# Preferred citation style

Axhausen, K.W. (2008) Patterns of daily movement: An agent-based model of Switzerland, presentation at the CCSS *International Workshop on Challenges and Visions in the Social Sciences 2008*, Zürich, August 2008.

# Patterns of daily movement: An agent-based model of Switzerland

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Institut für Verkehrsplanung und Transportsysteme
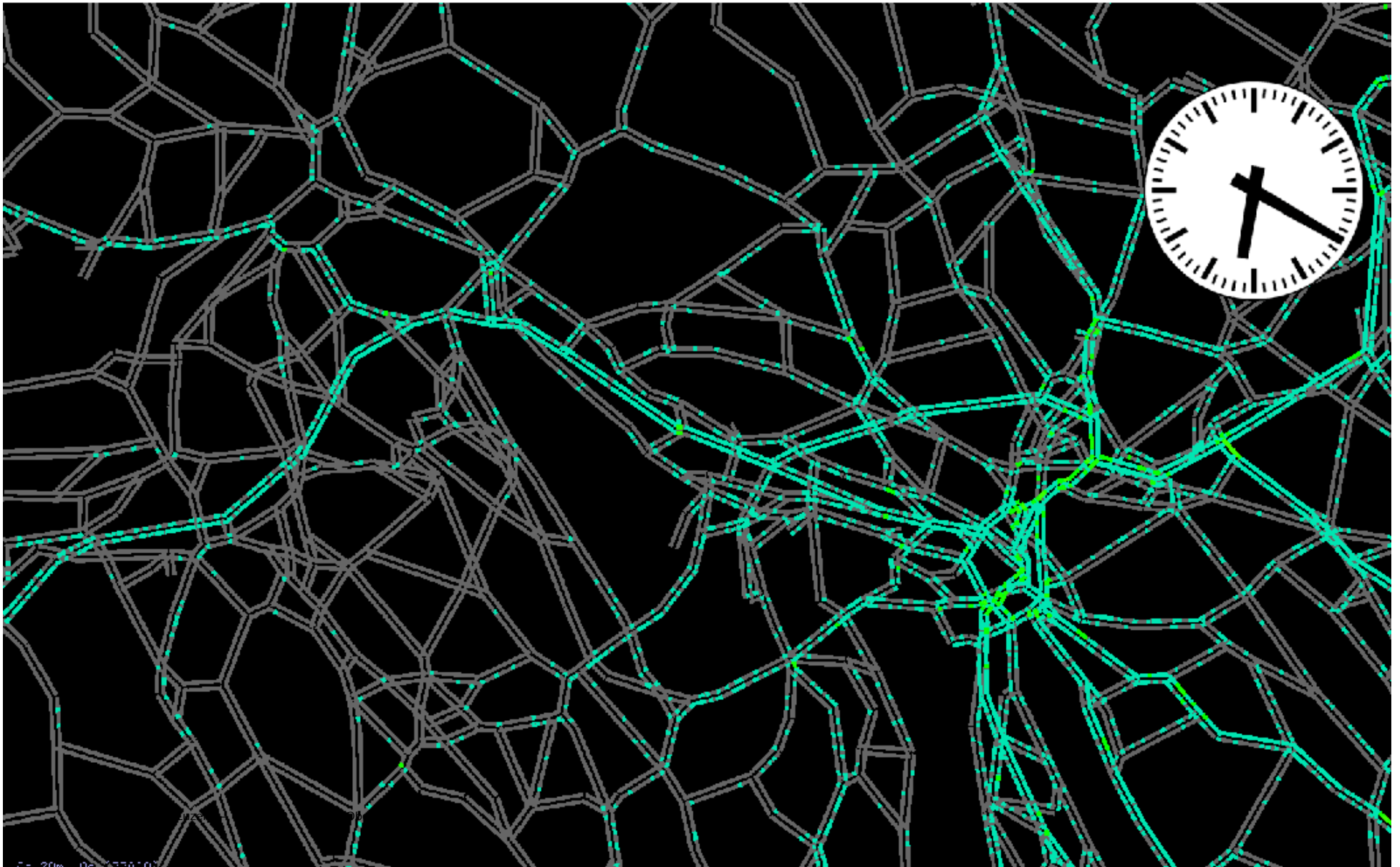Institute for Transport Planning and Systems

ETH

Eidgenössische Technische Hochschule Zürich
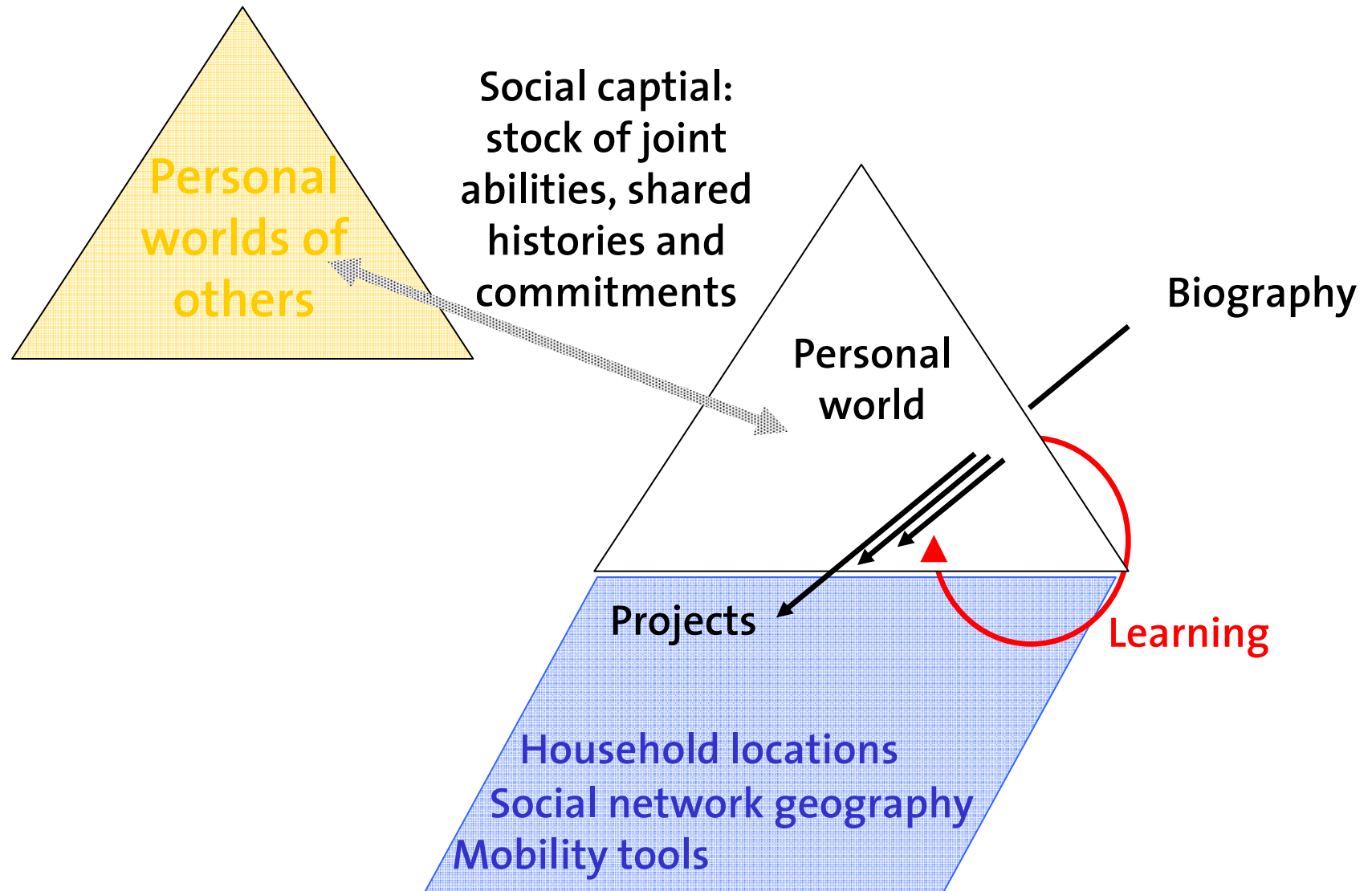Swiss Federal Institute of Technology Zurich

