Multi-Paradigm Evaluation of Exact Solvers in Graphical Model Discrete Optimization

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Abstract. Graphical models on discrete variables allows to model NP-hard optimization problems where the objective function is factorized into a set of local functions. In the graphical interpretation, each function's scope is represented by a clique. Deterministic graphical models such as Cost Function Networks (CFN) aim at minimizing the sum of all functions (or constraints if zero/infinite costs are used). Probabilistic graphical models such as Markov Random Fields (MRF) aim at maximizing the product of all functions (or constraints if using zero/one values) in the task of finding the most probable state. A direct (-log) transformation exists between the two frameworks that can also be modeled as Weighted Maximum Satisfiability (MaxSAT) or Integer Linear Programming (ILP). Strong connections exist between linear programming and bounds used in graphical models.

We report a large comparison of state-of-the-art exact solvers on several deterministic and probabilistic graphical models coming from the Probabilistic Inference Challenge 2011, the Weighted Partial MaxSAT Evaluation 2013, the Max-CSP 2008 Competition, the MiniZinc Challenge 2012 and 2013, and two libraries of Cost Function Networks and Computer Vision and Pattern Recognition problems (OpenGM2). These competitions are usually restricted to a family of dedicated solvers. We instead compare the efficiency of eight state-of-the-art exact solvers of each optimization language on these encodings. It includes MRF solvers daoopt (`https://github.com/lotten/daoopt` version 1.1.2), mplp2 (`http://cs.nyu.edu/~dsontag/` version 2), toulbar2 (`http://mulcyber.toulouse.inra.fr/projects/toulbar2/` version 0.9.6), MaxSAT solver maxhs (`http://www.cs.toronto.edu/~jdavies/`), ILP solver cplex (version 12.2), and constraint programming solvers numberjack mistral (`http://numberjack.ucc.ie/version1.3.40`), gecode (`http://www.gecode.org/` version 4.2.0), and opturion-cpx (`http://www.opturion.com` version 1.0.2).

All the 3018 instances are made publicly available in five different formats (uai, wcsp, wcnf, lp, mzn) and seven encodings at `http://genoweb.toulouse.inra.fr/~degivry/evalgm`. The results suggest the opportunity for a simple portfolio approach.

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