Research Topics in Constraint Programming

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MoVES Meeting
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Constraint Satisfaction Problem

- What is a CSP?
  - A set of variables, defined over domains
  - A set of constraints over the variables

- What is a solution?
  - A solution is a consistent assignment of values to the variables
  - Consistent assignment: does not violate any constraint

- Possibility to have an objective function
  - Find a solution maximizing the objective function

- CSP: simple example of a formal representation language
Solving CSP

- Specialized algorithm (for a specific CSP)
- Linear / mathematical programming
- SAT
- Local search
- Constraint programming
- ...
Constraint programming

- A field at the intersection of
  - Artificial intelligence
  - Operational research
- A framework for solving CSP

Objectives

- To reduce the development time
- To preserve efficiency
The CP Process

Constraint programming approach to programming:

- Formulate and represent your problem as a CSP (modeling)
  - listing the constrained variables (objects)
  - specifying the constraints expressing relationships between objects
- Solve the chosen representation using
  - (domain specific methods),
  - Or general methods

Flexible representation
- constraints can be added, removed, modified
Research topics

- Introduction of new structured domains
- Design of global constraints
- Constrained-based local search
- Constraints and Bioinformatics
Structured domains

- Existing structured domains in CP: sets
- Introducing new structured domains
  - Graphs: the domain of a graph variable is a set of graphs
  - Maps: the domain of a map variable is a set of functions
- Extending the CP languages to handle these new structured objects
- Design of (efficient) propagators
- Solving problems with these new objects
  - Subgraph isomorphism
Research topics

- Introduction of new structured domains
- **Design of global constraints**
- Constrained-based local search
- Constraints and Bioinformatics
Global constraints

- Global constraints on graphs
- Global constraints to handle statistical properties of a solution
  - E.g. Find values with the “best” deviation
- Global constraint for scheduling problems
Research topics

- Introduction of new structured domains
- Design of global constraints
- Constrained-based local search
- Constraints and Bioinformatics
Constrained-based local search

- A new paradigm for local search, based on constraints
- Problems are modeled using constraints
- Search of solutions using local search paradigms
- Supported by the Comet language
- P. Van Hentenryck and L. Michel

Constraint-Based Local Search
MIT Press, 2005
Do not miss …

GRASCOMP Graduate School in Computing Science

CONSTRAINT-BASED LOCAL SEARCH

by Pascal Van Hentenryck (Brown University)

20, 21 & 22 June 2007

UCL

See GrasComp web site for details
Research in CB local search

- Hybridation of local search and Constraint Programming
- Integration of very large neighborhood search techniques
Research topics

- Introduction of new structured domains
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Biochemical Networks

- Networks of **interactions** between biological entities within the cell
  - Gene (part of the DNA)
  - Polypeptide (Protein)
  - Complex (formed by several polypeptides)
  - Compound (ATP, ADP, water, proline, ...)

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Objectives and approach

- Design **methods** and associated software tools for the **analysis of biochemical networks**

- Integration of
  - standard (efficient) approaches
  - Constraint Programming framework
  - Machine Learning framework

- BioEdge prototype
People in UCLouvain

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