Working Paper

Accounting for route overlap in urban and suburban route choice decisions derived from GPS observations

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Accounting for Route Overlap in Urban and Suburban Route Choice Decisions Derived from GPS Observations

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Motivation

The increasing use of GPS studies to observe drivers’ route choice behaviour leads to two major challenges for researchers:

• the large number of available alternatives
• the similarity between alternatives

Neither the decision-maker nor the analyst is able to evaluate the full set of alternatives, the universal choice set.

The similarities issue is amplified due to the large number of alternatives and the density of the road network.

=> Interdependencies between choice set and similarity treatment should be investigated for high-resolution data.
Choice set generation

Generation of 20, 60 and 100 alternatives for 1500 car trips

Swiss Navteq network
   (408,636 nodes and 882,120 unidirectional links)

Choice set generation procedures tested:
   • Random Walk (Frejinger, 2007)
   • Branch & Bound (Prato and Bekhor, 2006)
   • Stochastic Choice Set Generation (SCSG)
   • Breadth First Search on Link Elimination (BFS-LE)
Computational Performance

Complete scale

Zoomed
Choice set size reduction

Bovy (2009) recommends:

- establish a master set as exhaustive as possible
- Reduce master set to the individual choice set taking into account attractiveness, plausibility and overlap

Reduction of choice sets with 100 alternatives to choice sets with 20 and 60 alternatives

Choice set size reduction procedures tested:

- Random
- Similarity-based
- Similarity distribution-based
- Rule-based
Travel time distributions for the different choice sets
Path size distributions for the different choice sets
Model estimations

Estimating models for all choice sets

Testing the influence of
  Travel time, road types, Sampling Correction (Bovy et al., 2009)

Treatment of route overlap
  Path Size (Ben-Akiva and Bierlaire, 1999)
  Path Size Correction (Bovy et al., 2008)
  Commonality Factor (Cascetta et al., 1996)
  Road type specific Path Size factor (based on Hoogendoorn-Lanser and Bovy (2007))
The road type specific Path Size

Formulation 1:

\[ RTPS_{1\text{irn}} = \frac{1}{L_{ir}} \sum_{a \in \Gamma_{ir}} \frac{l_a}{N_{na}} \]

Formulation 2:

\[ RTPS_{2\text{irn}} = \frac{1}{L_i} \sum_{a \in \Gamma_{ir}} \frac{l_a}{N_{na}} \]
Adj. $\rho^2$ for the transformations of the adjustment terms

<table>
<thead>
<tr>
<th>Adjustment term</th>
<th>B100</th>
<th>S100</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
<td>LN</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>0.21</td>
</tr>
<tr>
<td>PSC</td>
<td>0.22</td>
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<td>PS1</td>
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<td>PS2</td>
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<td>0.22</td>
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<tr>
<td>CF1</td>
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<td>0.24</td>
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<tr>
<td>PSRT1</td>
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<td>0.24</td>
</tr>
<tr>
<td>PSRT3</td>
<td>0.25</td>
<td>0.23</td>
</tr>
</tbody>
</table>
Utility correction for route overlap per degree of overlap

B100 – BoxCox(PSRT1)

S100 – BoxCox(PSRT1)
Influence of choice sets on travel time parameters

**BFS-LE**

- Motorway
- Extra-urban roads
- Urban main roads
- Local roads

**SCSG**

- RandomS20
- RandomS60
- RandomS100
- SimDistS20
- SimDistS60
- SimS20
- SimS60
- RulesS2
- RulesS1

Travel time parameter
Influence of adjustment terms on the travel time parameters

RulesB1

RulesS1
Conclusions

Most suitable choice set:

- First generate large route set, then reduce to a behaviourally realistic choice set
- Best reduction procedure: Rule-based
- Systematic parameter testing required for rule-based reduction

Best way to account for similarities:

- Road type specific Path Size
- BoxCox transformation
## Choice sets used in the model estimation

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Choice set size</th>
<th>Reduction procedure</th>
<th>Identification code</th>
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<tbody>
<tr>
<td>BFS-LE</td>
<td>20, 60, 100</td>
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<td>B20, B60, B100</td>
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<td>RandB20, RandB60</td>
</tr>
<tr>
<td></td>
<td>20, 60</td>
<td>Similarity distribution-based</td>
<td>SimB20, SimB60</td>
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<td>SimDistB20, SimDistB60</td>
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<td>Rule-based</td>
<td>RuleB1, RuleB2</td>
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<tr>
<td>SCSG</td>
<td>20, 60, 100</td>
<td>--</td>
<td>S20, S60, S100</td>
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<td>43, 95</td>
<td>Rule-based</td>
<td>RuleS1, RuleS2</td>
</tr>
</tbody>
</table>
Number of routes in rule-based reduced choice sets
Commonality Factor and Path Size

Commonality Factor

\[ CF_{in} = -\beta_0 \ln \sum_{j \in C_n} \left( \frac{L_{ij}}{\sqrt{L_i \cdot L_j}} \right)^\gamma \]

Path Size

\[ PS_{in} = \sum_{a \in \Gamma_i} \frac{l_a}{L_i} \frac{1}{\sum_{k \in C_n} \delta_{ak} \frac{L_{C_n}^*}{L_k}} \]
Sampling Correction (SC) and Path Size Correction (PSC)

Sampling Correction

\[
SC_{in} = \ln \left( \frac{f_{in}}{Q_{in}} \right)
\]

where

\[
Q_{in} = \frac{PS_{in} \exp(-c_{in}/b)}{\sum_{j \in C_n} PS_{jn} \exp(-c_{jn}/b)}
\]

Path Size Correction

\[
PSC_{in} = -\sum_{a \in \Gamma_i} \left( \frac{l_a}{L_i} \right) \ln \sum_{j \in C_n} \delta_{aj}
\]