Input Uncertainty in the Albatross Model System

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Input uncertainty in Albatross system

- Introduction
- Analysis and Results
- Conclusion
- Discussion
- Future Research
Introduction
Development and application of models of travel demand:
- Collect travel survey data
- Model developing: Discrete choice, rule-based...
- Estimate
  - trip generation
  - transport mode and destination choice
  - Derive OD-matrices
  - Assign to network to generate traffic flows
- Formulate planning scenarios
- Convert planning variables into the explanatory variables of the model
- Use estimated parameters to predict set of performance indicator variables
- Apply formal multi-criteria analysis or cost-benefit analysis to choose best policy
We assume data are correct, but in reality they likely are not.

We assume we have perfect knowledge (model is correct), but in reality it is likely not.

We assume we have data about all influential variables, but in reality we likely have not.

We assume that the future will unfold as described in the scenarios, but in reality it likely will not.

WE ASSUME A DETERMINISTIC SYSTEM AND GENERATE A DETERMINISTIC FORECAST, BUT URBAN – TRANSPORTATION SYSTEMS ARE STOCHASTIC AND THE BEST WE CAN DO IS TO GENERATE PROBABILISTIC FORECASTS.
Introduction – Uncertainty Analysis

- Create (a fraction of) the synthesized population
- In case of data uncertainty:
  - Assume multivariate distribution of uncertainty
  - Use Monte Carlo draws to sample realizations
- In case of model uncertainty
  - Discrete choice models: Monte Carlo draws from error distributions
  - Rule-based models: Monte Carlo draws from probabilistic decision trees
- In case of both data and model uncertainty: combination and study the contribution of different sources.
- Run model multiple times (10 – 100) with these inputs
Collect relevant generated output (performance indicators, OD matrices, traffic flows, etc.)

- Calculate uncertainty in these forecasts
  - Coefficient of variation: st.dev. / mean

- Decomposition of uncertainty by socio-demographic variables, spatial areas, temporal episodes, OD-pairs, links, etc.
Analysis and Results
Create synthetic population and use fraction for further uncertainty analysis.

Use Monte Carlo sampling and run the Albatross model system multiple times.

Perform analyses on the generated outcomes to quantify the amount and nature of uncertainty.
Multi-agent, rule-based activity based model developed for the Dutch Ministry of Transport for scenario evaluation.

It predicts which activities are conducted where, when, for how long, with whom and the transportation mode involved (Arentze and Timmermans, 2000, 2004, 2008).

Albatross uses different types of constraint: Institutional constraint, temporal constraint, space constraint ...

Speed of the car affect different facets of individual activity-travel patterns such as: possible location that can be reached within individual available time window for doing that activity or transport modes that can be used to reach the locations for doing that activity.
Uncertainty analysis of the Albatross model system regarding uncertain speed in some crucial links.

“Basisnetwork” is a national data base. Start and end coordinate of the links and average speed of the car on that link is represented.

Study area: Rotterdam metropolitan area (2nd largest in the Netherlands)

Statistics in 2005:
- population 600,000:
- households 280,000:
- fraction: 10%

Albatross run 20 times.
Input uncertainty
- expert elicitation and empirical measurement of uncertainty in speed in selected links

<table>
<thead>
<tr>
<th>Link ID</th>
<th>Average Speed in km</th>
<th>St. dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A16</td>
<td>80-100</td>
<td>8-10</td>
</tr>
<tr>
<td>A20</td>
<td>90-100</td>
<td>9-10</td>
</tr>
<tr>
<td>Gravendijkwal</td>
<td>20-40</td>
<td>4-8</td>
</tr>
<tr>
<td>Statenweg</td>
<td>15-40</td>
<td>3-8</td>
</tr>
<tr>
<td>Schieweg</td>
<td>15-30</td>
<td>3-6</td>
</tr>
<tr>
<td>Schiekade</td>
<td>20-30</td>
<td>4-6</td>
</tr>
</tbody>
</table>

Probability distribution function
With relevant mean and st.dev speed.
What is the effect of uncertain travel times on activity participation?

