LAST MILE DELIVERY WORKSHOP

UNIVERSITY OF MANNHEIM

22 - 23 JUNE 2017

CONTENT

PROGRAM SCHEDULE

Thursday, 22 June 2017, Room: 0 226/228

12:30 Seminar room opens
Lunch snacks will be provided

13:00 – 13:20 Welcome Session

13:20 – 14:40 Session 1: Attended Home Delivery of Groceries
Chair: Arne Strauss

A Laboratory for Profitable and Efficient E-Fulfillment for Attended Last-Mile Delivery Services
Charlotte Köhler

Simulation-Based Learning for Dynamic Time Window Allocation in Attended Home Deliveries
Magdalena Lang

COFFEE BREAK

15:00 – 17:00 Session 2: Same Day Pick Up & Deliveries
Chair: Remy Spliet

Same Day Delivery
Alp Arslan

Spatial Information in Value Function Approximation for Dynamic Vehicle Routing with Stochastic Requests
Artur Ansmann

State Space Partitioning for Anticipatory Vehicle Routing
Ninja Söffker

COFFEE BREAK

17:20 – 18:40 Session 3: The Consolidated VRP and Move Evaluations for VRPTW Heuristics
Chair: Jan Fabian Ehmke

Consolidated Vehicle Routing with Excess Vehicle Capacity in Last-Mile Deliveries
Joydeep Paul

Efficient Move Evaluations for Time-Dependent Vehicle Routing Problems with Route Duration Constraints
Thomas Visser

Walking together to dinner restaurant “Rheinterrassen”

19:00 Dinner

Friday, 23 June 2017, Room: 0 226/228

08:30 – 09:30 Discussion Session
Chair: Moritz Fleischmann

09:30 – 10:50 Session 4: Additional Problem Characteristics in Routing
Chair: Dirk C. Mattfeld

The Benefits of Flexible Fulfillment Center Assignments in Attended Home Delivery
Kilian Seifried

A Rich Vehicle Routing Framework for Dynamic Time Slot Management in Attended Home Delivery
Thomas Visser

COFFEE BREAK with short tour of the university

11:30 – 12:50 Session 5: Incentivizing Time Slots
Chair: Catherine Cleophas

Dynamic Pricing of Flexible Time Slots for Attended Home Delivery Services
Arne Strauss

Going Green: The Effectiveness of Non-Financial Incentives on Customers' Delivery Time Windows Choices
Niels Agatz

12:50 – 13:00 Farewell

ABSTRACTS

Going Green: The Effectiveness of Non-Financial Incentives on Customers' Delivery Time Windows Choices

Niels Agatz (Rotterdam)

In attended home delivery, it is common for the retailer to offer the customer a menu of delivery time windows to choose from. The customers' delivery time window choices determine the efficiency of the associated delivery operations. That is, routes are most efficient when customers in the same zip-codes are clustered in the same time windows. It is possible to increase the efficiency of the delivery operations by offering incentives to steer customers towards certain cost-efficient delivery time windows. Many e-grocers provide financial incentives (e.g. discounts) for choosing certain time windows. These organizations extrinsically motivate customers by using these incentives. Interestingly, a few internet grocers, including Ocado and Peapod, are appealing to the customers' environmental concerns by indicating which time windows would minimize fuel consumption for their order. Instead of external financial rewards, these incentives stimulate behavior that may internally rewarding to the individual. So far, there have been no systematic studies exploring the effectiveness of such 'green' incentives. We present the results of several experiments that test the effectiveness of non-financial 'green' incentives that appeal to the customer's intrinsic motivation to behave environmentally responsibly by choosing efficient delivery time windows.

