Agent-based Modelling of Parking Choice and Search

Rashid A. Waraich

IVT, ETH Zurich

November 2014

Institut für Verkehrsplanung und Transportsysteme
Institute for Transport Planning and Systems

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Motivation

Parking Policy

- Manage travel demand
- Sometimes alternative to road pricing
- Minimum/maximum parking requirements
- Influence search traffic (average 30%)
- Influence of new infrastructure projects

Recent developments:

- Renting private parking
- Performance based parking prices
- Promote electric vehicles

Figure sources: tournament.co.nz; areahousing.org

Challenges of Current Models

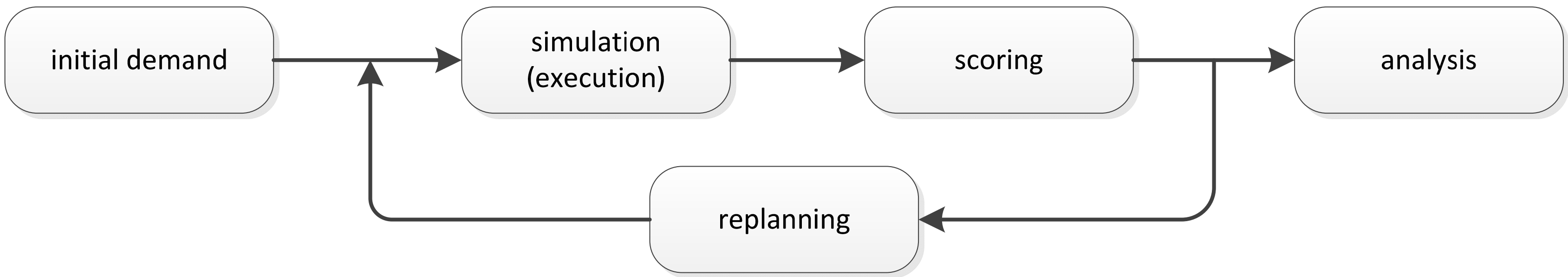
- Mostly aggregated
- Often very coarse time resolution
- Often limited modelling of spatial constraints
- Individual decisions missing or limited
- Integration between parking and traffic model missing

etc.

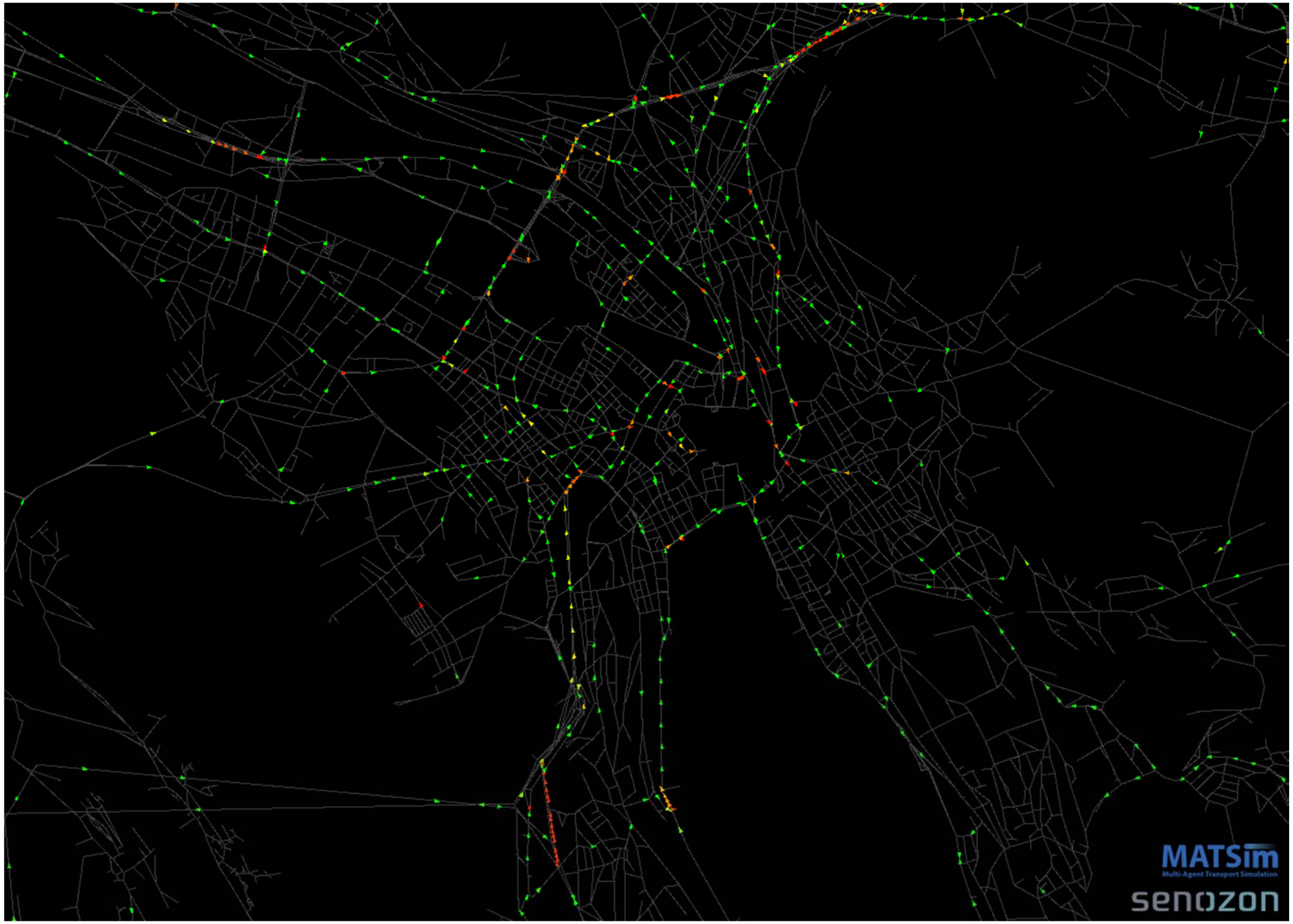
Agent-based Modelling (Example Singapore – MATSim)

How do we Model Travel Demand?

