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Agent-based Parking Choice

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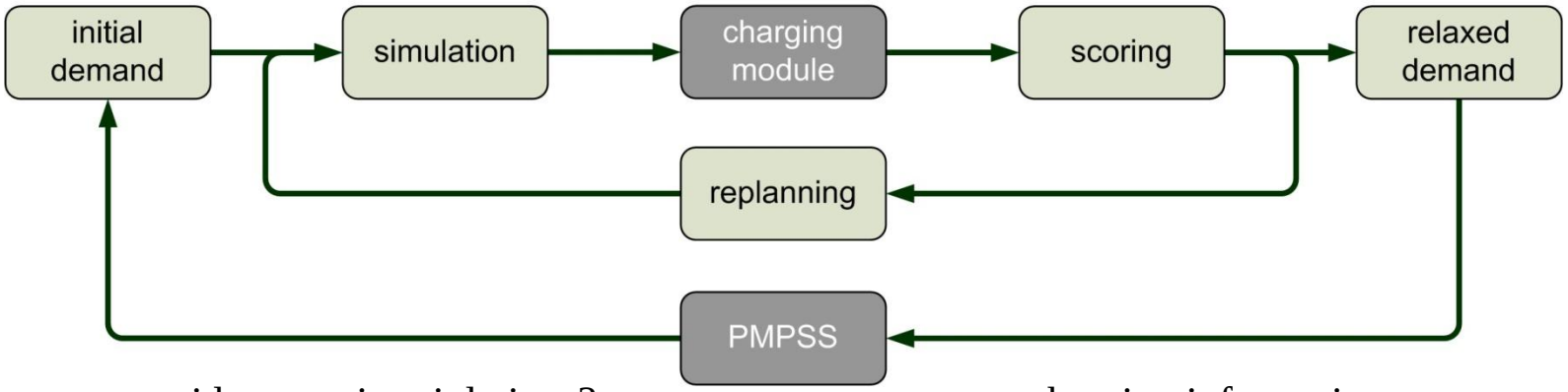
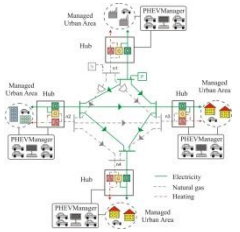
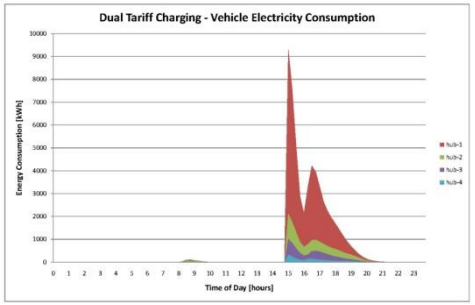
Simulating EVs/PHEVs in MATSim

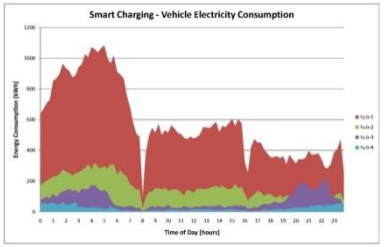


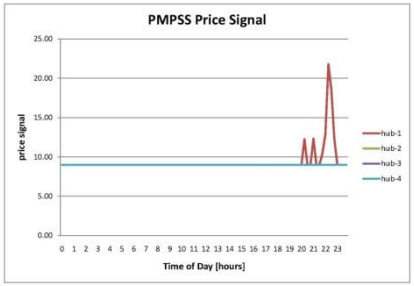


Test Scenarios

- Immediate Charging upon arrival
- Pricing time of use
- Smart charging
- Test Scenario with 16 agents







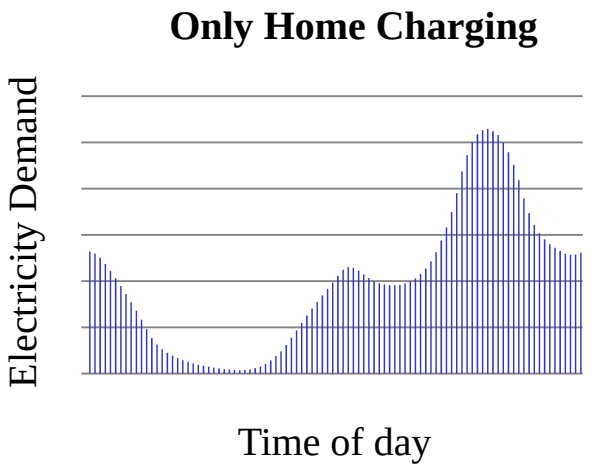
Zurich Scenario

30km radius

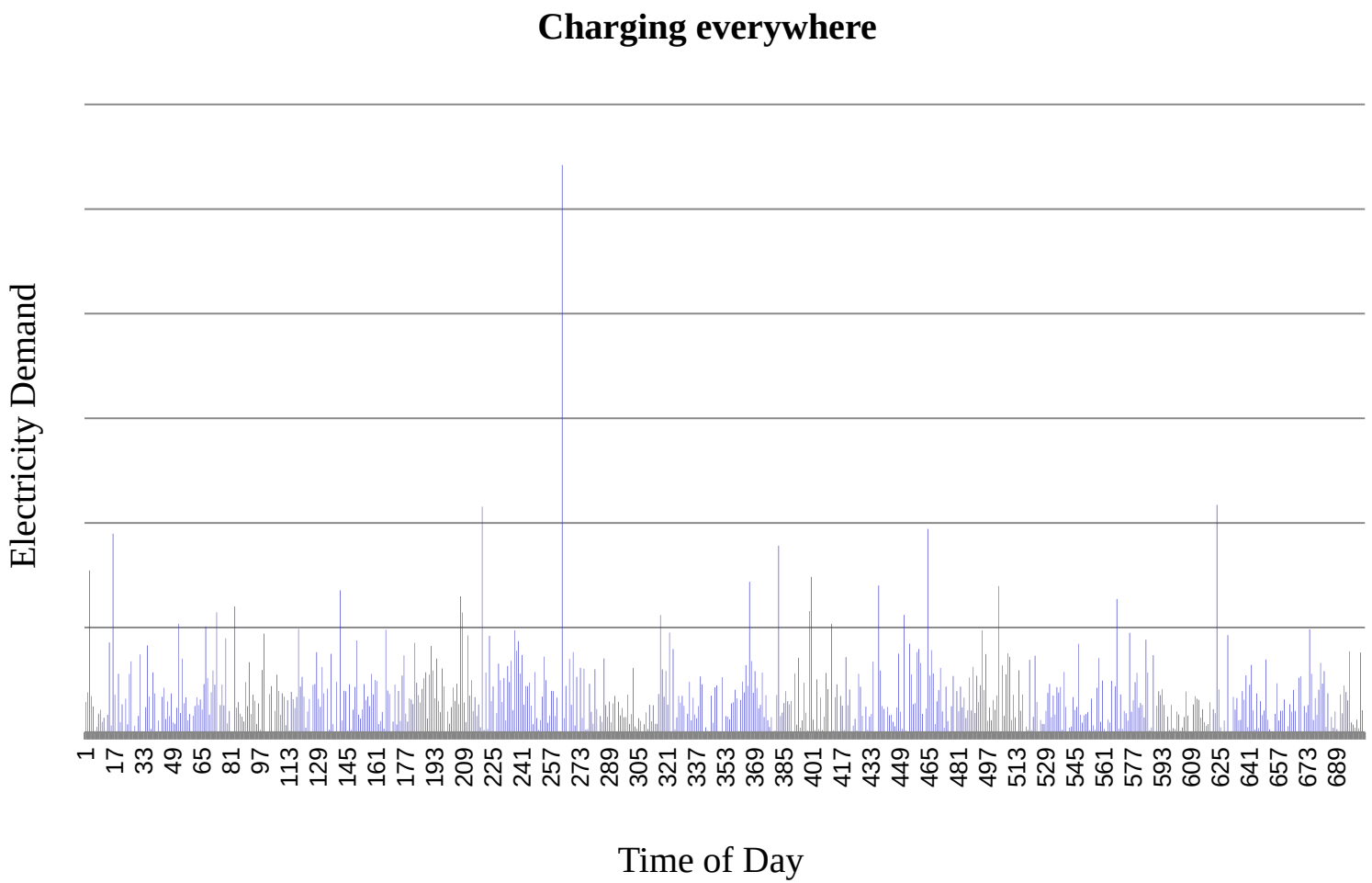
Facilities (work, education, leisure, shops, etc.)

High resolution navigation network (1M links).

First test case



ZH Scenario

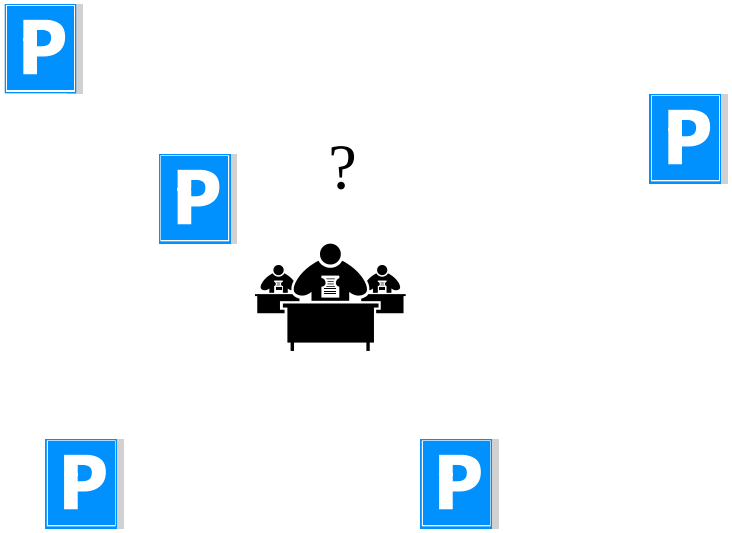

Charging everywhere
Electricity Demand
1
17
33
49
65
81
97
113
129
145
161
177
193
209
225
241
257
273
289
305
321
337
353
369
385
401
417
433
449
465
481
497
513
529
545
561
577
593
609
625
641
657
673
689
Time of Day

Problem definition

For a given activity destination, select from the set of public parkings in the neighbourhood so that the agent‘s utility is maximized?

