Professorship of Operations and Supply Chain Management
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Shaping Future Transportation Systems

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User-based Relocation Strategies for Free-Floating Car Sharing

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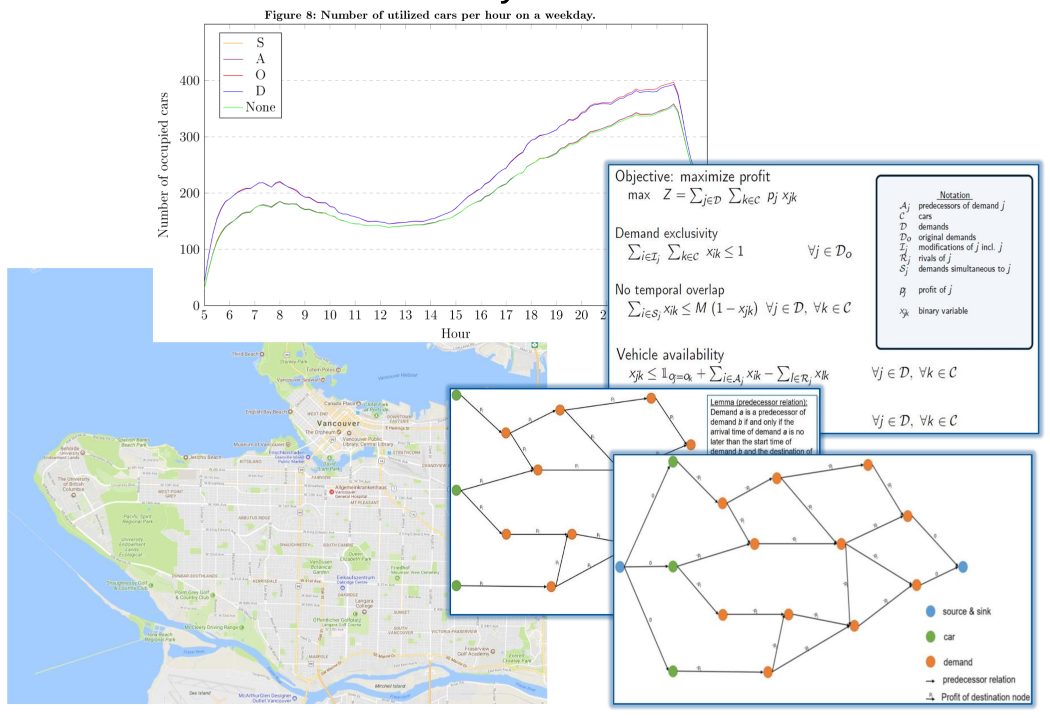
Problem: In free-floating car-sharing systems, fleet operators may increase their profit significantly by avoiding relocation costs, especially by reducing labor cost. A new concept currently discussed by fleet operators is to offer a price discount to the user in exchange for a slightly modified origin / destination, or departure time to better match consecutive demands (user-based relocation).

Method: We propose an integer problem that maximizes the utilization / profit of a free floating car sharing fleet through user-based relocation strategies. For this problem, we develop a graph representation that allows us to solve the underlying scheduling problem as a k-disjoint shortest path problem in polynomial time.

Results: We study a real-world case study based on the trip data of car2go Vancouver and the Vancouver street network. Our results show, that by user-based relocation, the utilization of the fleet can be improved by up to 42% on both week and weekend days.



