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Relocation Strategies for Free-Floating Car Sharing Operators

Masterstudium:
Business Informatics

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Context

Free-floating car sharing offers a convenient alternative to public transportation in urban regions. However, due to the flexibility of this approach, operators must be able to regularly respond to imbalances in the car sharing system in terms of car location and availability. In order for free-floating systems to operate efficiently, vehicles need to be allocated geographically to meet user demand. Naturally, such systems get imbalanced over time, and the need for relocating vehicles emerges.

Problem

Research question:
"How should vehicles in free-floating car sharing systems be geographically relocated to best fulfill customers' needs depending on time of day, weather conditions, and points of interest in a city."

Hypotheses:

1. During shop opening hours on rainy days, people tend to pick up car sharing vehicles around indoor shopping facilities.
2. During the daytime, customers tend to drop off car sharing vehicles near amenities for daily business.
3. On rainy evenings, customers tend to drop off car sharing vehicles around indoor leisure facilities.
4. On hot days, car sharing around subway stations increases compared to days with moderate temperature.

Method

The method, that is proposed in the thesis is a generic approach to knowledge discovery based on trip data from free-floating car sharing systems. The hypotheses outlined above represent examples of potential scenarios on which the method can be applied. There are many possible implementations of this approach, and it could lead to useful findings regardless of the underlying dataset. One goal of the thesis was to present a method that car sharing operators and other stakeholders can implement on individual datasets.

The following list sums the steps of the proposed method up and shows the actions necessary when a given assumption should be evaluated:

1. Collect empirical trip data
2. Normalize trip data (exclude duplicates and maintenance trips)
3. Define relevant points of interest
4. Define relevant trip location sub-dataset
5. Set up cluster analysis on trip location sub-dataset
6. Experiment with input parameters of DBSCAN until a meaningful number of clusters is found
7. Visualize point of interest and cluster data in a GIS tool
8. Confirm or reject hypothesis based on the distance between clusters and points of interest

Evaluation

Implementation of proposed method with Open Source Software based on weather data and empirical trip data from Viennese car sharing operators:

- Data collection and trip deduction: Java prototype
- Data normalization and analysis: PostgreSQL/PostGIS

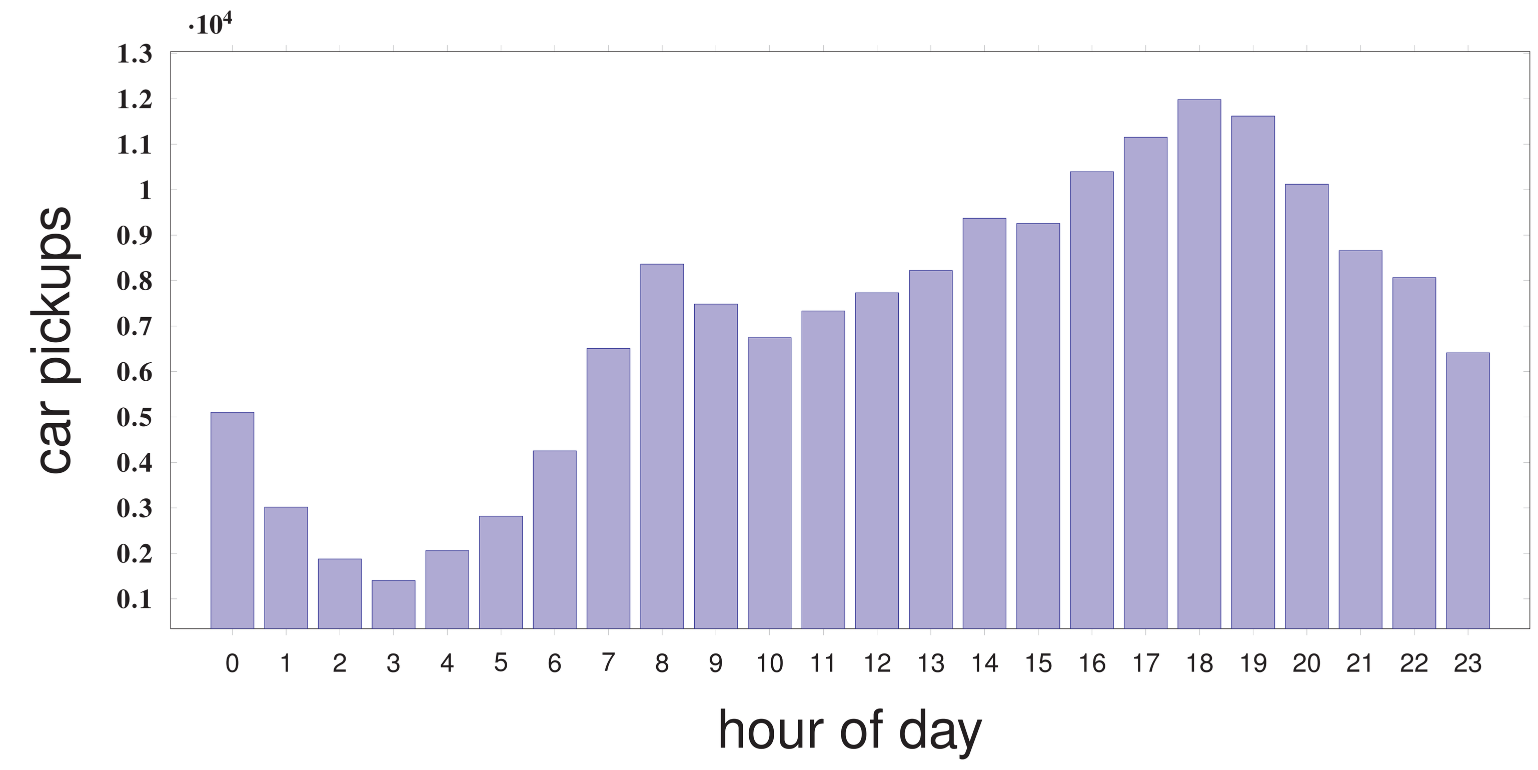

Figure: Car sharing departures per hour of day.

