Reimagining Transportation at Cornell

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In collaboration with Cornell Transportation & Parking
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Motivation

- Cornell Carbon Neutral Campus Initiative
- Reduce the need for parking
- Reduce congestion and other externalities associated with car traffic
- Reduce costs for commuter
My Research

• Determine the existing transit coverage
• Explore the sensitivity of the coverage to different parameters
• Propose better alternatives
  • New routes
  • New services (e.g. micro transit)
• Build the road network
• Build the bus network
• Merge the two
• Analyze the current coverage
• Build simulation, modeling, and optimization tools
The Road Network

• Package in Python queries Open Street Map for data and constructs road network
• Every road has a “type” (motorway, primary, tertiary, residential, etc.)
• We can map types to speed limits

Capabilities:
• Geospatial object that encodes the real road geometry
• The ability to determine the time it takes to get from point A to B
The Road Network
The Bus Network

• Load TCAT static GTFS feed into a database
  • GTFS is a google created format for transit data/schedules
• GTFS feed gives all stops, route geometries, schedules, etc.

Capabilities:
• Accurately simulate and model TCAT service
• Determine the precise access one has to TCAT transit
The Bus Network
Merging the Bus and Road Network

- We have geospatial data from both
- Must link the two
- Complication: (Blue = roads, yellow = bus stop)

Solution: Map matching
- If less than 20m from a node, map to node, else:
- Interpolate edge geometries between nearby nodes
- Select closest one
- Create node to represent bus stop
Merged Network
Analyzing Coverage

• What determines if an individual is covered?
  • Proximity
    • How close is the closest bus stop
  • Convenience
    • How much longer does it take to commute via bus than by car
  • Frequency
    • How often do busses come

*There are many other factors that contribute like weather or the need for child care but we lack the data to do this analysis
Feasibility Constraints

• Distance
  • Must be a stop (or multiple) within the coverage radius of the origin

• Convenience
  • The time has to be less than the time it would take to commute to campus via car multiplied by a scaling factor
  • 15min; t<10min: t*2; t<20min: t*1.75; t>20min: t*1.5

• Frequency
  • Requires a certain number of bus trips from origin to Cornell between 7:00 and 10:00am
  • Requires a certain number of bus trips from Cornell to origin between 4:00 and 7:00pm
Loosest Constraints

- 1200m coverage radius
- 1 stop in morning
- 1 stop in afternoon

*80% coverage of Cornell faculty and staff
Tight Constraints

• 500m coverage radius
• Every 30 minutes
• 15min; t<10min: t*2; t<20min: t*1.75; t>20min: t*1.5
### Results

<table>
<thead>
<tr>
<th>Coverage Radius/Frequency</th>
<th>250 meters</th>
<th>500 meters</th>
<th>750 meters</th>
<th>1200 meters (¾ mile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every 30 min</td>
<td>13.6%</td>
<td>31.6%</td>
<td>42.0%</td>
<td>50.4%</td>
</tr>
<tr>
<td>Every 20 min</td>
<td>10.3%</td>
<td>26.0%</td>
<td>33.4%</td>
<td>43.9%</td>
</tr>
<tr>
<td>Every 15 min</td>
<td>8.4%</td>
<td>20.0%</td>
<td>30.4%</td>
<td>42.8%</td>
</tr>
</tbody>
</table>

*Only Cornell Faculty and Staff

**Household locations are mapped to nodes
Next Steps

• Make the model more robust using permit data to account for walking/parking time

• Create predictive model on whether or not someone takes transit
  • Will allow us to predict whether or not someone will commute in a new system we design

• Continue refining optimization framework; add new capabilities
  • Shuttles
    • Fixed Routes
    • On demand
Goal

Design a system that is sufficiently convincing for TCAT or Cornell to launch a pilot program based on our results