**A comparative analysis of optimization solvers**

This paper provides a brief comparison of the best-known commercial solvers (Xpress, GuRoBi and CLPEX). Firstly, a timeline of the development of these solvers, as well as some information about different non-commercial solvers is stated. The observed conclusions when analyzing the attributes of these three solvers qualitatively is that there is no single best solver for all types of problems. In general, CPLEX and GuRoBi provide more competitive results on real life problems, with CPLEX being more efficient on highly dimensional problems but GuRoBi being faster due to its use of multiple cores. Xpress howeveri is slightly better at more complex problems and has higher scalability.

**Benchmarks for current linear and mixed integer optimization problems**

A more quantitative comparison of the Xpress, GuRoBi and CPLEX is performed by the author,using the MIPLIB 2010 library which contains test cases of both Mixed Integer and LP problems. This library contains easy, hard and open problems. For the purpose of the benchmark only easy problems were chosen, i.e problem that are considered solvable by commercial solvers in under an hour. Using 30 out of 215 easy instances, that were randomly picked, GuRoBi was found to be the fastest of them all in 14 instances, CPLEX in 9 instances and Xpress in 7. Xpress was only quicker in instances in which all solvers performed similarly, while also not managing to solve (under an hour 3 problems), so was ranked last. Gurobi managed to terminate across all instances and was faster in most, so was deemed best.

**Best practices for comparing optimization algorithms**

This paper aims to review the benchmarking process and provide suggestions fro fair and unbiased comparison. It breaks down the benchmarking process in four step. Firstly, the reason and overall goal behind benchmarking must be clearly determined to efficiently test algorithms. Secondly, the relevant test sets must be located based on the goal of the problem. The authors state relevant test sets that can be used based on different problems. Additionally, common pitfalls and best practices of selecting test cases are stated such as optimal size of problems and variety of problems examined. Then, the authors state ways of measuring the performance of algorithms. These boil down to three measures, efficiency, which concerns measures such as time to execute and iterations of solver, reliability, which concerns with the ability of a solver to terminate within a specific time window and quality of the output. Finally, a significant part of the paper is focused on the importance of analyzing and reporting the results in an understandable and explainable way. Such ways include tables (which is the most inclusive way, but can be hard to read and understand and graphics which are easier to understand but pack less information. Other ways that are used include performance profiles, accuracy profiles and data profiles.

**Analysis of commercial and free and open source solvers for linear optimization problems**

This paper conducted a case study for comparing both open source and commercial solvers on both MILP and LP problems, with the MILP problems being taken similarly to the first paper by the MIPLIB library and the LP problems being randomly generated and all being a different instance of a cell suppression problem. FIrstly, the superiority of the commercial solvers was stated when performing analysis on the MIPLIB test cases. The open-source solvers (GLPK, LP-solve) achieved optimality in approximately 5 % of the instances, always in much slower wall clock time. However, even the commercial solvers (Xpress, CPLEX,GuROBi)  failed in 28% of the test cases. Similar performance was reported in the LP cases, although in this case the open-source solvers always managed to find a solution, albeit much slower than commercial ones.