Parking characteristics

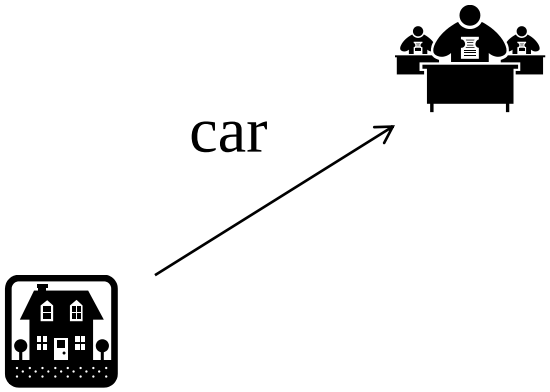
- price
- walking distance
- capacity
- parking access
- parking type
- (Etc.)



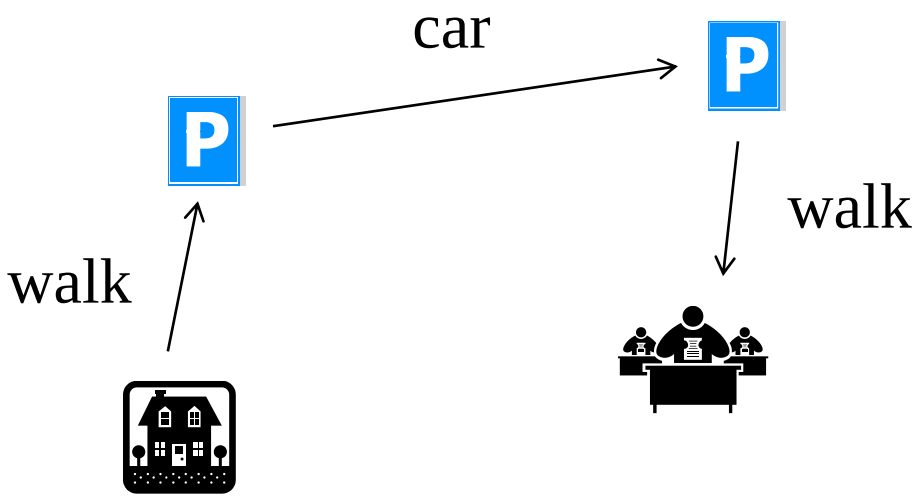
Parking Location Choice (not Parking Search!)

No changes to the MATSim simulation

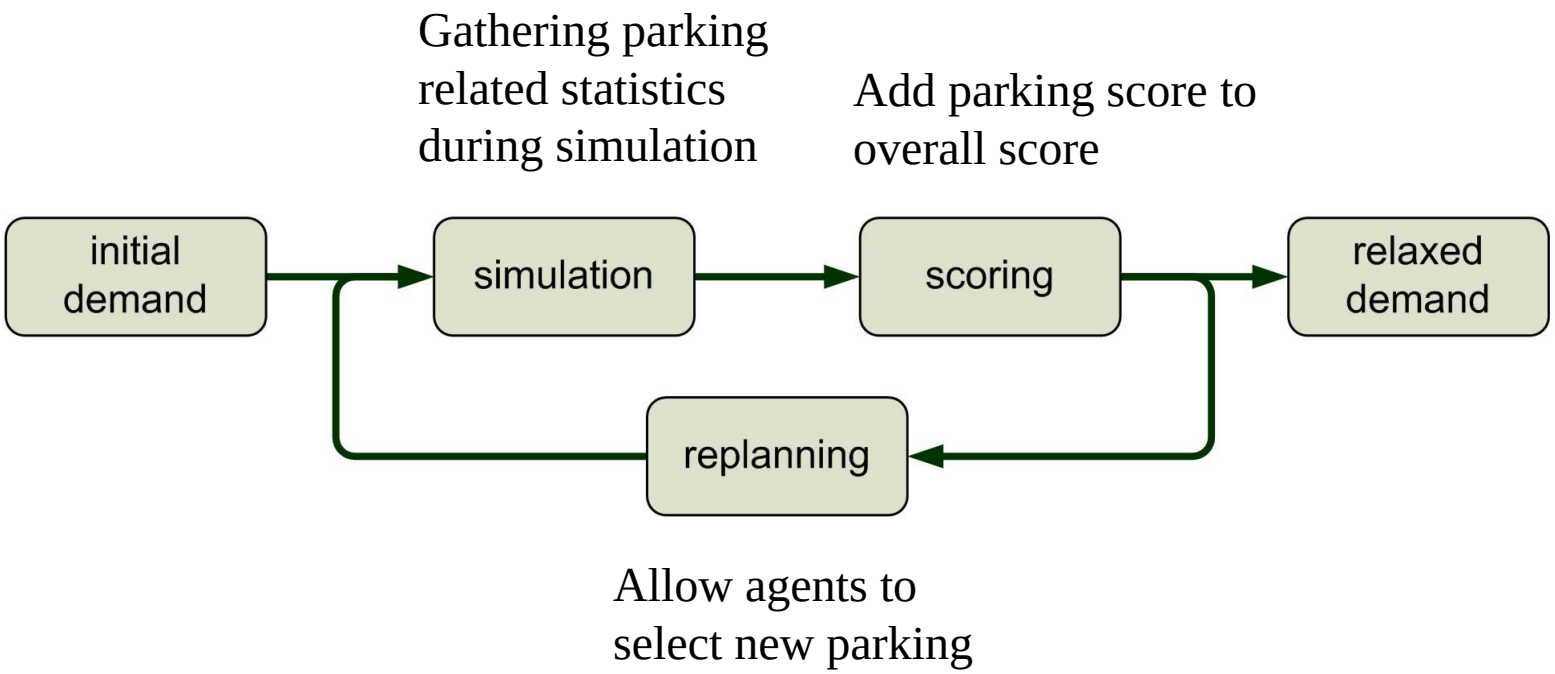
till now



with parking



Parking location choice - implementation overview



Parking scoring function for experiments

- Components of the parking scoring function:
  - ParkingPriceScore
    - Parking duration, parking price, income
  - ParkingAccessScore
    - access time, any other access disutility
  - ParkingWalkingScore
    - distance, target activity duration and type
  - ParkingCapacityViolationScore
    - how full is parking at arrival time (this can be explicit or implicit)

- Weightes chosen:
  - Parking gets a total score between 0 and 5
  - ParkingCapacityViolationScore gets 10 times higher weight than other 3 Scores

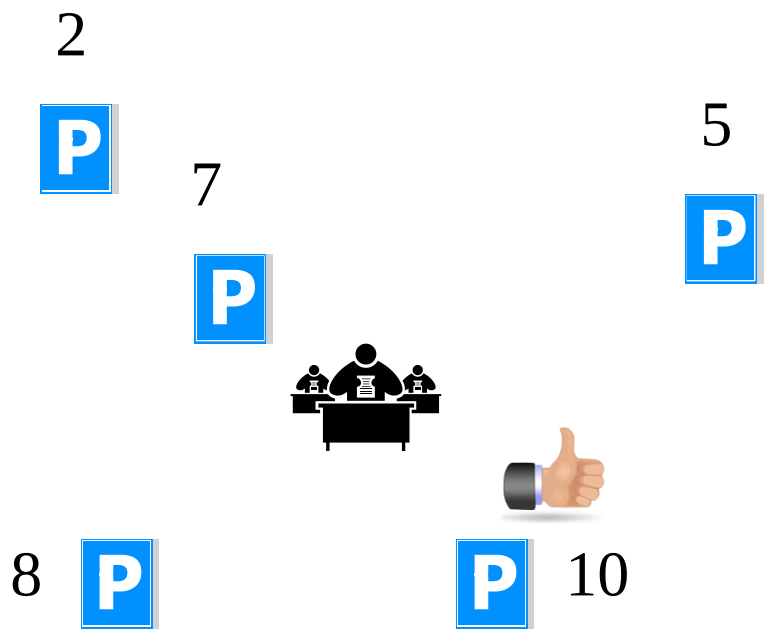
Parking location choice - replanning

Select, which parking to replan from all parkings done during the „previous“ day:

If (setOfParkingsWithCapacityViolation not empty){
    Select randomly one parking from setOfParkingsWithCapacityViolation;
} else {
    Select randomly one parking from from all parkings.
}

Parking location choice – replanning (cont.)

