Assessing complex route choice models using mental representations

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Agenda

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

Agenda

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)

Kazagli, E., Bierlaire, M., and Flötteröd, G. (2015). Revisiting the Route Choice Problem: A Modeling Framework Based on Mental Representations. Technical report TRANSP-OR 150824. Transport and Mobility Laboratory, ENAC, EPFL.

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

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

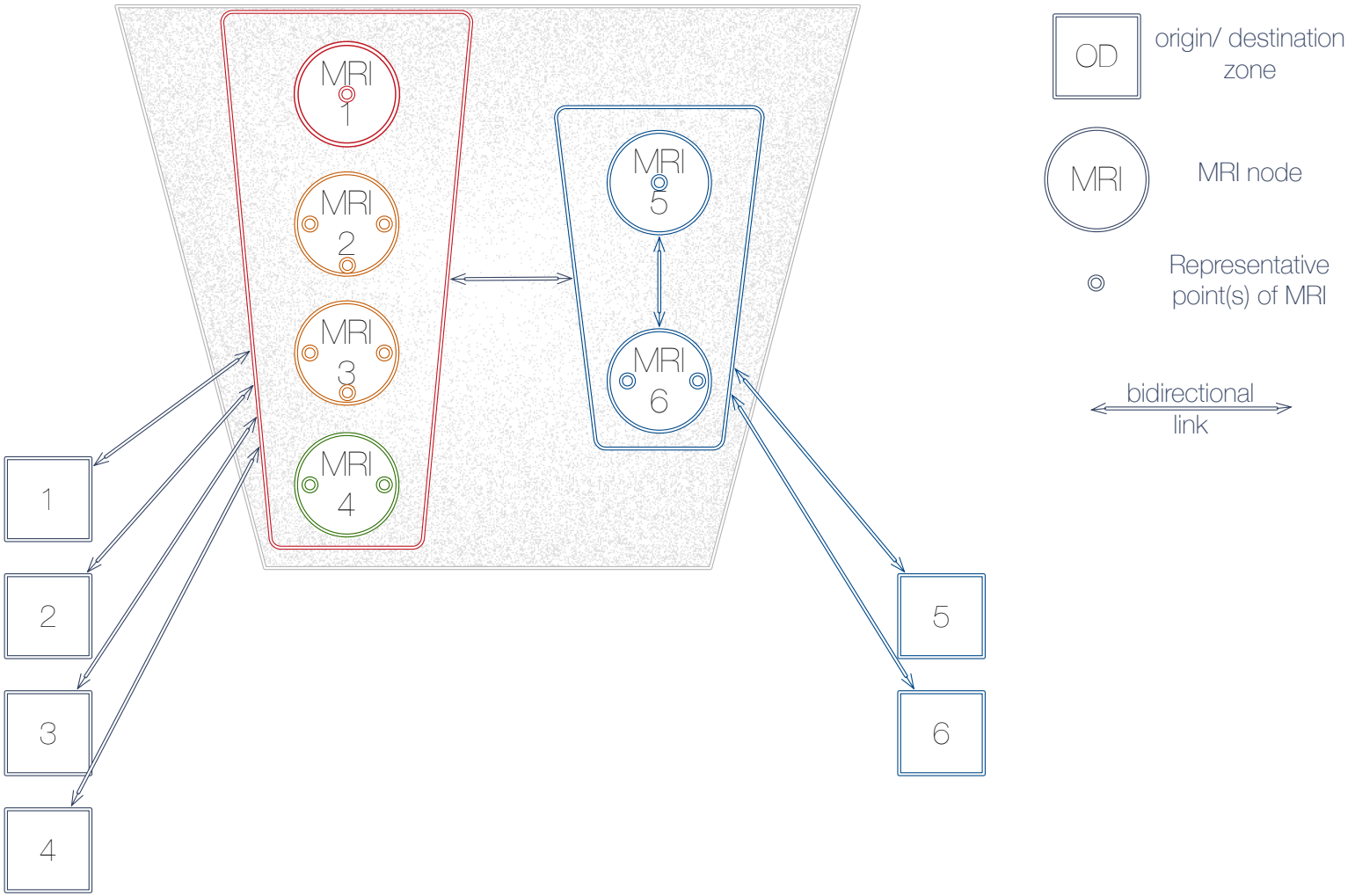
For a given case study & scope of analysis

1. Define the MRIs and the origin o and destination d zones.
2. For each MRI r creat 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 $\mathcal{R}$ and zone centroids $\mathcal{S}$.
4. For each pair of nodes in the MRI network create a link (edge) ℓ if the transition from one node to another is allowed.

