Effective usage of short-term parking zones by offering real-time information on the utilisation of parking lots

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Introduction

- **Short-term parking zones** introduced in many European cities
- **Still parking search traffic** is a reason for high traffic volume
- Existing real time systems showing on-street occupancy of parking spaces are expensive and controversial discussed
- **Forecast** of the occupancy rates is preferred to reduce parking search traffic at the destination
Objectives

Development of a real-time information service for the utilisation of short-term parking zones

Usage of three existing real-time data sources:
- counts and location of electronically purchased parking tickets
- counts of short term parkers in car parks
- counts of flowing car traffic

No indication of occupancy of single parking lots
Data flow in the real-time information system

Real-time data input
- Mobile phone parkers
- Garage occupancy
- Flowing car traffic

Real-time utilisation model

Validation and iterative improvement

Output
- Visualisation tool
- Data-interface for integration in other real-time services

Ground truth: parking space survey
- Day curves
- Short term variability
Real time data sources

- Cooperation with mobile network operator to get information on the cell-IDs, from which electronic parking tickets are booked
- Due to data protection concerns data is not available in real-time, but for the model calibration
- Data from 3 parking garage operators available
- Traffic flow data available for the whole city
Parking space survey

- Aim of the survey: ground truth for calibrating and validating the occupancy model
- Two test areas with 3,000 on-street parking spaces and 2,400 parking spaces in garages
- Three observation periods between February and April 2012 each including 3 days from 8.00 am to 10.00 pm.
Parking space survey
Parking space survey

1. district

6. district

- electronic ticket
- no permission
- fill-in ticket
- permanent permission

occupancy rate

time

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Correlation between occupancy rate and real time data

- No systematic relationship between car park inflow and parking space occupancy
- No significant correlation between traffic flow data and utilisation of on-street parking spaces
- These two real-time data sources were not integrated in the model
Correlation between occupancy rate and real time data

Correlation between mobile phone parking data and occupancy rates

<table>
<thead>
<tr>
<th>Kind of permission</th>
<th>Area 1</th>
<th></th>
<th>Area 2</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>r</td>
<td>p</td>
<td>r</td>
</tr>
<tr>
<td>fill-in tickets</td>
<td></td>
<td>0.515</td>
<td>0.000</td>
<td>0.503</td>
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<tr>
<td>permanent permissions</td>
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<td>0.241</td>
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<td>total occupancy rate</td>
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<td>0.659</td>
<td>0.000</td>
<td>0.115</td>
</tr>
</tbody>
</table>

Correlation coefficients (r) and significance (p)
Correlation between occupancy rate and real time data

- A linear regression model given the number of electronic tickets explains $r^2 = 43.5\%$ of the occupancy rate variance in area 1 and only $r^2 = 1.3\%$ of the variance in area 2.
Real-time model

- An average day curve model was defined to measure the improvement in prediction accuracy gained from the real-time information.

- Usage of real-time mobile phone parking data in the model can:
  
  ⇒ slightly increase the fraction of explained variance in the current time interval

  ⇒ not reduce the prediction error for future time intervals

  ⇒ increase the accuracy of the model in exceptional situations
Real-time model
Conclusion and outlook

- Mobile phone parking data can help to indicate and predict the occupancy rate in short term parking zones.
- The day curve model predicts the occupancy very well and can hardly be outperformed by a real-time model.
- Unusual deviations from the day curve due to exceptional events can only be predicted by the real-time model.
- To further develop the model data protection concerns have to be tackled.
Thank you for your attention!

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