

Empirical Analysis of Free-Floating Carsharing Systems in Munich and Berlin

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Motivation

- free-floating carsharing (FFCS) systems are established in major cities worldwide
- promising alternative to private car ownership
- optimal systems can meet spatio-temporal customer demand
- understanding usage is key to successful operations

Goal

- analysis and comparison of FFCS in Munich and Berlin, Germany, especially:
 - data preparation and rental analysis
 - trip classification (one-way, ABC, roundtrip)
 - temporal and spatial analysis (movements and flows)
- unconstrained demand measures

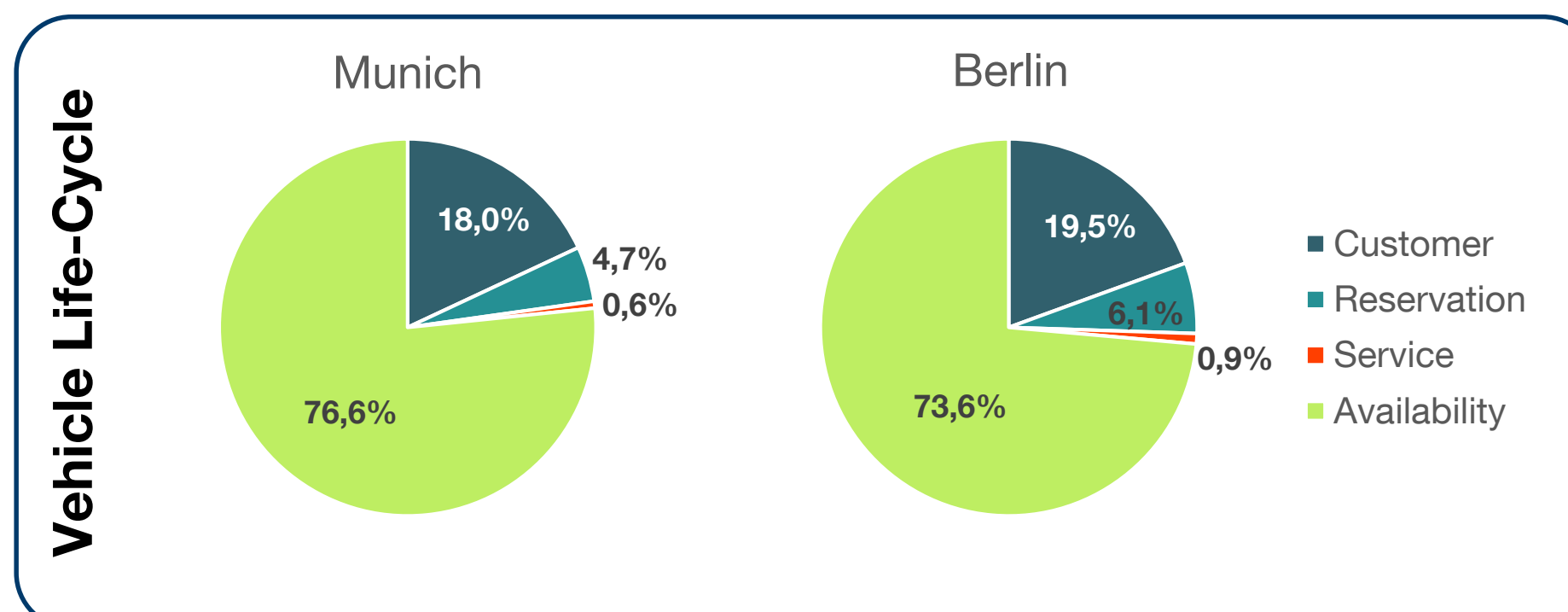
Data

- Munich and Berlin, Germany
- September - November 2019

	Berlin	Munich
Rental Records	339,127	192,346
Active Usage Records, cleaned	223,785	136,528
Size of Business Area	163.77 km ²	99.96 km ²
City Area Covered	18.4%	32.7%