<table>
<thead>
<tr>
<th>number of activities</th>
<th>Mean no of people</th>
<th>Std. deviation</th>
<th>CV (Std. Mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 activities</td>
<td>15224</td>
<td>104.56</td>
<td>0.0069</td>
</tr>
<tr>
<td>1 activities</td>
<td>8844</td>
<td>93.14</td>
<td>0.0105</td>
</tr>
<tr>
<td>2 activities</td>
<td>4516</td>
<td>43.68</td>
<td>0.0097</td>
</tr>
<tr>
<td>3 activities</td>
<td>2277</td>
<td>44.97</td>
<td>0.0197</td>
</tr>
<tr>
<td>4 activities</td>
<td>1079</td>
<td>32.07</td>
<td>0.0297</td>
</tr>
<tr>
<td>5 activities</td>
<td>481</td>
<td>22.14</td>
<td>0.0460</td>
</tr>
<tr>
<td>6 activities</td>
<td>204</td>
<td>11.57</td>
<td>0.0567</td>
</tr>
<tr>
<td>7 activities</td>
<td>85</td>
<td>5.14</td>
<td>0.0603</td>
</tr>
<tr>
<td>8 activities</td>
<td>31</td>
<td>4.94</td>
<td>0.1609</td>
</tr>
<tr>
<td>9 activities</td>
<td>10</td>
<td>2.4</td>
<td>0.2462</td>
</tr>
<tr>
<td>10 activities</td>
<td>5</td>
<td>1.39</td>
<td>0.2808</td>
</tr>
</tbody>
</table>

CV increases with increasing number of activities.
What is the effect of uncertain travel times on start and end of the activities?

Variation in start and end times of activities is relatively large.

3 min for work
14 min for BrgGet
What is the effect of uncertain travel time on the duration of activities?

<table>
<thead>
<tr>
<th></th>
<th>Work</th>
<th>Bring/get</th>
<th>Social</th>
<th>Leisure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average</strong></td>
<td>430,5</td>
<td>9,8</td>
<td>126,7</td>
<td>102,2</td>
</tr>
<tr>
<td><strong>Max</strong></td>
<td>433,7</td>
<td>10,0</td>
<td>128,8</td>
<td>103,7</td>
</tr>
<tr>
<td><strong>Min</strong></td>
<td>427,1</td>
<td>9,6</td>
<td>125,7</td>
<td>100,8</td>
</tr>
<tr>
<td><strong>CV</strong></td>
<td>0,005</td>
<td>0,013</td>
<td>0,007</td>
<td>0,008</td>
</tr>
</tbody>
</table>

Work is least affected. CV=0.50%
BrgGet is most affected. CV= 1.3%
Analysis

What is the effect of uncertain travel times on transport mode choice?

<table>
<thead>
<tr>
<th>Mode choice proportions</th>
<th>Car Driver</th>
<th>Slow</th>
<th>Public</th>
<th>Car Passenger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>0.385</td>
<td>0.433</td>
<td>0.070</td>
<td>0.111</td>
</tr>
<tr>
<td>Std</td>
<td>0.002</td>
<td>0.003</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>CV</td>
<td>0.006</td>
<td>0.006</td>
<td>0.014</td>
<td>0.009</td>
</tr>
</tbody>
</table>

Coefficient of variation is the highest for Public transport and lowest for Car driver and Slow mode.
Conclusion
Conclusions

uncertainty in car speed affects the start and the time mostly in absolute terms and activity participation in a relative sense (CV) at least in this study.

Results indicate that the degree of variation tends to differ between mandatory and flexible activities.
Discussion
Discussion

Uncertainty in travel times was only implemented for a certain corridor in the study area and consequently not all individuals face this uncertainty.

The behavioral mechanisms in Albatross kept constant. Assuming that in short run people do not adopt to uncertain speed. If it continued then they might structurally adapt their departure time.
Future Research
Future research agenda

Spatial variability analysis.

The effect of uncertainty in speed at the individual level.

Examine the effect of travel time variability on different segments of the population.
Questions?
More Information?

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