August 2008

# Why transport planning/traffic engineering ?

- Provide forecasts of the changes in use and impact of transport system change (short term to long term)

- Assess the economic viability of those changes (social benefit or individual/firm benefit)

- Provide input into the political assessment of projects and service changes

- Optimise the operation of the systems (social costs)

# A peak hour

# Conceptual understanding



Personal worlds of others

Social captial: stock of joint abilities, shared histories and commitments

Personal world

Biography

Projects

Learning

Household locations
Social network geography
Mobility tools

# Time horizons of transport planning

|  | System | Person |
|---|---|---|
| Long term | Slots<br>Regulation | Home/work location<br>**Car ownership**<br>*Social networks* |
| Medium term | Services offered<br>Prices<br>Awareness | **Season tickets**<br>Projects |
| Short term | Operation | **Daily schedule** |

# Generalized cost function of the schedule

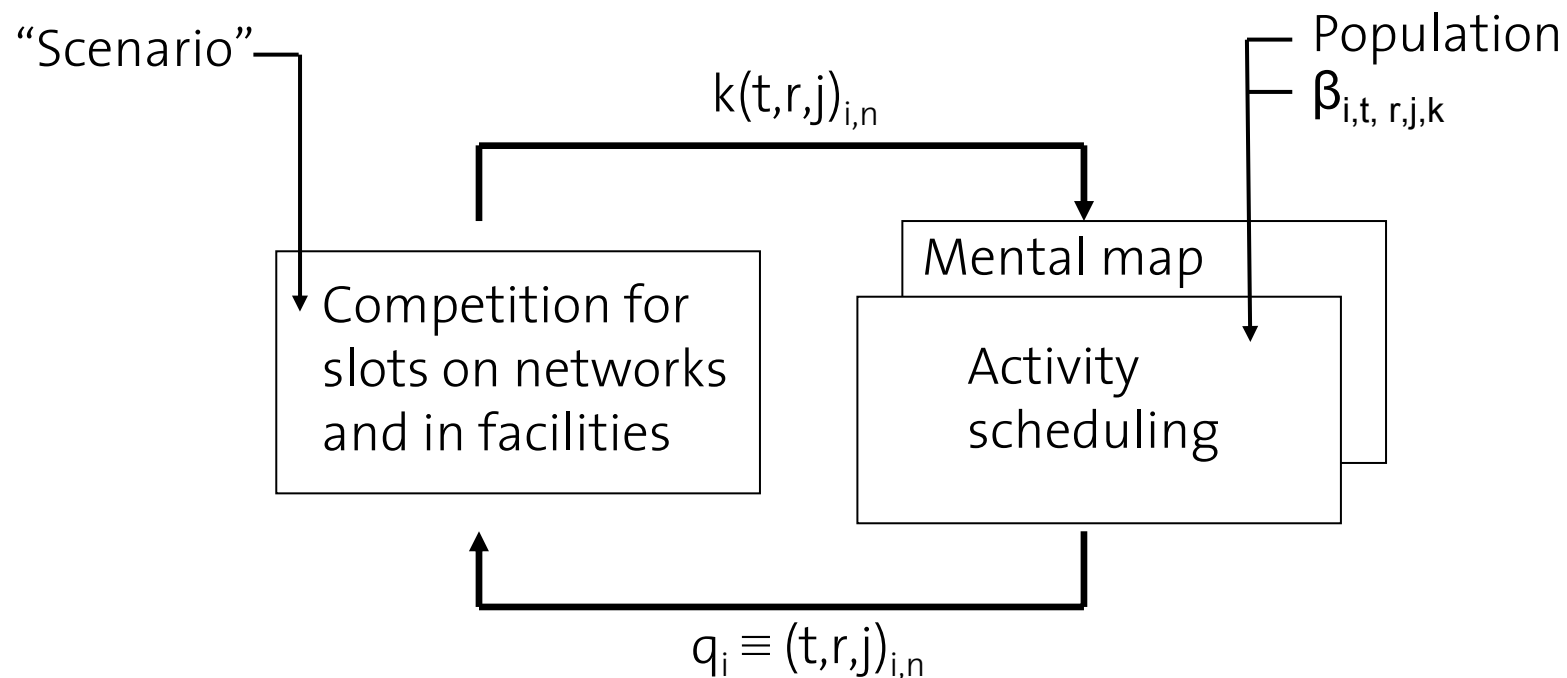Risk and comfort-adjusted weighted sum of times, expenditures and social content of activities and travel:

$$U_{plan} = \sum_{i=1}^{n} U_{act,i} + \sum_{i=2}^{n} U_{trav,i-1,i}$$

$$U_{act,i} = U_{dur,i} + U_{late.ar,i}$$

# Choices currently modelled in MATSim-T

- *Number and type of activities*
- *Sequence of activities*

  - Start and duration of activity
  - Composition of the group undertaking the activity
  - Expenditure division
  - *Location of the activity*

