# Workshop Schedule

## Monday, 10 June

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| 13:30 – 14:30 | **Arrival + Light Lunch** |
| 14:30 – 15:00 | **Welcome + Introductions** |

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**Session 1**

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| 15:00 – 15:25 | **Felix Spühler** *(Technical University of Braunschweig)*<br>A data-driven analysis of cycling preferences in route planning |
| 15:25 – 15:50 | **Charlotte Achva** *(Otto von Guericke University of Magdeburg)*<br>Integrated freight and passenger transportation utilizing a ferry service |
| 15:50 – 16:15 | **David Fleckenstein** *(University of Augsburg)*<br>From approximation errors to optimality gap – Explaining the performance impact of opportunity cost approximation in integrated demand management and vehicle routing problems |
| 16:15 – 16:35 | Corner Discussion |

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| 16:35 – 17:10 | **Coffee Break + Group Picture** |

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**Session 2**

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| 17:10 – 17:35 | **Gustavo Hurovich** *(Rotterdam School of Management)*<br>Real-time routing cost predictions for time slot management |
| 17:35 – 18:00 | **Jan Strackbein** *(University of Mannheim)*<br>On the economic performance of e-grocery deliveries: Growing profitable or die trying? |
| 18:00 – 18:20 | Corner Discussion |

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| From 19:00 | **Conference Dinner** |

# Tuesday, 11 June

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| | **Session 3** |
| 08:30 – 08:55 | **Steffen Elting** *(University of Vienna)*<br>Query-based bundle selection in horizontal transport collaborations |
| 08:55 – 09:20 | **Liana van der Hagen** *(Rotterdam School of Management)*<br>Feasibility prediction in attended home delivery with uncertainty: A machine learning approach |
| 09:20 – 09:40 | Corner Discussion |
| 09:40 – 10:00 | **Coffee Break** |
| 10:00 – 11:00 | **Practice Session** *(Konstantin Düngen & Marc Leon Selzer)*<br>Last-mile delivery @ Picnic |
| 11:00 – 11:20 | **Coffee Break** |
| | **Session 4** |
| 11:20 – 11:45 | **Gideon Gottschalg** *(WHU – Otto Beisheim School of Management)*<br>Dynamic routing and scheduling optimization of teleoperated car-sharing service |
| 11:45 – 12:10 | **Katrin Waßmuth** *(University of Mannheim)*<br>An evaluation model for time window templates in online grocery delivery |
| 12:10 – 12:30 | Corner Discussion |
| 12:30 – 12:45 | **Coffee Break** |
| 12:45 – 13:00 | Workshop Debrief |
| From 13:00 | **Departure / Optional: Lunch in Town** |

# Abstracts

**Charlotte Achva** *(Otto von Guericke University of Magdeburg)*

Integrated freight and passenger transportation utilizing a ferry service

In water-rich cities like those with canals, fjords, or bays, traffic often faces detours. While passenger ferry systems mitigate this, last-mile delivery of goods still depends on road networks, leading to extended travel distances and potential delays due to traffic. Therefore, we propose a combined transportation system for freight and passengers, utilizing ferries. The ferries dock at shoreline stations, serving as delivery points and temporary storage for goods, which are then delivered inland. While goods are dropped off during the day, more capacity becomes available for passenger transportation. Although demand fluctuates daily, the ferry service should follow a fixed schedule, since otherwise it will not be attractive to passengers. To this end, we propose a two-stage decision problem ensuring reliable scheduling for passengers while simultaneously managing the transportation of goods. We solve the problem using a tailored large neighbourhood search which exploits the information on the simulated input data and the second-stage performance. We find that applying the tailored operators improves the solution quality of the large neighbourhood search, leading to solutions outperforming benchmarks significantly. Our results further show that, with the right strategy, transporting goods has very little impact on the quality of the passenger transportation.

**Steffen Elting** *(University of Vienna)*

Query-based bundle selection in horizontal transport collaborations

Steffen Elting, Jan Fabian Ehmke, Margaretha Gansterer

To reduce costs and greenhouse gas emissions in the last-mile delivery sector, multiple transportation service providers can engage in an auction-based horizontal collaboration. With the help of a central auctioneer, delivery orders are reallocated among the carriers so that the total driving duration can be decreased compared to isolated planning. To minimize information sharing, the auctioneer conducts a combinatorial auction which usually requires an exponential number of bids to be communicated where each bid is equivalent to solving a complex vehicle routing problem. We investigate an integrated, query-driven approach to limit the number of bids while still obtaining an efficient order allocation. Rather than executing the bundling and bidding steps of the auction separately/sequentially, the auctioneer iteratively poses a few value queries to the carriers at a time and uses their responses to train regression models that are used as surrogate fitness functions when searching for the next queries. We simulate a collaboration in the city of Vienna, Austria, with three carriers and 50 customers each. Our results show that the proposed approach can be up to 10% better than the sequential benchmark from the literature and up to 20% better than a random benchmark. However, these results depend on the number of value queries that the auctioneer is allowed to ask, as the regression-based approaches require sufficient training data to work well.

