

Cooperative Problem Solving

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Constraint programming evolution

1. constraint programming system = **black box system**
 - tightly integrated language and solver
2. constraint programming system = **modelling tool + solver**
 - the language is separated from one solver
 - solver = blackbox system
3. constraint programming = **modelling tools + strategies + solvers**
 - several (glass box) solvers
 - control for making solvers cooperate
 - strategy: from a few functionalities to a complete language

Needs for cooperations/strategies

- resolution aspects:
 - hybrid constraints/problems (sharing variables)
 - distributed problems (either by nature, or for security and confidentiality reasons)
 - inefficiency of generic solvers
w.r.t. specific (but with limited scope) solvers
 - demand for better performance
 - quality of solutions
- software engineering aspects:
 - reuse and integration of solvers
 - extensible and flexible systems

Major aspects of cooperation

- formal framework:
 - semantics (result): global optimum, correctness, completeness
 - proof of cooperative algo.: fixed point, termination, complexity
- interaction (data):
 - shared constraints and variables
 - exchanged information
- strategy (control):
 - control of resolution
 - coordination of solvers
- software engineering:
 - system architecture
 - communication
 - interoperability

Types of cooperations

- intra-solver cooperation (endogenous cooperation):
 - cooperation of “simple” functionalities (“parts” of solvers)
 - glass box mechanism
 - mainly devoted to propagation-based solvers
- ad-hoc cooperation (exogenous cooperation):
 - devoted to a class of problems
 - solvers, interaction, and strategies are fixed
- cooperation languages (exogenous cooperation):
 - tools for solver integration and reuse
 - instructions for controlling resolution and designing strategies

Future Prospects

- a robust cooperation system
- separate computation strategy from search strategy
 - Constraint programming = modelling tools + computation strategy + search strategy + solvers
- towards a kind of calculus for cooperation:
 - a relation linking cooperation, solvers, constraint properties
 - to analyze cooperations
 - to automatically generate cooperations
 - an abstract machine
- synergies between:
 - complete + incomplete methods,
 - local search,
 - CP + AI + OR, ...