Towards a Twin Cities Transit Route Choice Model

Ben Tomhave
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Outline

1. Problem Statement
2. Choice Set Generation
3. Route Choice Calibration
4. A Line Case Study
Problem Statement

• How do transit users get from A to B and what trip attributes influence their decisions the most?

Regional Context

• No known model since 2004
  – Blue Line, Green Line, A Line
Data Sources

- Demand
  - 2016 Transit On-Board Survey
    - 30,500 Respondents

- Transit Network
  - Fall 2016 GTFS
  - Tuesdays

2. Choice Set Generation
Existing Framework

- SBSP Algorithm (Khani)
  - Shortest path/person

- Transit Route CHOICE model

2b. Trip Elimination
Trip Elimination: Iteration 1

SP: 4 → 11

Trip Elimination: Iteration 2

Parent SP: 4 → 11

Eliminate: 11
New SP: 4 → 5
Trip Elimination: Iteration 2

Parent SP: 4 → 11

Eliminate: 4
New SP: 18 → 5

Result After 1 Level of Elimination

Initially Shortest Path
4 --> 11

Exclude Route 4
New Shortest Path
18 --> 5

Exclude Route 11
New Shortest Path
4 --> 5
3. Route Choice Calibration

**Model Constraints**

- Transfer distance: \( \leq 0.1 \) miles
- Access (Egress) Walk: \( \leq 1.1 \ (0.72) \) Miles
- Transfer Wait Time: \( \leq 20 \) min
- Walking Speed: 3 mph
- Path Length: \( \leq 160\% \) Shortest Time
## Route Choice Parameter Comparison

<table>
<thead>
<tr>
<th>Parameter</th>
<th>New Model Value</th>
<th>PB Consult (2004)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheduled IVT</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Transitway IVT</td>
<td>0.37</td>
<td>--</td>
</tr>
<tr>
<td>Access Walk</td>
<td>1.75</td>
<td>0.82</td>
</tr>
<tr>
<td>Egress Walk</td>
<td>2.89</td>
<td>0.82</td>
</tr>
<tr>
<td>Access Wait</td>
<td>3.11</td>
<td>2.76</td>
</tr>
<tr>
<td>Transfer Penalty</td>
<td>29 Minutes</td>
<td>7.5 Minutes</td>
</tr>
</tbody>
</table>
### Tabular Results

<table>
<thead>
<tr>
<th>Path</th>
<th>Prob.</th>
<th>Total Time (Min.)</th>
<th>Access Walk (Min.)</th>
<th>Initial Wait (Min.)</th>
<th>IVT (Min.)</th>
<th>TR Wait Time (Min.)</th>
<th>Egress Walk (Min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4→22</td>
<td>63.2%</td>
<td>64</td>
<td>10</td>
<td>4</td>
<td>31</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>6→22</td>
<td>19.6%</td>
<td>65</td>
<td>20</td>
<td>3</td>
<td>31</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>18→22</td>
<td>5.5%</td>
<td>73</td>
<td>6</td>
<td>11</td>
<td>40</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>4→5</td>
<td>5.3%</td>
<td>64</td>
<td>10</td>
<td>4</td>
<td>32</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>4→11</td>
<td>4.4%</td>
<td>58</td>
<td>10</td>
<td>4</td>
<td>32</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

4. A Line Case Study
Case Study: A Line 2015 → 2016

• Q: What impact has the A Line had on ridership of other routes across the region??

• FAST-TrIPs Assignment Algorithm
  – ~ 211,000 passengers
  – Compare for 2016 GTFS data with & without A Line information

Case Study Results

<table>
<thead>
<tr>
<th>Route Number</th>
<th>Description</th>
<th>Daily % Change</th>
<th>Daily Count Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>84</td>
<td>Snelling-Highland Village-Sibley Plaza</td>
<td>-89%</td>
<td>-1585</td>
</tr>
<tr>
<td>87</td>
<td>UMN STP-Cleveland-Highland</td>
<td>-19%</td>
<td>-285</td>
</tr>
<tr>
<td>65</td>
<td>Dale St- Co Rd B-Rosedale</td>
<td>-10%</td>
<td>-118</td>
</tr>
<tr>
<td>74</td>
<td>46th St-Randolph-W 7th St. - Sunray</td>
<td>-6%</td>
<td>-302</td>
</tr>
<tr>
<td>67</td>
<td>W Minnehaha – Raymond Station-Franklin Ave</td>
<td>-4%</td>
<td>-113</td>
</tr>
<tr>
<td>32</td>
<td>Robbinsdale-Lowry Ave- Rosedale</td>
<td>+5%</td>
<td>+95</td>
</tr>
</tbody>
</table>
Conclusion & Contributions

• New Choice Set Generation Method [SBSP + Trip Elimination]

• New Twin Cities Route Choice Model (With Transitways)

• Implementation of A Line, as expected had the largest effect on RT 84
  – Greater than 5% ridership magnitude change: RTs 87, 65, 74, 32
MNL Route Choice Calibration

\[ P(i|C_n) = \frac{e^{V_{in} + \beta_{PS}PS_{in}}}{\sum_{j \in C_n} e^{V_{jn} + \beta_{PS}PS_{jn}}} \]

- \( P(i|C_n) \) = Probability of taking path \( i \) given the choice set \( C \) for person \( n \)
- \( V_{in}, V_{jn} \) = Utilities for path \( i \) and \( j \) for person \( n \) respectively.
- \( PS_{in} \) = Path-size correction for path \( i \) in choice set \( C_n \)
- \( \beta_{PS} \) = Estimated coefficient for the path size correction term.

Trip Elimination Modifications

- Remove shortest path trips from network & rerun
- Iterate over each trip within path
Methodology Validation

• 52 Route Sample (>1000/RT)
  • 11% underestimation

• Apparent 9-12% overestimation in Geospatial commons

• Fitted Regression Line
  • With LRT: \( m = 1.45 \)
  • Without LRT: \( m = 1.02 \)