



$$\min \mathbf{w}^T \mathbf{x} + \mathbf{v}^T \mathbf{y}$$

so that $\mathbf{F}\mathbf{x} = \mathbf{e}$

$$\mathbf{A}\mathbf{x} \leq \mathbf{c}$$
$$\mathbf{B}\mathbf{x} + \mathbf{G}\mathbf{y} \leq \mathbf{i}$$



Master Thesis:

Development of Branch-and-Bound Algorithms to Solve European Air Traffic Flow Management Problems with Conflict Reduction

Task-Description:

The European airspace is one of the most congested airspaces in the world. Subsequently, there are many potential separation conflicts between planned trajectories. To reduce the number of conflicts, flight plans should be adapted, without reducing efficiency. Due to the interconnectedness of the trajectories, a large scale Air Traffic Flow Management problem is to be solved. This optimization problem has quadratic conflict cost and linear capacity constraints. The quadratic costs are replaced by linear conflict cost constraints and a surrogate variable. However, linear surrogates for quadratic cost have weak lower bounds in the lp-relaxation; hence the optimization framework SCIP takes a long time to find optimal solutions. The branch-and-bound process is designed so that it is sufficient for a wide range of optimization problems. In this work, the branch-and-bound process should be enhanced with customized modules to solve the ATFM problem more quickly. The Institute of Air Transportation Systems provides a research model for the European ATFM, the Network Flow Environment (NFE). Following tasks should be worked on:

- Get to know the optimization problem of ATFM with deconfliction
- Become acquainted with the solution process of the optimization framework SCIP
- Implement custom branching rules and node selectors
- Study the solution process for selected scenarios
- Discussion and documentation

Requirements:

- Studies in Applied Mathematics, Engineering, Computer Science, Operations Research, etc.
- Motivation and ability to work independently and collaboratively
- High language proficiency of English or German
- Knowledge about Algorithms and Optimization
- Good programming skills (C/C++ preferably, but not necessary)
- Accurate and reliable working style

Begin and duration:

From now on, for approximately 6 month.

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