    - Connection between sequential locations

      - Location of access and egress from the mean of transport
      - *Vehicle/means of transport*
      - Route/service
      - Group travelling together
      - Expenditure division

# What does MATSim-T do ?

"Scenario"

$k(t,r,j)_{i,n}$

Population
$\beta_{i,t,\,r,j,k}$

Mental map

| Competition for slots on networks and in facilities | Activity scheduling |

$q_i \equiv (t,r,j)_{i,n}$

Demand q are the $i^{th}$ movements of person p from the current location at time t on route (connection) r to location j. The resulting generalised costs k are used to adjust the schedules and to change the capacities C and prices P of facilities f

# What does it return?

```
<person id="22018">
    <plan score="157.72" selected="yes">
        <act type="h" x="703600" y="236900" link="5757"
                                                        end_time="07:35:04" />
        <leg num="0" mode="car" dep_time="07:35:04" trav_time="00:16:31">
                <route>1900 1899 1897</route>
        </leg>
        <act type="w" x="702500" y="236400" link="5749" dur="08:12:05" />
        <leg num="1" mode="car" dep_time="16:03:40" trav_time="01:10:22">
                <route>1899 1848 1925 1924 1923 1922 1068</route>
        </leg>
        <act type="l" x="681450" y="246550" link="2140" dur="01:20:00" />
        <leg num="2" mode="car" dep_time="" trav_time="00:34:35">
                <route>1067 1136 1137 1921 1922 1923 1925 1848 1899</route>
        </leg>
        <act type="h" x="703600" y="236900" link="5757" />
    </plan>
</person>
```

# MATSIM-T: Steady-state version

- Scale:
  - 7.5 mio agents,
  - 2 mio homes
  - 1 mio facilities
  - 1 mio links and nodes

- Continuous time resolution: Seconds
- Spatial resolution: Address (individual facilities)

# Example: 3% of Swiss population
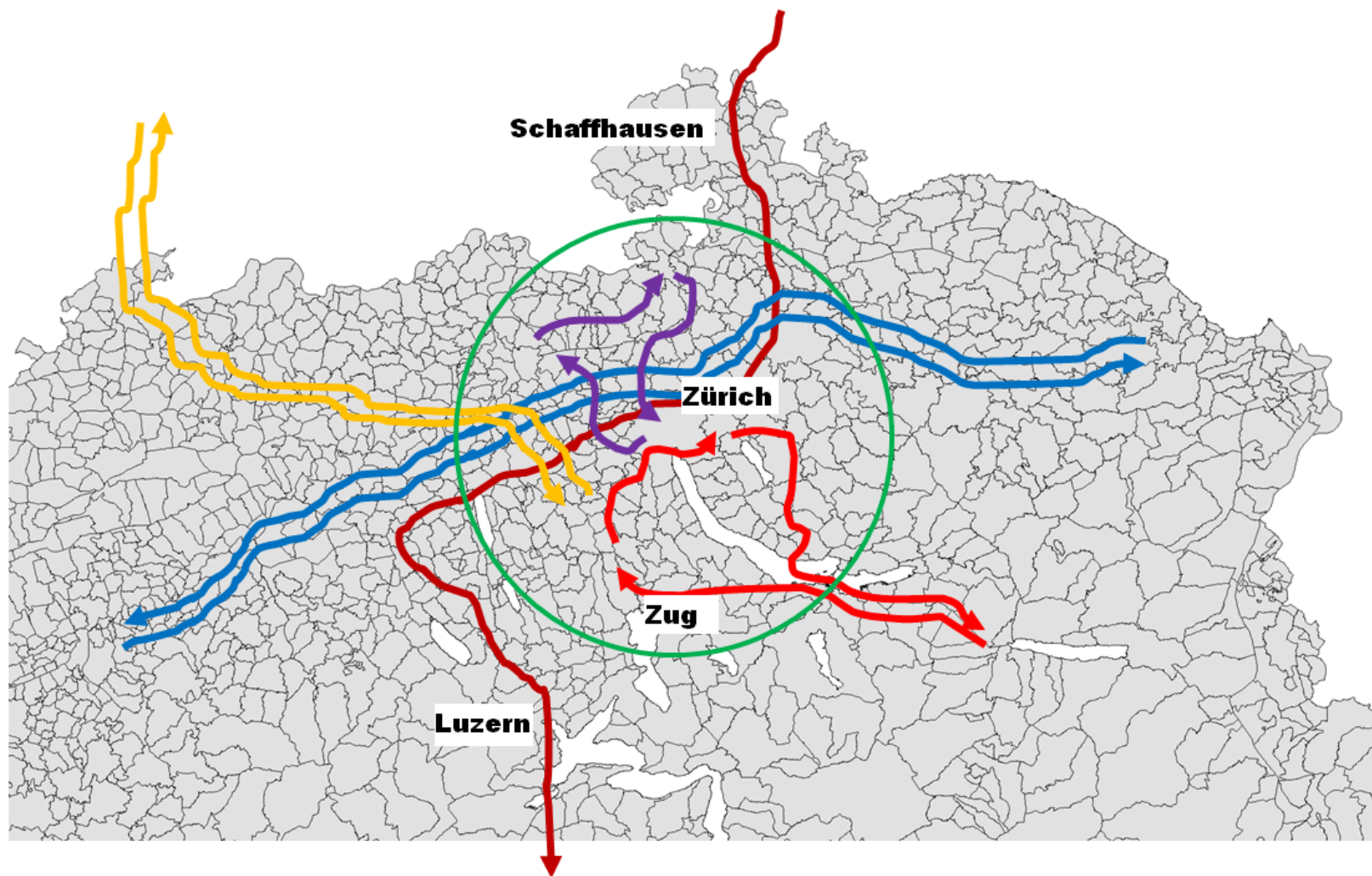
# Example: Computing times by step

| Operation | Unit | Units/sec |
|---|---|---|
| Initial demand | | 0.12h |
| Scheduling (fixed components) | | 14.40h |
| | | |
| Scheduling (planomat) | Agent | 100 |
| Scheduling (routing) | Agent | 1000 |
| Time-step based traffic flow simulation | Agent | 300 |
| Learning | Agent | 250'000 |
| | | |
| Total iteration (with I/O) | | 0.22h |
| Total run (with I/O) (100 iterations) | | 23h |