- Points of interest: OpenStreetMap
- Visualization and interpretation: QGIS

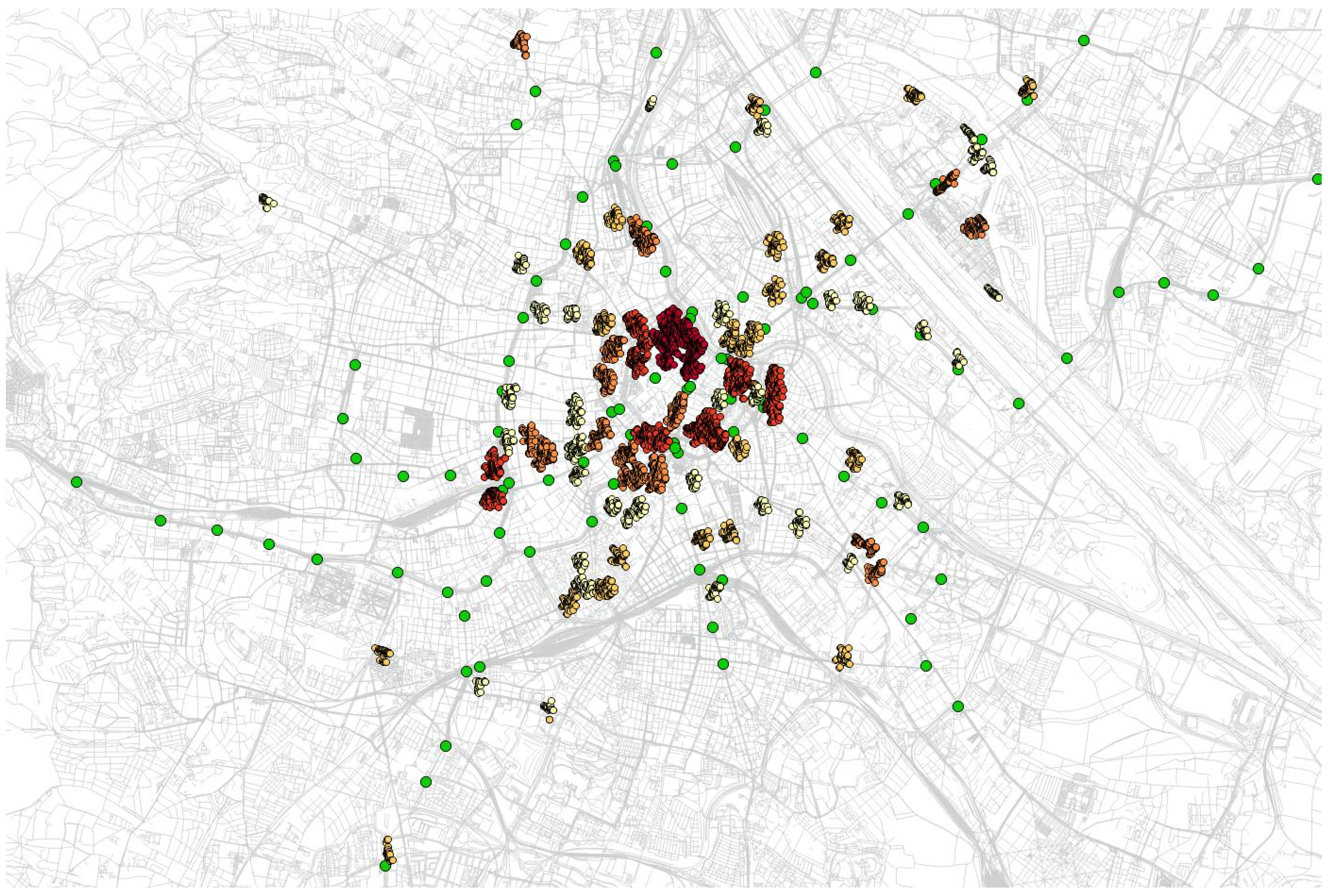

Figure: Evaluation of Hypothesis 4: Subway stops and pickups during hours with high temperature.

Results

Besides the evaluation of the method and thereby the proof for its applicability, the concrete implementation of the approach provided insight into the car sharing systems under investigation. Two of the four stated hypotheses (3, 4) could be confirmed using the proposed method, the other two (1, 2) had to be rejected. From the evaluations, a number of suggestions for the improvement of operators' relocation strategies could be deduced:

1. User incentives or operator-based relocations on rainy evenings around indoor leisure facilities.
2. Coverage of high demand of vehicles around public transportation stations during hot summer days.
3. Coverage of high demand of vehicles around recreational areas during hot summer days.

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