- MATSim (open source)
- Synthetic population: people -> agents
- Individual preferences (based on survey data)
- Initial plans based on census data/travel diaries
- Plans contain acitivites (work, shopping, education) and trips
- Several transport modes available (car, walk, public transport and bike)
- Optimization of activity and travel demand for whole day
- First step of optimization: simulation

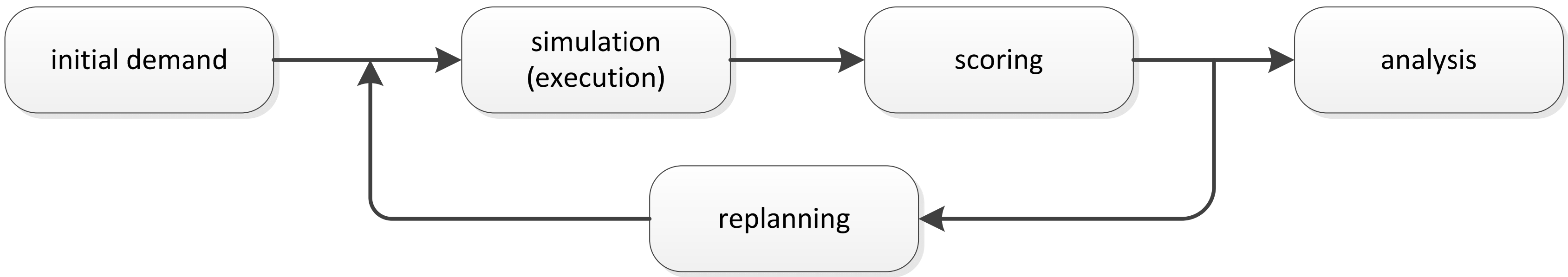


Simulation



MATSim

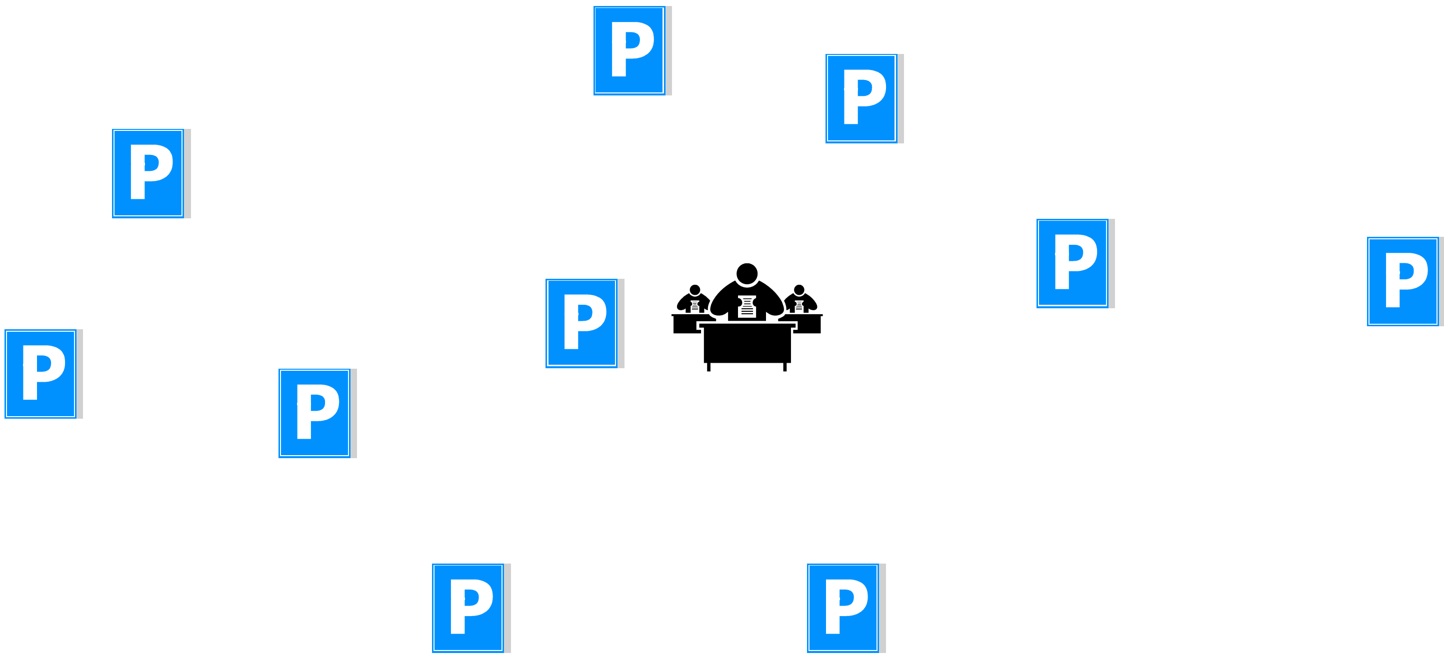
- simulated plans are scored
- Lower travel time and performing activities gives better score
- The goal of each agent is to maximize its score
- Iterative process, based on idea of evolutionary algorithm
- Replanning (change travel mode, route, times, etc.)
- Co-existence of several plans
  - Bad plans deleted over time, good plans have higher chance of getting selected for execution -> survival of the fittest
  - Iteration continues -> optimal plans (“Nash Equilibrium”)