Try to find parking with potentially higher score for the selected target activity (based parking statistics/estimates gathered during traffic simulation) in neighbourhood of target activity:

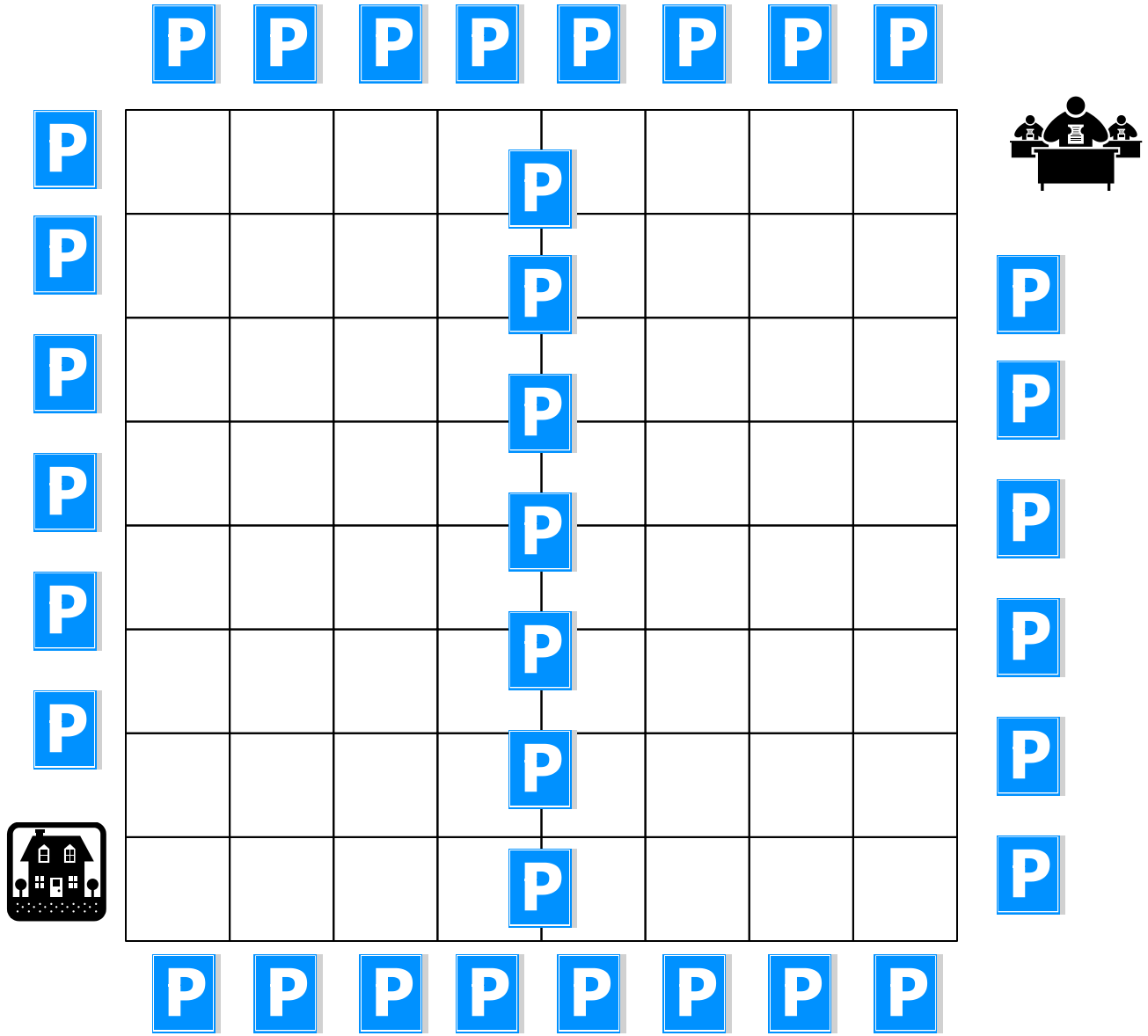


(the parking type choice also happens in this step)

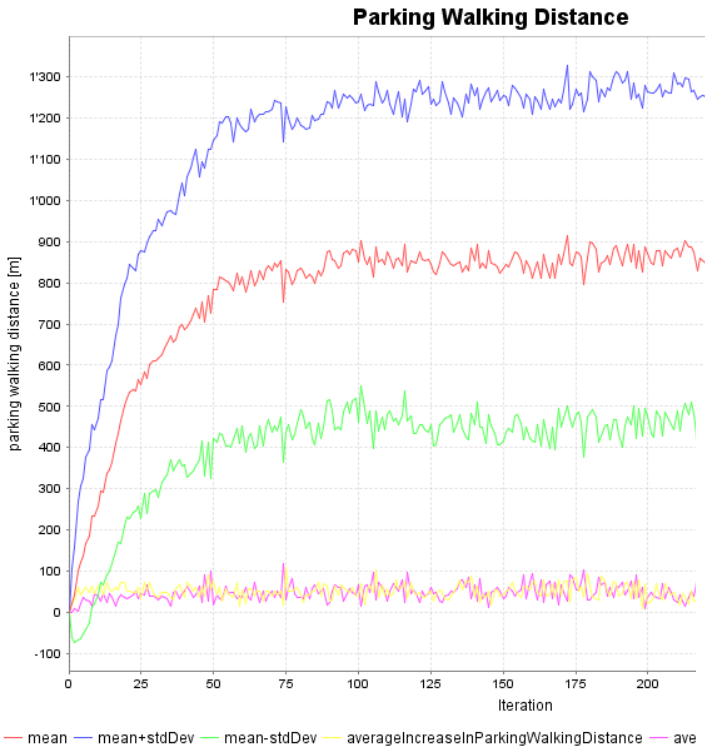
Experiments and sensitivity analysis results

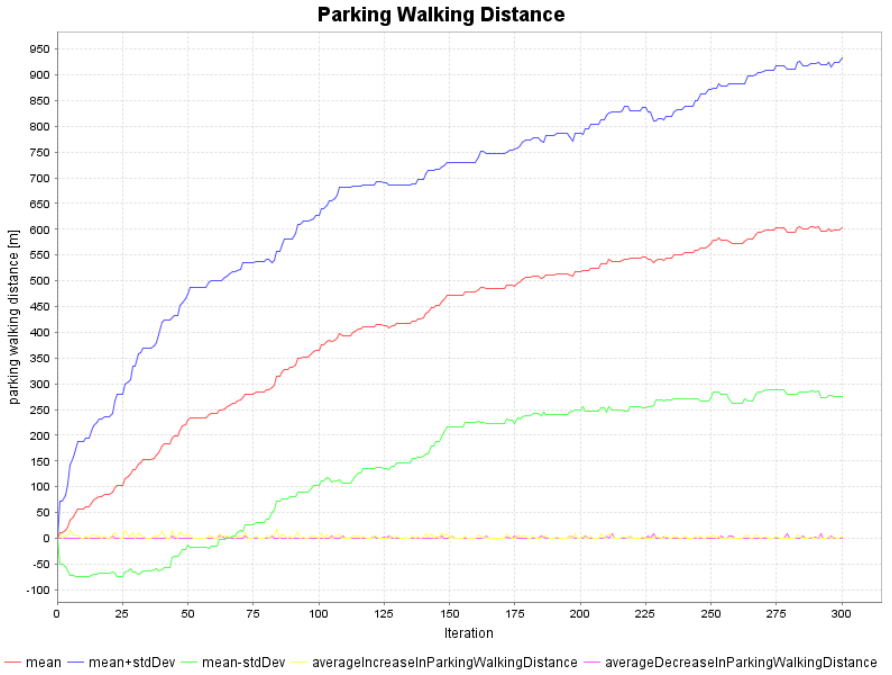
- Using small test scenario
- Run with one million agents on the test network tried out

Scenario layout (chess board)