The MRI network

Blueprint example

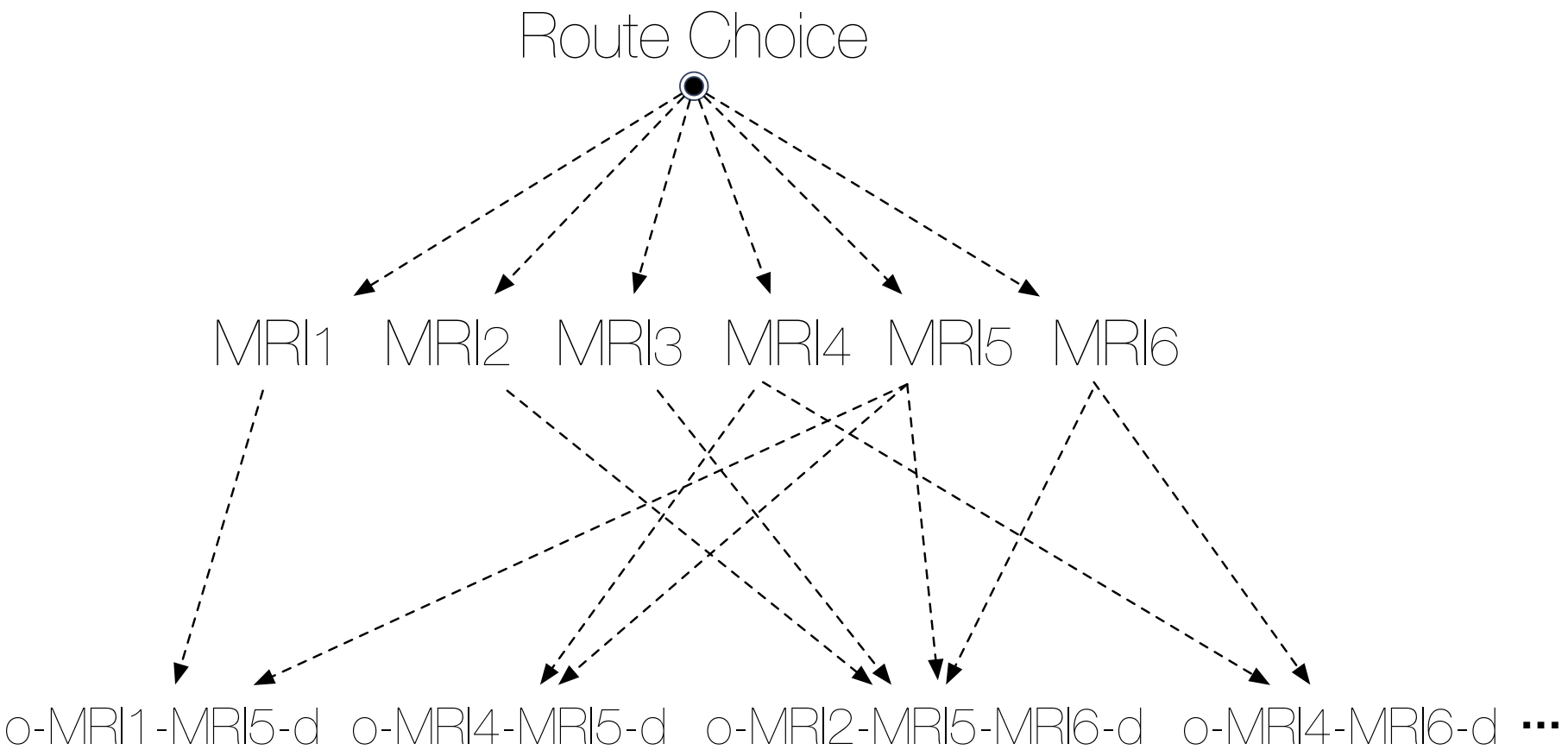


CNL with MRIs

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

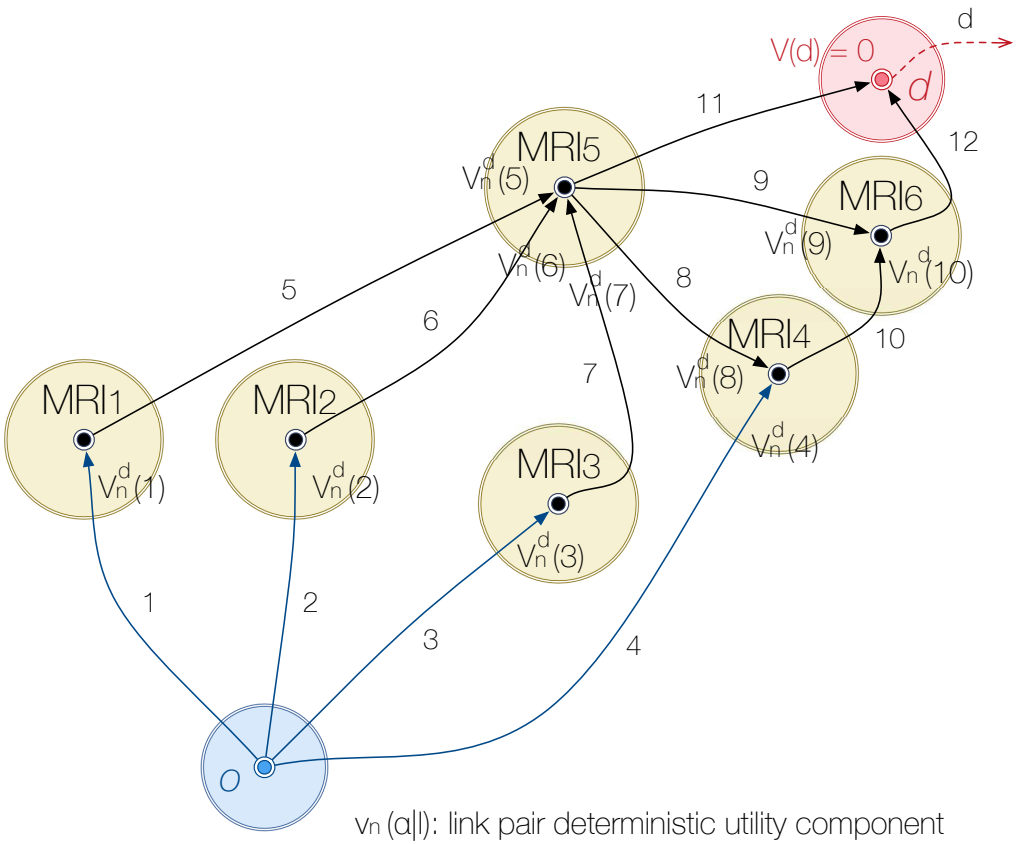
This is similar to [Vovsha and Bekhor, 1998] and [Lai and Bierlaire, 2015], but nests correspond to MRIs instead of links.

The underlying MRI nesting structure



RL with MRIs

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.



$v_n(a|l)$: link pair deterministic utility component

$V_n^d(a)$: value function for the expected downstream utility

d: dummy link (absorbing state)