Spatial Information in Value Function Approximation for Dynamic Vehicle Routing with Stochastic Requests

Artur Ansmann (Braunschweig)

We study the Dynamic Vehicle Routing Problem with Stochastic Customers (DVRPSC), a common problem setting for Courier, Express and Parcel service providers. In particular, a dispatcher must decide which dynamically occurring customer requests should be confirmed and how these should be integrated into the tour of a service vehicle. The vehicle must serve all confirmed requests and return to its depot within a given time limit; usually, not all requests can be confirmed. In order to confirm a maximum number of requests, anticipation of future requests for a current state's decision is necessary. To allow real-time control, the required calculations need to be conducted offline, often by means of Value Function Approximation (VFA). The calculation's outcome for every state is then stored in aggregated form and can be accessed efficiently in the online execution. Current VFAs for the DVRPSC are not able to integrate any spatial information in their aggregation but solely draw on temporal state attributes. Therefore, in problem settings expressing characteristic spatial distribution of requests, these are not able to anticipate sufficiently. In this paper, we propose Anticipatory Time Budgeting with Spatial Information (ATBS) to close this gap. We compare ATBS to a state-of-the-art VFA of the literature on a set of benchmark instances with varying spatial distribution parameters. Results show that the integration of spatial information is highly beneficial.

Same Day Delivery
Alp Arslan (Rotterdam)

Same day delivery has to become the standard service for certain products, such as food and groceries. However, the service brings extra burdens on the logistic service providers. In this study, we study the same delivery problem in a single depot setting in which delivery orders are placed in a pre-defined service period and all of them have to be served within the same day. We formulate the same day delivery problem (SDDP) as a multi-trip vehicle routing problem with release times which primarily aims to the total durations of work periods. The problem distinguishes itself from the canonical capacitated vehicle routing problem (CVRP) by relaxing the following two assumptions. Firstly, each vehicle can make more than a single trip; and secondly, not all the parcels available for picking up at the beginning. We develop construction and improvements heuristics for SDDP based on the problem specific techniques. Furthermore, we conduct an extensive computation study to assess and quantify the performance of our heuristics.

A Laboratory for Profitable and Efficient E-Fulfillment for Attended Last-Mile Delivery Services
Charlotte Köhler (Frankfurt (Oder))

With the ongoing boom in e-commerce, attended last-mile delivery services gain more importance, e.g., when ordering groceries online. Hence, retailers and their customers mutually agree on tight delivery time windows to avoid costly failures of deliveries. Since profit margins are often low, retailers need to plan delivery services carefully.
In this presentation, we introduce a virtual laboratory for e-fulfillment planning. We consider delivery time windows as a scarce resource and as the critical interface between order capture and order delivery. We will give an overview of ongoing research streams for e-fulfillment and demonstrate how we combine methods from revenue management with methods from vehicle routing to utilize delivery time windows. We model the e-fulfillment process of a retailer in an iterative fashion, and calibrate the laboratory with transaction data obtained from an online retailer.
Using the e-fulfillment laboratory, we plan to show first results from a solution approach that focuses on the profitability of e-fulfillment, but also ensures sufficient availability of delivery time window options for certain customer segments. Based on a set of forecasted order requests, we create routes that service the most valuable subset of requests for a given fleet of delivery vehicles (predictive routing). We model the predictive routing problem as Orienteering Problem with Time Windows and compare the results to established mechanisms from the literature.

Simulation-Based Learning for Dynamic Time Window Allocation in Attended Home Deliveries
Magdalena Lang (Aachen)

For attended home delivery services, allocating time windows to delivery requests affects both delivery costs and the future orders that can be accepted given a limited delivery capacity. Revenue management provides approaches to forecast the demand for deliveries per time window and to efficiently control the time window allocation, but it requires to know an order's capacity consumption and the resulting left-over capacity. For deliveries, the travel time needed to service an order depends on the overall set of accepted orders, so that the effect on capacity cannot be fully determined on individual order request arrival. Vehicle routing methods can approximate travel time and costs but lack sufficient means to anticipate stochastic customer choice and to effectively deploy allocation controls. Moreover, vehicle routing is usually too time-consuming to be computed per arriving order request.
Here, we present a simulation-based learning framework to approximate the opportunity costs of time window allocation. These opportunity costs can then inform a dynamic allocation decision on request arrival. Thereby, the approach anticipates effects on both overall acceptable revenue from orders and delivery costs. It uses simulated request arrival samples to estimate the future effects of control decisions. We present work in progress on the conceptual realization of such a framework and first computational results.