Autonomous Mobility on Demand Systems

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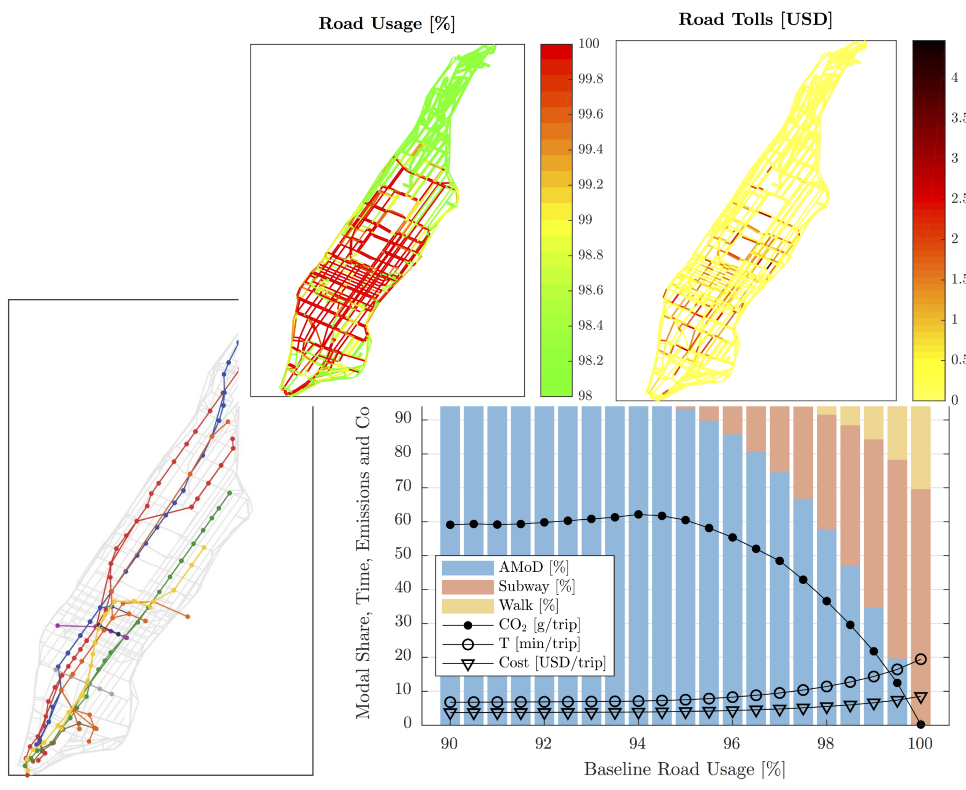
Problem: We study the impact of autonomous mobility on demand (AMoD) systems and their deployment in future transportation systems.

Method: We develop multi commodity flow based modeling approaches to assess the system benefit from a mesoscopic perspective. Additionally, we develop real-time algorithms for balanced and staggered routing.

Results: We show that AMoD systems significantly improve current transportation systems, especially in cities in combination with public transportation.



City Center Design for Sustainable City Logistics

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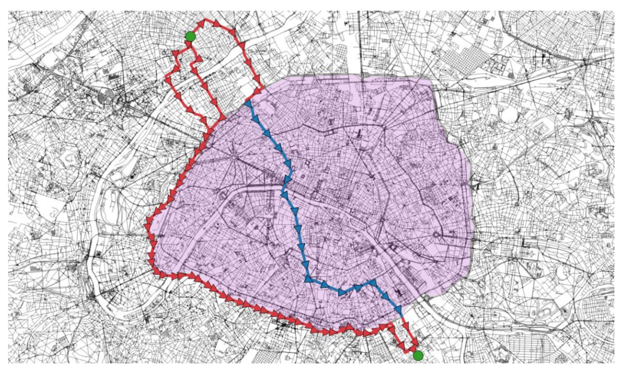
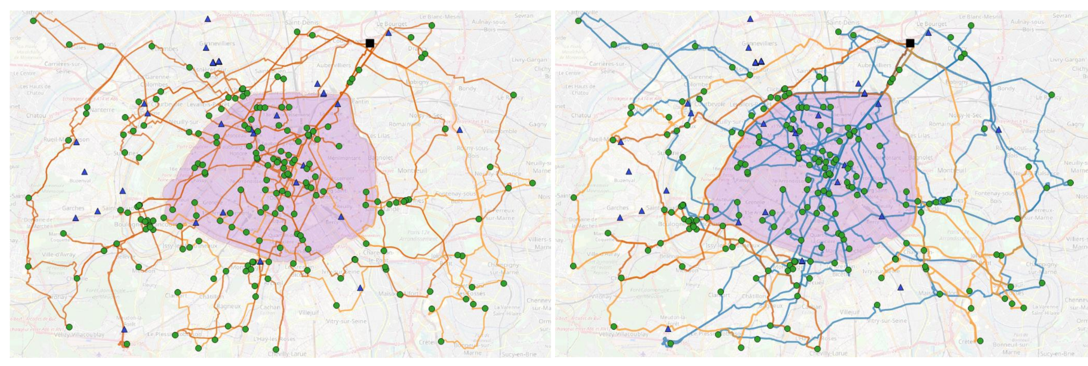