Vehicle Utilization

	Berlin	Munich
Average Daily Rentals	8.57	5.52



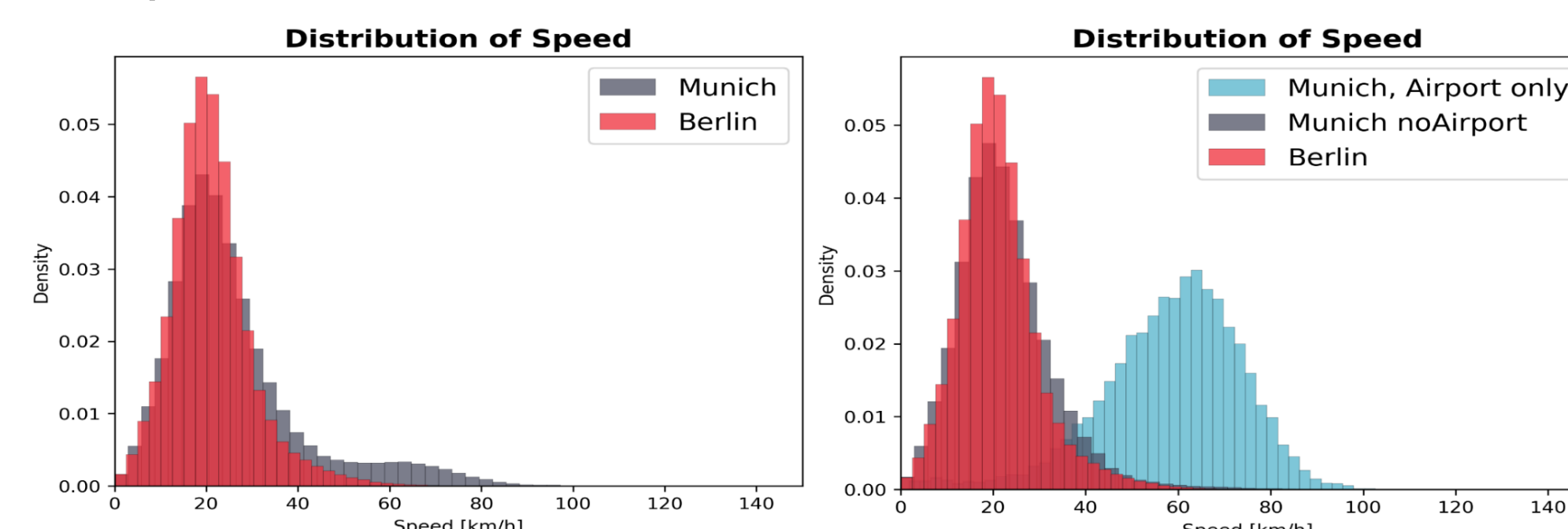
Data Preparation and Rental Analysis

- data clean up to retrieve consistent vehicle life cycles
- elimination of outliers, trips with technical issues and unrealistic rentals
- analysis of influence of special areas, e.g. Munich airport

Rental Statistics:

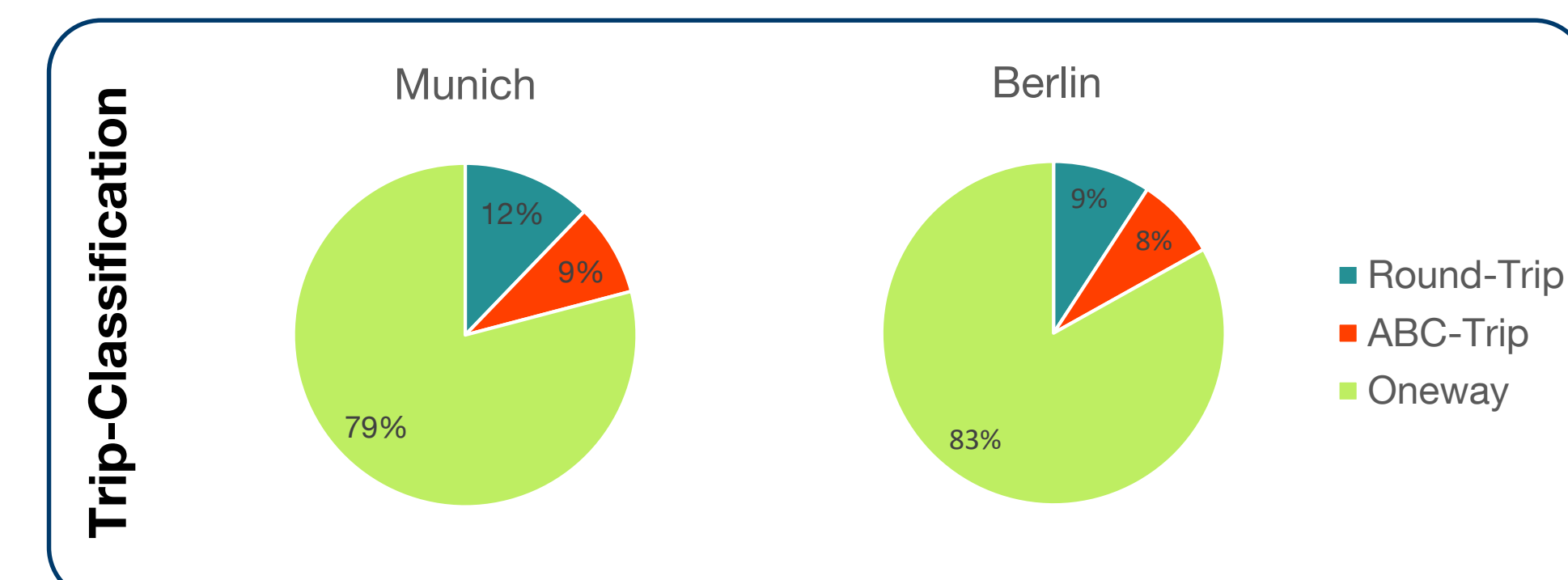
Median (Mean)	Berlin	Munich
Duration [min]	22 (41)	23 (51)
Mileage [km]	7.5 (12)	8.5 (18)
OD Dist. [km]	3.9 (5)	3.8 (6)
Euclidean Factor	0.6 (0.52)	0.57 (0.49)

Speed Distribution:



Trips - Classification

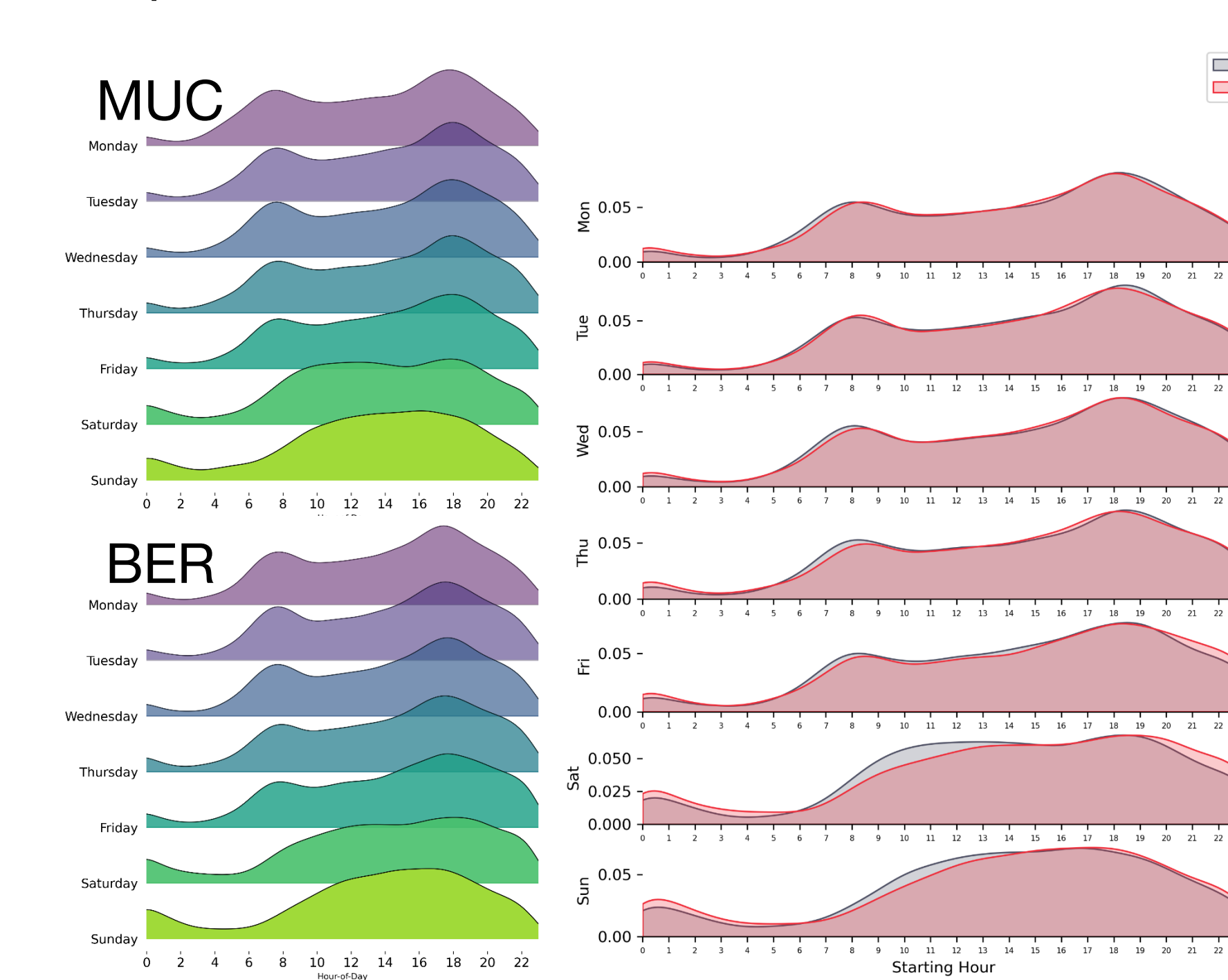
- Classification based on Euclidean Factor (EF), that is Euclidean Distance / realized mileage, and OD-distance: $EF \leq 0.26$ & $OD-Dist. \leq 800$ m