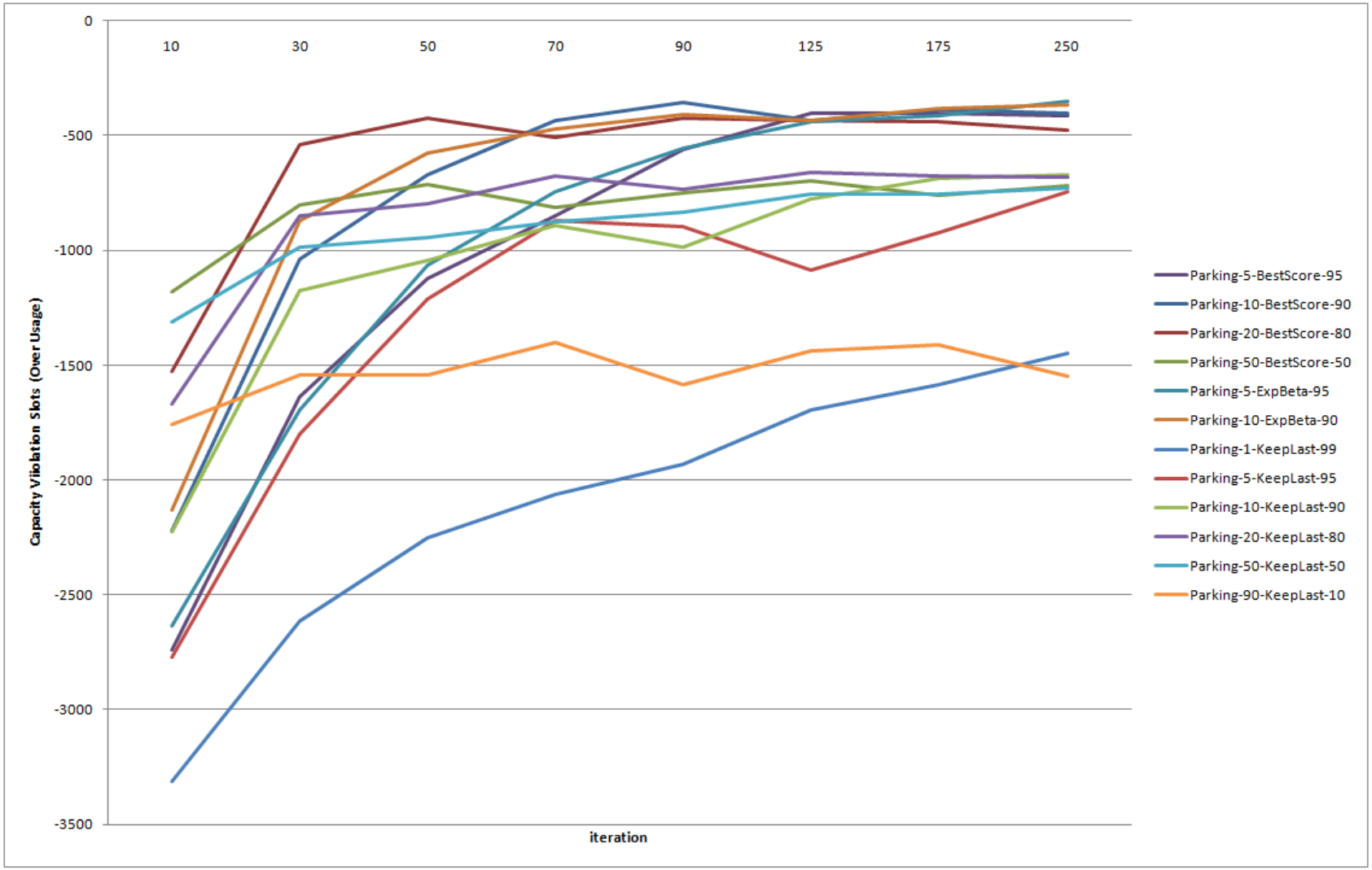


Does system relax? How many iterations?

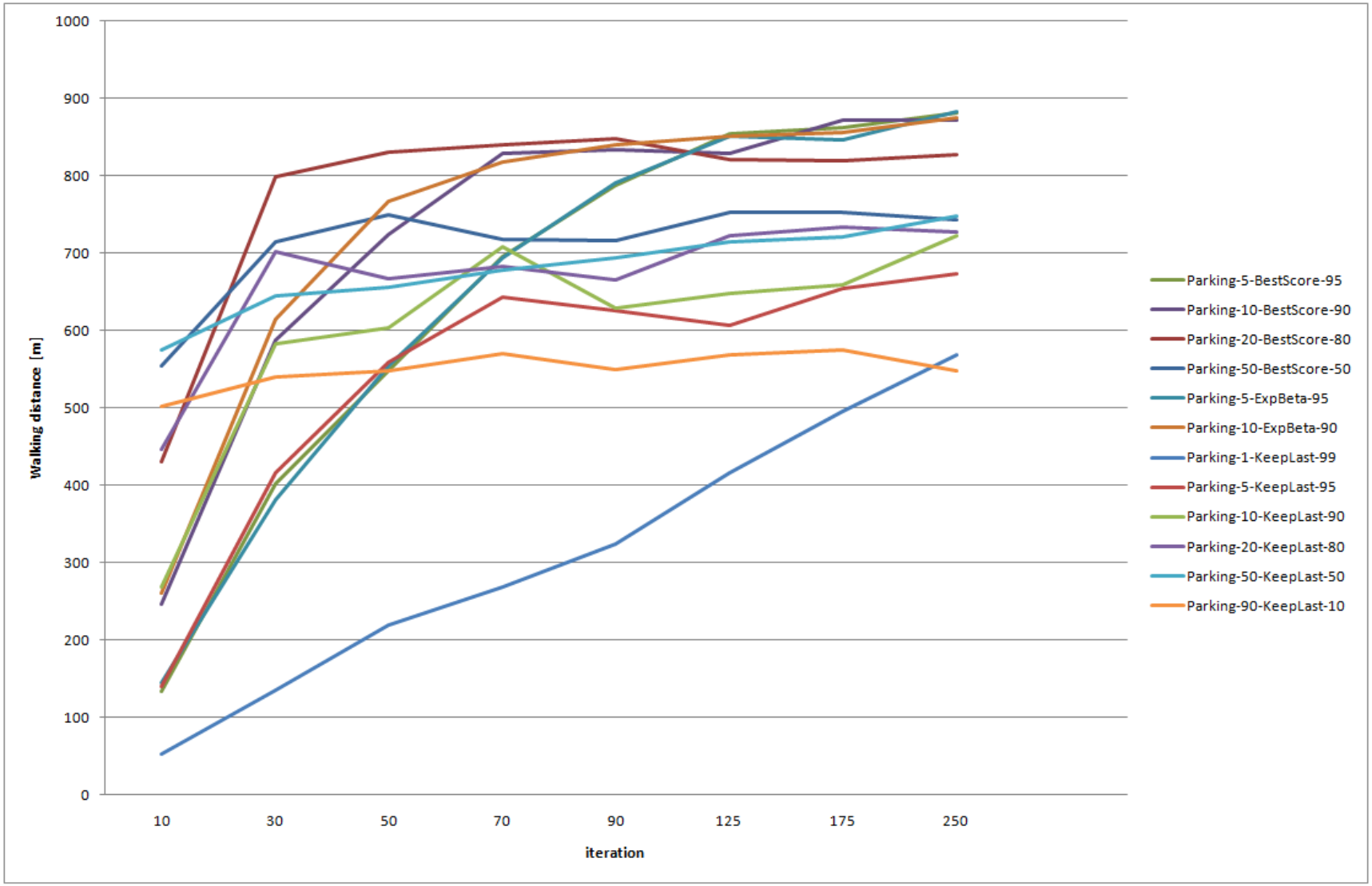




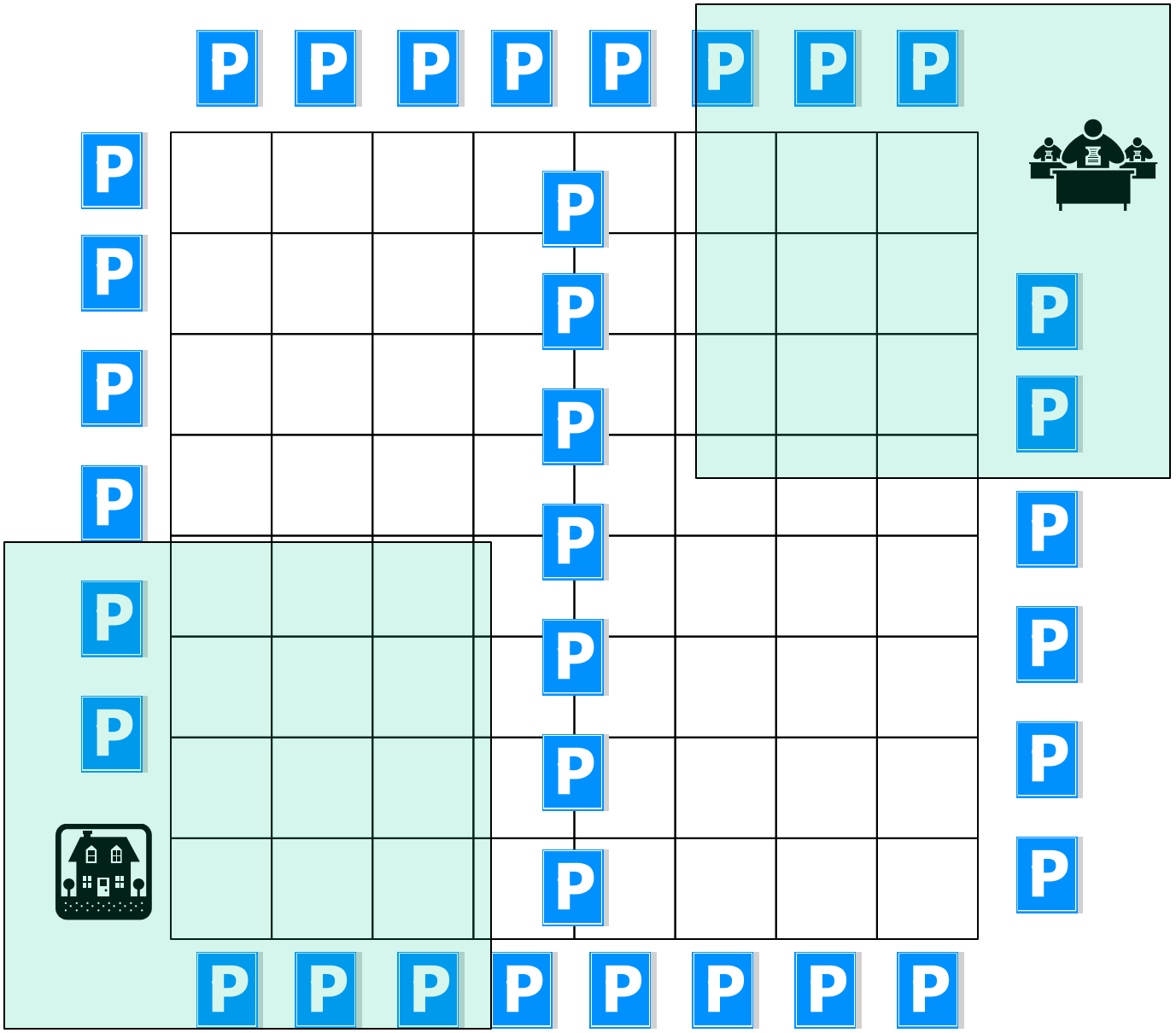
Relaxation measure 1: capacity violation reduction



