1. Predictive Analytics

1.1. Predicting garbage separation
Description: for players in the recycling industry clean waste separation is crucial for their production purposes. Therefore, prediction of waste components is of core interests to those companies. So far, they have no estimator of the household waste composition. The task is to define a household garbage-to-bin choice problem, identify potential exogenous variables and to design a choice experiment. The experiment should be tested on a small sample of households and a first model estimation is expected.

1.2. Park-and-Ride Choice
Description: we have a unique data set at hand that encompasses the travel choices of commuters in the south of Germany. Basically, the choices are between public transport, car, and a combination of both (park-and-ride). The task is to specify a corresponding choice model, derive elasticities, and to analyze various scenarios of park-and-ride locations by making predictions of the corresponding demand.

1.3. Electric Vehicle Purchasing Behavior in Beijing, China
Description: based on recent data (stated choice) a predictive model for purchasing behavior of vehicles in Beijing is estimated. The alternatives are electric vehicle, hybrid car, and standard car. The task is to identify relevant attributes and characteristics as well as estimate elasticities and market shares under various policy scenarios.

1.4. Rotterdam Mode Choice
Description: based on large revealed data on mode choice behavior in Rotterdam, Netherlands a discrete choice model is estimated. The task is to identify whether there are correlations between the modes and if so to adequately account for the correlations. Further, individual perceptions need to be integrated in the choice model – either via a mixed logit or a hybrid choice model.

1.5. Penalty shot choice behavior
Description: for goalies in soccer, handball, and hockey the prediction of the behavior of the shooter is crucial to increase the likelihood of a save. Therefore, the task is to define a shooter choice problem (alternatives, variables) and to search for corresponding sports data to estimate and test a corresponding discrete choice model.

1.6. Predicting Interchange Times in Urban Mass Transportation
Description: when public transport service providers intend to reduce their dwell times, the understanding of the interchange processes at stops is crucial. We have conducted a small pedestrian experiment on the interchange processes. The task is (i) to estimate a predictive model for the interchange times on this data and (ii) to set up a large scale experiment or to find large scale data that describes such kind of processes.

1.7. Crowd Operations Management
Description: we have conducted a unique experiment examining the behavior of pedestrians at bottlenecks. We find that the actual behavior does not comply with the predicted behavior in state-of-the-art simulation approaches. The task is to rigorously analyze the data with respect to these differences and to provide reasonable explanations.
1.8. Human Choice Behavior in Car Driving
Description: Besides electrification the second big thing in the automobile industry is the autonomous vehicle. However, self-driving vehicles are an ongoing endeavor for more than two decades now. Over the years the underlying principle moved from ex-ante rule-based algorithms towards a learning approach, i.e., “auto pilot learns from human driver”. In fact, many decisions while driving a car, are of discrete nature. The human driver is considered as the choice maker, while state-dependent alternatives may be accelerating, brake, left-/right-turn etc. Scrap the web for in-drive choice data and estimate adequate choice models.

1.9. Measuring disruptions in last-mile delivery operations
Description: The rapid growth of urbanization and e-commerce has increased the number of home deliveries to be made in the last mile. As a result, congestion, pollution and the number of unexpected events in urban areas have increased. These disruptions lead to delays, higher operational costs and lower service levels in last-mile delivery. Using tools such as Google API and Google OR, it is possible to build analytical models to measure the impact of different disruptions on last-mile delivery operations’ sustainability. The task is to develop an analytical model that allows to measure or estimate the impacts of disruptions in last-mile deliveries.

2. Prescriptive Analytics

2.1. Construction of Fair Sales Territories
Description: based on Haase/Müller (2014) an optimization model for the design of fair sales territories developed. The model is implemented in GAMS. Some extensive computational experiments are performed. We are interested in the solution performance and the robustness in terms of the fairness.

2.2. Optimal Locations of Photovoltaic System Seed Installation to Speed Up Technology Diffusion
Description: using the predictive model of Rode/Müller a mathematical model that maximizes diffusion over a given time horizon is developed. Therefore, the predictive model needs to be integrated in the prescriptive model (optimization model) via constraints. The resulting model is to be implemented in GAMS and tested on small artificial data first. Then the analysis should be performed for whole Germany.