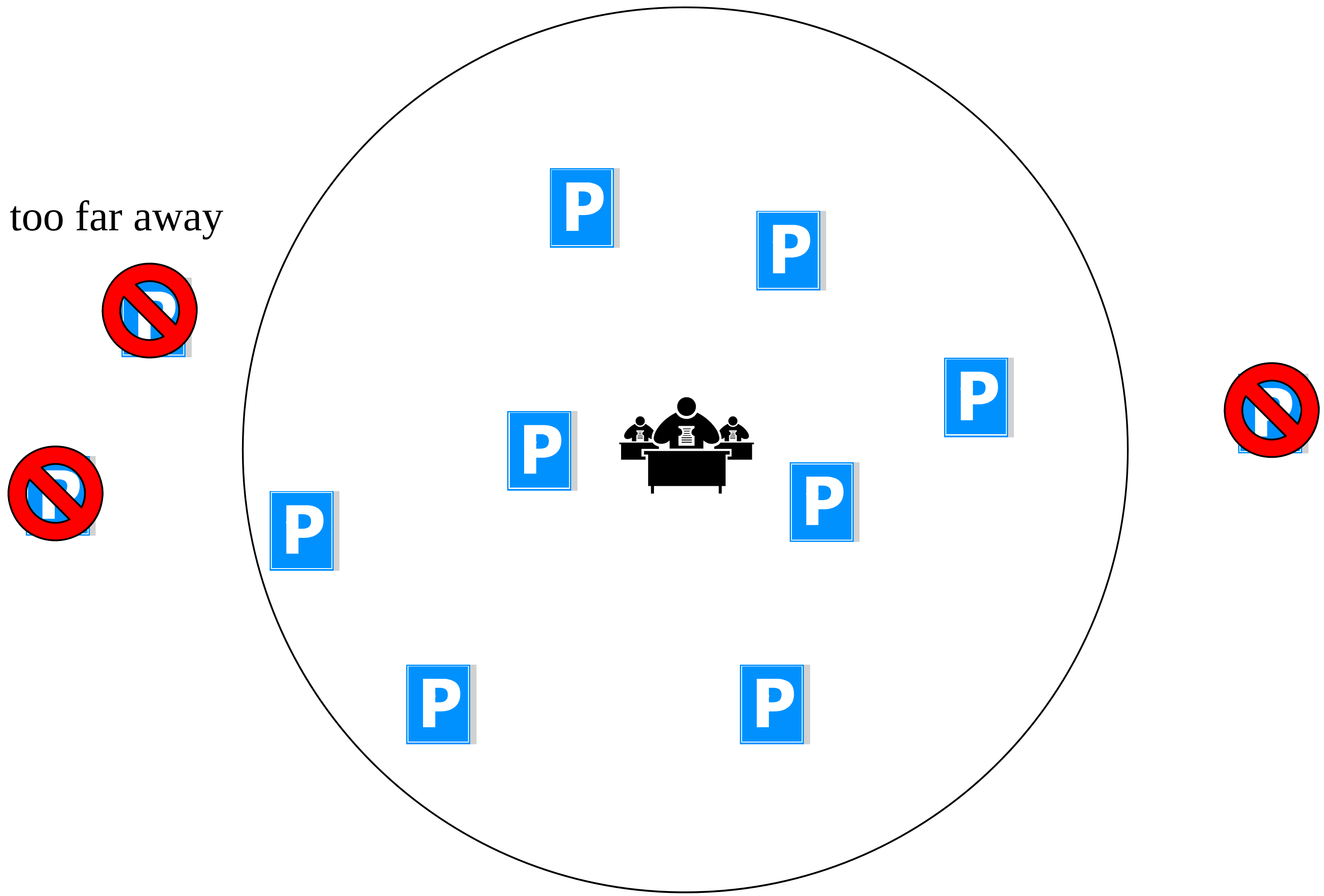
How is Parking Modelled in MATSim

- Parking choice model (very fast)
- Parking search (allows to model missing search traffic)

