Leaving the Ivory Tower of a System Theory: From Geosimulation of Parking Search to Urban Parking Policy-Making

Itzhak Benenson[1], Nadav Levy[1], Karel Martens[2]

[1]Department of Geography and Human Environment, Tel Aviv University
69978, Ramat Aviv, Tel Aviv
Telephone: +97236409896
Fax: +97236406243
Email: bennya@post.tau.ac.il, ndvlevy@gmail.com

[2]Institute for Management Research, Radboud University Nijmegen,
PO Box 9108, 6500 HK, Nijmegen, The Netherlands
Telephone: +31243612740
Fax: +31243611841
E-mail: k.martens@fm.ru.nl

1. Introduction

A car trip is over only when the driver parks near the destination. Urban traffic models focus on vehicles driving from origins to destinations, but take it for granted that the driver would eventually park. This is not always easy. Parking is a critical component of a trip and the lack of parking, or non-balanced pricing can be the reason of continuous cruising for parking, traffic jams, and failure of the entire urban transportation policy.

The paper considers parking as a major component of urban traffic and proposes the approach for parking policy making in the city. The approach is based on a series of spatially explicit high-resolution agent-based and analytical models (Benenson et al. 2008; Levy et al, 2012) that all aim at simulation and prediction of the parking phenomena in the city based on the drivers parking behavior and spatio-temporal patterns of parking supply and demand.

Three models of parking represent parking phenomena at different levels of spatio-temporal aggregation: PARKANALYST presents an aggregate analytical view that focuses on the temporal dynamics of cruising for parking. PARKFIT presents spatially explicit and high resolution but static view of the parking phenomenon; it aims at assessing the balance between parking demand and supply. New version of PARKAGENT, an agent-based model of parking dynamics in the city is a full featured simulation of all aspect of the urban parking that revealed deep systemic characteristic of the emerging urban parking patterns (Levy et al, 2012).

The models are being applied for studying different aspects of the urban parking phenomena in several cities in the world. These applications bring essential understanding of the problems of applied geosimulation as well as the examples of solutions of these problems.

2. Models of parking in the city

2.1 PARKANALYST

PARKANALYST is an analytical mean-field model of parking, in which every driver is confronted with averaged parking conditions. The model represents the situation in which drivers search for parking along a one-way and sufficiently long ring-like street divided into units which length is equal to the length of a parking place. The cars arrive to the area at an average rate a(t). A destination is chosen randomly and uniformly from the total set of parking places. The driver drives along the street towards the destination with a constant speed, aiming to park at the destination or as close as possible to it. Parked cars leave a parking place randomly and uniformly over the parking area at an average rate d(t). PARKANALYSTS provides distribution of the cars according to the duration of parking search; it is investigated in depth in (Levy et al, 2012).

2.2 PARKFIX

PARKFIX is a spatially explicit static model that aims at assessing parking spatial patterns given the patterns of parking demand and supply. The main PARKFIX assumption is that the driver arriving to the area will successfully find the best possible parking place available at the moment. It this way, PARKFIX supplies the optimistic estimate of the consequences of parking policy in the city. PARKFIX is an ArcGIS application. Typically PARKFIX is applied for studying parking phenomena during the periods of low parking activities, e.g. at night (Figure 1).

2.3 PARKAGENT

PARKAGENT, a spatially explicit agent-based simulation model of parking dynamics in the city is built on deep understanding of drivers' and parking inspectors' behavior and enables full investigation and comparison of the parking alternatives and the ways of parking control, including drivers' cruising time, parking-related congestion and air pollution, parking inspectors' routes ways of work (Levy et al, 2012). PARKAGENT is s an ArcGIS application and is based on all available urban GIS and population data. As a GIS application, PARKAGENT enables easy substitution of the dataset of one city by the dataset of the other city, including the ability to investigate the abstract city settings that is necessary for studying parking dynamics as a complex system phenomenon (Figure 2).

Bat Yam city, business as usual scenario, 2030
The number of building's residents who will park, at night, at 10+ minute walk from their residence