Relaxation measure 2: walking distance

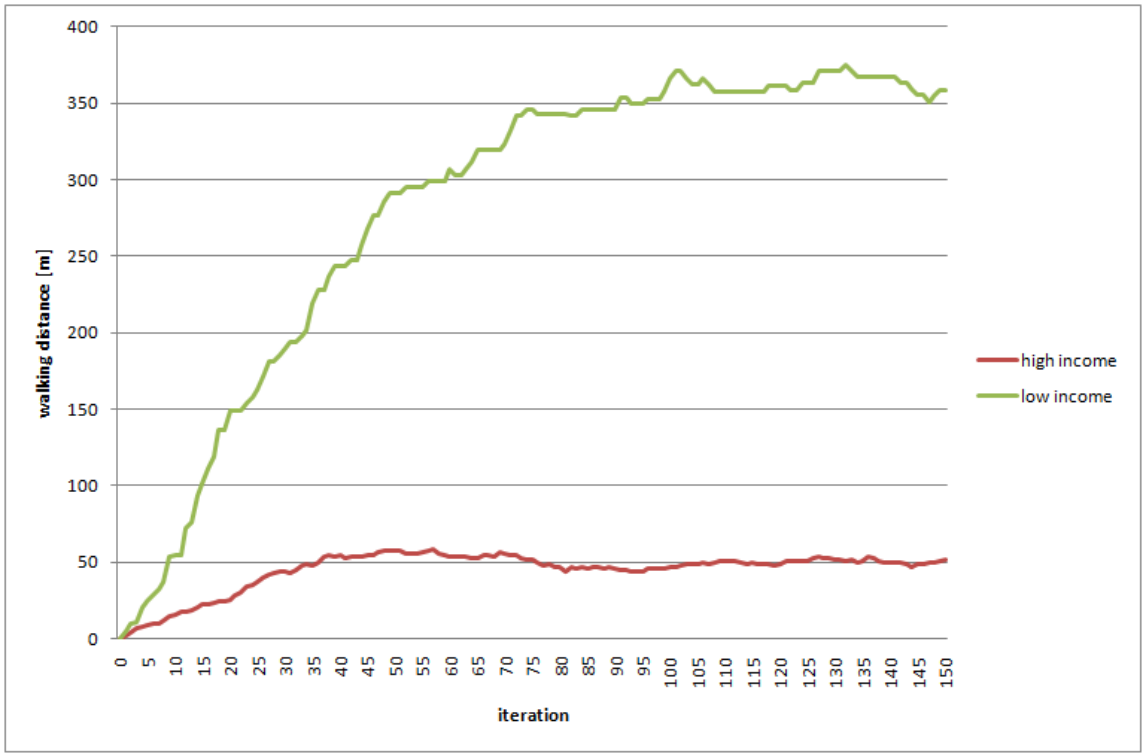


Scenario layout – grouping of parkings

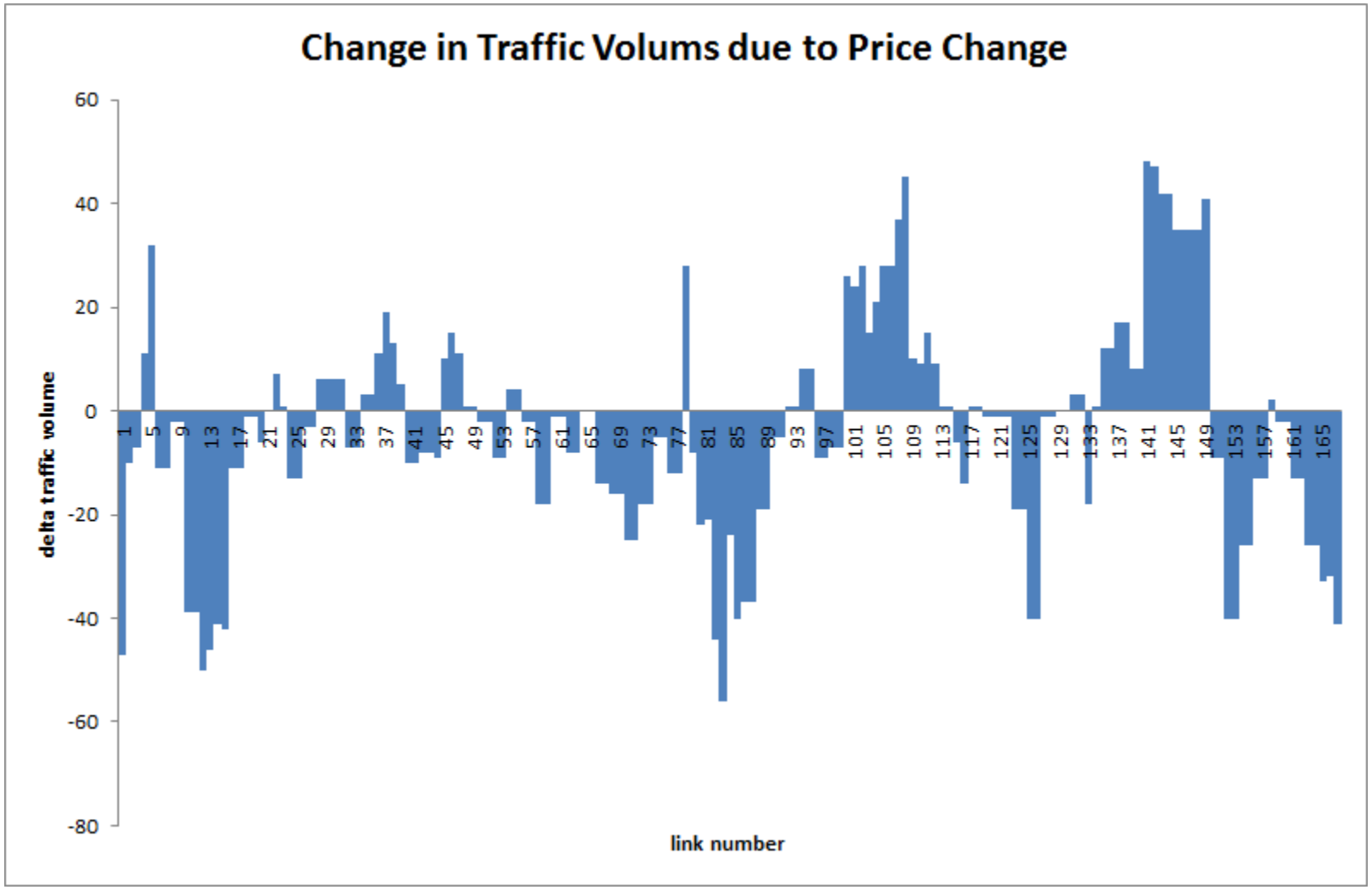


Parking price and income

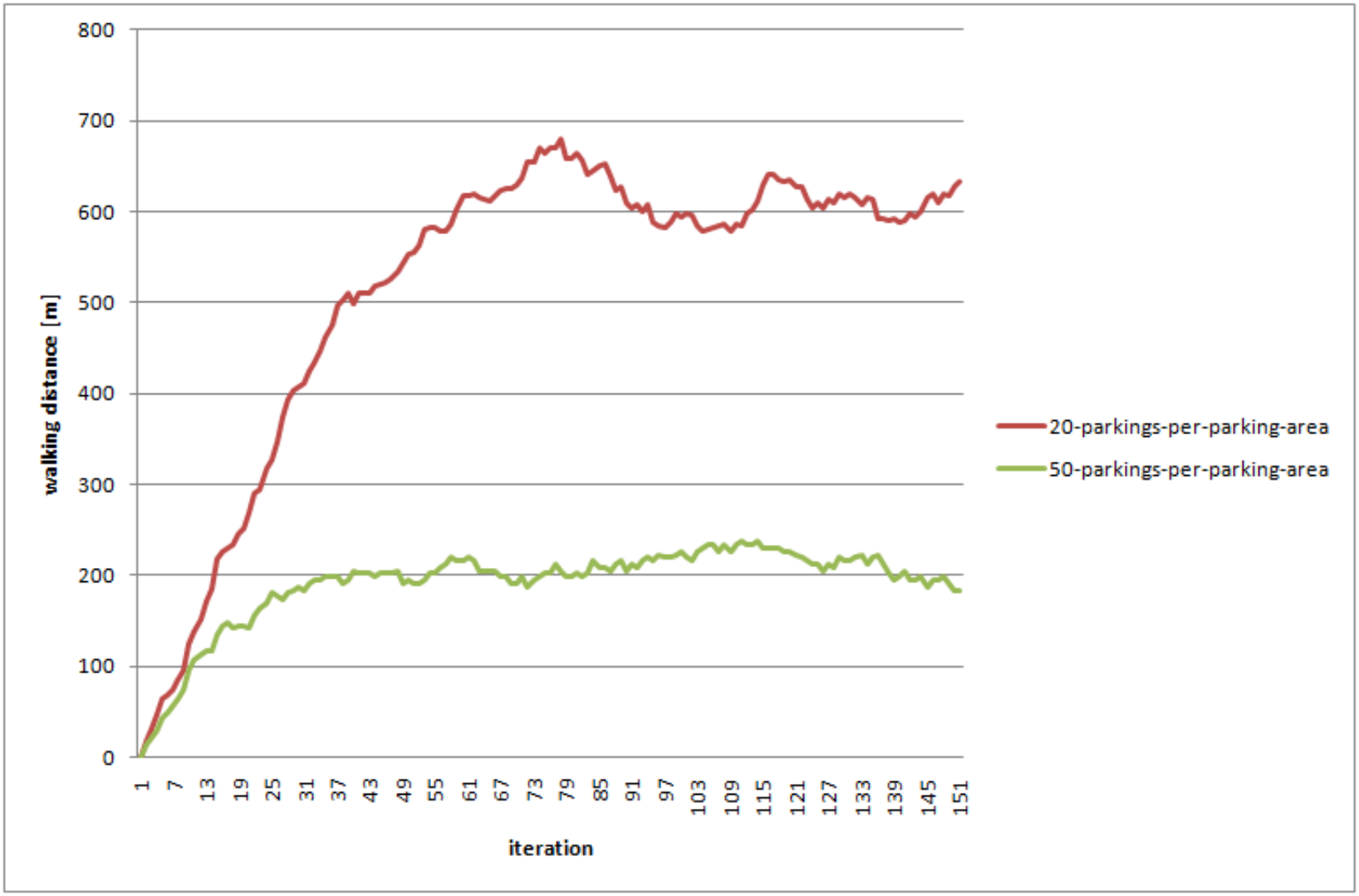
- Two groups: one with very high and one with very low income (50% of people belong to each group)
- Parkings close to home and work are MUCH more expensive than the parkings further away.