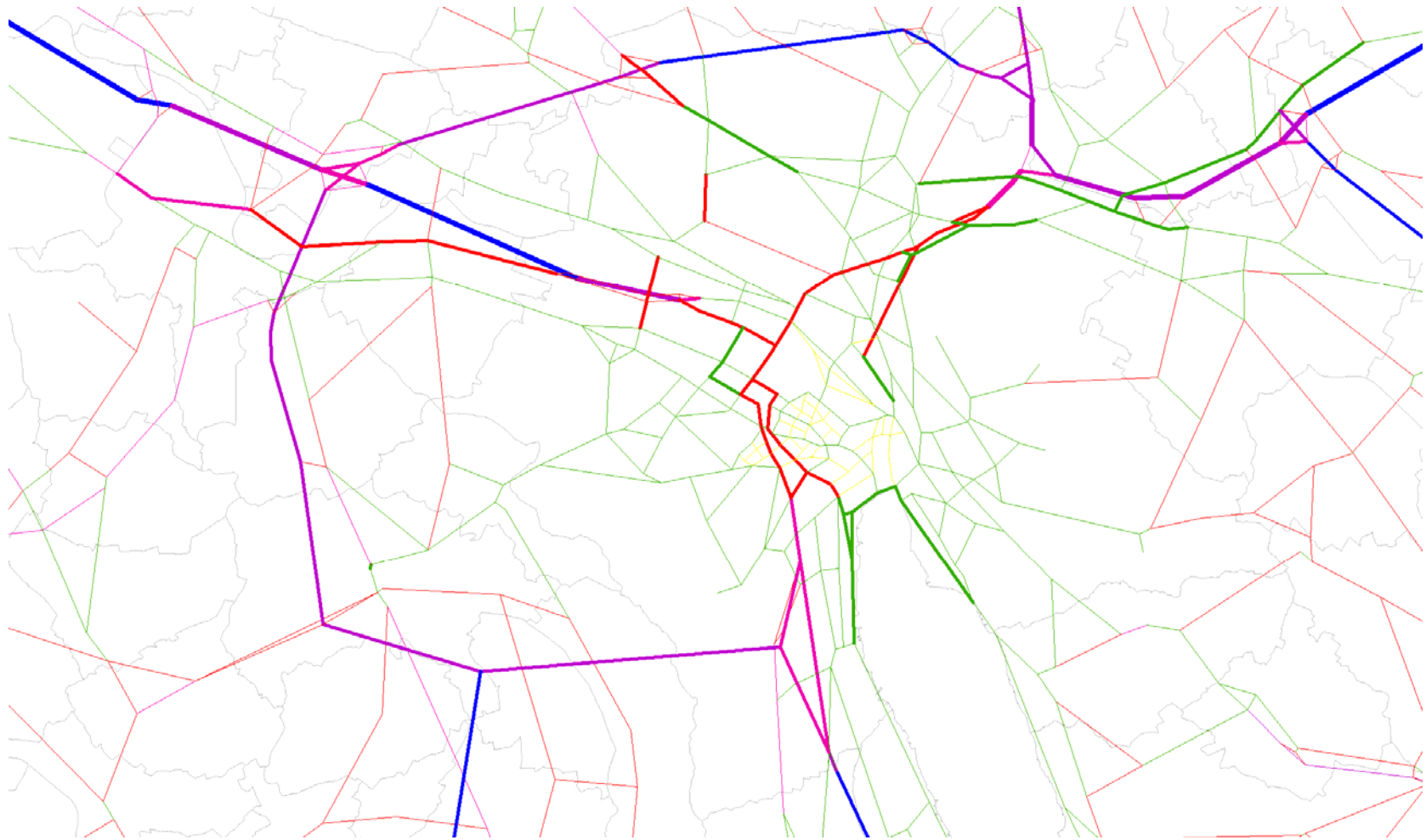# Example: Score/generalised costs by iteration