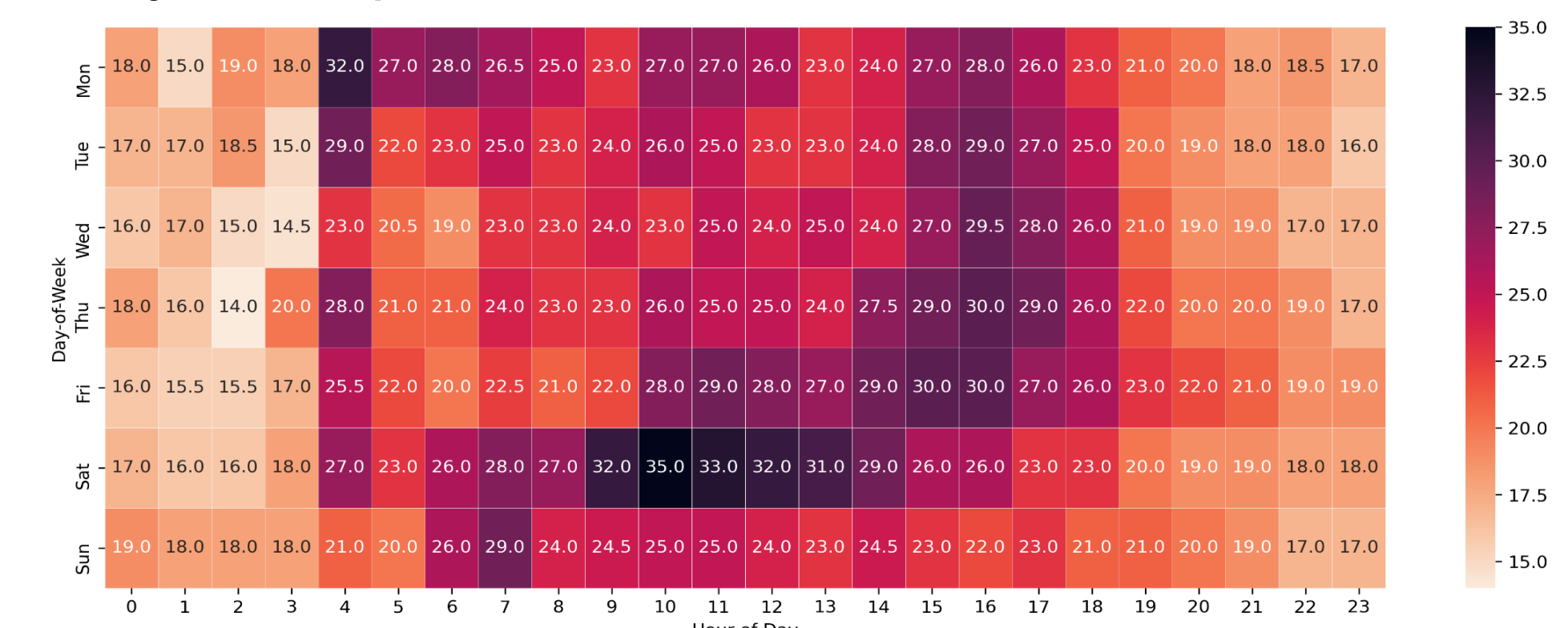
Temporal Analysis

- usage patterns in both cities are comparable
- usage patterns over weekdays differ
- patterns follow known activity patterns
- morning peak in Munich starts half an hour earlier
