Parking Policy-Making
Academic View of Practical Needs

Itzhak Benenson¹
bennya@post.tau.ac.il

Nadav Levy¹ and Karel Martens²

¹ Department of Geography and Human Environment, Tel Aviv University, Israel
² Institute for Management Research, Radboud University Nijmegen, the Netherlands

http://geosimlab.tau.ac.il/
Establishing parking policy...

- Parking demand and supply
- Drivers’ parking behavior
- Parking management and policy assessment

**WE STUDY THE CURRENT STATE**

- Parking spatial pattern

**WE AIM AT FORECASTING**

- Parking dynamics in space and time
Parking demand and supply

Parking spatial pattern
BASIC ESTIMATES OF PARKING DEMAND AND SUPPLY: GIS + Aerial photos + Population Census

Estimation of demand:

Night:
Householders' car ownership rate

Day:
Office area/20 or proportional to Shops’ turnover

Estimation of supply:

Curb:
Length of streets /5 m – prohibited places

Lots:
Lots area /8 sq m * number of floors
TURNOVER and DRIVERS’ TYPES: Field surveys

For a certain day of the week and hour, parameters of the parking system are stable

<table>
<thead>
<tr>
<th></th>
<th>Residents</th>
<th>STD</th>
<th>Visitors</th>
<th>STD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average occupancy (weekdays)</td>
<td>61.8%</td>
<td>0.94%</td>
<td>17.4%</td>
<td>1.77%</td>
</tr>
</tbody>
</table>
DESTINATION-PARKING PLACE DISTANCE: Field surveys + Population Census

Given the parking fees, driver’s satisfaction is defined by

- **Duration of the parking search**
- **Distance between the parking place and destination**

![Graph showing the relationship between the percentage of occupied parking and average cruising time.](chart)

- **Obtained with the PARKAGENT model**

![Bar chart showing the percentage of parked cars at different distances.](bar_chart)
Standard GIS and census data together with the proper survey methodologies guarantee reliable estimates of parking demand, supply, and spatial patterns.

For typical Western city, field surveys demand 20-40 person-weeks and are performed in 2-4 weeks.
Drivers’ parking behavior
DRIVERS’ PREFERENCES DURING PARKING SEARCH: GPS data loggers and interviews with drivers

Car speed during the trip

Car speed versus distance to parking

Drivers’ parking behavior
DRIVERS’ BEHAVIOR ON THE WAY TO DESTINATION:
GPS data logging + GIS + Heuristics

Drivers do not take the shortest path...

Which turn to choose?
DRIVER’S BEHAVIOR AFTER MISSING THE DESTINATION: GPS data logging + GIS + Heuristics
Analysis of drivers’ parking trajectories, as registered by the GPS, provides adequate heuristic algorithms of drivers’ parking behavior.

Parking behavior does not depend on gender and age. The only meaningful feature is driver’s experience of parking in the area, and its effects are currently studied by Geert Tasseron (Nijmegen).
Parking dynamics in space and time
High-resolution data on parking demand and supply enable static estimate of the parking pattern for **constant (usually maximal) demand**

<table>
<thead>
<tr>
<th>ID</th>
<th>Underground Parking</th>
<th>Resident's demand</th>
<th>Workers demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>34</td>
<td>10</td>
<td>20</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID</th>
<th>Road ID</th>
<th>Curb Parking</th>
<th>Restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>4809</td>
<td>20394</td>
<td>10</td>
<td>Residents only</td>
</tr>
</tbody>
</table>
PARKING SPATIAL PATTERNS: PARKFIT algorithm
PARKFIT: fixed distance to destination
PARKFIT: varying distance to destination
PARKFIT outputs

Bat Yam, distance to parking place, 2012

Distance to parking, by buildings

Distance to destination

POLIS, HELSINKI, SEPTEMBER 20, 2012
PARKING SPATIO-TEMPORAL PATTERNS
Multi-Agent Simulation Model
PARKAGENT

Every parking car is an agent
Every parking inspector is an agent
PARKAGENT is spatially explicit
PARKAGENT is easily adjustable to a new city
PARKAGENT generates great variety of parking statistics

- Occupancy rate per street
- No of issued tickets
- Distance to Destination
- Cruising time
A closer look at the PARKAGENT
PARKAGENT REVEALS UNIVERSAL DEPENDENCIES
Driver’s cruising time as a function of occupation rate

Average cruising time (seconds)

Percentage of occupied parking places
PARKAGENT REVEALS UNIVERSAL DEPENDENCIES
Average cruising time, fraction of drivers failed to park, fraction of drivers parking at a certain distance to destination as a function of OCCUPANCY RATE

![Graph showing parking dynamics in space and time](image-url)
Simulation models adequately describe parking dynamics in space and in time. The models exploit data on parking demand, supply, turnover and on the drivers’ parking behavior, and are easily adjusted to a new city.

