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Optimization and its **A**pplications in **L**earning and **I**ndustry (OptALI)

IRSES

Ongoing Deliverable D1.2

Description of Research Seminars

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Research Seminar

offered by Philipp Heßler (UNIKL)

in February 2014,

in Auckland, New Zealand

Subject: Evacuation by Bus with Integrated Location Decisions

Problem: In German cities there is a constant threat of unexploded bombs from the Second World War. Mostly, these bombs are found on constructions sites. A recent example for such an incident is the bomb that was found on the 3rd January 2014 in Bonn which killed a construction site worker and injured 13 people. If such a bomb is found the neighboring houses have to be evacuated to shelter locations which are outside the endangered area (gymnasiums in most cases). The largest evacuation due to unexploded bomb took place on the 4th December 2011 when two bombs were found in the river Rhine during a drought. 45000 people had to be evacuated from the city of Koblenz and 12000 places in shelters were prepared.

We consider the evacuation of those people who do not have access to private transportation and rely on public transportation, in our case buses. In a first model the people are evacuated to fixed shelter locations as fast as possible. In the second one we include the decision on where to locate the shelters and the collection points into the model. This will help practinioners to determine good locations for shelters as well as collection points.

Main Results: Our solution to the first model is a branch and bound algorithm. We analysed several lower and upper bounds and their impact on the computation time. The best performing lower bound is based on a network flow relaxation of the bus evacuation problem. The choice of the upper bound does not have a big impact on the computation time and there

is no best upper bound among the bounds we considered but we were able to improve the computation time a lot by a symmetry breaking rule in the branching step.

The second model can be solved with a branch-cut-and-price algorithm which uses our first algorithm as a subroutine. In the pricing step new bus routes are computed by solving a shortest path problem. We branch over the possible location decisions and once all locations are fixed we can apply our branch and bound scheme of the first problem.

Both algorithms perform very well compared to general integer programming solvers. The city of Kaiserslautern provided us with realistic data. The resulting instances were solved to optimality in a few minutes by our algorithms whereas commercial integer programming solvers needed several hours to compute an optimal solution and even some minutes to find feasible solutions at all.

Participants: industry representatives and reasearchers taking part in the OptALI Optimisation in Industry Workshop 2014 in Auckland

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