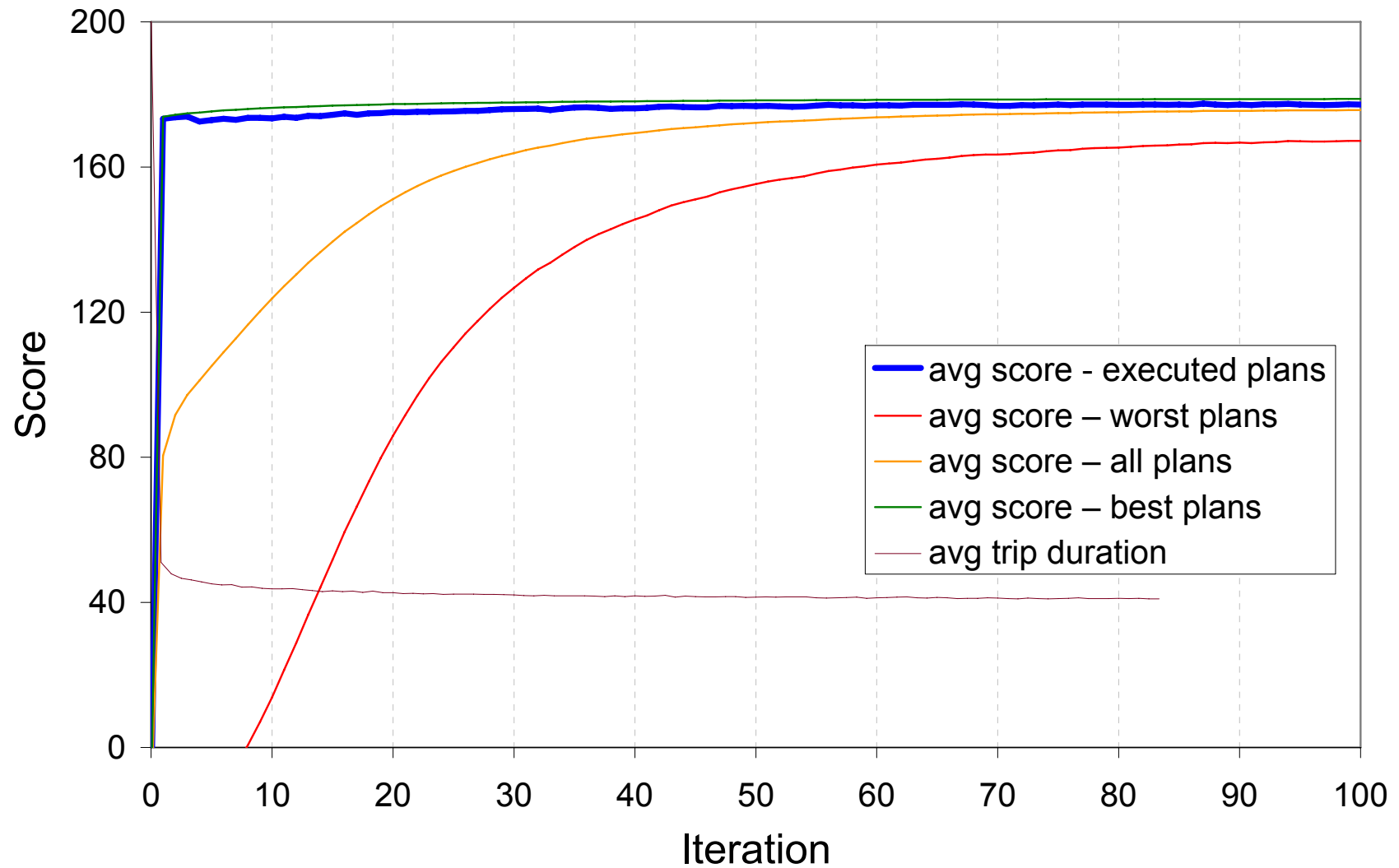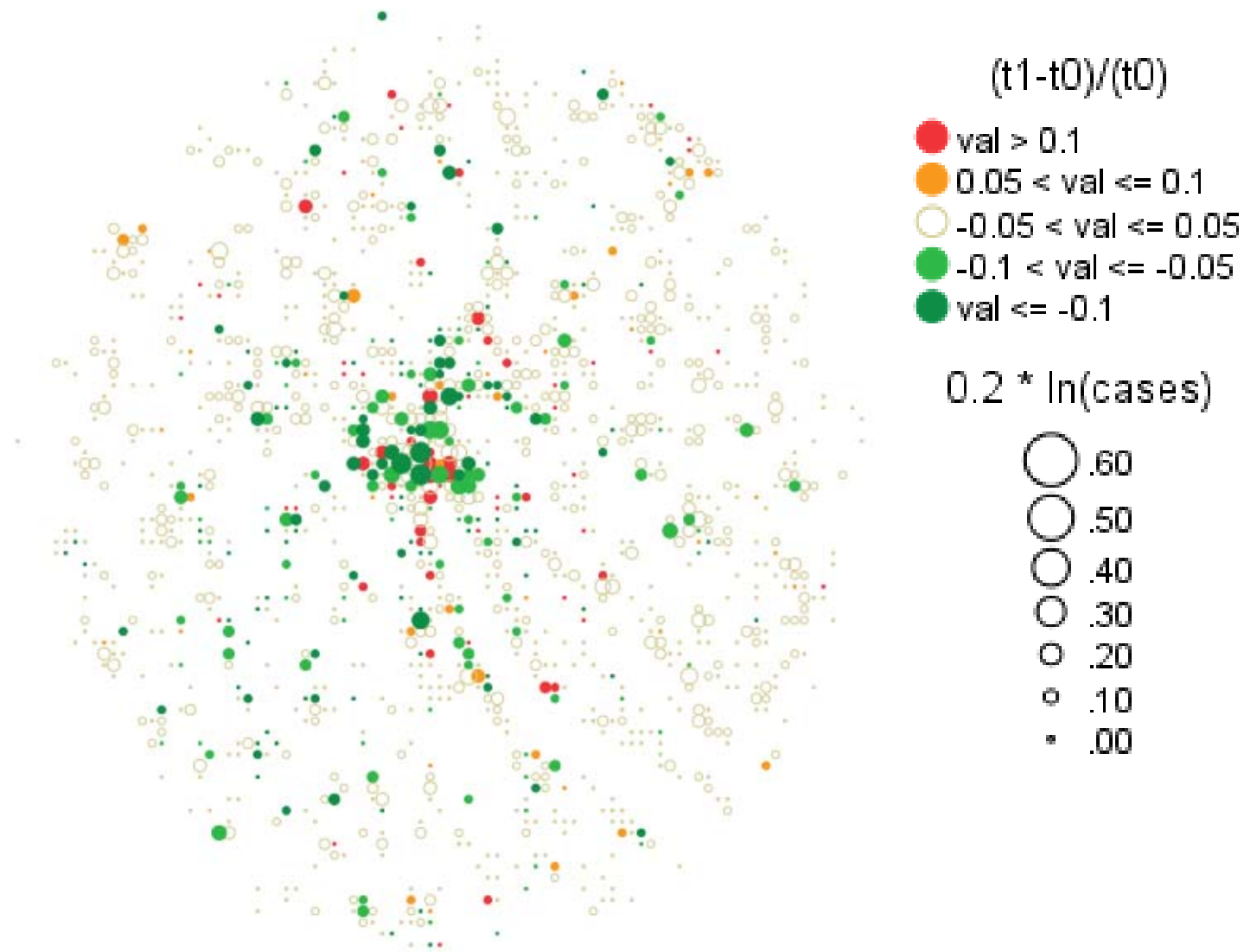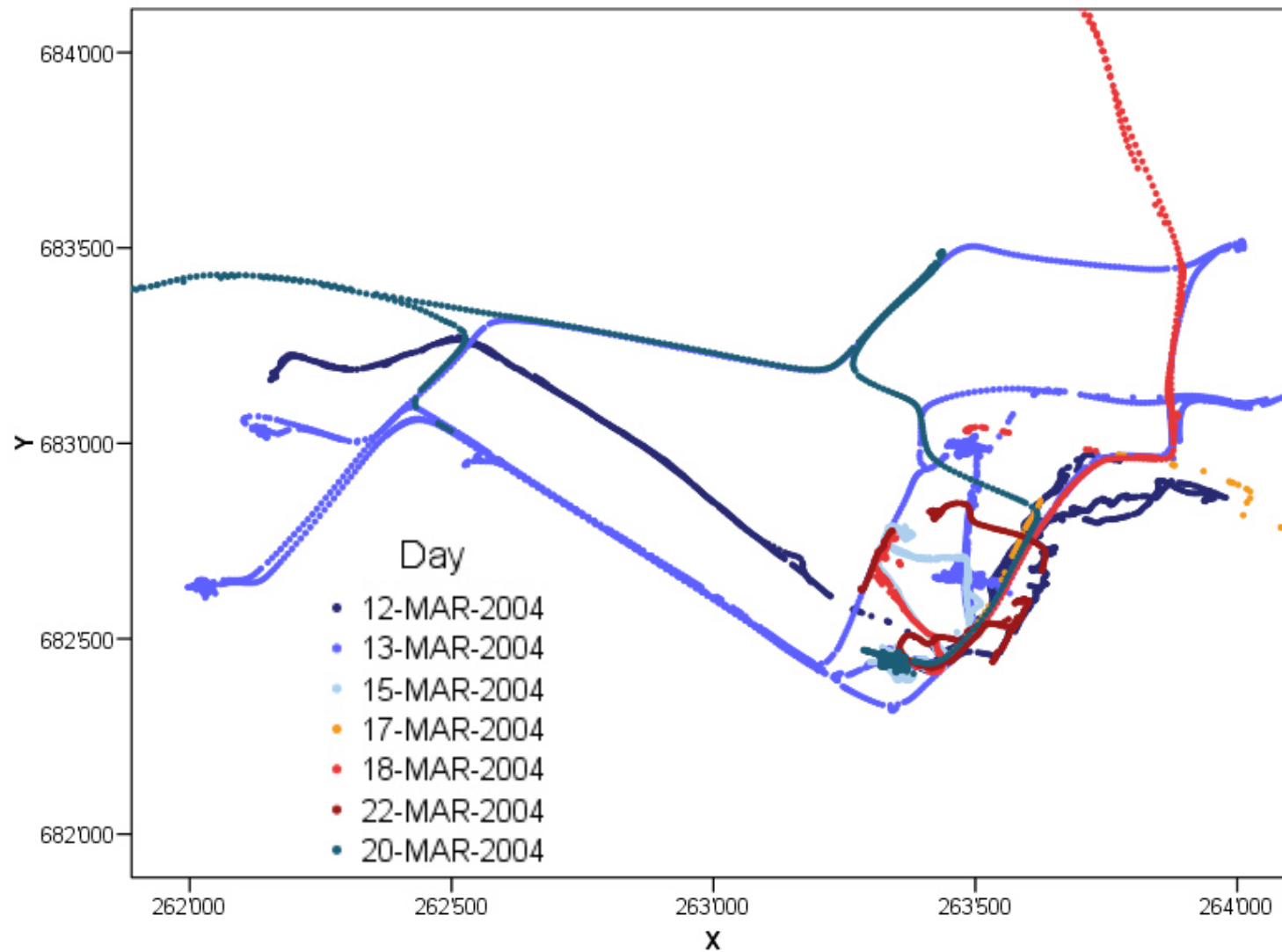