The models reveal several universal characteristics of the urban parking patterns. Model results fit very well to the survey data.
Parking management and policy assessment
Different development plans were interpreted as the models scenarios:

For each scenario, estimates of occupancy rate, distance to destination, search time

Example of the model outputs

<table>
<thead>
<tr>
<th>Scenario, certainty</th>
<th>Average dist to the office</th>
<th>Average parking search</th>
<th>Parked in Bialik Garage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, low</td>
<td>150</td>
<td>8.8 min</td>
<td>348</td>
</tr>
<tr>
<td>B, low</td>
<td>243</td>
<td>6.6 min</td>
<td>514</td>
</tr>
<tr>
<td>C, high</td>
<td>214</td>
<td>5.5 min</td>
<td>600</td>
</tr>
</tbody>
</table>
PARKAGENT: New garage will not justify itself unless signpost system will be introduced

The signpost system that directs drivers to the lots that have vacant places decreases search time by 30%
PARKAGENT: Estimating the necessary level of inspection for a new censor technology

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Route</th>
<th>Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parking events</td>
<td>1268</td>
<td>1263</td>
</tr>
<tr>
<td>Parking violations</td>
<td>204</td>
<td>190</td>
</tr>
<tr>
<td>Number of empty parking's checked</td>
<td>278</td>
<td>0</td>
</tr>
<tr>
<td>Number of valid driver's checked</td>
<td>2373</td>
<td>0</td>
</tr>
<tr>
<td>Number of drivers that have a ticket</td>
<td>31</td>
<td>0</td>
</tr>
<tr>
<td>Number of tickets issued</td>
<td>313</td>
<td>180</td>
</tr>
<tr>
<td>Total number of parking checked</td>
<td>5281</td>
<td>180</td>
</tr>
<tr>
<td>Ticket / checks ratio</td>
<td>0.046</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Route</th>
<th>Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parking events</td>
<td>1282</td>
<td>1222</td>
</tr>
<tr>
<td>Parking violations</td>
<td>365</td>
<td>362</td>
</tr>
<tr>
<td>Number of empty parking's checked</td>
<td>274</td>
<td>1</td>
</tr>
<tr>
<td>Number of valid driver's checked</td>
<td>1971</td>
<td>0</td>
</tr>
<tr>
<td>Number of drivers that have a ticket</td>
<td>35</td>
<td>0</td>
</tr>
<tr>
<td>Number of tickets issued</td>
<td>232</td>
<td>337</td>
</tr>
<tr>
<td>Total number of parking checked</td>
<td>1225</td>
<td>338</td>
</tr>
<tr>
<td>Ticket / checks ratio</td>
<td>0.09</td>
<td>0.99</td>
</tr>
</tbody>
</table>

15% violations

30% violations
PARKFIT: Planning parking in Bat-Yam (200,000) in 2030

Unhandled Parking Demand 2030

<table>
<thead>
<tr>
<th>Year</th>
<th>Growth of parking supply</th>
<th>Parking deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>3703</td>
<td>~720</td>
<td>360</td>
</tr>
<tr>
<td>3704</td>
<td>~360</td>
<td>0</td>
</tr>
<tr>
<td>3705</td>
<td>~325</td>
<td>0</td>
</tr>
</tbody>
</table>
Antwerp application (Geert Tasseron, Nijmegen)

- Closure of huge free parking lot of 3000 places along the quay
- Use PARKAGENT to study the effects of new underground paid parking lot of 1000 pp
- Study on effects of closure of free parking lot Gedempte Zuiderdok
Our data and models are sufficient for the knowledge-based parking policy making at all levels, from assessment of local parking solutions to establishment parking policy for the neighborhood, region, or entire city.

THANK YOU!