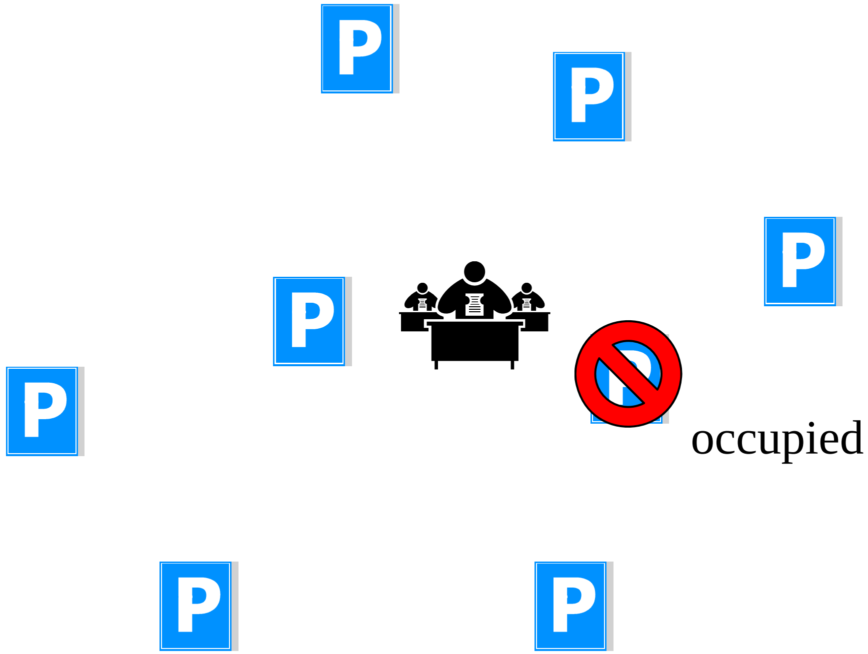
Parking Choice Algorithm



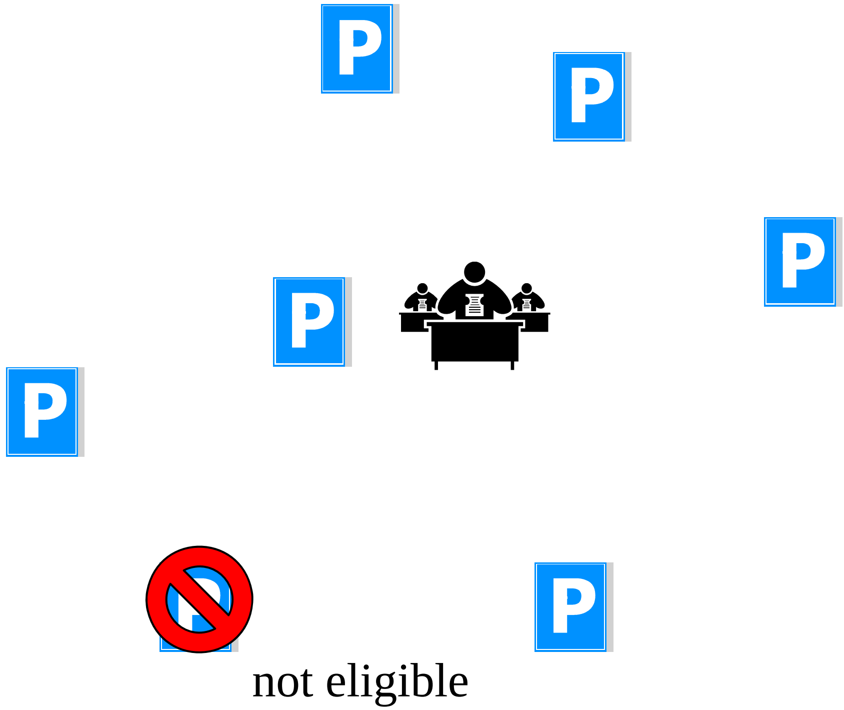
Parking Choice Algorithm



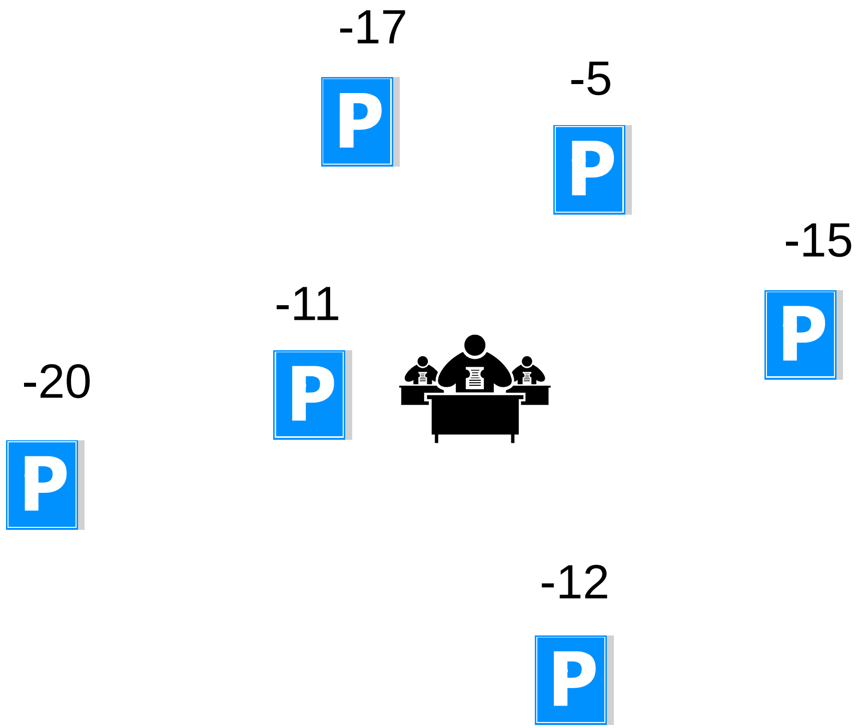
Parking Choice Algorithm



Parking Choice Algorithm

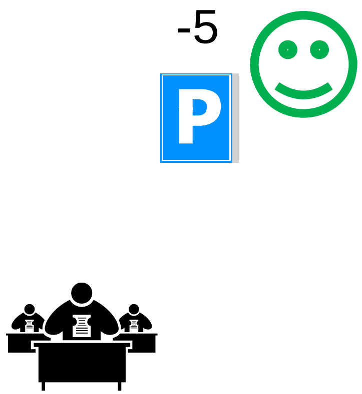


Parking Choice Algorithm



$$U_{parking,i} = U_{P_{cost},i} + U_{P_{searchTime},i} + U_{P_{walk},i} + \cdots + \epsilon_i$$

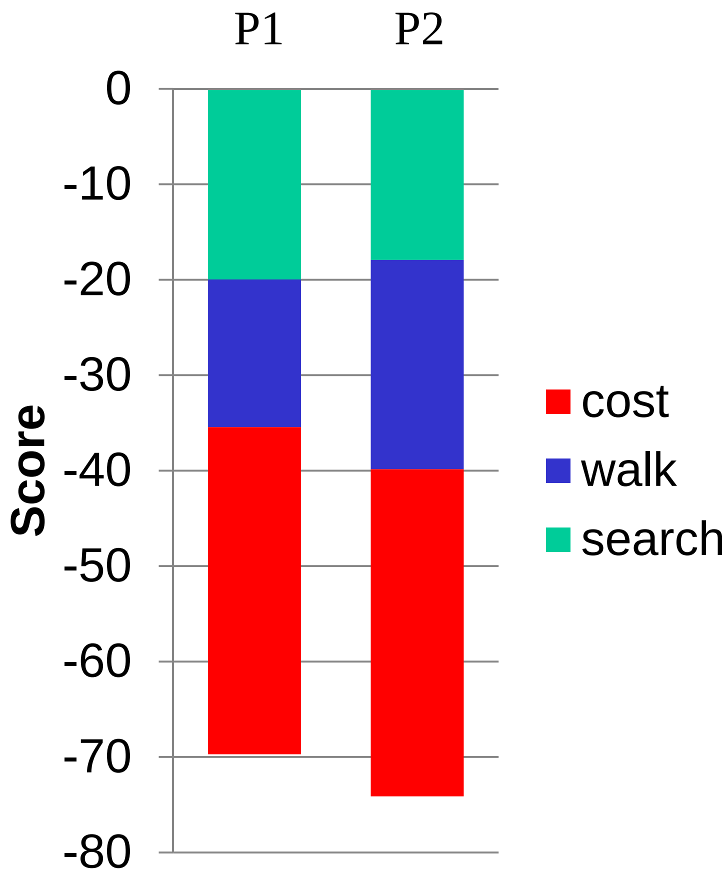
Parking Choice Algorithm



$$U_{parking,i} = U_{P_{cost},i} + U_{P_{searchTime},i} + U_{P_{walk},i} + \cdots + \epsilon_i$$

Individual Parking Utility Scores

Parking situation: search time = 3 min; walk time=3min; parking cost=4 CHF; activity duration ca. 5 hours.