2.3. Intelligent Vehicle Loading Problem
Description: the task is to develop an optimization model to minimize the doors open time during stops of public transport vehicles – i.e., the time needed by passengers to enter or exit the vehicle. Here pedestrian dynamics and passenger choice behavior needs to be accounted for. Some preliminary data from pedestrian experiments already exist and is available.

2.4. Discrete Choice & Branch-and-Bound
Description: the idea is to use discrete choice models to help the branch-and-bound procedure, which solves mixed-integer programs. This is an exceptionally daring new and bold idea. No prior experience on this topic exists so far. Some fun on coding is needed here!

2.5. Choice-Based Revenue Management
Description: based on Korfmann (2018) the optimization model for choice-based revenue management is to be implemented in GAMS and tested on artificial data. In particular, the tractability and effectivity in terms of the model choice behavior needs to be investigated.
2.6. Public Transport Operations
Description: based on current script to the lecture the task is to find and incorporate most recent references to the various chapters. Further, an artificial region needs to be designed such that every step of the planning process is done in this region (network, lines etc.).

2.7. Public Transport Revenue Management
Description: for the revenue maximizing tariff zone planning problem a GAMS implementation exists. Also, an instance generator is available. The task is to perform numerous computational studies using real world and artificial data and to rigorously report the results.

2.8. Optimal Feature Selection for Discrete Choice Models
Description: finding a satisfying specification of discrete choice models is often a tedious task. This is true in particular for more complex choice models like nested or mixed logit. The objective of this thesis is to develop a mixed-integer non-linear program to select and identify the choice model parameters at the same time. The corresponding objective function could be maximizing model fit or minimize predictive error.

2.9. Line Plan Design for Public Transport
Description: line plan maps are designed such that passengers can easily find their way through the public transport network. Usually, the map design is based on several design principles which again might be in conflict to each other. Task is to develop a mixed-integer program that accounts for the design principles and optimizes the speed of way finding.

2.10. Simultaneous Assortment and Screen Layout Planning
Description: traditionally assortment optimization is applied to problems in offline retailing. However, with increasing online sales we find an increasing number of applications in online context. So far, the space and the arrangement for product placements in online shops is assumed to be given for assortment optimization. We intend to develop a decision model for simultaneous assortment and layout decisions.

2.11. Profit-maximizing network design
Description: traditionally demand assumed to exogenously given in network design problems. However, different solutions of the network design might yield different level of service (travel-times, f.e.). Obviously, demand depends on the level-of-service and hence on the solution of the network design. The task is to develop an optimization model that considers demand as an endogenous variable.

2.12. Supply Chain Contract Design
Description: in a classical newsvendor a buyer gets a guaranteed capacity (supply) from a supplier and pays a corresponding price for that capacity. Information asymmetries in the supply chain (i.e., between supplier and buyer) yield inefficiencies. Therefore, it is crucial to design contracts between supplier and buyer that account for these asymmetries. One concept is, to offer a number of contracts (with price and capacities as attributes) to the buyer from which the buyer selects one. The task is to develop a mathematical decision problem to design such contracts with respect to the number of contracts, i.e., the larger the number of contracts the larger the probability of a buyer to defect.
2.13. **Optimization for sustainable and resilience transport systems**
Description: Transportation offers the opportunity to connect decentralized systems and ensures a constant flow of resources between them. The risk is associated with unexpected events, such as emergencies, that generate uncertainty and disruptions in the flow of resources, affecting the performance of the urban transport system. The opportunities and risks have led to ever-growing interest in the principles of resilience and sustainability in transport management. The task is to develop a structured method (mathematical model or heuristic) to deal with disruptions and increase the resilience capacity of the urban transport system.

2.14. **Models for optimizing shared mobility**
Description: The high population density in urban areas, limited parking spaces and government regulations have motivated transportation companies to investigate car and trip sharing transportation systems. The design and implementation of these shared transport systems offer several potential benefits for both users and transportation companies. The task is to develop a structured method (mathematical model or heuristic) to determine optimal transportation routes using the concept of trip and car sharing.

2.15. **Choice-Based Optimization**
Description: the task is to summarize the state-of-the-art in choice-based optimization, i.e., the integration of discrete choice models and combinatorial optimization problems. One feasible way of structuring this literature review is along fields of application: assortment optimization, facility location, revenue management, transport planning etc.