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Optimization and its Applications in Learning and Industry (OptALI)

IRSES

Ongoing Deliverable D1.2

Description of Research Seminars

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Participants:	UGOE UNIKL DTU UOA UC
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Research Seminar

offered by Simon Bull (DTU)

February 2015,

in Auckland, New Zealand

Subject: Line Planning to Minimize Passenger System Time

Problem: The line planning problem is that of selecting a set of routes in a rail network and assigning a frequency to each, such that operational targets are met and passengers are satisfactorily transported. For Copenhagen's S-train network, an additional factor is that a line may skip stations on its route, so a line is defined by its route and stopping pattern. The possibility of having different stopping patterns for every route greatly increases the problem size.

In the network, passengers spend time traveling in vehicles and transferring between lines. The presence of skipped stations on a line saves some travel time for those passengers bypassing the station but at the expense of passengers traveling from or to the skipped stations, who must possibly transfer more times than if the station were not skipped. Furthermore, due to the large variation in possible line frequencies in the S-train network passengers may have a short wait time when transferring between lines, if the lines are at high frequency, or a significantly longer wait time transferring between less frequent lines.

We address the problem of finding a feasible line plan that minimizes passenger time in the system, taking into account both moving time in train vehicles and the estimated wait time when transferring between lines, dependent on line frequency.

Main Results: We present an initial model and results for the described problem, using data for the S-train network in Copenhagen obtained from the national rail operator in Denmark, DSB. The possibility of arbitrary stopping patterns leads to a very large number of lines; we reduce this by considering only stopping patterns that meet some criteria defined by DSB.

To model passengers, we use OD data obtained from DSB that gives hourly demands between almost every pair of stations. We present a per-OD flow based model for passengers that captures the relevant information on travel time and line transfers, but due to the still-large number of lines and the number of OD pairs, we find the problem to be intractable. However, we present an aggregation of the flow problem which greatly reduces the size of the subsequent integer program (IP) formulation, and show that we are able to find close-to-optimal line plans in reasonable time. We also present some heuristic approaches to reduce the problem size based on the IP formulation, which generally provide better solutions than those obtained by trying to solve the full formulation.

Participants: students and researchers from the University of Auckland.

Publication: -