STSM Scientific Report

Cost Action TD 1207

Host: Prof. Thorsten Koch
                  Technische Universität Berlin, Germany
                  Institut für Mathematik

Visiting person: Dr Hanna Sawicka
                  Poznan University of Technology, Poland
                  Faculty of Machines and Transportation
                  Division of Transport Systems

Period: 28/09/2015 – 10/10/2015
Reference code: COST-STSM-ECOST-STSM-TD1207-280915-067281

Purpose of the STSM

The workshop of the German National Science Foundation Collaborative Research Center TRR 154 "CO@Work" organized at Technische Universität Berlin, was composed of two major streams, i.e. theoretical and practical. It was concentrated on combinatorial optimization and mathematical programming methods, tools, e.g. SCIP, Gurobi, CPLEX, and their applications in companies, e.g. telecommunications, gas transport, rail and traffic, industry. There was presented the theoretical background of these methods and problems' solutions. The participants had also the opportunity to solve problems described as case studies using the wide range of varieties of methods and tools.

The purpose of the STSM was to refresh my current knowledge and acquiring new one within optimization methods and tools. I could combine this experience with the field of my interest, i.e. simulation, multiple criteria decision making, artificial intelligence applied in transportation and logistics networks, to solve real-world problems.

Description of the work carried out during the STSM

The STSM was a great opportunity for me to learn about:
- the work with Linux, i.e. operating system;
- the work with ZIMPL, i.e. the language translating mathematical model into linear and nonlinear mathematical program;
- the advanced optimization techniques (methods and tools) to solve practical transportation problems, such as: knapsack problems, network problems, traffic problems, etc.

The advantage of the presented approaches and tools was the possibility to apply them in real-world situations and to solve very complex problems in a very short time.

My field of interest is focused on application of object-oriented simulation methods and tools combined with multiple criteria decision aiding methods to solve decision problems in transportation and logistics. In some cases it is much more efficient to use optimization techniques.

In such situations I usually applied tools such as Solver by Frontline Systems (add-in to MS Excel). However, in many cases it was time consuming to find the optimal solution. During the STSM it was presented SCIP, which is a solver dedicated for mixed integer programming (linear and nonlinear) problems. It provides very fast solutions. I found it very promising tool, which could complete the field of my research (details are presented in the next part of the report).

Description of the main results obtained

I am considering three different areas of SCIP application. The first one is the research problem of the best (optimal or compromise) assignment of forklifts to the transportation tasks, which I am working on. These tasks are loading and unloading operations in the warehouses. They are spread in the selected EU countries. I am constructing the simulation model in the ExtendSim tool to represent the operations and assignment rules. I would like to compare the results of the computational/ simulation experiments with the optimal solution.

The second one area is didactic, i.e. lectures within the "optimization methods in transportation". There are presented different methods and their applications in the real-world problems, e.g. the transportation method, the assignment method, the shortest path method. I would like to start with the SCIP and add it to the program of studies.

The last one area is also didactic, but these are projects implemented by the students within their masters' thesis. One of them is concentrated on the knapsack problem, i.e. the optimal assignment of different household products to the transportation means, such as trailers and containers. As a supervisor, I would like to share the STSM experience with my student. Her research work would be based on finding the optimal solution using one the tool presented during the CO@Work workshop.

Future collaboration with the host institution

The STSM gave me the opportunity to recognize the host institution area of interest and research. The final stage of my research within SCIP application to solve the above mentioned assignment of forklifts to the transportation tasks problem, would be the starting point of the collaboration with the host institution. The one of the future common research field is the stochastic optimization.

Foreseen publications/ articles resulting from the STSM

There is planned a publication of the research results. This would be a scientific paper concentrated on the computational experiments carried out with an application of simulation tool ExtendSim and optimization tool SCIP. The most important part would be the comparison of different approaches of modeling the problem and the comparison of final results.

Confirmation by the host institution of the successful execution of the STSM

A certificate of participation in the workshop "Combinatorial Optimization at Work 2015" signed by Prof. Thorsten Koch is enclosed to this STSM Scientific Report.