Max-CSP competition 2007: toolbar/toulbar2 solver brief description

S. Bouveret[3], S. de Givry[1], F. Heras[2], J. Larrosa[2], E. Rollon[2], M. Sanchez[1], T. Schiex[1], G. Verfaillie[3], and M. Zytnicki[1]

[1] INRA, Toulouse, France
[2] Dep. LSI, UPC, Barcelona, Spain
[3] ONERA, Toulouse, France

All solvers, except toolbar/MaxSAT, exploit an initial upper bound found by INCOP local search solver.

```
B.Neveu, G.Trombettoni.
INCOP: An Open Library for INcomplete Combinatorial OPtimization.
In Proc. of CP2003, LNCS 2833, pages 909-913, Cork, Irlande.
ftp://ftp-sop.inria.fr/coprin/neveu/articles/cp03.ps.gz
command line parameters:
narycsp result problem.wcsp 0 1 5 idwa 100000 cv v 0 200 1 0 0
```

toolbar (in C code)

The search procedure is MEDAC*, a branch and bound with soft local consistency as described in:

```
S. de Givry, M. Zytnicki, F. Heras, and J. Larrosa.
Existential arc consistency: Getting closer to full arc consistency in WCSP
In Proc. of IJCAI-05, pages 84-89, Edinburgh, Scotland, 2005.
http://www.inra.fr/mia/T/degivry/Heras05.pdf
```

No options are used, except in a preprocessing step, n-ary constraints of arity smaller than 10 are projected on binary constraints.

toolbar/BTD (in C code)

The search procedure is EDAC-BTD+, a branch and bound exploiting a tree decomposition and soft local consistency as described in:

```
S. de Givry, T. Schiex, and G. Verfaillie.
Exploiting tree decomposition and soft local consistency in Weighted CSP.
In Proc. of AAAI-06, page 6p., Boston, MA, 2006.
http://www.inra.fr/mia/T/degivry/Schiex06a.pdf
```

The min-degree heuristic is used to compute a tree decomposition. The root cluster is chosen as minimizing tree height then maximizing cluster product of domain sizes. Cluster separators larger than 5 are removed, by merging clusters. The same preprocessing as toolbar for n-ary constraints is done. The value heuristic chooses the last value in the best solution found so far before sorting values by increasing unary cost.

toolbar/MaxSAT (in C code)

The search procedure is Max-DPLL, a branch and bound enhanced by several inference rules as described in:

```
F. Heras & J. Larrosa.
New Inference Rules for Efficient Max-SAT Solving.
In Proc. of AAAI-2006. Boston, USA, 2006.
http://www.lsi.upc.es/~larrosa/PAPERS/PAPER-AAAI-06/pic.pdf
```

The usual direct encoding is used to convert Max-CSP into Weighted Max-SAT. An initial upper bound is found by maxwalksat (Selman et al., 1993) local search solver with 5 tries.

toulbar2 (in C++ code)

The search procedure is the same as toolbar, i.e. MEDAC*, except that:

- EDAC* propagates soft ternary constraints as defined in:

  ```
  M. Sanchez, S. de Givry, and T. Schiex.
  Mendelian error detection in complex pedigrees
   using weighted constraint satisfaction techniques.
  In Constraints, 2007, to appear.
  ```

- the variable heuristic includes a basic form of conflict back-jumping as described in:

  ```
  C. Lecoutre, L. Sais, S. Tabary, and V. Vidal.
  Last Conflict based Reasoning.
  In Proc. of ECAI-06, pages 133-137, Trento, Italy, 2006.
  http://www.cril.univ-artois.fr/~lecoutre/research/publications/ -
  2006/ECAI2006LAST.pdf
  ```

- the search uses a binary branching scheme: domain splitting is applied to the chosen variable for domain sizes greater than 10, otherwise the chosen variable is assigned to its fully supported value (EAC*) or this value is removed from its domain.
- a limited form of variable elimination (with degree less than or equal to 2) is applied during the search as proposed in:

  ```
  J. Larrosa, E. Morancho, and D. Niso.
  On the practical applicability of Bucket Elimination:
   Still-life as a case study.
  Journal of Artificial Intelligence Research. 23 :421-440, 2005.
  ```

- a Limited Discrepancy Search (Harvey and Ginsberg, IJCAI-95) scheme is performed by iteratively running MEDAC* with a power-of-two increasing limit in the number of discrepancies until optimality proof has been reached (when no limit occurred).