Robust Solutions in Constraint Programming
(Master ORO)

Providing robust solutions for constraint problems is crucial in practice: either some data may be unknown, or unexpected changes may appear and requiring some modifications within a given solution. In this work we will not consider the problem of dynamic constraint networks (where some constraints may be removed or added and the solution can be repaired in order to remain valid). We will focus on the case where the user needs to change the value of one or several variables in a solution.

In this context, two main classes of techniques exist: predictive methods (when the data are not complete) and reactive approaches, which aim at finding solutions minimizing the effect of the modification of one or several values of variables. These techniques are either specific to an applicative context, e.g., scheduling problems solved by linear programming [1][2][3], or more generic, e.g., super-solutions for constraint problems [4]. Algorithms used to find super-solutions are not suited to event-based solvers, where propagators exploit the structure and some properties of constraints. Moreover, to become a standard implemented in all existing solvers, the notion of super-solution should be validated in several practical contexts, which is not the case nowadays.

This research work will have three main objectives:

- Provide an exhaustive state of the art of techniques and problems where finding robust solutions is of interest.
- Highlight the links between the different definitions of robust solutions and the corresponding solving techniques.
- Provide a new generic approach, suited to a set of practical problems (e.g., by refining the notion of "linked variables"), and that can be directly implemented with an event-based constraint toolkit. Experiments will be implemented using Choco (http://www.emn.fr/z-info/choco-solver/), a free constraint solver written in java.

[1] C. Artigues, J.C. Billaut, and C. Esswein. Maximization of solution flexibility for robust shop scheduling. European Journal of Operational Research, 165(2):314-328, 2005.
[2] W. Herroelen, R. Leus. Project scheduling under uncertainty: Survey and research potentials. European Journal of Operational Research 165(2): 289-306, 2005
[3] C. Artigues and R. Leus. Une approche d'optimisation robuste pour l'ordonnancement de projet sous contraintes de ressources avec durées incertaines. In 11ème congrès de la société Française de Recherche Opérationnelle et d'Aide à la Décision (ROADEF 2010), Toulouse, 2010.
[4] Robust Solutions for Constraint Satisfaction and Optimisation under Uncertainty, ph.D thesis, Emmanuel Hebrard, University of New South Wales, 2006.

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