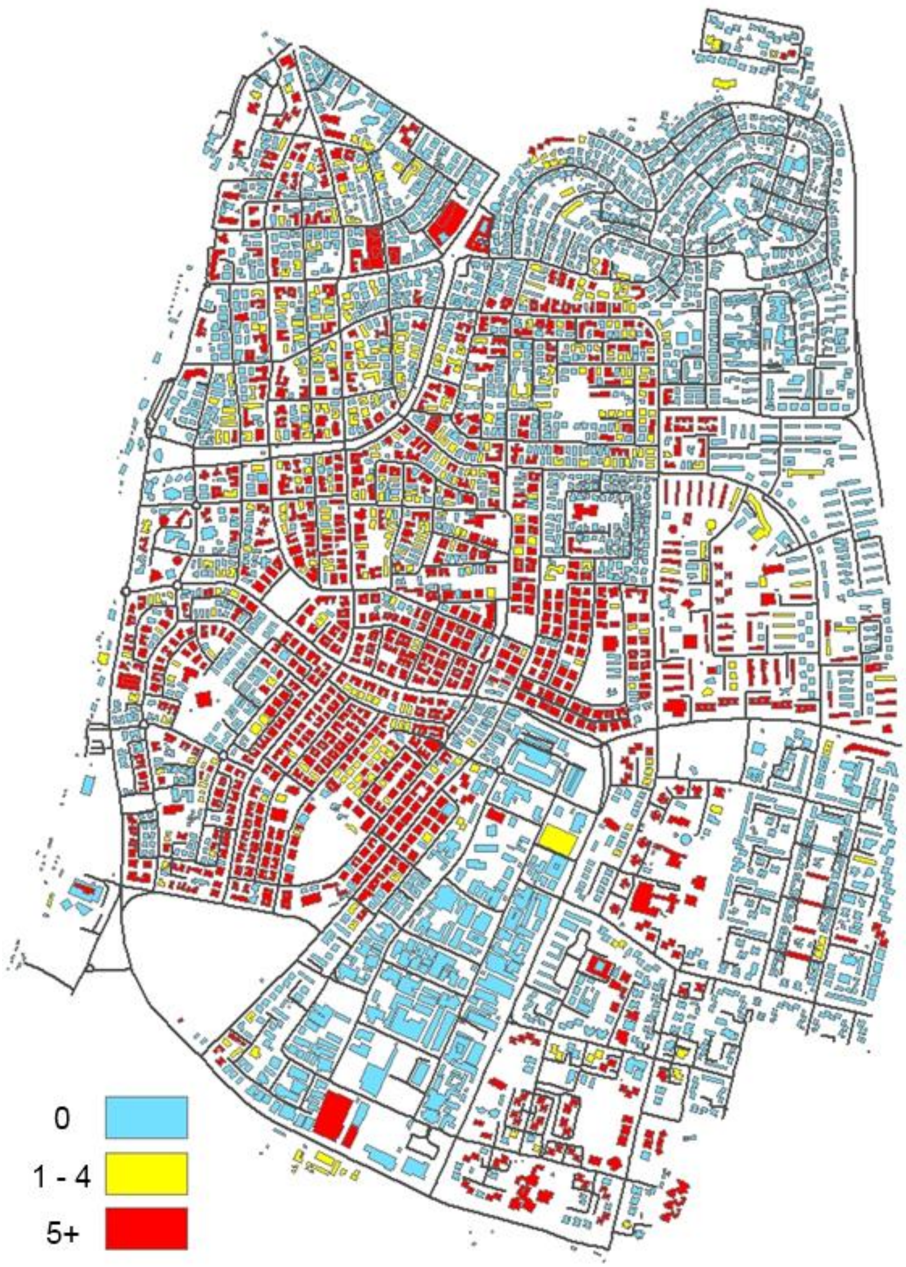

Figure 1. Typical PARKFIT output – the map of the night parking in the city of Bat Yam (260,000 pop) estimated according to the city's 2030-development plan scenario. The plan database is a source of the GIS layers of buildings and car ownership in the buildings, and parking facilities (including parking lots and on-street parking).