**David Fleckenstein** *(University of Augsburg)*

From approximation errors to optimality gap – Explaining the performance impact of opportunity cost approximation in integrated demand management and vehicle routing problems

David Fleckenstein, Vienna Klein

The widespread adoption of digital distribution channels both enables and forces more and more logistical service providers to manage booking processes actively to maintain competitiveness. As a result, their operational planning is no longer limited to solving vehicle routing problems. Instead, demand management decisions and vehicle routing decisions are optimized integratively with the aim of maximizing revenue and minimizing fulfillment cost. The resulting integrated demand management and vehicle routing problems (i-DMVRPs) can be formulated as Markov decision process models and, theoretically, can be solved via the well-known Bellman equation. Unfortunately, the Bellman equation is intractable for industry-sized instances. Thus, in the literature, i-DMVRPs are often addressed via decomposition-based solution approaches involving an opportunity cost approximation as a key component. Despite its importance, to the best of our knowledge, there is neither a technique to systematically analyze how the accuracy of the opportunity cost approximation translates into overall solution quality nor are there general guidelines on when to apply which class of approximation approach. In this work, we address this research gap by proposing an explainability technique that quantifies and visualizes the magnitude of approximation errors, their immediate impact, and their relevance in specific regions of the state space. Exploiting reward decomposition, it further yields a characterization of different types of approximation errors. Applying the technique to a generic i-DMVRP in a full-factorial computational study and comparing the results with the observations in the existing literature, we show that the technique contributes to better explaining algorithmic performance and provides guidance for the algorithm selection and development process.

**Gideon Gottschalg** *(WHU – Otto Beisheim School of Management)*

Dynamic routing and scheduling optimization of teleoperated car-sharing service

Teleoperated vehicles are a promising concept for increasing the attractiveness and profitability of car-sharing services. Such vehicles can be remotely steered by an operator to the location of an on demand vehicle requesting user. It therefore eliminates both the need for users to walk to a reserved car-sharing vehicle and the need for providers to relocate vehicles with drivers on site to meet the temporal and spatial vehicle demand.
The key to a successful teleoperated car-sharing service is to ensure an acceptable level of service in terms of user waiting time by effectively utilizing the fleet of vehicles and the limited number of available operators. The corresponding sequential decision process therefore involves deciding which vehicle should be steered next by an available operator in order to fulfil which user request. This decision is particularly challenging as both the future demand and the future availability of vehicles are uncertain, since the rental duration and return location of vehicles are unknown to the operators.
We tackle this problem with a two-step allocation algorithm that combines a value function approximation with the prediction of future vehicle returns in order to minimize the waiting time for current and potential future users. The first step of the algorithm focuses on identifying effective vehicle-user matchings by means of a value function approximation that balances the waiting time for users and the driving effort for operators. In the second step, the sequence in which the identified matchings are executed by the operators is determined, anticipating the potential improvement of matchings due to predicted future vehicle returns and potential future users. We demonstrate the merits of our approach in comparison to a range of intuitive benchmark policies in a comprehensive computational study that also highlights the characteristics of this novel problem.

**Gustavo Hurovich** *(Erasmus University Rotterdam)*

Real-time routing cost predictions for time slot management

In the context of online attended home delivery services, the last-mile operations constitute the costliest stage. Businesses make significant efforts to optimize these operations for maximum efficiency and cost reduction. Currently, in most e-grocery companies, customers are presented with a selection of available delivery time slots to choose from. When a customer initiates a purchase, the seller must quickly decide which time slots to offer and whether to incentivize them to pick one that allows for efficient routes. To make these decisions, the retailer has to first evaluate if there is spare capacity in each available slot and how costly it would be to serve them in those slots. Determining the extra cost and distance associated with accepting that customer in each available time slot is a difficult problem. In practice, routing heuristics are in place to estimate these costs, but they are constrained by the real-time aspect of the decisions, which imposes a limit on the available computing time. In this work, we explore the use of Machine Learning models to better predict these extra routing costs.