- longer lasting second peak in Berlin Fri & Sat

Temporal Rental Distribution Munich and Berlin:



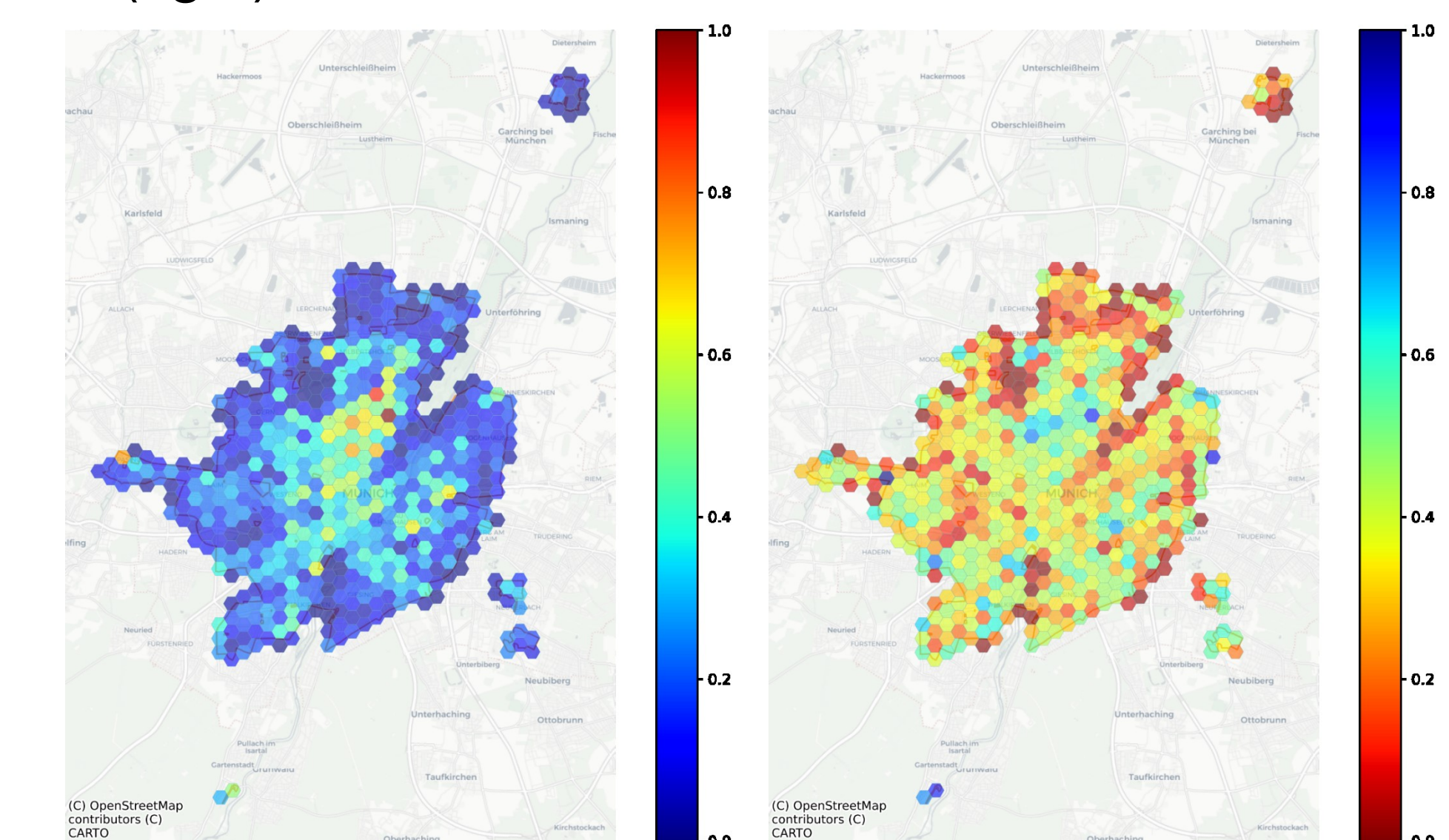
Length of Rentals based on Day-of-Week - Hour-of-Day, example Munich:



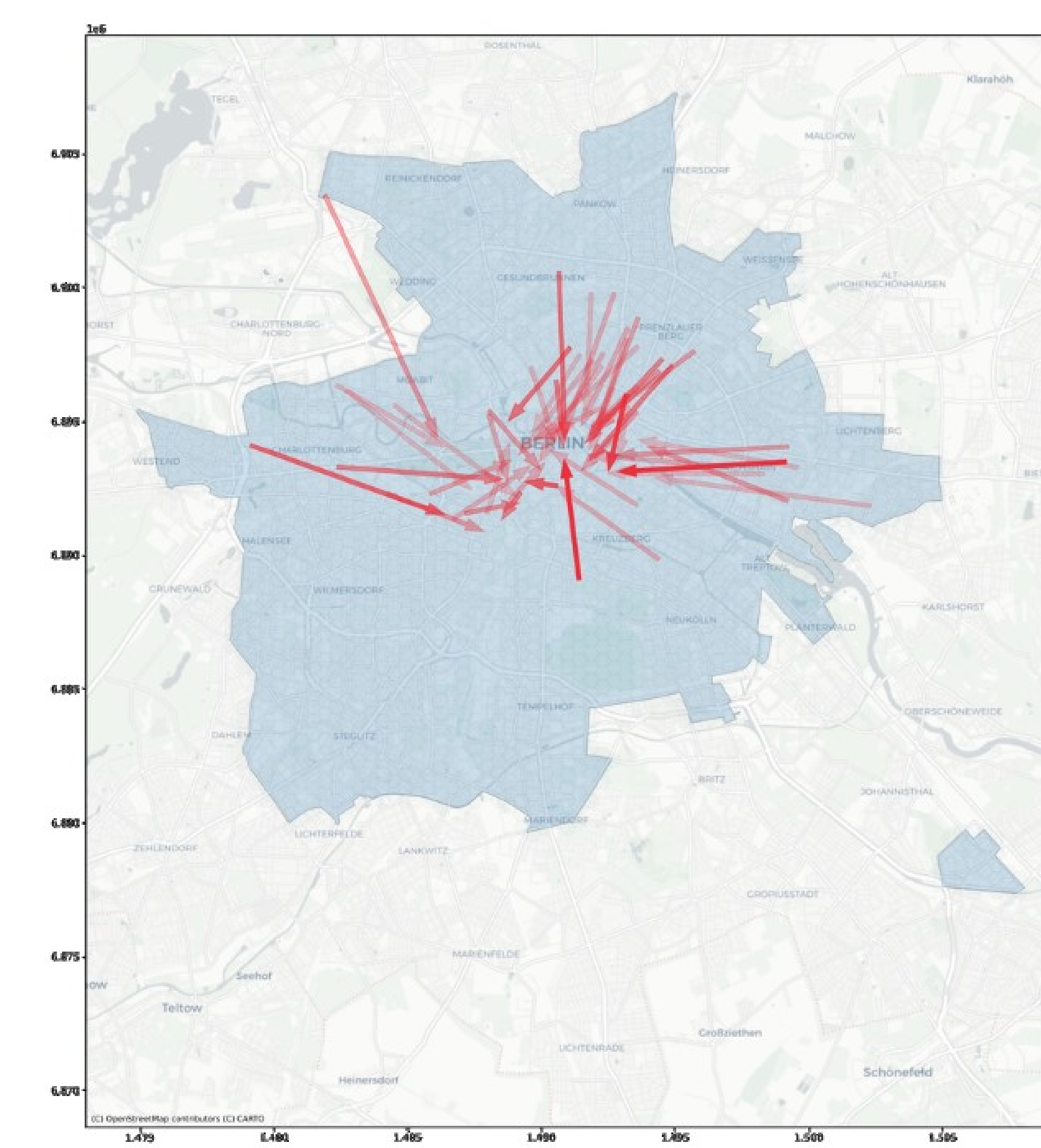
- usage peaks in the morning and afternoon for weekdays, more homogeneous at weekends
- longer rentals in the early morning, evenings, and Saturdays