# Westumfahrung Zürich: Before
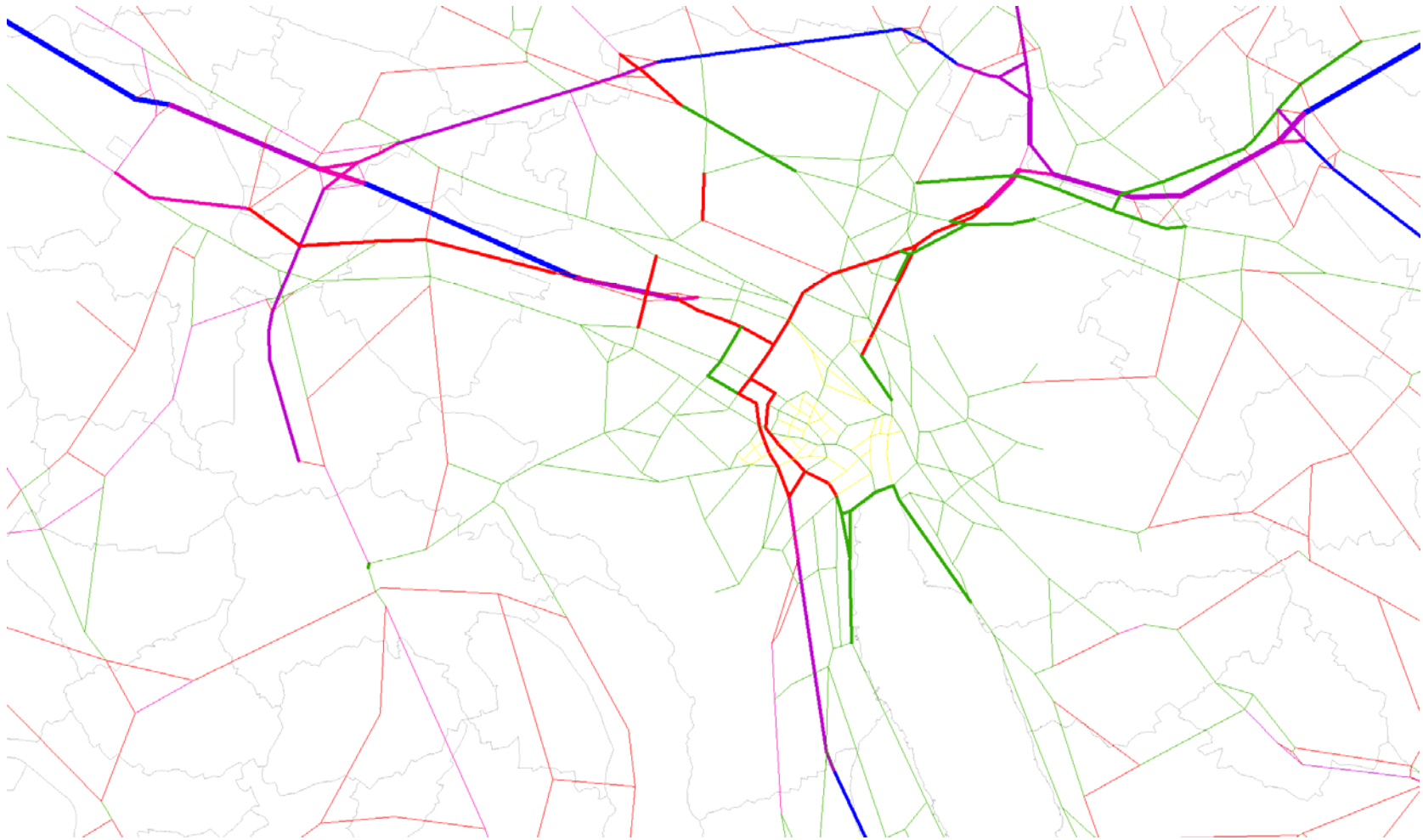
# Validation of status-quo