**Felix Spühler** *(Technical University of Braunschweig)*

A data-driven analysis of cycling preferences in route planning

Courier services have a long tradition in urban logistics, primarily in the delivery of valuable documents or medicines. Furthermore, there is a trend forward using cargo bikes for last-mile deliveries. For short distances, bicycle couriers have major advantages: they are less affected by traffic volume and congestion, they do not block small streets while serving, and they can more easily serve customers in car-free zones.
Companies are slowly shifting their focus to employee satisfaction because workforce is an increasingly important and a limited resource. Thus, the operator's primary goal is not only to maximize delivery profits, but also to consider the well-being of the riders. One option could be to integrate preferences of the riders into the planning process. Here, we focus on preferences for routing in the real road network.
Since cities are structured differently and therefore are differently bike-friendly, it may be more or less expensive from an economic perspective to integrate preferences into route planning in one city or another. In our research, we consider several cycling profiles based on different preference types. Based on these profiles, we generate different routes between pairs of nodes. We perform a data-driven analysis of these profiles, the corresponding routes, and different cities. Preliminary results confirm our assumptions that the routes differ both in terms of profiles and cities.

**Jan Strackbein** *(University of Mannheim)*

On the economic performance of e-grocery deliveries: Growing profitable or die trying?

Scholars and industry experts alike commonly consider grocery home deliveries (e-groceries) in Europe as lacking profitability, despite the spiking demand for e-groceries during the recent pandemic and the increasing demand for convenience services in general. The strict quality requirements for handling groceries (e.g., regarding temperature conditions), low profit margins due to high industry competition, and geographical dispersion of customer in last-mile delivery are a few examples that contribute to the poor economic performance of e-grocers. According to official company reports, many e-grocers count on economies of scale and thus on reaching profitability through growth. Parcel delivery services and online channels other than grocery serve as motivating examples operating under similar yet not identical conditions.
The present study investigates the validity of reaching profitability of e-grocery operations by means of scaling. To this end, we consider the main components of the fulfillment process and model their dependence on key problem parameters. We then calibrate the model based on publicly available information and isolate the impact of demand growth. We use the calibrated model to investigate the effective scale effects of e-grocery services under different growth strategies, and we critically compare them to hypothesized profitability targets.

**Liana van der Hagen** *(Erasmus University Rotterdam)*

Feasibility prediction in attended home delivery with uncertainty: A machine learning approach

In attended home delivery, retailers usually let customers select a delivery time slot for receiving their orders. The delivery capacity, i.e., the number of vehicles and drivers, is often fixed and inflexible in the short term. To effectively use their delivery capacity, e-grocers may dynamically close time slots for certain new customers given the already accepted customer orders. One complicating factor is that for example online grocers allow customers to change their order basket at any time before the cut-off. Consequently, the e-grocer is uncertain about how much vehicle capacity should be reserved for each of the customers during the booking process. We study the challenges that arise with this order size uncertainty and propose strategies to deal with it. For each of the time slots to be evaluated, we use machine learning to quickly predict the probability that a feasible route plan exists that visits all accepted customers in their selected time slot.

**Katrin Waßmuth** *(University of Mannheim)*

An evaluation model for time window templates in online grocery delivery

Katrin Waßmuth, Niels Agatz, Moritz Fleischmann

The online grocery business is characterized by the need for customer presence at the time of delivery and the challenge of achieving profitability due to small margins and restrictive time window constraints. In practice, we see great variation in the set of time windows offered to customers, including long or short, many or few, overlapping or non-overlapping options. It is essential to understand how these choices impact demand and fulfillment. We develop a model to evaluate sets of time windows (time window templates) in terms of demand and the delivery performance, including fulfillment costs and fleet requirements. The evaluation model can incorporate different types of demand functions and it approximates the components of the delivery system through tractable functional expressions based on continuous approximation. Our results provide valuable building blocks for time window template design decisions and highlight the fundamental trade-offs when making such decisions. With this, the research provides guidance for service providers in shaping their business model and review their current operations strategy to become economically sustainable.

# Participants

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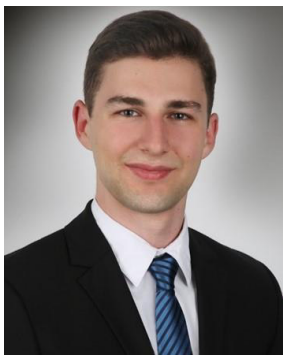
Moritz Fleischmann



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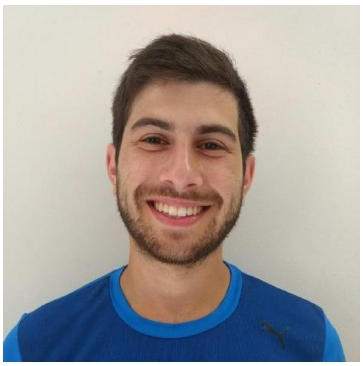

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