Spatial Analysis & Flows

- rental distribution (left) and availability distribution (right) in Munich:



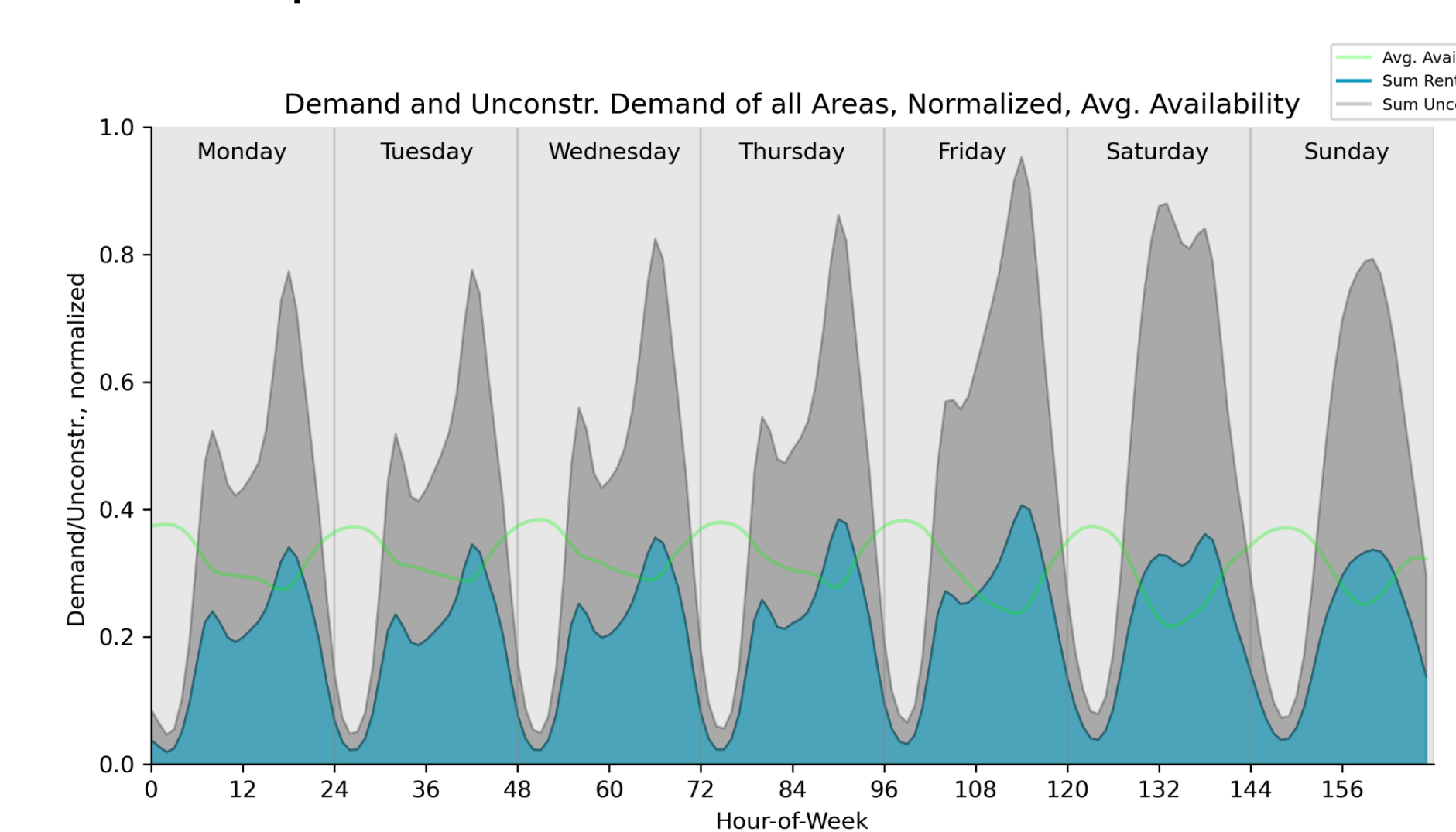
- 50 largest vehicle flows, example of Berlin (AM):



- vehicle flows visualize the most frequent movements within the business area

Unconstrained Demand Measures

- demand without any limitations based on vehicle availability leads to significantly higher demand to be expected in the business area
- example of Munich:

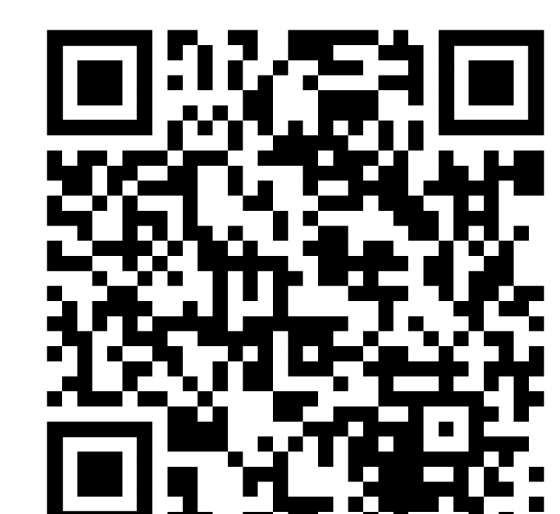


Conclusion

- vehicles are used more often and for a larger share of the day in Berlin compared to Munich
- vehicle utilization rates in both cities are more than 4 times higher compared to private vehicles
- thorough analysis of FFCS data reveals potential for further optimization and utilization
- three different trip classifications are applicable: one-way trip, roundtrip, and ABC trip (one-way trip with large detour).
- special areas with deviant usage patterns can distort general findings and parameters
- FFCS usage follows daily activity patterns with peaks and lows, cities differ to some extent in temporal and spatial context
- weekday and weekend usage differs
- further sophisticated methods can help to find true parameters, e.g. EF-analysis & Unconstraining

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