Problem: We analyze the effects of city center restrictions for last-mile deliveries and its impact on electric vehicles utilization in commercial fleets

Method: We account for a fleet operator's behaviour as a cost-optimal mixed fleet problem on a real-world street-graph. We solve this NP-hard problem with a hybrid genetic algorithm.

Results: We evaluate different penalty policies and their impact on a fleet operator's strategic (fleet mix) and operative (routing) decisions. We study three real-world case studies for Paris, Vienna, and New York. Our results show that distance-based fees are superior to per-entry fees. As soon as electric vehicles are deployed in a fleet, they are beneficially used outside the restricted area as well.



Mixed Fleet Routing with Electric Vehicles

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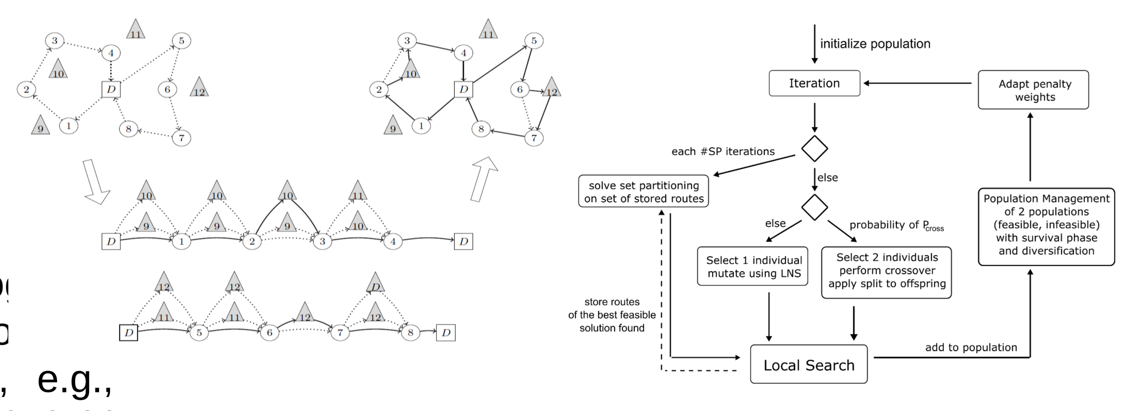
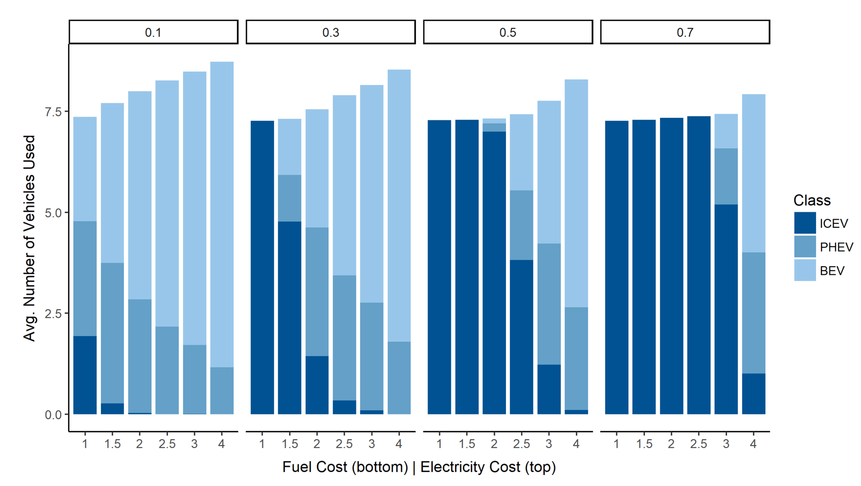


Problem: We study the impact of a lo operators fleet composition on its route selectio total cost considering different technologies, e.g., different types of conventional (ICEV), plug-in hybrid (PHEV) and pure battery electric vehicles (BEV).