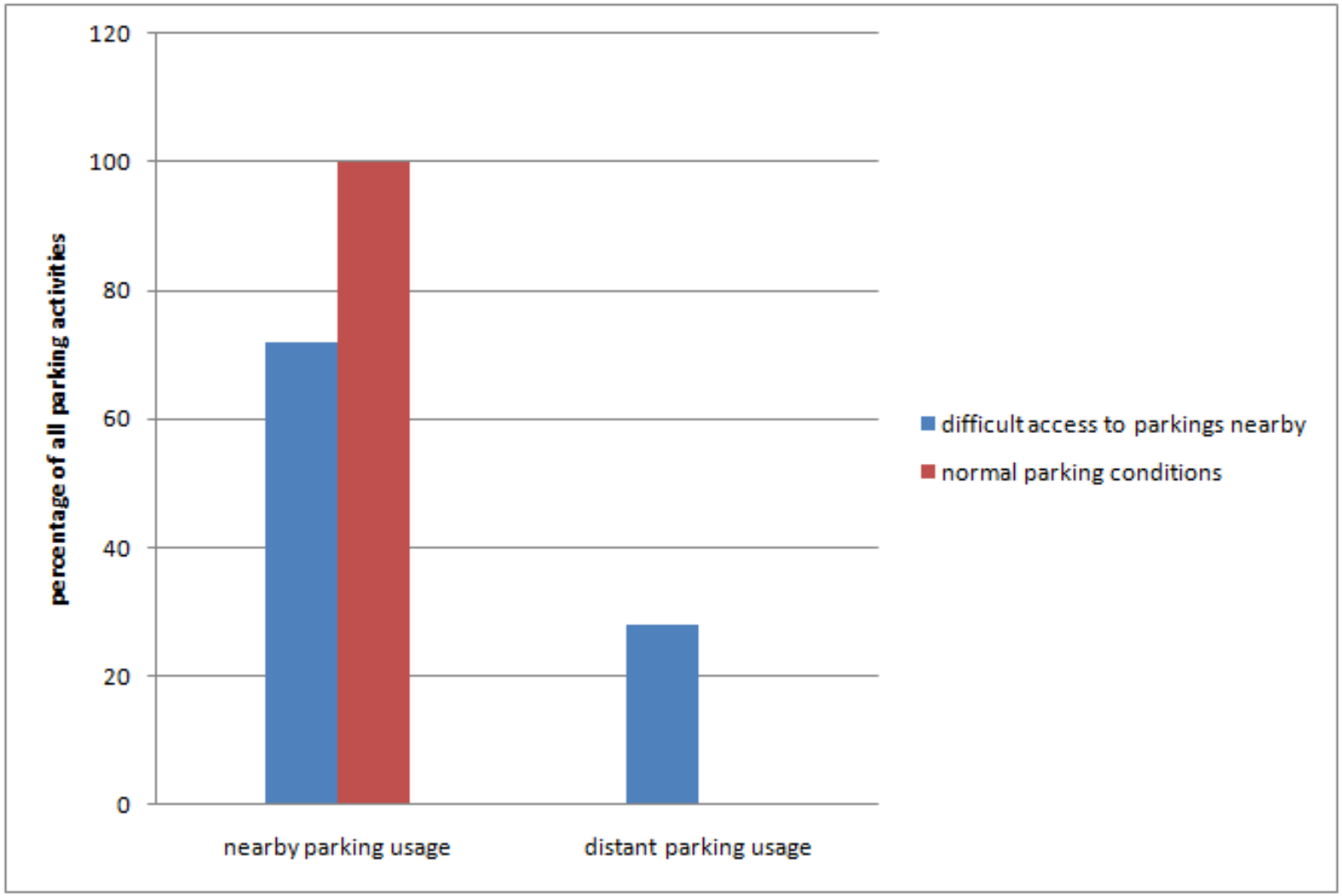
Parking price and income (con't)



Parking supply



Introducing parking access constraints



Don’t look at single agents!

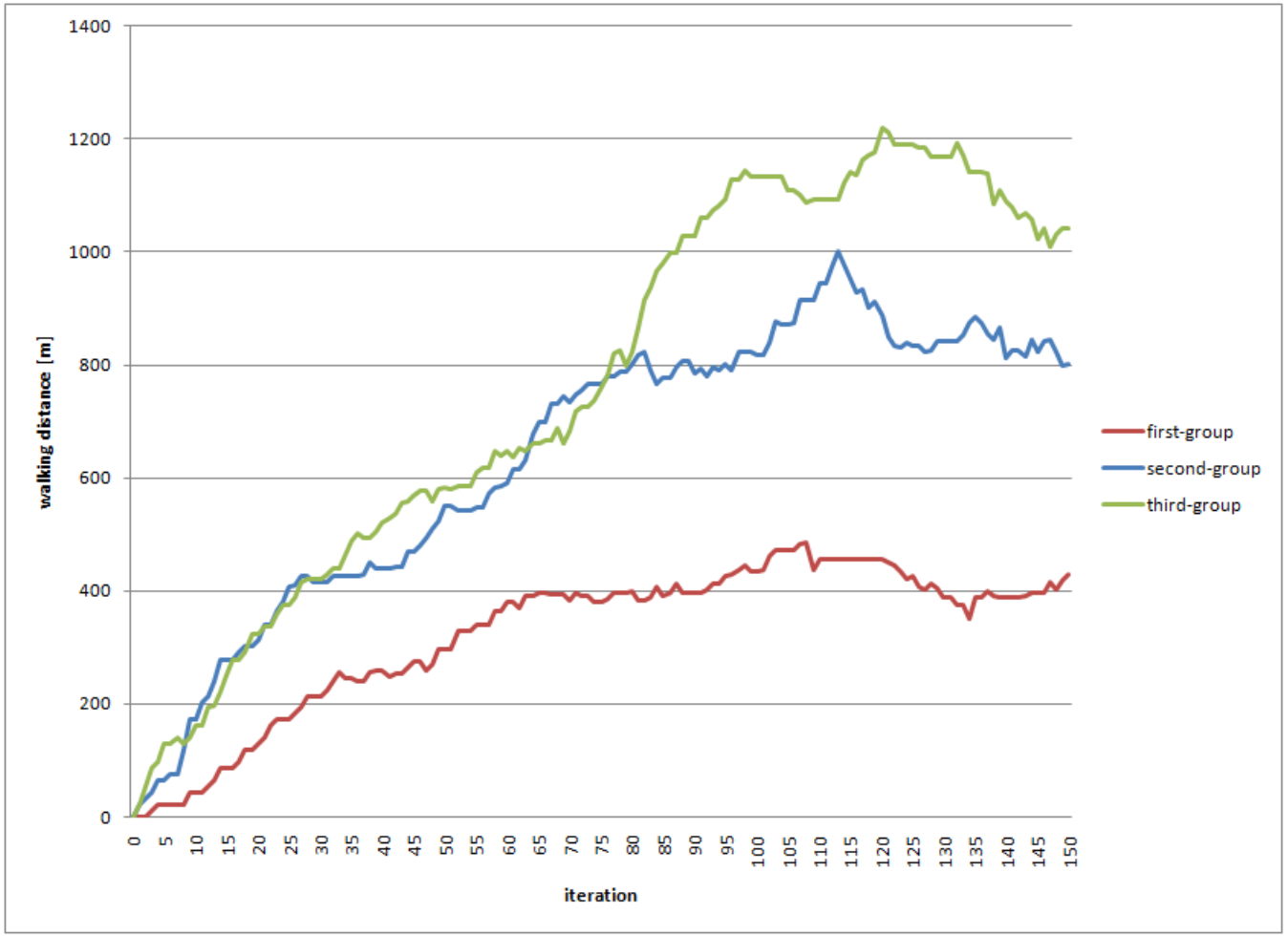
- System is changing in each iteration (trying to optimize)
- Don’t look individual agents but on aggregate values!

- This means, that it may happen that isolated agents may have wrong parking behavior, but average behavior should be right

- Experiment
  - Enumerate agents from 1 to 99 and each agent departs one minute ahead of time than the next agent
  - This means that there is a clear temporal advantage towards the parking for agents departing earlier
  - Even though this advantage can get lost (e.g. agent 32 may get a worse parking than agent 33)
  - Aggregated statistics should be right!

Temporal aggregated advantage

First-group: 1-33, second-group: 34-66, third-group: 67-99



Rethinking the Model

- Requires changes to the plan structure (integration more defficult/combination with other replanning modes needed)
  - A more generic model needed.
- Private parking model missing

Requirements

- Policy measures should be reflected in model
  - Number of parkings
  - Price
  - Reserved parkings (for diabled people/el. vehicles)
  - Illegal parking (change in law enforcement, penalties, etc.)

