Polylithic Modeling and Solution Approaches for Hard Mixed Integer Optimization Problems Exploiting Multi-Grid Parameter Techniques

J. Kallrath[1] **and R. Blackburn**[2]

Abstract: Polylithic modeling and solution approaches are tailor-made techniques to solve hard mixed integer optimization problems exploiting several models and their solutions to establish primal feasible points, and sometimes even improved lower bounds of minimization problems. These models can be relaxations of the original MIP problem, or auxiliary models to obtain, for instance, better lower bounds on the original problem, or bounds on integer variables. They can also establish algorithms in their own right, $e.g.$, variants of Fix-and-Relax. Usually, such techniques involve tuning parameters controlling the selection of auxiliary models or conditions under which to operate them. Depending on data instances, these parameter may lead to variations in running time or quality of the solution. It is not possible to determine $a\ priori$ optimal settings of all of those parameters.

To weaken the dependence of the running time and quality of the solution on such tuning parameters and to improve the quality of the solution, we have implemented a multi-grid parameter approach in the algebraic modeling language GAMS. The essence of this approach is to run the whole polylithic approach on several kernels of the CPU or on a cluster of computers in parallel for a full or partial list of parameter combinations. We can either let each job for a certain parameter combination extracted from a list of parameter combinations run for a certain time and extract the best solution, or, alternatively, if we have a problem with a single objective function or if we are able to qualify the goodness of the solution in the multi-criteria case, we can terminate jobs if they are dominated by the current best solution.

Especially scheduling problems benefit strongly from this approach. We demonstrate this by examples from various application areas, among them chemical industry.

In addition to improving the quality of the solution, the grid approach helps us to maintain a test suite of examples for the real world optimization problem at hand, to improve the best solution found so far, and last but not least, to calibrate the tailor-made polylithic approach.

---

[1] Department of Astronomy, University of Florida
Gainesville, FL 32611, USA
jkallrath@ufl.edu

[2] Discrete Optimization and Logistics, Karlsruhe Institute of Technology
76133 Karlsruhe, Germany
robert.blackburn@alumni.uni-heidelberg.de