Method: We develop a hybrid genetic algorithm that simultaneously takes strategic decisions on the fleet size and compositions as well as operational routing decisions.

Results: Operational cost of mixed fleet are at least 7% lower compared to a homogeneous fleet with a single vehicle type. Although PHEVs are expensive, their flexibility can help to cut down operational cost for certain application cases.



Spatio-temporal demand forecasting

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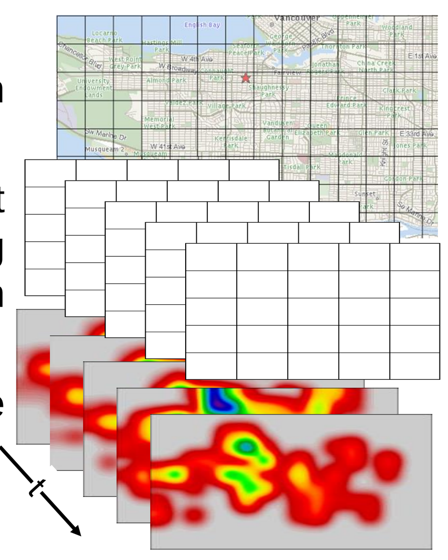

Problem: We forecast travel demands in mobility systems, e.g., car sharing networks.

Method: We develop novel approaches that combine classical temporal forecasting methods with neural networks used in picture recognition

Results: Our algorithms provide a new state of the art in terms of solution quality.

Interaction with the Power Network

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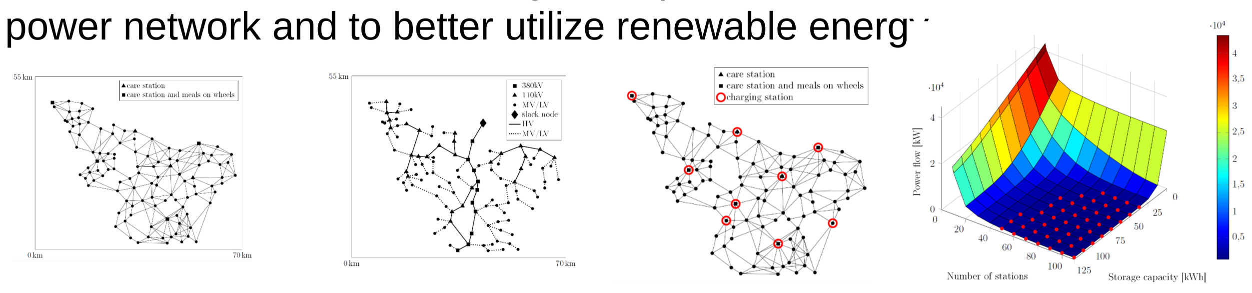
Problem: We analyze the impact of an electric vehicle fleet's charging behaviour on the power network. Herein, we study the benefit of small decentralized energy storages.

Method: We develop mixed integer problems with graph aggregation and decomposition techniques to solve large scale problems.