Agenda

Goal

Specification and comparison using real data

model type	MRI	path
logit	⊕	–
CNL	⊕	–
RL	⊕	⊕

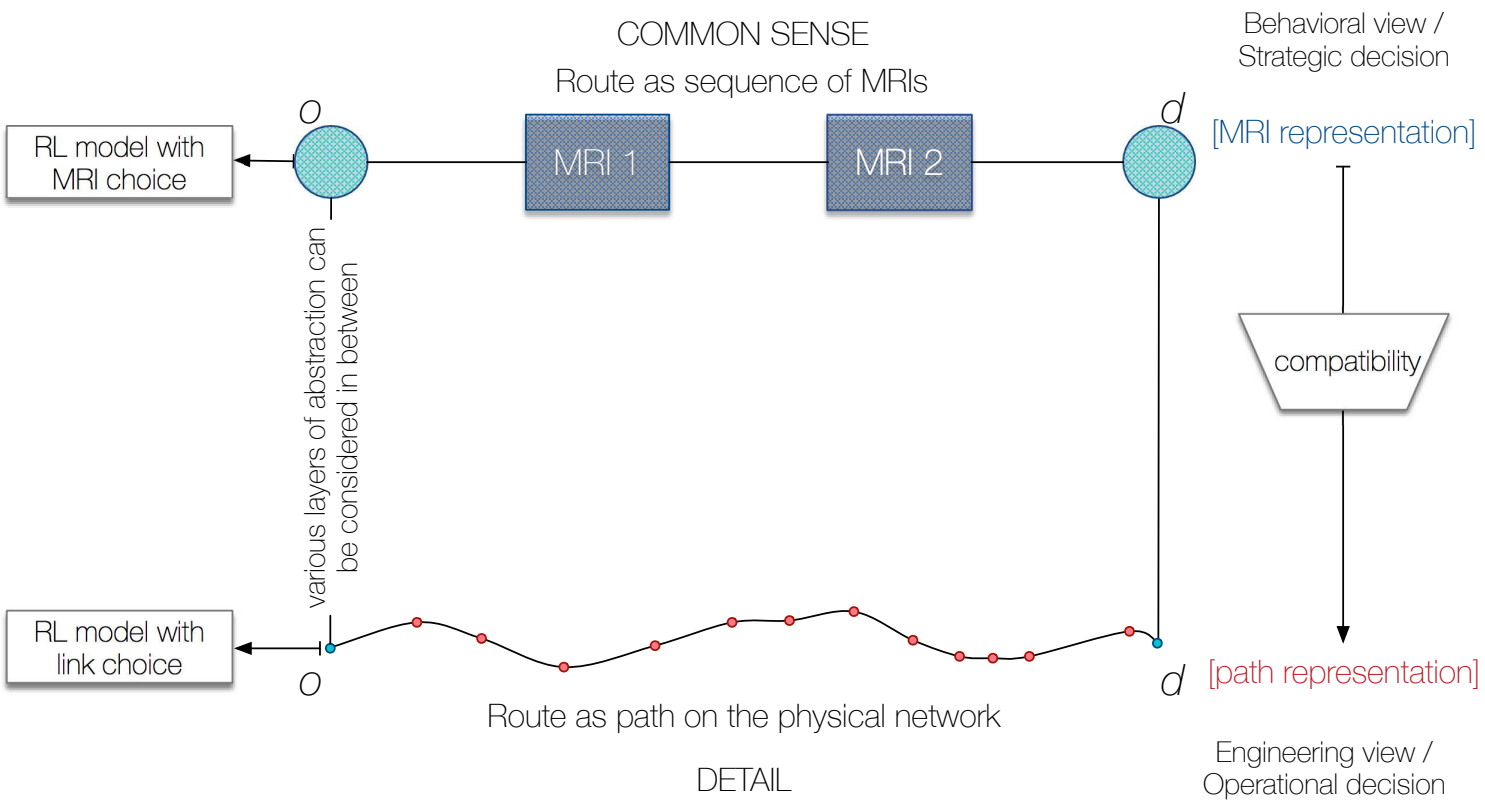
⊙ Operational issues

→ Modeling

Evaluation

1. Direct comparison
   - Probabilities
   - Elasticities
2. Indirect comparison
   - Link flows
3. Computational times

From MRIs to paths



Borlänge dataset

1. GPS data $\rightarrow$ `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

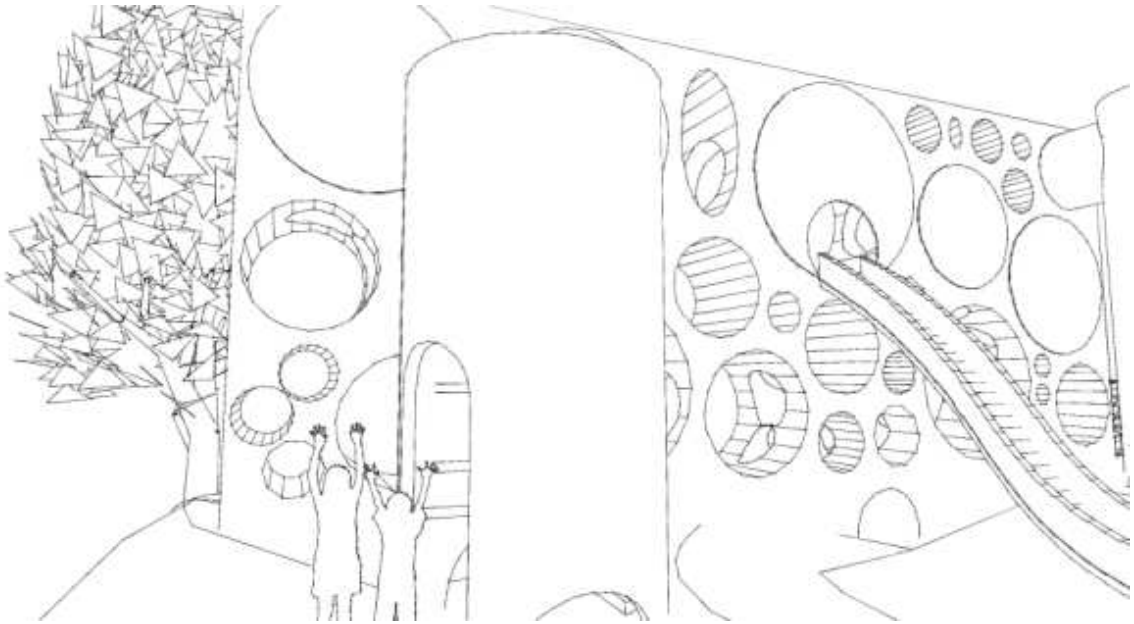
1. Smartphone data collection $\rightarrow$ `more than 20'000 GPS trajectories`
   - ✓ Departure times
   - ✓ Trip purposes
   - ✓ Land use information
2. Quebec road network:

   $\sim$ 20'000 nodes and 40'000 unidirectional links

Agenda

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!

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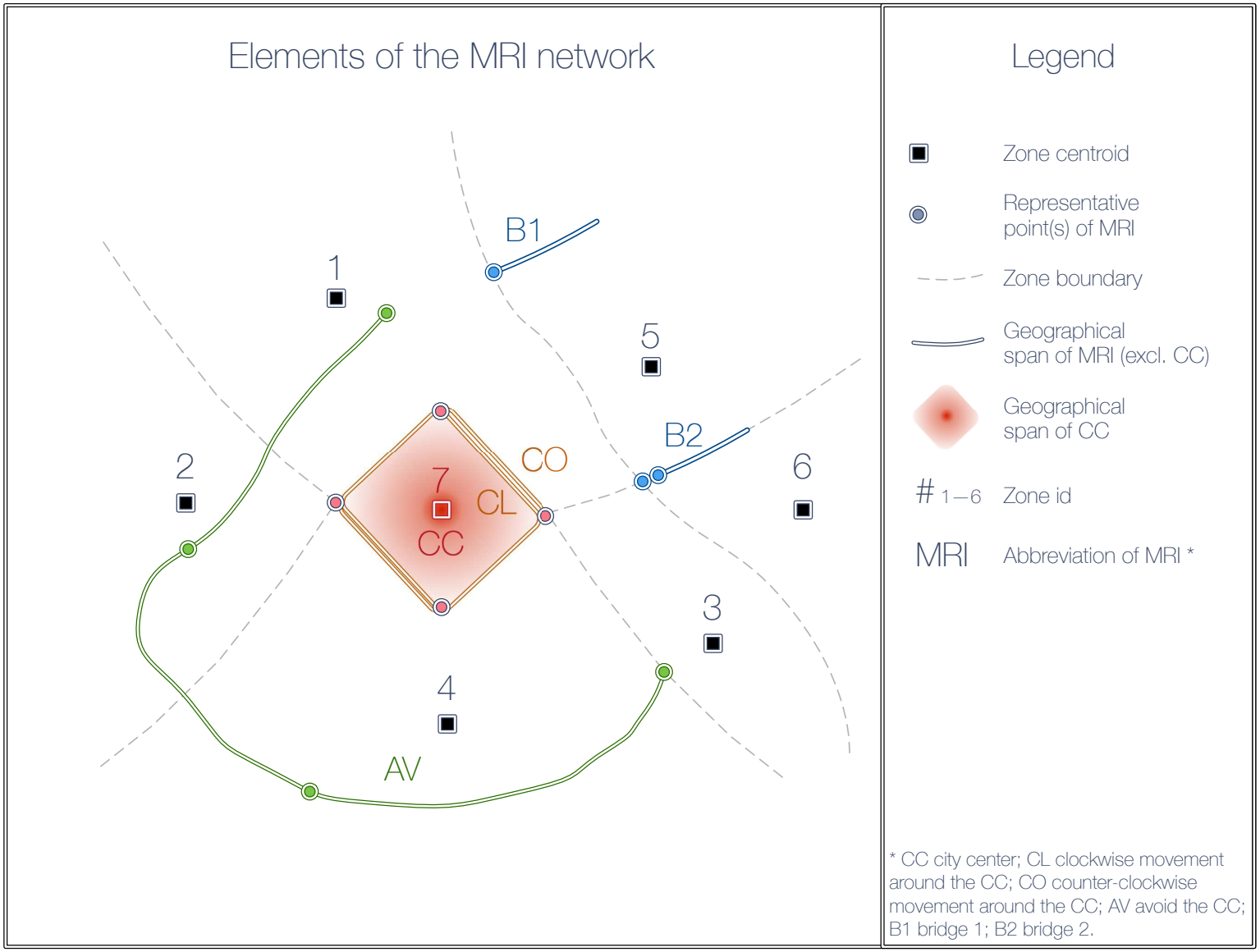
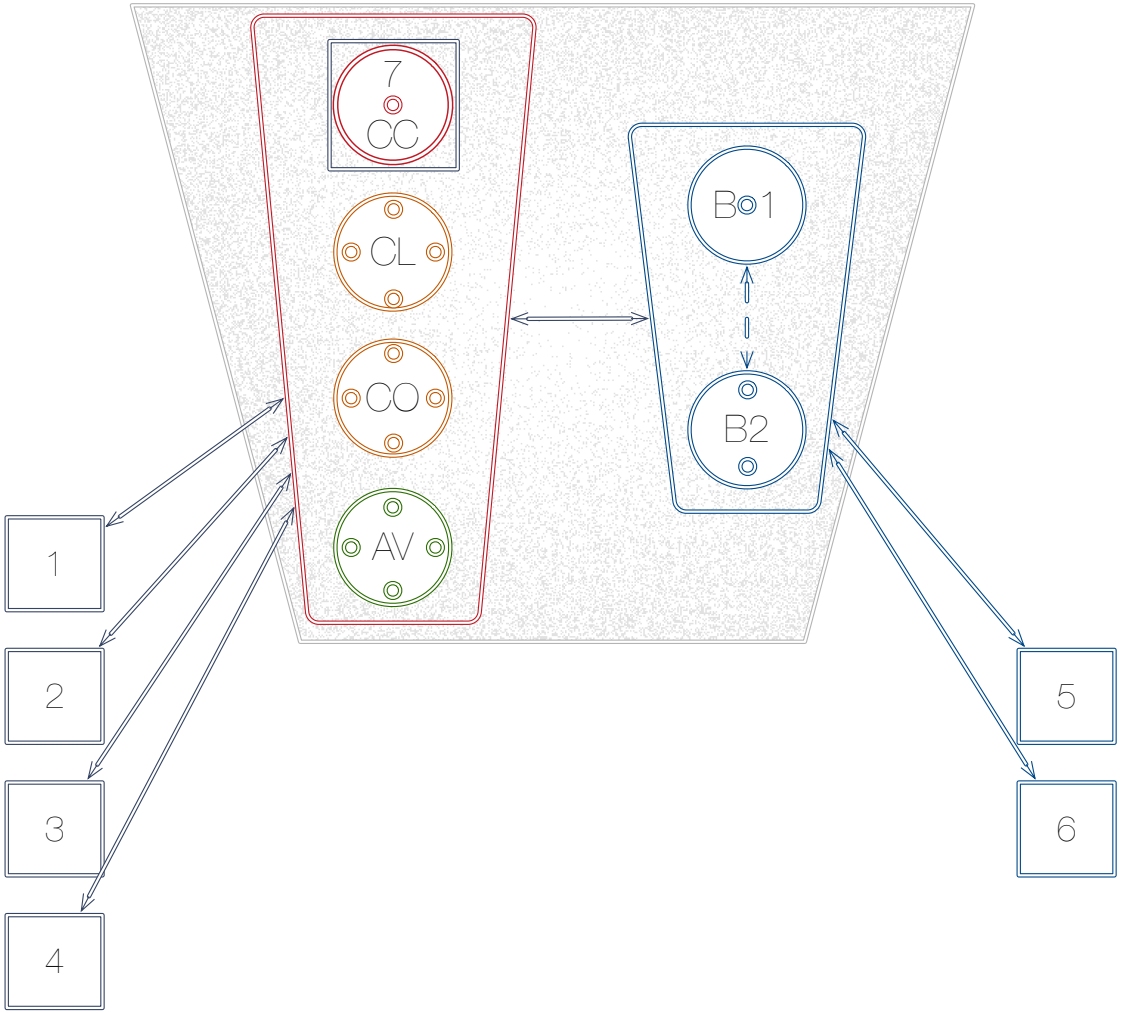
Borlänge MRI network elements