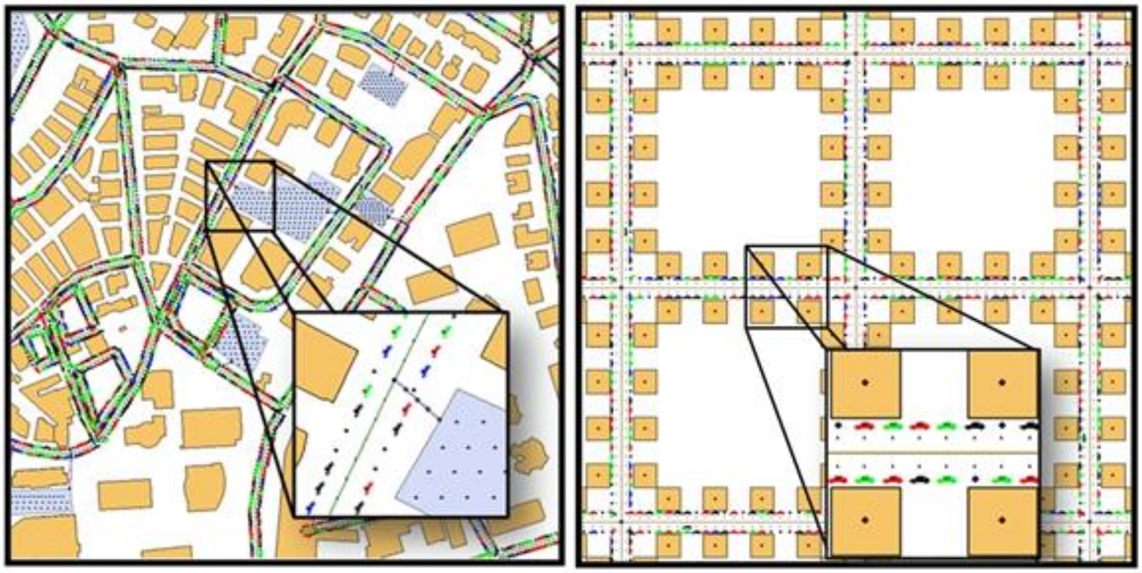

Figure 2. A PARKAGENT view of the area in the center of Tel Aviv (a) and of an abstract rectangular city (b). The small points on the centerline in case of the one-way road, see zoom in (a) or on parallel lines of small points on both sides of the centerline in case of the two-way road, see zoom in (b), denote the road cells; two outer rows of larger points represent parking places.

PARKAGENT enables straightforward evaluation (Figure 3), and enables estimating of the critical characteristics of parking policy consequences in the city, as a fraction of drivers searching for parking for too long, distribution of the distances between the parking place and destination, effectiveness of the parking inspection, etc., etc.

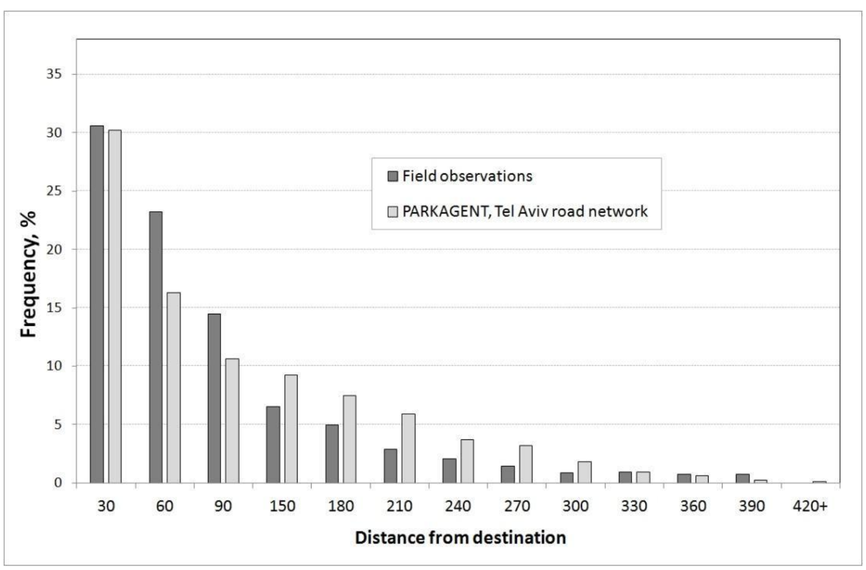

Figure 2: Histogram of the distance to destination, field experiment and PARKAGENT output.

3. From the Ivory Tower of theoretical modeling to the real-world applications

Tight coupling between GIS data and spatially explicit high-resolution predictive simulation makes PARKFIX and PARKAGENT inherently attractive for policy-making applications. The existing parking management/policy-making applications of the models are of several kinds (in order or growing spatial dimensions of the project):

- Estimating of the effectiveness of various practices of parking management (sensors, cameras, human control), optimizing parking violation control;
- Assessment of the parking garage construction projects, including a huge parking garage for 600-1200 places within the office area of 20,000 workers population, in the city of Ramat Gan, Israel;
- Investigation of parking policy alternatives in the city of Bat Yam, Israel (260,000 pop), within the framework of the 2030-development plan;
- Investigation of parking policy alternatives in Antwerp, Belgium in response to the land-use changes in the centre of the city.

The accumulated experience of applications clearly demonstrates that Geosimulation models *per se*, no matter how realistic, are insufficient for urban management and policy-making. Applicative Geosimulation demands:

- Scalability of the models; ability to coupled the models, easy and tightly, with the municipal GIS;
- Clear methodology of the data collections, especially in regards to the agents behavior (i.e. drivers' parking behavior);
- Clear methodology of model evaluation; the ability to re-evaluate the model in every new case study

The importance of these and other aspects of applied Geosimulation will be illustrated in the conference paper.

4. References

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Levy, N., Martens, K., and Benenson, I., 2012, Exploring Cruising for On-Street Parking Using Agent Based and Analytical Models, Transportmetrica, DOI:10.1080/18128602.2012.664575