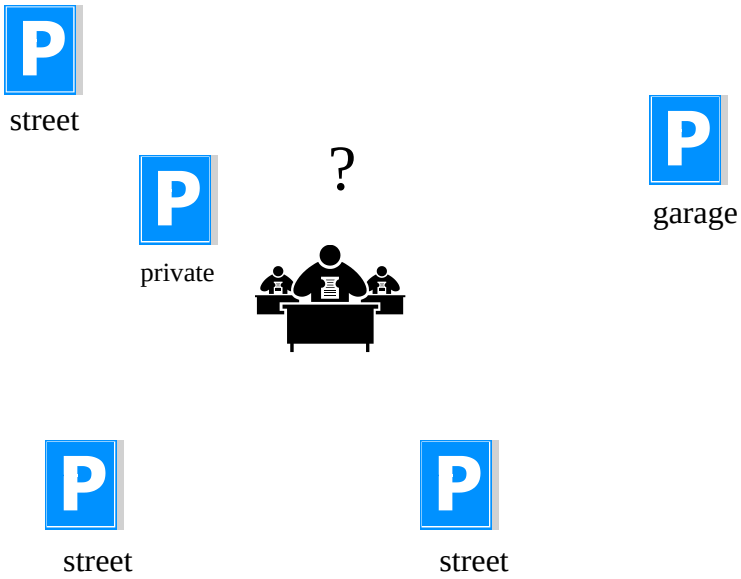
Secondry requirements: Reimplementing/Simplifying Models

- Walking to the parking (not separate legs)
  - Advantage: No special integration with the other replanning modules required (simpler to maintain)
- Access time: E.g. garage parkings vs. street parkings
- Search time: garage parking vs. street parking
- Add private parkings

$\Rightarrow$ Detailed modell can be added over time

The New Model

- Available free parkings
- Distance (walking time)
- Price
- Access time
- Search time



Also have to define a format for the different attributes for the different attributes for the parkings.

Updated Scoring Function

- Consider all parkings, in range *max*SearchDistanceInMeters from the destination.
- Score as follows and rank them:

$$\emptyset_{actPerfEarningRate} = \frac{\sum_i U_{act,i}}{\sum_i dur_{act,i}} \left[\frac{util}{s}\right] , \forall i \in act$$

$$cost_{parking} = \int_{parkArr}^{parkDep} f_{parkingPrice}(t) \, [util]$$

$$\boldsymbol{U_{parking} = -\left(2 \times \left(t_{walkToPark} + t_{parkAccess}\right) + t_{parkSearchTime}\right) \times \emptyset_{actPerfEarningRate} - cost_{parking} \, [util]}$$

Replanning Algorithm

<module name=*"strategy"*>
<param name=*"maxAgentPlanMemorySize" value="5" />*

<param name=*"ModuleProbability_1" value="0.75" />*
<param name=*"Module_1" value="* SelectExpBeta *" />*

<param name="ModuleProbability_2" value="0.05" />
<param name="Module_2" value="ChangeLegMode" />

<param name="ModuleProbability_3" value="0.05" />
<param name="Module_3" value="ReRoute" />

<param name="ModuleProbability_4" value="0.05" />
<param name="Module_4" value=" *TimeAllocationMutator* " />

<param name="ModuleProbability_5" value="0.05" />
<param name="Module_5" value="
*playground.wrashid.parkingSearch.planLevel.replanning.**ParkingPlanStrategy*** " />

…
</module>

Want to try «directed evolution» in case of no parking available (specify, which leg/act has problems and should be replanned).

Parking Module in Config File

```
<module name=parking">
    <param name="scalingFactor" value="0.25" />
    <param name="maxSearchDistanceInMeters" value="1000" />
    <param name="parkingPenaltyWeight" value="0.1" />
    <perhaps more...>
</module>
```

Private Parkings

- Assign private parkings not only to specific facilities but assign them to specific activities (inside facilities), as typically there are several activities possible in the same building like home, work, shop, etc.

Parking Data for ZH

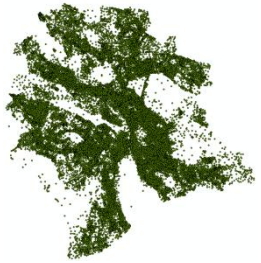
Public Parkings

street parkings (49’409)

garage parkings (16’277)

Private Parkings

Indoor (118’531)

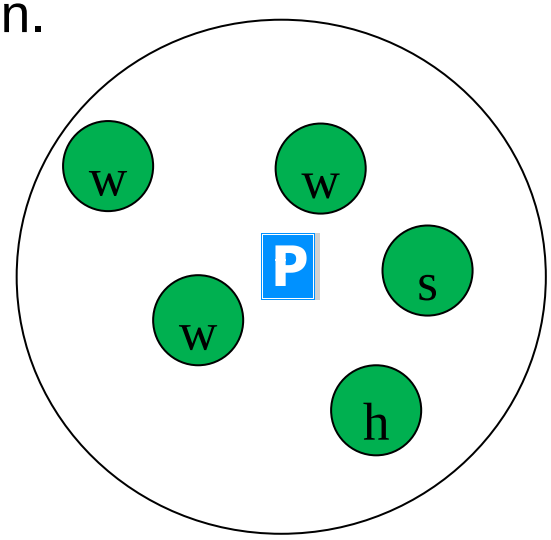


Outdoor (82’781)

(Parking counts from «Statistisches Jahrbuch der Stadt Zürich 2011»)

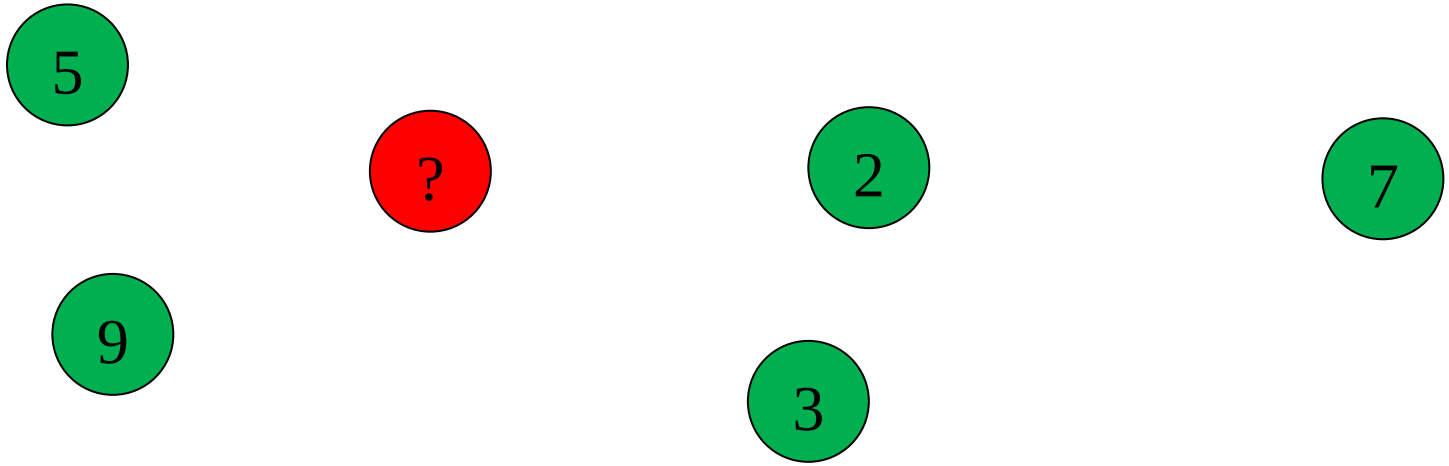
Assigning Private Parkings to Facilities/Act T.

- Heuristic: E.g. If main usage of infrastrucutre to which the parking is attached to is work, find all facilities within distance 50 meters from the parking work activities and assign 75% of the parkings to the workplaces proportionally (dropping quadratically with distance from parking).
- As only the main purpose of usage is given, we assign 25% of the parkings to the other activities within 50m from the parking.
- Of course, if there would be no building in the area, we would double the radius for consideration.