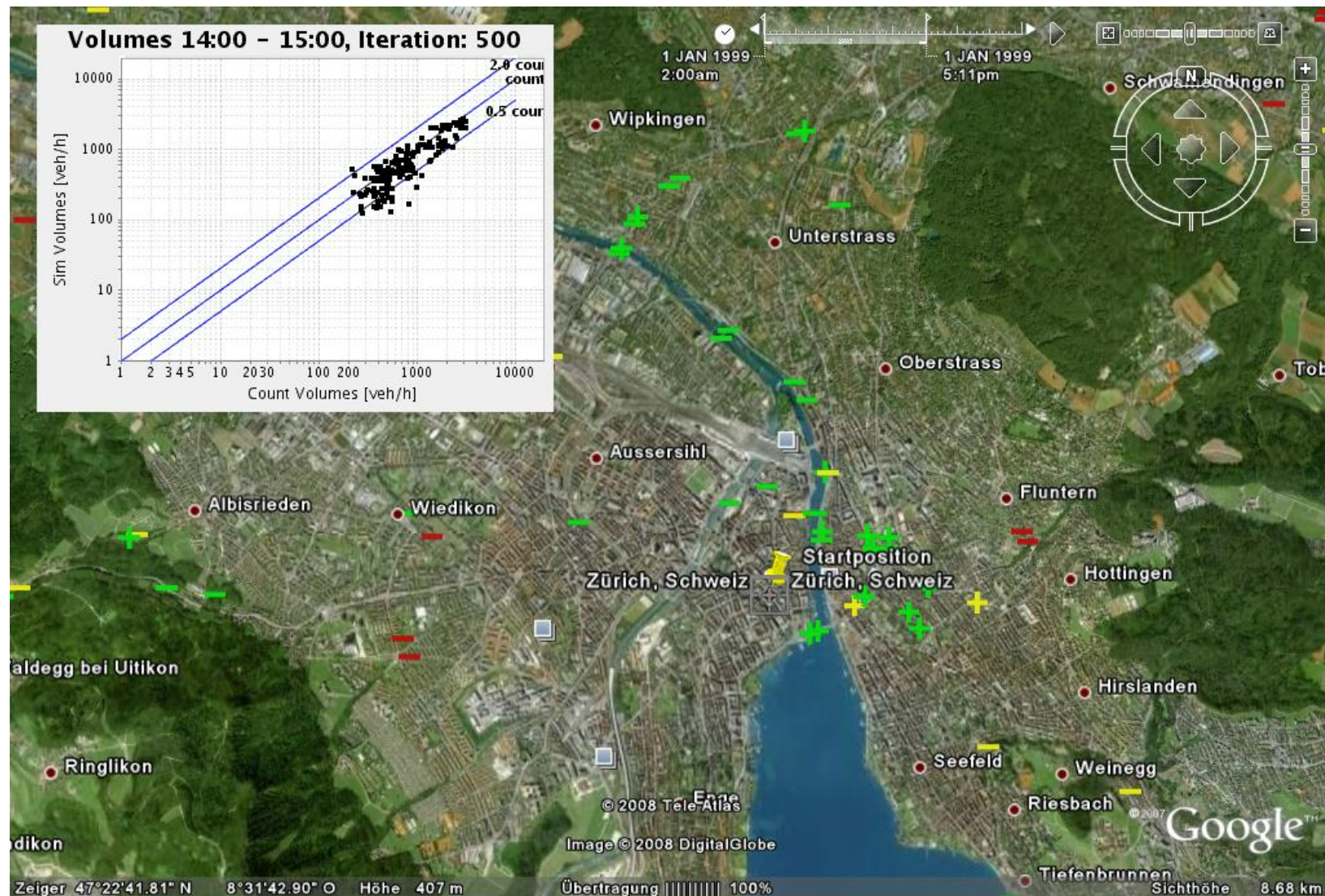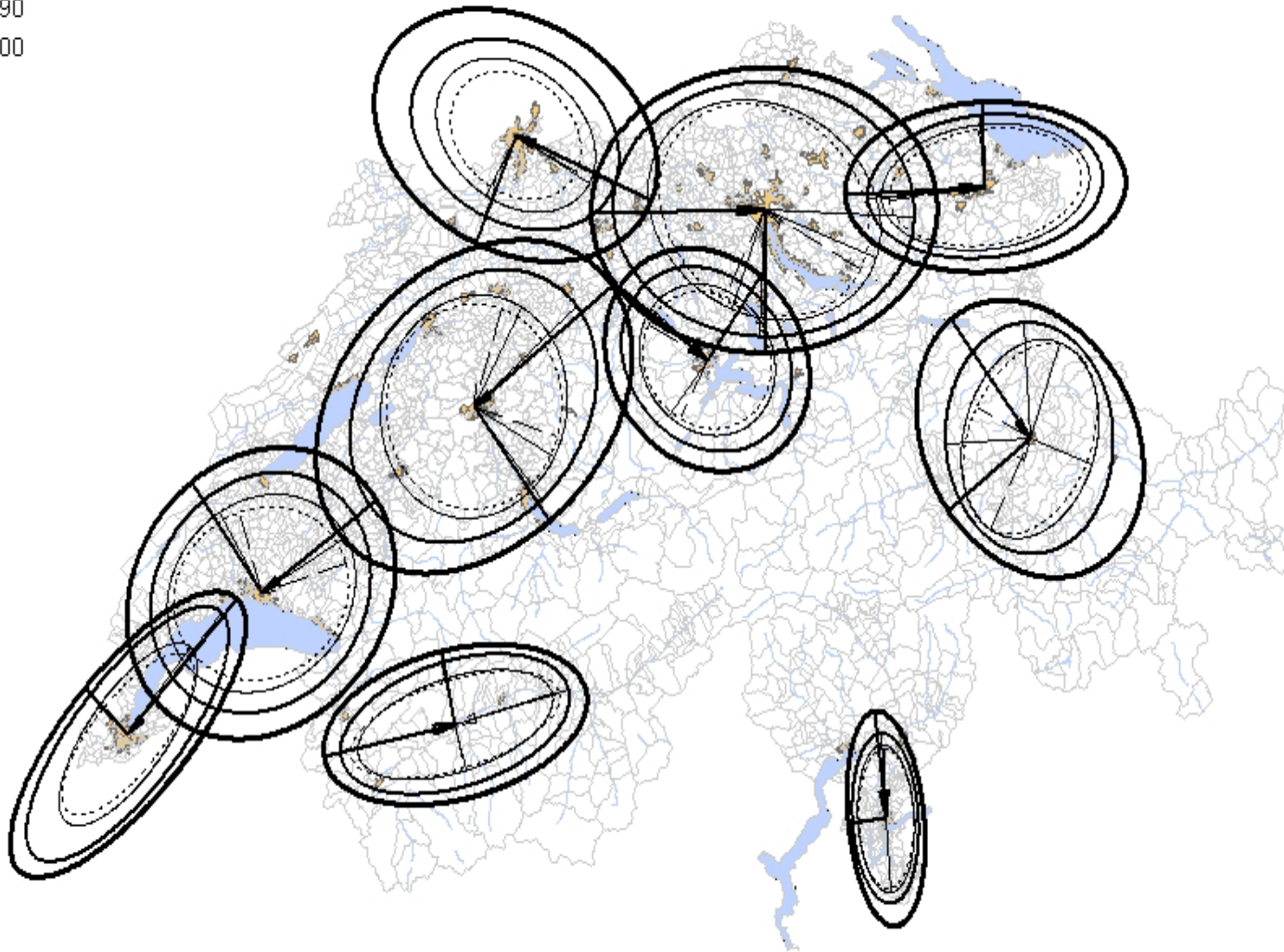
# Westumfahrung Zürich: After