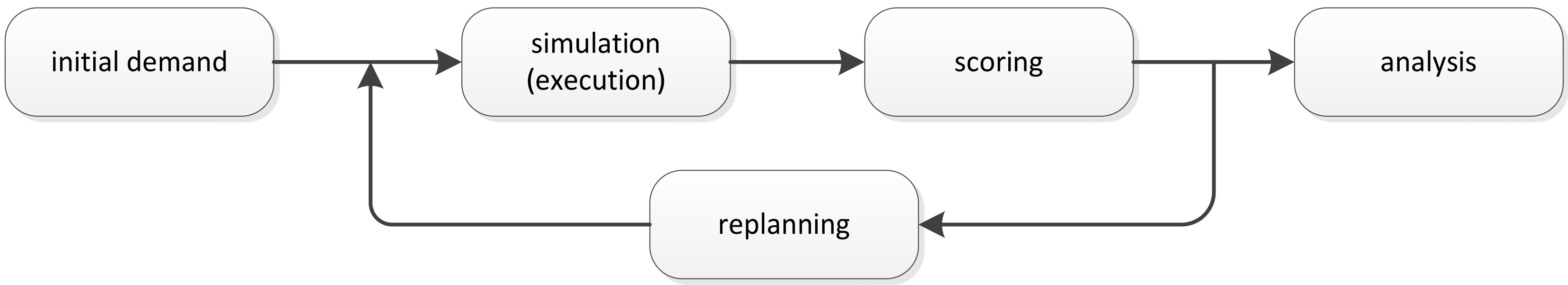
P1: female, age 20

P2: male, age 80

Income both: 4000 CHF/month

MATSim Scoring

$$U_{plan} = \sum U_{travelTime} + U_{travelCost} + U_{performAct} + \cdots + \boldsymbol{U_{parking}}$$

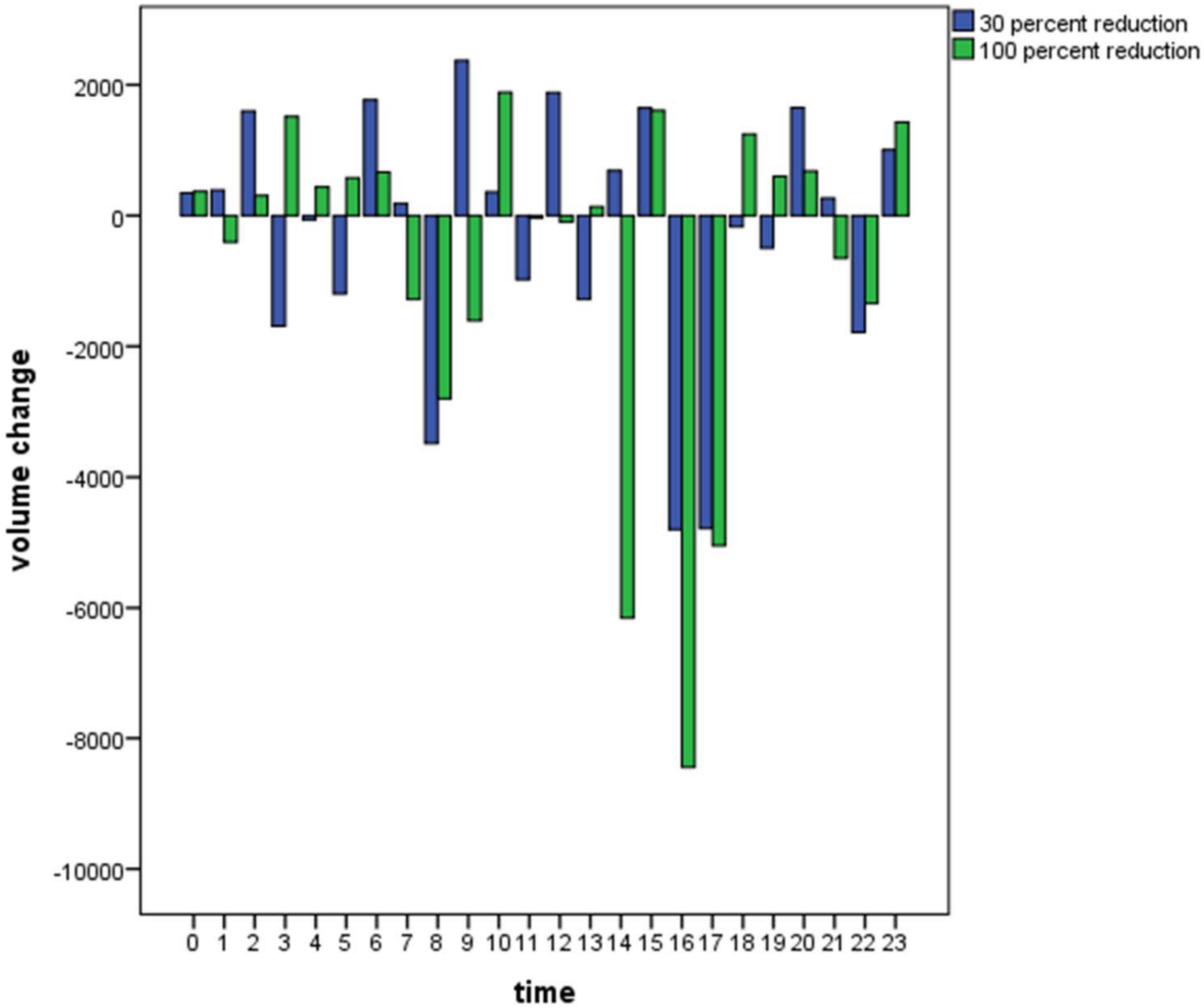


Sample Policy: Reduce Peak Traffic

- Goal: reduce traffic on links with highest traffic volume during evening peak hours (16:00 to 19:00)
- Approach:
  - Identify high volume links (top 10%)
  - Identify agents traveling on these links
  - Identify activity location of previous and next activities
  - Identify clusters of activities
  - Reduce parking capacity in clusters by 30% resp. 100%

- Alternative goal:
  - Select not highest volume, but most congested links during peak hour