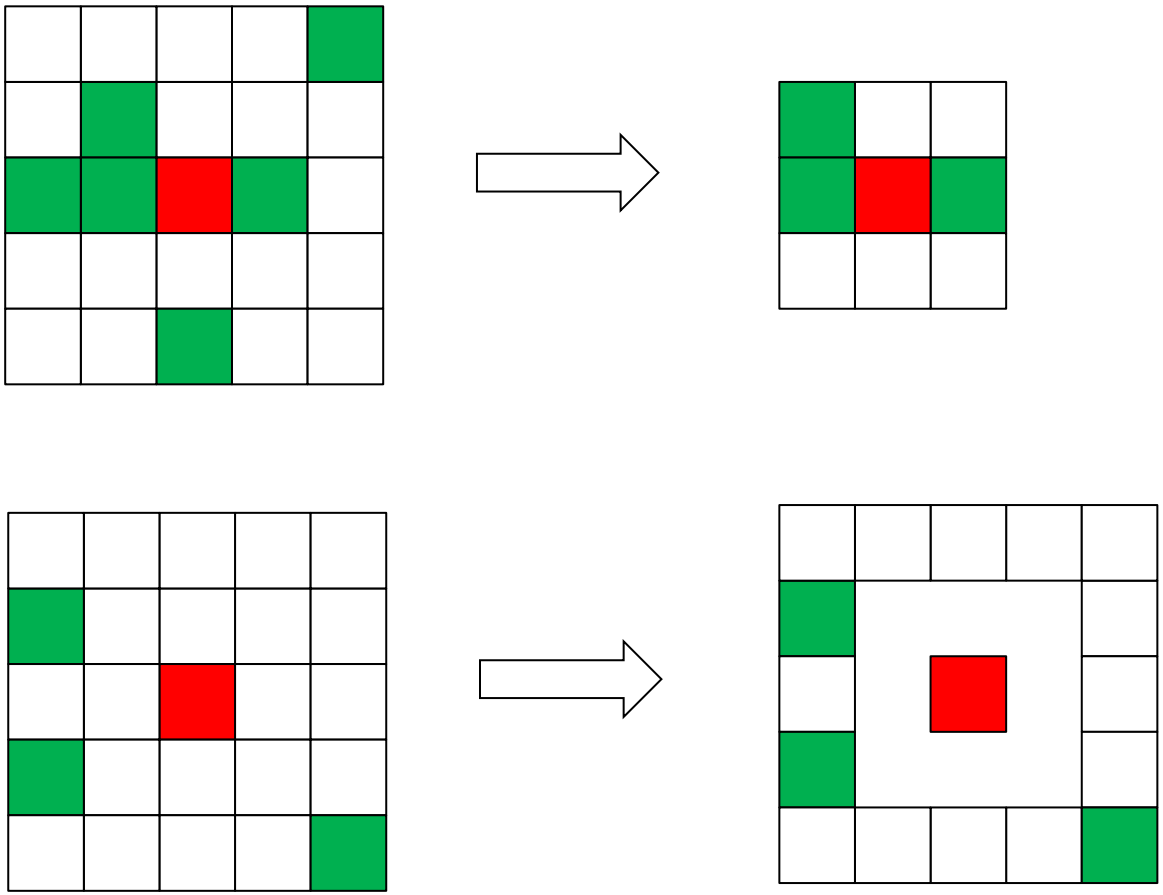


Geografical Data Extrapolation

- Data from surveys
  - Parking Price
  - Income
  - Parking available at work (e.g. %)
  - Etc.

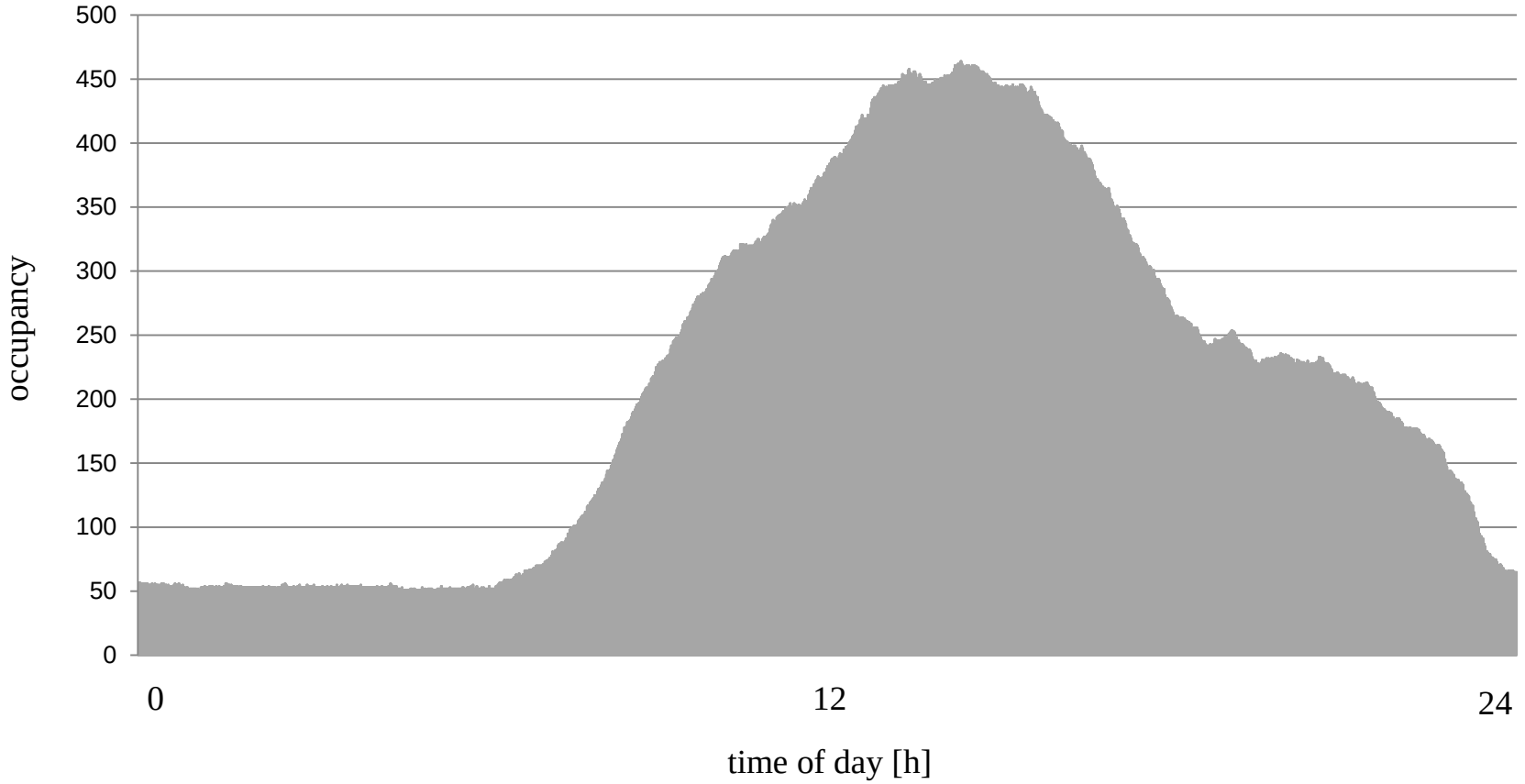


Geografical Data Extrapolation



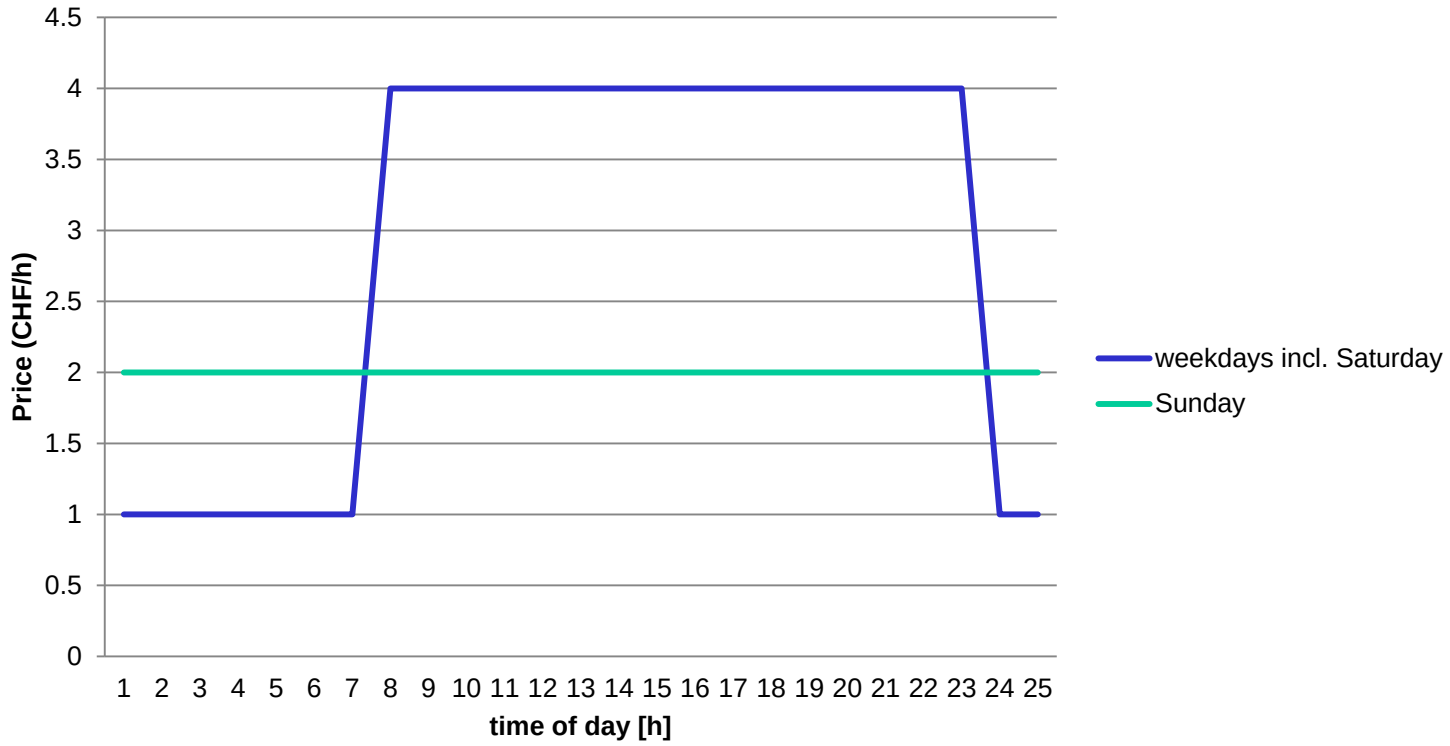
Garage Parkings Occupancy Data

- Detailed occupancy data counts for 68 parkings



Occupancy on Wednesday, 9th March 2011, City Parking / Gessnerallee 14, Zürich). Max. Occupancy: 620. From www.pls-zh.ch

Garage Parkings Occupancy Data (cont.)



(www.cityparkingzuerich.ch)

Conclusions:

- Some progress
- Still work to do

Questions?