Workshop on Traffic Optimization

Date: Thursday, October 8, 2015

Time & Location: 9:00, Room 432
Im Neuenheimer Feld 368
69120 Heidelberg, Germany

Program

Time	Speaker	Title
09:00	Welcome	
09:10	Ángel Corberán Statistics and Operations Research Department University of Valencia, Spain	*"Arc Routing Problems: History, Applications and Perspectives"*
10:00	Coffee break	
10:30	Silvano Martello DEIS, University of Bologna, Italy	*"Routing Problems with Loading Constraints"*
11:20	Tuan Nam Nguyen Institute of Computer Science Heidelberg University, Germany	*"Routing Algorithms in Traffic Assignment Modeling"*
12:10	Lunch	
14:00	Raul Borsche Fachbereich Mathematik Technische Universität Kaiserslautern, Germany	*"Microscopic and Macroscopic Descriptions for Coupled Traffic Models"*
14:50	Coffee break	
15:20	Gábor Galambos Department of Applied Informatics University of Szeged, Hungary	*"Application Oriented Vehicle Scheduling Problems in Public Bus Transportation"*
16:10	End of Workshop	

Abstracts of the talks

Arc Routing Problems: History, Applications and Perspectives

Ángel Corberán
Statistics and Operations Research Department
University of Valencia, Spain

Arc routing problems consist of determining a minimum cost traversal of some or all the arcs or/and edges of a graph, possibly subject to some side constraints. They define an exciting area because, on the one hand, most of these problems are challenging problems from the point of view of its study and resolution and, on the other hand, because they are encountered in many practical situations, such as garbage collection, street cleaning, road maintenance and school bus routing, and, since the money involved on arc routing operations represents millions of Euro, there exists a considerable potential for savings. This talk is about arc (and edge) traversal, arc routing problems and their applications for real-life problems.

Routing Problems with Loading Constraints

Silvano Martello
DEIS, University of Bologna, Italy

Difficult combinatorial optimization problems arise in transportation logistics when one is interested in optimizing both the routing of vehicles and the loading of goods into them. As the separate routing and loading problems are already NP-hard, and very difficult to solve in practice, a fortiori their combination is extremely challenging and stimulating. After a general introduction to vehicle routing and to packing problems, we review vehicle routing problems with two- and three-dimensional loading constraints, as well as other combinations of routing and special loading constraints arising from industrial applications.

Routing Algorithms in Traffic Assignment Modeling

Tuan Nam Nguyen and Gerhard Reinelt
Institute of Computer Science
Heidelberg University, Germany

In traffic assignment modeling, one of the most important tasks is to forecast the potential paths of drivers which depend on one or many objectives. This talk presents some algorithms for finding alternative paths applied in traffic assignment modeling, e.g., k shortest loop-less paths (KSLP), dissimilar shortest paths (DSP), and multi-objective shortest paths (MOSP). We not only give a general introduction, but also introduce new heuristic algorithms for KSLP and DSP. The computational results of the new algorithms are compared with some popular existing algorithms. At the end of the talk, we present an application of routing algorithms in traffic assignment modeling with a case study for the mixed traffic in Hanoi, Vietnam.

Microscopic and Macroscopic Descriptions for Coupled Traffic Models

Raul Borsche
Fachbereich Mathematik
Technische Universität Kaiserslautern, Germany

For traffic phenomena different mathematical models exist, many arising from a microscopic or macroscopic description. In this lecture we discuss a mean-field process to derive macroscopic equations starting from microscopic models. Besides a derivation of some classical models, this technique can help to understand the coupling conditions at intersections in road networks.

Finally we consider the interaction of pedestrians and road traffic. Applying the mean field process to such coupled problems leads to a variety of different models. Depending on the context, either purely microscopic or macroscopic equations or models of mixed types can be obtained. In several numerical examples we investigate these models for different traffic scenarios.

Application Oriented Vehicle Scheduling Problems in Public Bus Transportation

Gábor Galambos, Victor Árgilán, János Balogh, József Békési
Balázs Dávid, Miklós Krész and Attila Tóth
Department of Applied Informatics
University of Szeged, Hungary

For public transportation services a certain number of stations, and previously determined – bus or other vehicles – lines are given. Each line connects a pair of stations. The lines are fixed in timetables which provide the departure and arrival time of the trips for each line, and – sometimes – further services for each day are also fixed. One of the most important subjects of a public transport company is to minimize its operational costs. This process is a complex task, so the procedure is divided into subtasks, and these are to be solved as separated optimization problems, such as route planning, timetabling, vehicle scheduling, driver scheduling and driver rostering.

In this talk we will consider the vehicle scheduling problem (VSP) consisting of scheduling a fleet of vehicles to cover the timetabled trips with minimum cost. Generally, the objective function to be minimized is constructed from the costs of the scheduled vehicles, the transportation costs of the timetabled trips and the service costs of the "deadhead"-trips, which cover any trips without passengers between two geolocation-points. To solve the VSP, certain mathematical models have been investigated. Most of these formulations are based on network-flow models and quasi-assignment approaches. However, in real-world applications further additional constraints are considered which are not covered by these models (e.g. fuelling, the different parking rules, and the maintenance prescriptions). We refer to vehicle scheduling problems with these constraints as application-oriented vehicle scheduling. In the following, some typical real-world motivated application oriented problems are presented.

- According to the transportation company, certain additional conditions need to be considered. The variant traffic conditions may result in different types of buses (e.g. solo-bus, double-bus), taking into account the environmental requirements, a company may prescribe buses with differing propellant (gasoil or gas), and considering the traffic habits low-floor vehicles need to be ordered to certain trips. These new requirements result in a new subproblem which we call vehicle assignment problem.
- Furthermore, if we intend to serve a realistic model, we need to take into account those "soft"-rules which are induced by several driver rules while we produce an acceptable

schedule. These prescriptions can be handled in two steps: firstly we do driver scheduling, which is followed by a driver rostering. The first one decides a theoretical driver ordering, while the second one orders the “real” driver to the scheduled vehicles considering the rules which are presented in a given transport company. Therefore, producing vehicle schedules which are flexible enough for the subsequent driver scheduling and driver rostering phases is a central question in the real-world operational environment.

- A good-managed vehicle scheduling can be destroyed by some unexpected events (e.g. vehicle breakdown, or any lateness according to the timetable). These events may render the accepted schedule infeasible, and so a rescheduling process is requested. Similarly, in a vehicle assignment with respect to the daily schedules in a long-term plan (several weeks or months), it is very hard to fit those duties of the vehicles which are not related to the timetable. In this talk we present efficient models and methods for the above mentioned real-world vehicle scheduling problems.

The solutions were developed by an implementation-oriented approach, which will be demonstrated by real-world test cases.