Consolidated Vehicle Routing with Excess Vehicle Capacity in Last-Mile Deliveries
Joydeep Paul (Rotterdam)

Consolidation of transport flows in logistics is one of the key ways for sustainability in urban transportation. The load factor for trucks in Europe is around 50% and a similar trend is seen in other parts of the world as well. In this paper, we introduce a novel dynamic strategy between logistics carriers where one (external carrier) offers the other (focal carrier) the possibility to piggyback on its routes by using its unused capacity. The number of nodes whose demand can be redirected from the focal carrier to the external carrier is constrained by the excess capacity in the vehicles of the external carrier. It is observed that the excess capacity in the external carrier routes varies from day to day, hence it is not always cost-feasible for the focal carrier to consolidate demands of customer locations with the external carrier. There is a fixed cost per trip to move items from the focal warehouse to the external warehouse, which offsets the savings obtained by collaboration and also adds another dimension of complexity to the problem. The decision to collaborate is very ad-hoc and depends on the instance characteristics. We applied our consolidation strategy on a small real-life case study in the Netherlands to show the potential savings. Since the problem is computationally hard for large instances, we develop different heuristics to efficiently decide which customers to visit and which customers to redirect to an external route. An extensive computational study demonstrates the benefits of this strategy under different scenarios.

The Benefits of Flexible Fulfillment Center Assignments in Attended Home Delivery
Kilian Seifried (Mannheim)

Attended home delivery in narrow time windows is the prevailing service model in internet grocery retailing. E-grocers typically serve their customers from one or more dedicated e-fulfillment centers. To simplify planning, each fulfillment center is often responsible for a fixed delivery region. In this contribution, we investigate the benefits of allowing flexibility in the assignment of customers to fulfillment centers from a routing perspective. The underlying routing problem can be characterized by a multi-depot vehicle routing problem with time windows.
We analyze the advantages of a flexible assignment as compared to a decomposed planning per fulfillment center by using a new exact mixed-integer programming model and a state-of-the-art heuristic. In addition, we investigate the impact of different factors on this benefit and the associated solutions.

State Space Partitioning for Anticipatory Vehicle Routing
Ninja Söffker (Braunschweig)

For courier, express and parcel services that offer to pick up parcels at customers' homes, it is mandatory to serve customer requests fast, preferably on the same day. Usually, not all requests can be served which implies that some requests can be accepted while others have to be rejected. This can be due to time restrictions like working time constraints or due to other constrains like vehicle capacities. In order to serve as many customer requests as possible in a stochastic and dynamic setting, value function approximation, a method of approximate dynamic programming, uses offline simulation to approximate the value of being in a particular state. For large problem settings, not every state can be evaluated individually which results in a need for a state space partitioning. Static a priori partitionings, however, require an a priori understanding of problem and instance, this is mostly not available. In this presentation, a partitioning approach is presented that adapts the state space partitioning according to the problem and instance requirements.

Dynamic Pricing of Flexible Time Slots for Attended Home Delivery Services
Arne Strauss (Warwick)

In e-commerce, customers are usually offered a menu of regular home delivery time windows of which they need to select exactly one. We define a flexible delivery time slot as any combination of such regular time windows (not necessarily adjacent). In selecting a flexible time slot, the customer agrees to be informed only shortly prior to the dispatching of the delivery vehicle in which regular time window (out of the set of windows that form the flexible product) the items will arrive. In return for providing this flexibility, the company offers the customer a reduced delivery charge.
We study dynamic pricing of regular and flexible time slots in this context for attended home delivery. Initial numerical experiments, based on realistically-sized scenarios, indicate that expected profit may increase by around 0.5%-1.2% depending on demand intensity when adding flexible slots rather than using only regular slots.