# Westumfahrung Zürich: Winners/Loosers



(t1-t0)/(t0)

- 🔴 val > 0.1
- 🟠 0.05 < val <= 0.1
- ⚪ -0.05 < val <= 0.05
- 🟢 -0.1 < val <= -0.05
- 🟢 val <= -0.1

0.2 * ln(cases)

- .60
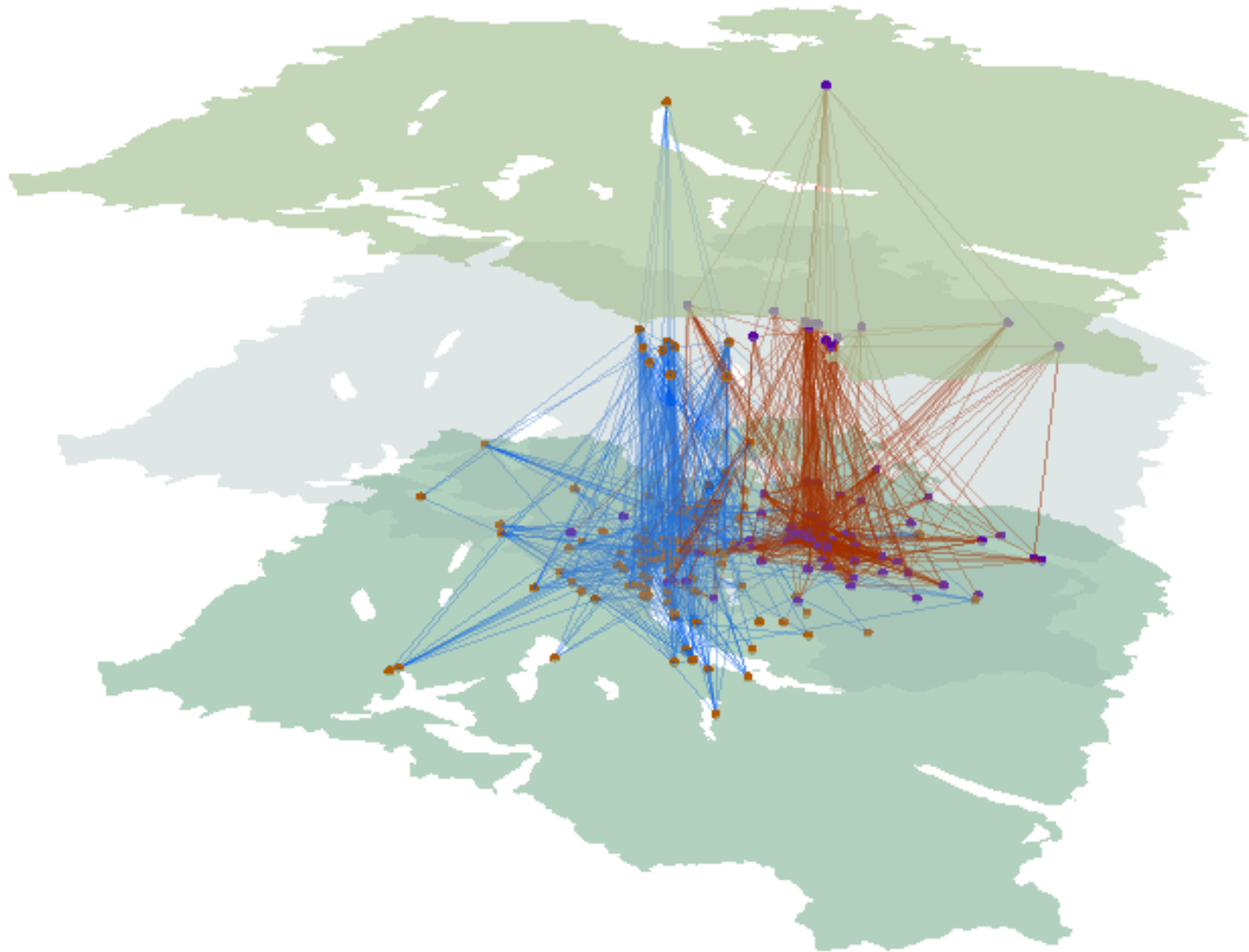- .50
- .40
- .30
- .20
- .10
- .00

# Outlook: Exploit the existing (coming) data wealth

# Outlook: Integration of supply side actors

# Outlook: Joint choice and information flow

# Outlook

- Stability of simulation with multiple actor types

- Path dependence
- Development of crisis


- Validation
- Computing times

# www.matsim.org

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