An Experimental Evaluation of CP/AI/OR Solvers for Optimization in Graphical Models

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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 Network (CFN) aim at minimizing the sum of all functions (or constraints if zero/infinite costs are used). Probabilistic graphical models such as Markov Random Field (MRF) aim at maximizing the product of all functions (or constraints if using zero/one probabilities). A direct (-log) transformation exists between the two frameworks that can also be modeled as weighted MaxSAT or ILP. Strong connections exist between LP itself and bounds used in graphical models.
We report a large comparison of state-of-the-art CP/AI/OR exact solvers on several deterministic and probabilistic graphical models coming from the Probabilistic Inference Challenge 2011, the Weighted Partial MaxSAT Evaluation 2013, the MiniZinc Challenge 2012 and 2013, and a library of Cost Function Networks. 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 CP 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 1062 instances are made publicly available in five different formats (uai, wcsp, wcnf, lp, mzn) and seven formulations at `http://genoweb.toulouse.inra.fr/~degivry/evalgm`. The results suggest the opportunity for a simple portfolio approach and we give preliminary results based on the numberjack platform.

Keywords: Graphical Model, Markov Random Field, Weighted Constraint Satisfaction Problem, Integer Linear Programming, Max-SAT

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