A Rich Vehicle Routing Framework for Dynamic Time Slot Management in Attended Home Delivery
Thomas Visser (Rotterdam)

The focus of this presentation is the problem of managing the availability of time slots for attended home delivery in real-time during the customer ordering process, called the Dynamic Time Slot Management (DTSM) problem. Many online retailers providing attended home delivery offer customers to choose from a set of narrow delivery time-windows, called time slots. Since the customers' choice affects the efficiency of the delivery routes, it is crucial to manage how much demand is accepted for each time slot. DTSM exploits dynamic routing to, in real-time, evaluate and update available time slot capacity based on already placed customer orders and available vehicles. In our DTSM problem, we include rich vehicle routing characteristics as heterogeneous fleet, multiple satellite hubs and time dependent travel times. Further, we introduce the by practice inspired concept of time slot reservations. The customer can reserve a time slot for a limited time before they build and finalize their order. This poses additional challenges, since at reservation it is unknown if the order will materialize and what the order size will be. We propose a rich vehicle routing framework and test its performance on real-world data from our industry partner. Our study is part of a large research project in which we collaborate with software developer ORTEC and the largest online grocery retailer of the Netherlands, Albert Heijn Online.

Efficient Move Evaluations for Time-Dependent Vehicle Routing Problems with Route Duration Constraints
Thomas Visser (Rotterdam)

We consider the Vehicle Routing Problem with Time Windows, time-dependent travel times and in which route duration is constrained and/or minimized. This problem arises in many real world transportation applications, for instance when modeling road traffic congestion and driver shifts with maximum allowed working time. To obtain high quality solutions for instances of 1000+ requests, (meta-) heuristics are needed, which typically rely on some form of Neighborhood Search. In such algorithms, it is crucial to quickly check feasibility and exact objective change of local improvement moves. Although constant time checks based on preprocessing are known for both the time-dependent VRPTW, and the VRPTW with duration constraints, the combination of the two is significantly harder, leading to quadratic time complexity in the number of requests. We show how preprocessing can be used to decrease the move evaluation complexity from quadratic to linear time. Furthermore, we introduce a new data structure that reduces computation times further by maintaining linear time move evaluation complexity even when the neighborhood is searched in non-lexicographic order. We support our complexity results by presenting numerical results of various benchmark instances.

OVERVIEW OF PARTICIPANTS

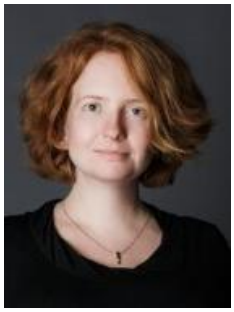
Department of Technology and Operations Management
Erasmus University Rotterdam


Niels Agatz


Alp Arslan


Joydeep Paul

Advanced Analytics
RWTH Aachen


Catherine Cleophas

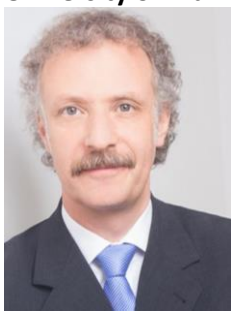

Magdalena Lang

Business Analytics
European University Viadrina, Frankfurt (Oder)


Jan Fabian Ehmke


Charlotte Köhler

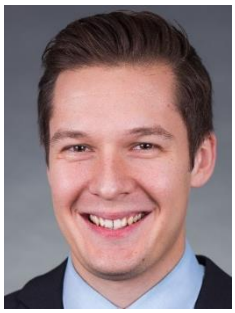
Logistics & Supply Chain Management
University of Mannheim