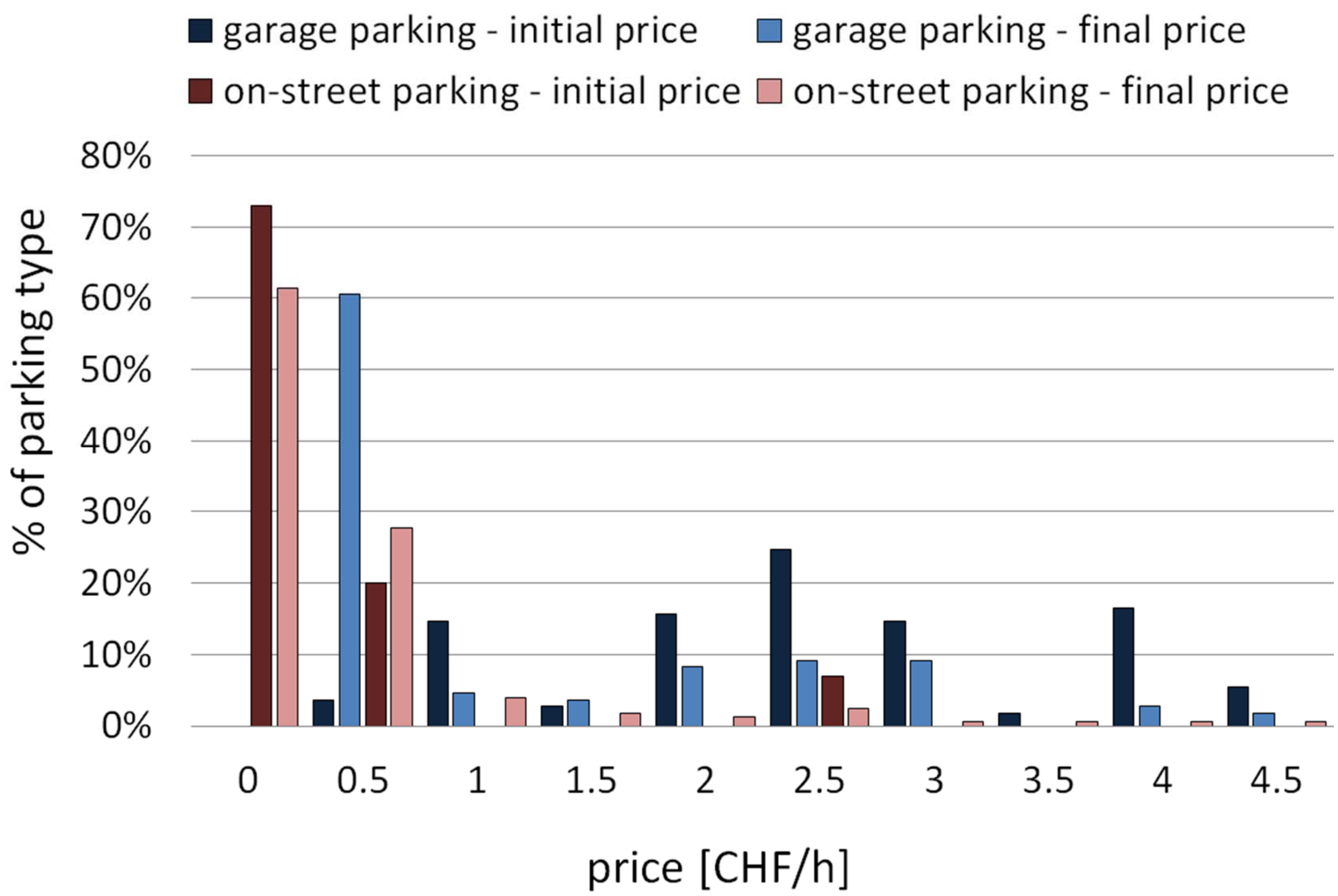
Sample Policy: Reduce Peak Traffic



Performance-based Pricing for Zurich

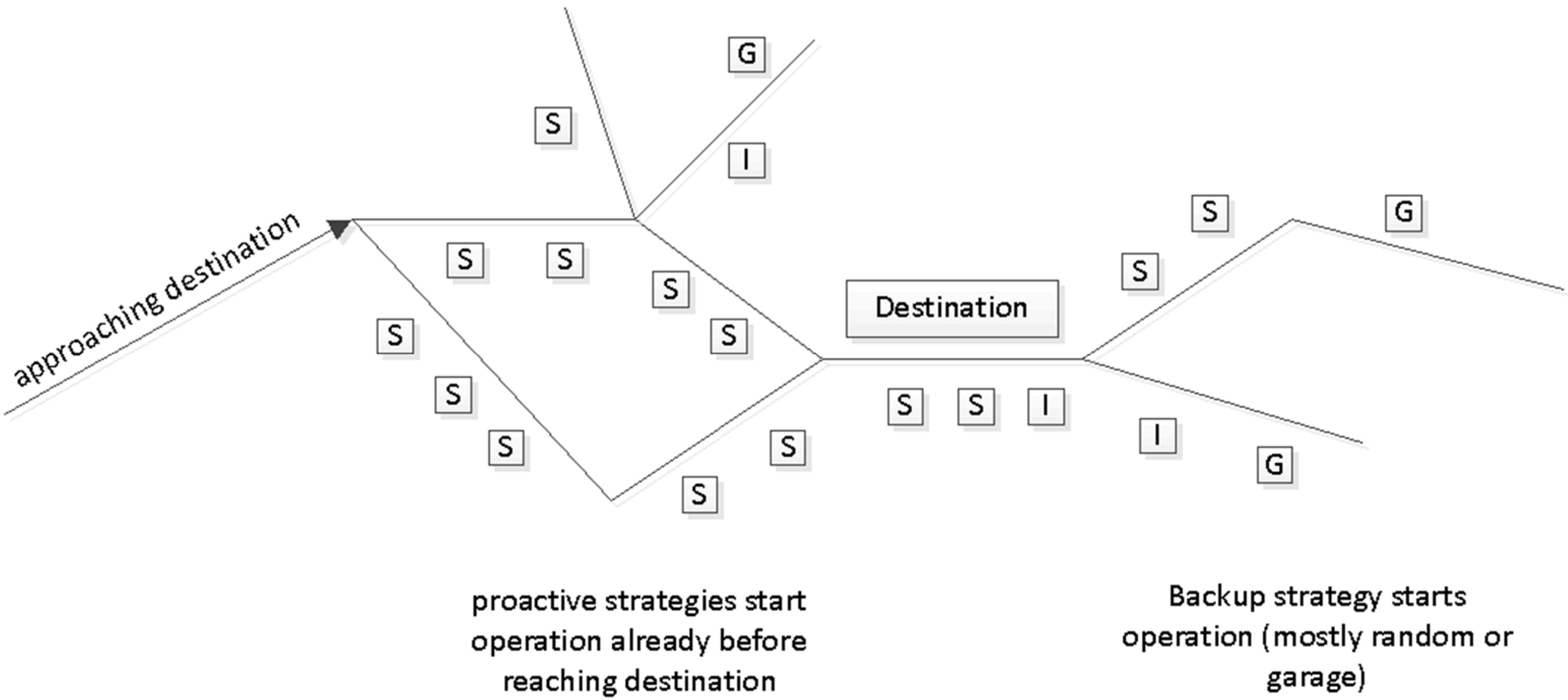
- Currently: High prices for garage parking, low prices for street parking.