Borlänge MRI network



OD — origin/ destination zone

MRI — 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

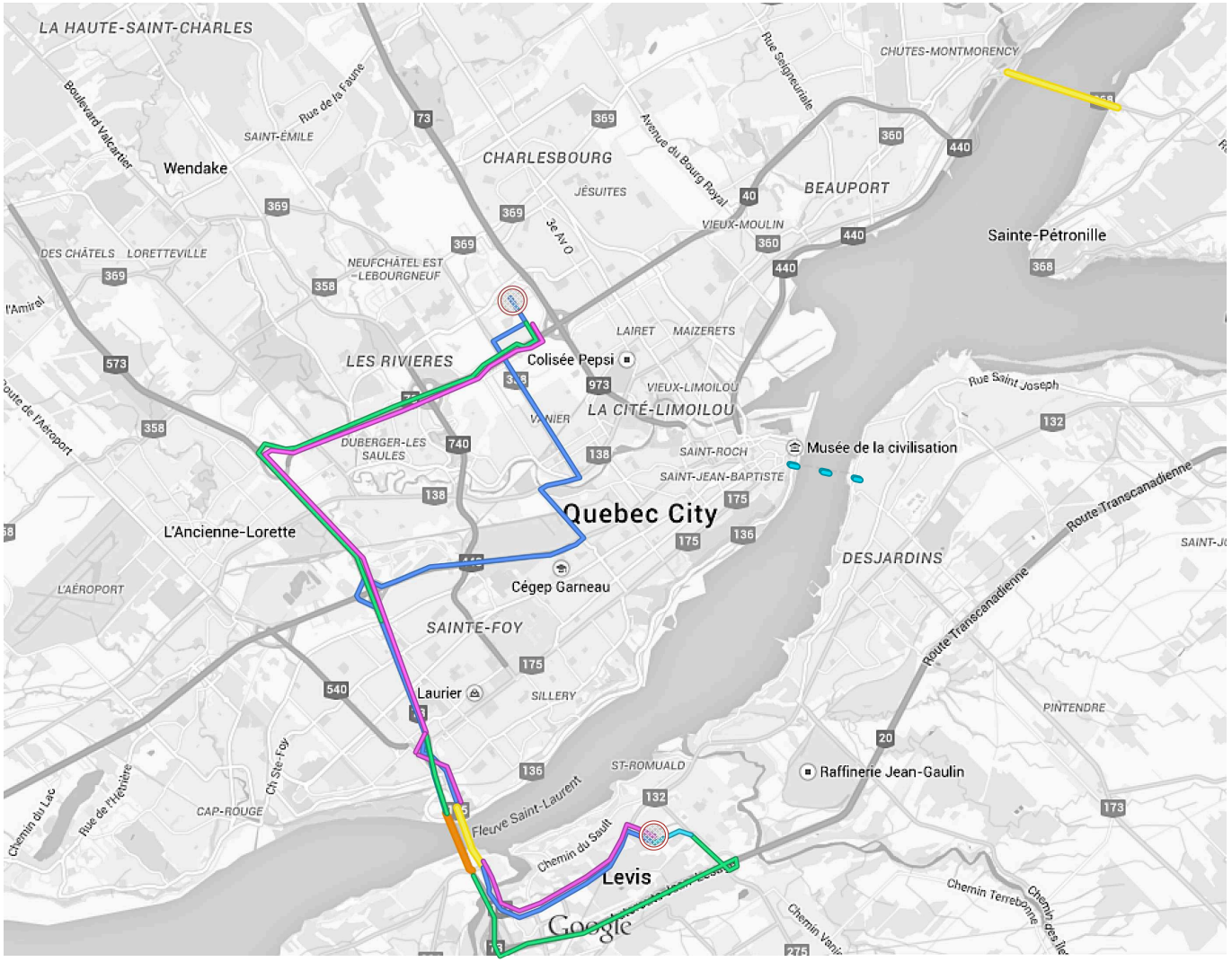
B2 — Bridge 2

bidirectional link

assist-link

Quebec

Autoroutes and bridges



Quebec

Bridge vs ferry boat