Moritz Fleischmann


Kilian Seifried

Decision Support
TU Braunschweig


Dirk C. Mattfeld


Artur Ansmann


Ninja Söffker

Department of Econometrics
Erasmus University Rotterdam

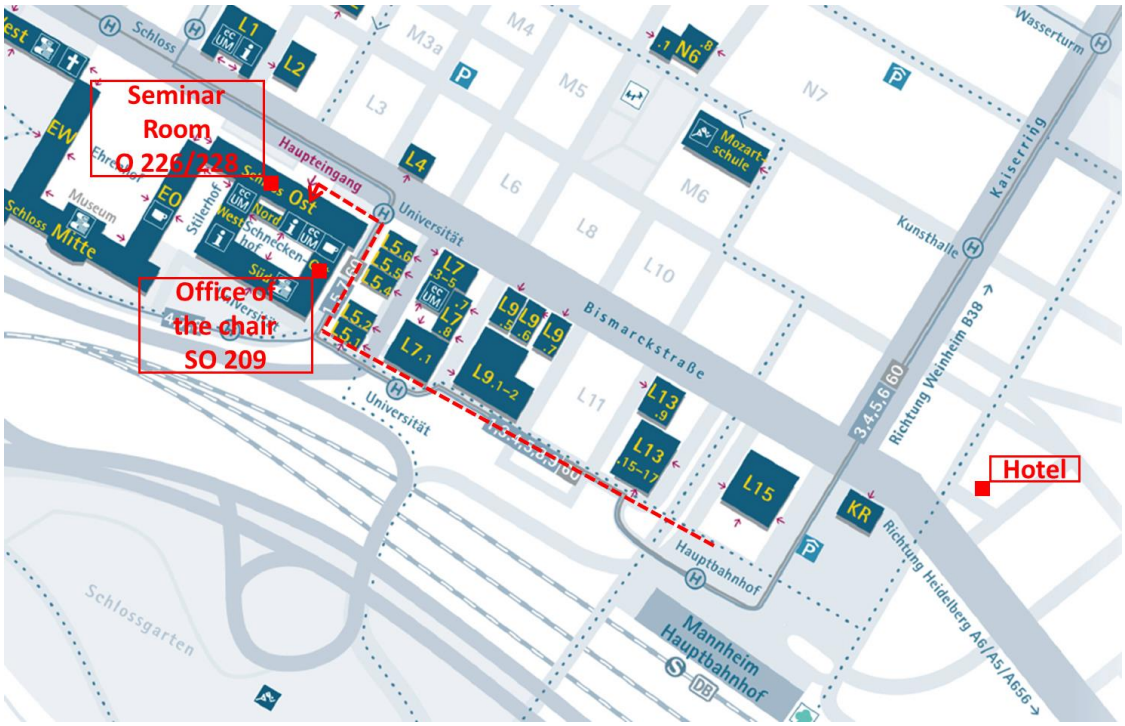

Remy Spliet


Thomas Visser

Operational Research
University of Warwick


Arne Strauss

DIRECTIONS



By foot:
The easiest way to the university is by foot. Exit the train station and turn left. Walk straight along the road right to the InterCityHotel/KPMG building until you are in front of the castle. Then cross the tram rails and walk right around the castle building and enter at the main entrance.

By tram/bus:
Exit at the stop “Universität”.
Note that currently there is large construction going on that leads to major reroutings in the Mannheim tram network. (The advantage: currently almost all lines call at “Universität”.) A map of the current network can be found here. General info on Mannheim public transport you can find at: www.vrn.de

Finding the seminar room:
After entering, walk up the central stairs towards the mezzanine opposite the main entrance. Then walk up two additional flights of stairs and you will find yourself in a room with antique statues. Walk along the corridor starting left of the Laocoon Group until you arrive at the seminar room.
The room number is **O 226/228**.

CONTACT INFORMATION

Office of the chair of Logistics & Supply Chain Management
Room: SO 209
Phone: +49 621 181 1653
E-mail: logistics@bwl.uni-mannheim.de

Moritz Fleischmann
Room: SO 208
E-mail: mfleischmann@bwl.uni-mannheim.de

Kilian Seifried
Room: SO 210
Phone: **+49 621 181 1649**
+49 172 9712937
E-Mail: kilian.seifried@bwl.uni-mannheim.de