Performance-based Pricing for Zurich

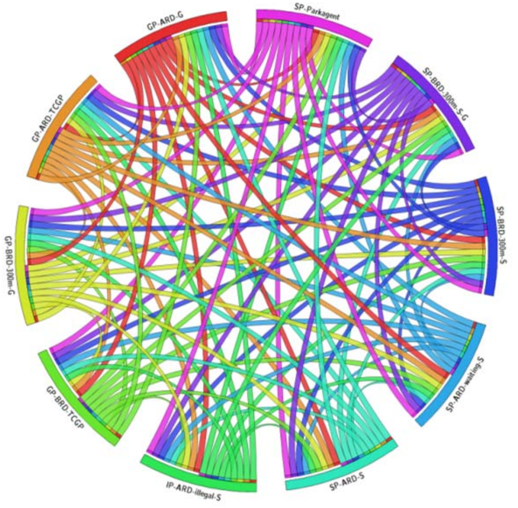


Modelling Parking Search

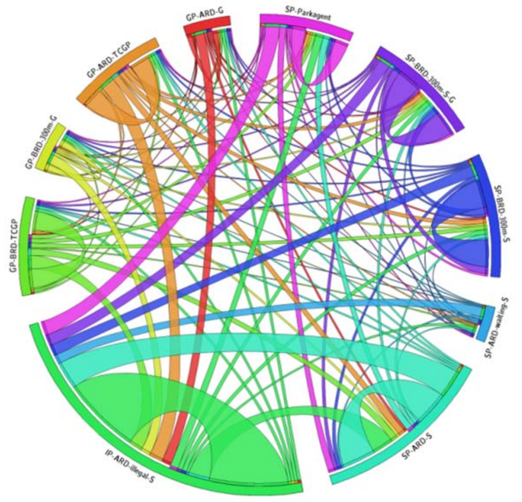
General Structure of Parking Search Strategies



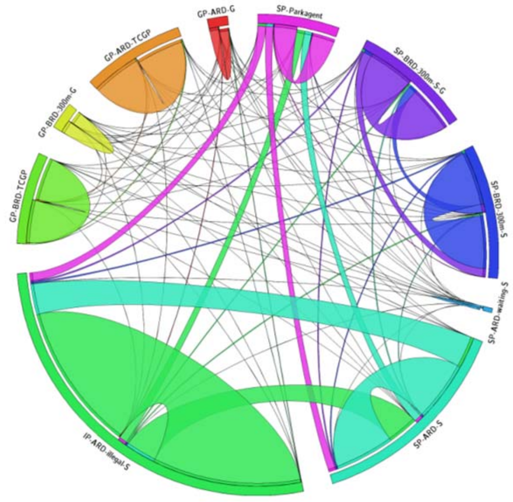
Strategy Group Switches



(a)



(b)

