Improved Algorithm for Finding (a,b)-Super Solutions

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Abstract. Super solutions are a mechanism to provide robustness to constraint programs. We introduce a new algorithm that exploits the similarity between a super solution and its repairs in order to do inference during search. It improves on previous methods since it is more space efficient and also faster in practice.

The super model/solution framework [2,3] permits us to formalize a notion of fault tolerance. An (a, b)-super solution is a solution in which, if a small number of variables lose their values, we are guaranteed to be able to repair the solution with only a few changes. We introduce a new algorithm for finding super solutions that solves a *master problem* and a number of *sub-problems* generated during search. This approach is simple and can be implemented using most of the constraint toolkits currently available. We then show how we can do inference while solving a subproblem to reduce the master problem.

The main observation that we make in order to improve the search for a super solution is that there must be at least $n - (a + b)$ variables assigned equally in the master problem and any sub-problem. For a given sub-problem, if the set, or a subset, of variables that need to be assigned the same as in the master problem is known, then we can prune both the master and the sub-problem, thus greatly reducing the search space. We introduce two methods to discover these variables. The first method uses classical filtering methods (such as GAC or SAC [1]). The second idea is that, intuitively, a repair must be *close* to the break in the constraint graph. For instance, in a $(1, 1)$-super solution, any "repaired" variable must share a constraint with the "broken" variable. We use the corresponding notion of neighborhood to deduce equalities between master and sub-problems.

References

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P. van Beek (Ed.): CP 2005, LNCS 3709, p. 848, 2005.