The Royal Academy of Engineering

Global Research Awards

A Geometrical Approach for Finite Set Constraint Languages

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Host: Brown University, RI, USA

CONTEXT: The complexity of tackling combinatorial design problems has created an urgent need to develop new appropriate programming environment systems that combine ease of modelling with effective resolution techniques.

APPLICATIONS: Such combinatorial problems are present in real world applications in areas as diverse as 1) coding, 2) sport scheduling, and more recently 3) optical networks and 4) cryptography.
Such problems share some structural properties among which a natural set-based setting including intersection constraints, cardinality restrictions, and inherent symmetries. $X \subseteq \{1,..,10\}, |X| < 5, X \cap \{3,4\} = \varnothing$

CHALLENGE: To model such problems with a natural formulation enhanced with effective techniques, a new generic modelling language needs to be designed based on sets, with effective algorithms. Existing systems are expressive but lack efficiency!

The secondment consisted of designing such a new set solver that combines expressiveness and efficiency.

Approach : New set domain representation and set solver based on a dual view of variables & constraints
Technical idea: Length-lex ordering on the domain (instead of inclusion)

Achievements:

- New algorithms performing operations in $\tilde{O}(k)$ time (k is the set cardinality)
- Very competitive pruning at a fraction of the computational cost!

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