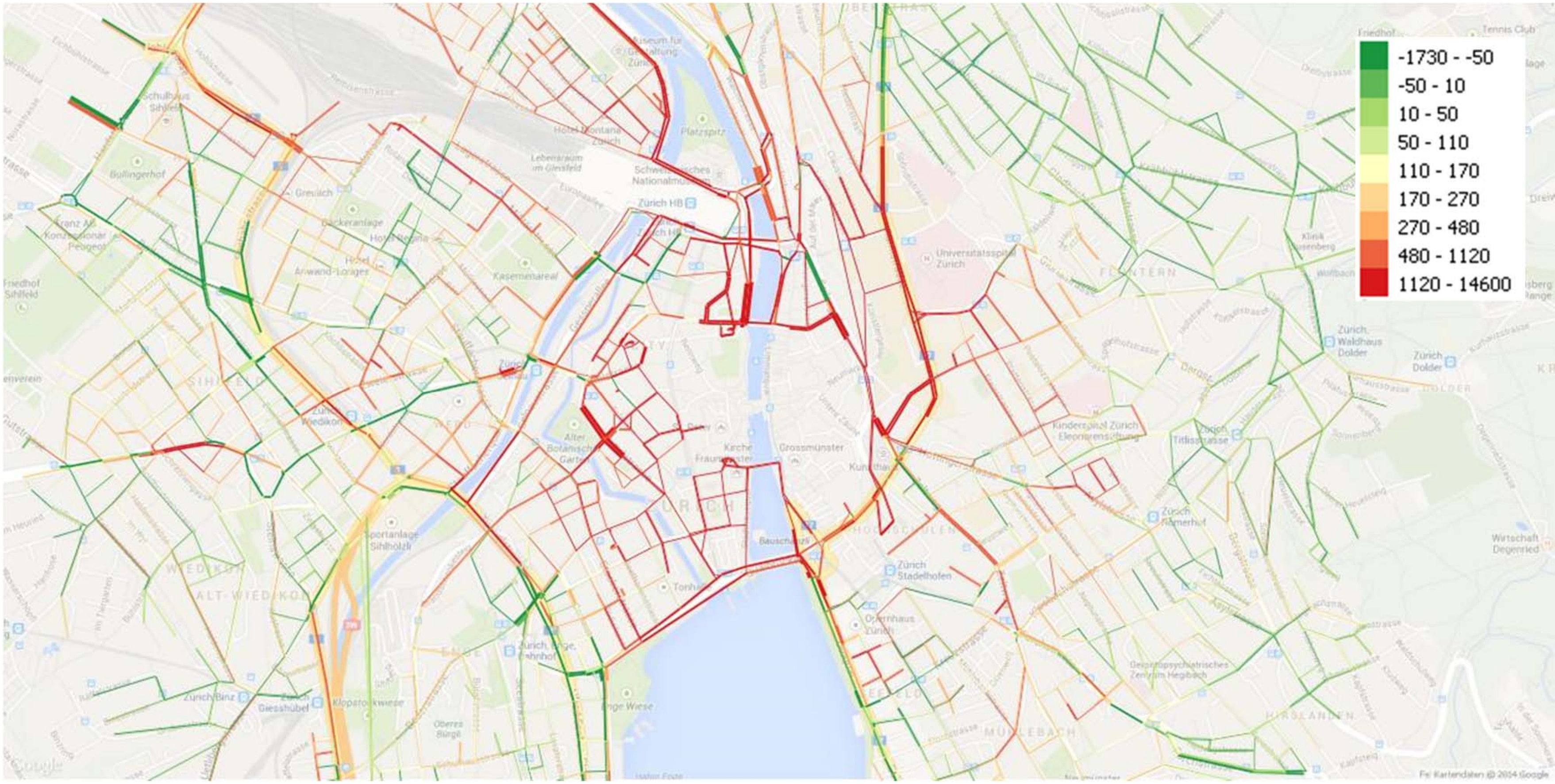


(c)

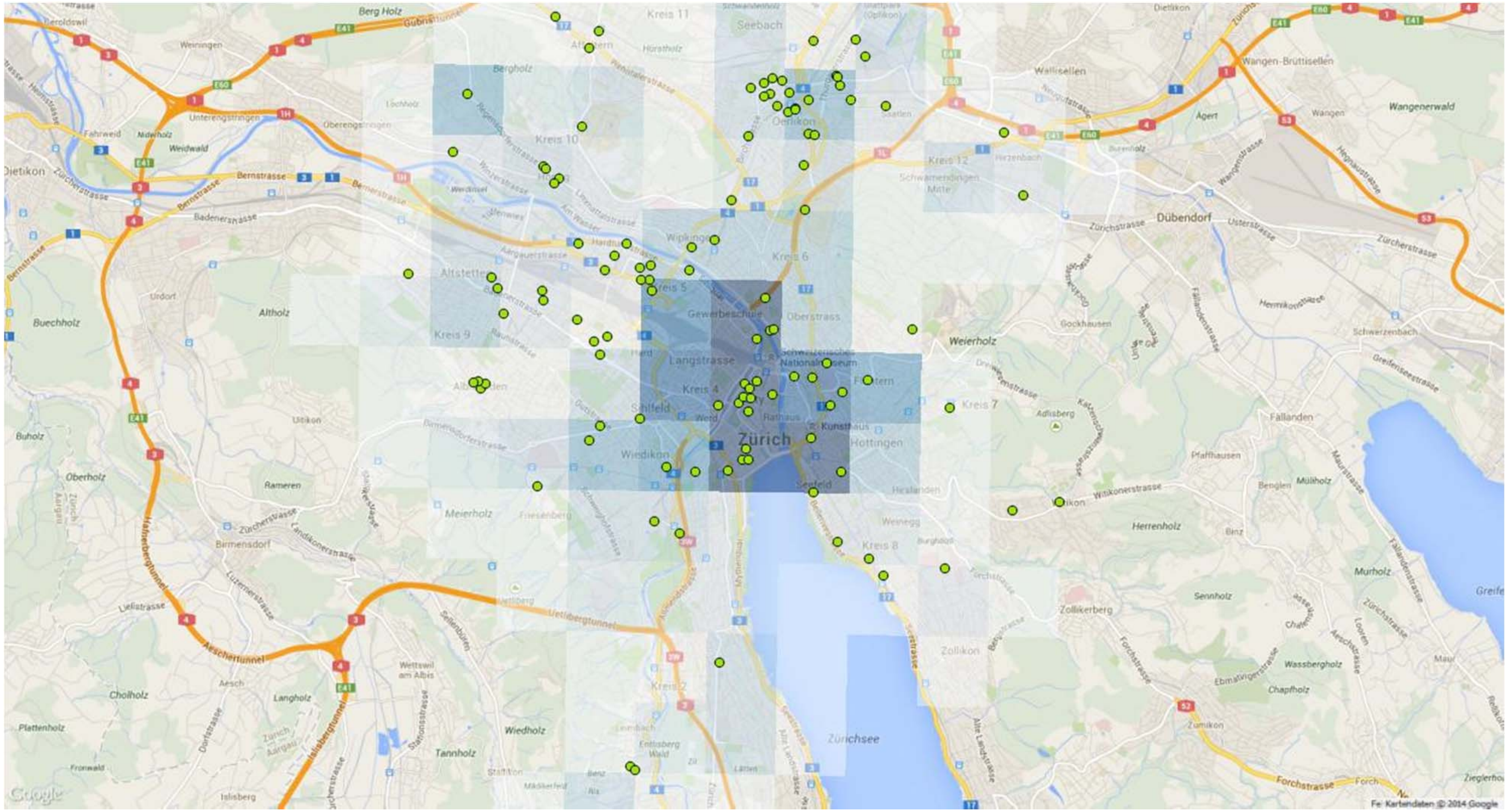
Strategy switches between groups (10 groups)

a) During initialization (10 iterations) => random switches
b) At 80%MNL (final last 100 iterations)
c) At full MNL (final 100 iterations) => most agents do not change strategy group or switch within same strategy group

Traffic Counts Difference (Missing Parking Search Traffic)



Usage of Garage Parking Strategies



Conclusions & Future Work

- Modelling parking decisions and traffic
  - Disaggregated
  - Equilibrium model
- Various applications/extend models

Questions