Results: Decentralized storages help to reduce the load flow in the power network and to better utilize renewable energ



State of the Art Algorithms for Rich Routing and Network Design Problems

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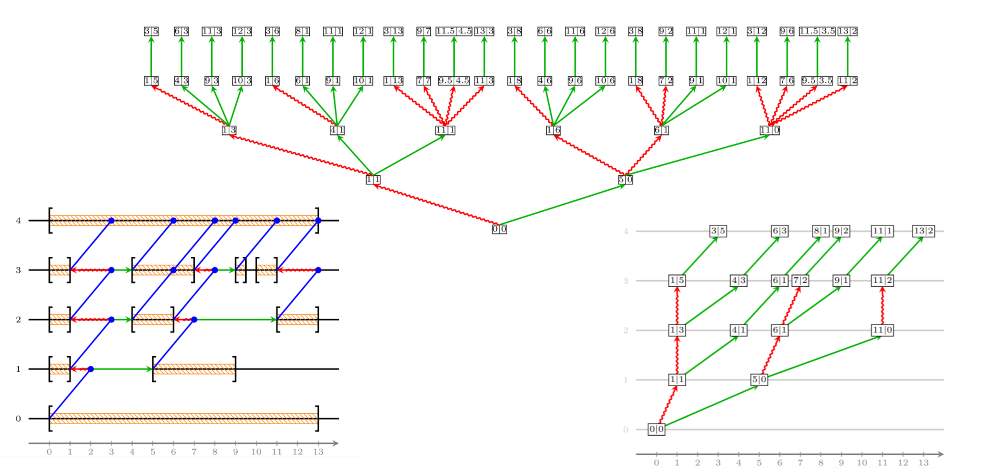
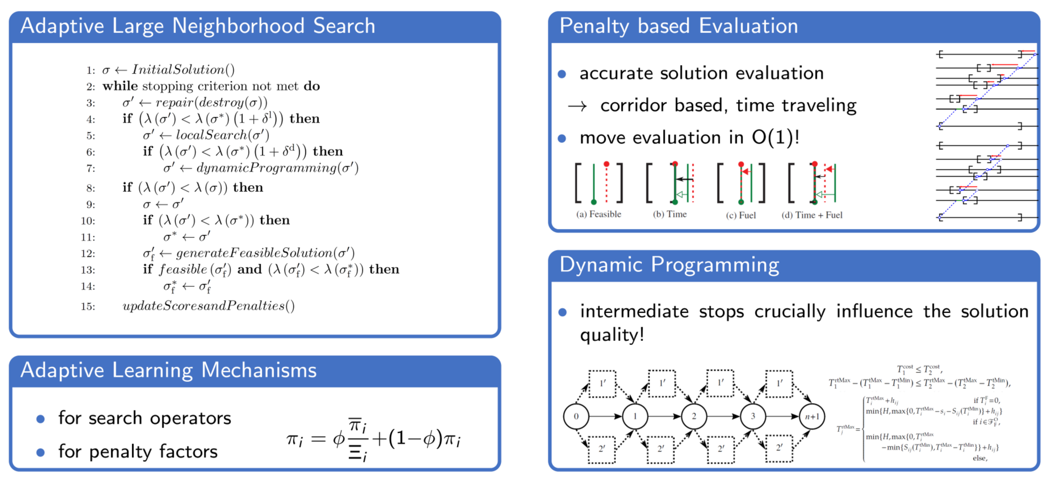
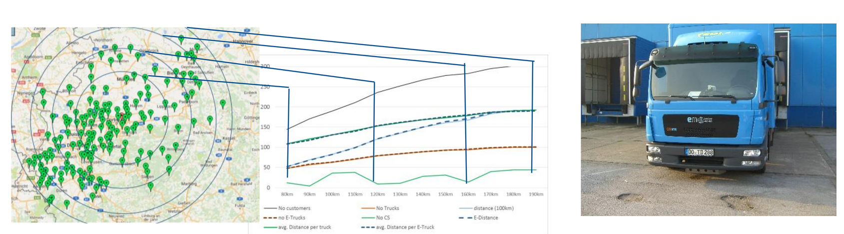


Problem: Today's and future logistics networks become inherently complex due to i) emerging technologies, ii) e-commerce and multiple time window deliveries, and increasing customer requirements.

Method: We develop new heuristic and exact state of the art algorithms for both academics and practitioners.

Results: Our algorithms provide a new state of the art in terms of solution quality, computational times, generality, and





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