Assessing complex route choice models using mental representations

Evanthia Kazagli & Michel Bierlaire

Transport and Mobility Laboratory
School of Architecture, Civil and Environmental Engineering
École Polytechnique Fédérale de Lausanne

May 18, 2016
Agenda

1. Context
2. Route choice with MRIs
3. Playground
4. Conclusion
Agenda

1. Context

2. Route choice with MRIs

3. Playground

4. Conclusion
Route choice modeling

- Data

1. Choice set generation

2. Correlation of alternatives
Recent advances

1. [Fosgerau et al., 2013] Recursive logit (RL)
   1. Sequential link choice in a dynamic framework.
   2. Avoids full enumeration.
   3. No need for sampling.
   Further extended by [Mai et al., 2015] to the nested RL.

2. [Lai and Bierlaire, 2015] Cross-nested logit (CNL) with sampling of alternatives
   1. Avoids full enumeration.
   2. Metropolis-Hastings for route choice proposed by [Flötteröd and Bierlaire, 2013].
   3. Expansion factor inspired by [Guevara and Ben-Akiva, 2013].
The MRI approach

How can we represent a route in a behaviorally realistic way without increasing the model complexity?

→ Model the strategic decisions of people instead of the operational ones.

✓ Mental Representation Item (MRI)

Current work

Objective

Potential of the MRI approach in simplifying complex route choice models:

1. RL
2. CNL

so that they can be applied to large networks.

Comparison of the performance under the two representational approaches:

1. path
2. MRI

→ Identify the trade-offs:

- model fit
- complexity
- computational time
Agenda

1. Context
2. Route choice with MRIs
3. Playground
4. Conclusion
Recap The MRI definition

**Conceptual:** a name and a description; **Operational:** a point and a span
Recap Definition of alternatives

Following the definition of the MRI, a route is defined as:

1. an origin,
2. an ordered sequence of MRIs (possibly only one), and
3. a destination.
The MRI network

For a given case study & scope of analysis

1. Define the MRIs and the origin $o$ and destination $d$ zones.
2. For each MRI $r$ create a node.
3. For each $o$ and $d$ zone determine the centroid $s$ of the zone and create a node corresponding to it.

   The number of vertices of the MRI network equals the summation of the number of MRIs $R$ and zone centroids $S$.

4. For each pair of nodes in the MRI network create a link (edge) $\ell$ if the transition from one node to another is allowed.
The MRI network

Blueprint example
CNL with MRIs

- Each MRI is a nest.
- An alternative $i$ belongs to nest $m$ if MRI $m$ appears in the sequence $i$.

This is similar to [Vovsha and Bekhor, 1998] and [Lai and Bierlaire, 2015], but nests correspond to MRIs instead of links.
The underlying MRI nesting structure
As soon as the MRI network is defined it is trivial to apply the formulation proposed by [Fosgerau et al., 2013] for the RL model.
Agenda

1. Context

2. Route choice with MRIs

3. Playground

4. Conclusion
## Goal

*Specification and comparison using real data*

<table>
<thead>
<tr>
<th>model type</th>
<th>MRI</th>
<th>path</th>
</tr>
</thead>
<tbody>
<tr>
<td>logit</td>
<td>⊕</td>
<td>−</td>
</tr>
<tr>
<td>CNL</td>
<td>⊕</td>
<td>−</td>
</tr>
<tr>
<td>RL</td>
<td>⊕</td>
<td>⊕</td>
</tr>
</tbody>
</table>

- Operational issues

→ **Modeling**
Evaluation

1. Direct comparison
   - Probabilities
   - Elasticities

2. Indirect comparison
   - Link flows

3. Computational times
From MRIs to paths

 COMMON SENSE
 Route as sequence of MRIs

 RL model with MRI choice

 various layers of abstraction can be considered in between

 RL model with link choice

 Route as path on the physical network

 Behavioral view / Strategic decision

 Engineering view / Operational decision

 [MRI representation]

 [path representation]
Borlänge dataset

1. GPS data → map-matched trajectories

2. Borlänge road network:
   1. 3,077 nodes and 7,459 unidirectional links
   2. Link travel times
   3. Clear choices

3. We use a sample of 239 observations.
Quebec dataset

1. Smartphone data collection $\rightarrow$ more than 20,000 GPS trajectories
   - Departure times
   - Trip purposes
   - Land use information

2. Quebec road network:
   $\sim$ 20,000 nodes and 40,000 unidirectional links
Agenda

1. Context
2. Route choice with MRIs
3. Playground
4. Conclusion
Exploiting behavioral rationale to facilitate the application of route choice models to large networks.

1. CNL: MRI to reduce the number of nests.
2. RL: MRI to reduce the state space.

Comparison under the MRI approach.
Thank you!

evanthia.kazagli@epfl.ch
transp-or.epfl.ch
Bibliography

Metropolis-Hastings sampling of paths.

A link based network route choice model with unrestricted choice set.

Sampling of alternatives in multivariate extreme value (mev) models.

Specification of the cross-nested logit model with sampling of alternatives for route choice models.

A nested recursive logit model for route choice analysis.
*Transportation Research Part B: Methodological*, 75:100 – 112.

Link-Nested Logit Model of Route Choice: Overcoming Route Overlapping Problem.
*Transportation Research Record: Journal of the Transportation Research Board*, 1645:133–142.
Borlänge MRI network elements

Elements of the MRI network

Legend

- Zone centroid
- Representative point(s) of MRI
- Zone boundary
- Geographical span of MRI (excl. CC)
- Geographical span of CC
- # 1–6 Zone id
- MRI Abbreviation of MRI *

* CC city center; CL clockwise movement around the CC; CO counter-clockwise movement around the CC; AV avoid the CC; B1 bridge 1; B2 bridge 2.
Borlänge MRI network

- 1
- 2
- 3
- 4
- 5
- 6

- OD: origin/destination zone
- MRI node
- Representative point(s) of MRI
- CC: City center
- CL: Clockwise around the CC
- CO: Counter-clockwise around the CC
- AV: Avoid the CC
- B1: Bridge 1
- B2: Bridge 2

Bidirectional link
Assist-link
Quebec

Autoroutes and bridges
Quebec

*Bridge vs ferry boat*