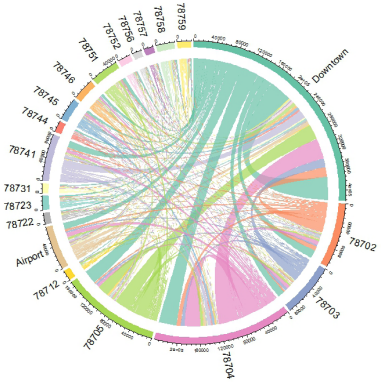
- Sample duration—6 months
- Period—7/24/2016 to 2/6/2017
- Total trips—820,816
- Average trip duration—12 minutes
- Average trip distance—8 kilometers
- Average hourly pickups—173/hour

DAILY TRIP DEMAND

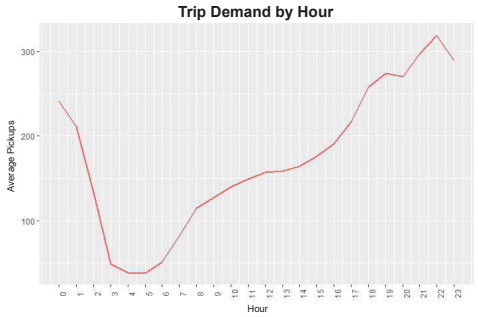


Daily Trip Demand *Average Trip Distance*

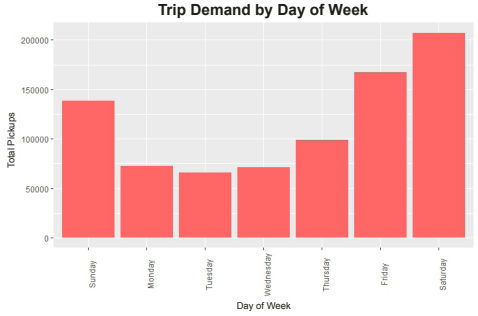
TRIP DEMAND BETWEEN ORIGINS AND DESTINATIONS



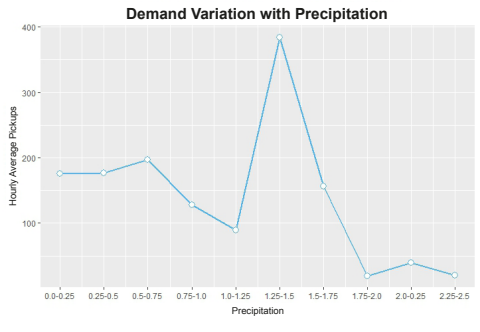
DEMAND VARIATION BY HOUR



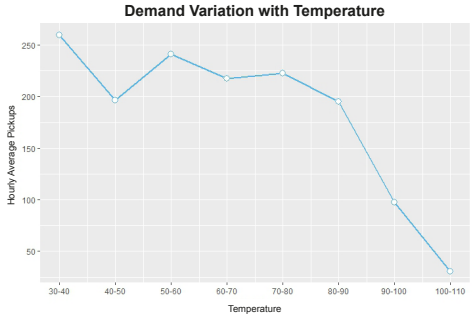
DEMAND VARIATION BY DAY OF WEEK



DEMAND VARIATION WITH PRECIPITATION



DEMAND VARIATION WITH TEMPERATURE



TRIP-DEMAND FORECASTING

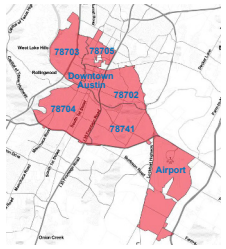
Objective:

- Predict the future pick-up counts in the next hour for seven zip code zones in Austin, Texas

Model:

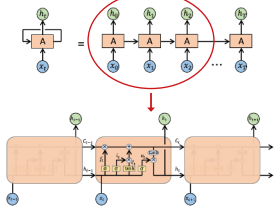
- Deep learning—long short-term memory
- Model input
  - Past six hours of pick-up counts in each zip code zone
  - Day of week, hour of day, weather, holiday or not
- Model training—data from 7/24/2016 to 1/6/2017
- Model testing—data from 1/7/2017 to 2/6/2017

ZIP CODE ZONES FOR TNC PREDICTION

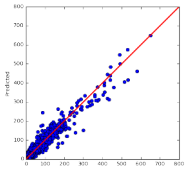


LONG SHORT-TERM MEMORY

A special recurrent-neural-network architecture designed to learn time-series data with long time spans and high dimensions

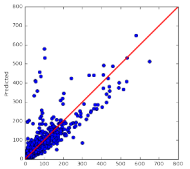


LONG SHORT-TERM MEMORY



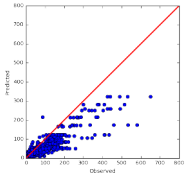
Long short-term memory:

- Mean absolute error—7.2
- Root mean square error—12.3



Instantaneous trip demand:

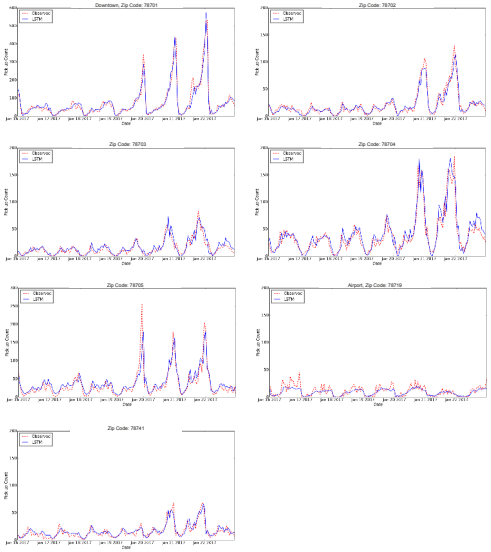
- Mean absolute error—9.5
- Root mean square error—22.5



Historical average:

- Mean absolute error—11.5
- Root mean square error—25.0

PREDICTION VERSUS OBSERVATION



NEXT STEPS

- Apply the methodology to more zones with higher spatial granularity
- Compare with more advanced baseline models
- Build prediction models for special trip generators (e.g., airports)

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