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Description of Research Seminar: Robust timetable information

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Participants:	UGOE UNIKL DTU UOA UC
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Research Seminar

offered by Marie Schmidt (ES-UGOE-2)

in February 2011,

in Auckland, New Zealand

Subject: Optimization in public transportation - Robust timetable information

Problem: In many applications optimization tools can nowadays be used to calculate good (or even optimal) solutions. Unfortunately, there is one major drawback that prevents many solutions from being established in real-world applications: nearly always there will be some kind of disturbance, e.g. input data changes, disruptions, delays or any other unforeseen event. To overcome such difficulties and make solutions applicable for real-world problems, researchers are working on various concepts of *robustness*. The goal of these concepts is not to find the best solution to the (undisturbed) problem but to calculate a *robust* solution which is still 'good' in case of a disturbance. In robust optimization the objective is purely deterministic. It aims to find a solution to an optimization problem which keeps (maybe relaxed) feasibility when some disturbing events occur. Hence one solves a suitably defined *robust counterpart* of the given optimization problem which takes the uncertainty in the input data into account and which is supposed to produce more robust solutions.

We apply and evaluate the concepts of strict and light robustness for a real-life problem, namely the problem of timetable information which consists of determining a best passengers' path for traveling in a public transportation network. Since delays are unavoidable in most transportation systems, a passenger is interested in a path which enables her to reach her goal even in the case of delays. We investigate how the strict and light robustness models from literature can be used to achieve this goal.

Main Results: The classic notion of strict robustness leads to the problem of identifying those changing activities which will never break subject to the specified set of delay scenarios. We show that this is in general a strongly NP-hard problem. However, a subset of these robust changing activities can be determined by dynamic programming in polynomial time. To this end, we compute the maximum amount of delay which can be accumulated at some arrival event. A strictly robust passenger path can now be found using shortest path algorithms in the network containing only the determined subset of robust connections.

Allowing only strictly robust solutions will often lead to paths with very long travel time that will probably not be accepted by the passengers. The idea of light robustness is to require a certain nominal quality for the robust solution. In our setting this means that the output for the passenger should be a path with reasonable length, that is its length should not exceed the length of a nominal optimal path to much. Among all solutions satisfying this criterion one looks for the "most robust" one.

Given the set of strictly robust connections light robust timetable information can be solved in polynomial time.

Compared to the approach of strictly robust timetable information, light robust paths are not necessarily maintained under disruptions. But taken into account that passengers do not only wish to have a guaranteed travel route, but are willing to sacrifice some robustness for shorter travel times, this trade-off may be wanted. In particular, we can consider light robustness as a bicriteria approach to timetable information, in which the level of robustness can easily be controlled.

Participants: students and researchers from UOA.

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