Slides for NSF Panel on Constraint Solving

Research Challenges in Constraint Solving

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Constraint Solving

All problem solving is constraint solving.

The range of problems include geometric constructions, planning/scheduling/optimization, search, CAD/CAM, databases, and puzzles and games.

Applications within the core of computing include modeling, verification, refinement, test generation, static analysis, compiler optimization, and program execution.

I had predicted many years ago that fast constraint solvers would be used in everything from toasters to airplanes. We ought to be there now!

All programming is logic programming. —Bob Floyd

Varieties of Constraint Solving

Numeric: Find concrete assignments to variables — soundness and incompleteness might be tolerated.

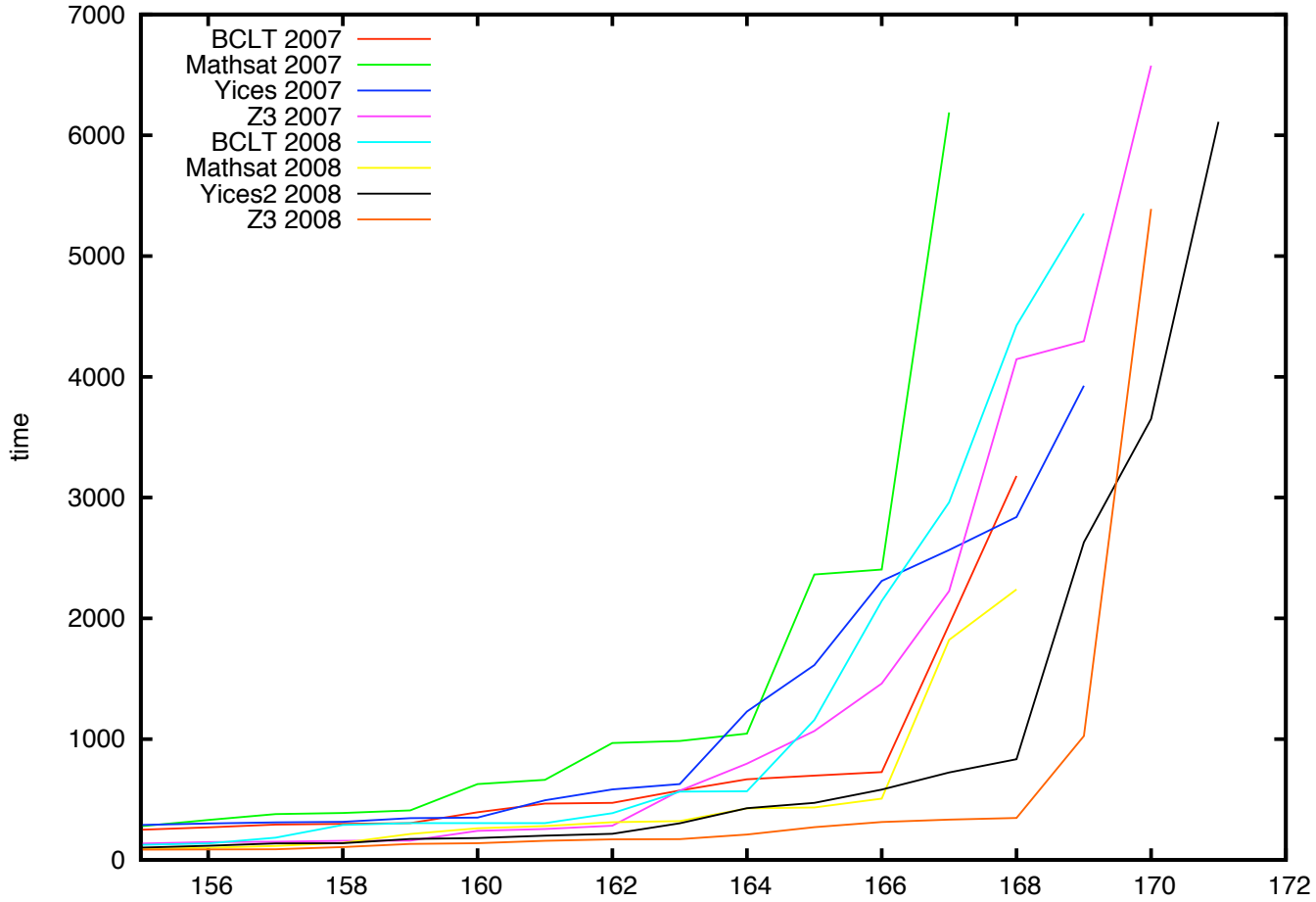
Symbolic: Use logical and algebraic manipulations for demonstrating infeasibility as well as in extracting concrete solutions.

Probabilistic: Given some probabilistic constraints, what is the marginal probability of a particular observation?

Game: Find a winning strategy.

Meta-constraint: Find a formula, e.g., program, invariant, or interpolant, satisfying a constraint.

SMT Progress on QF_RDL [courtesy Bruno Dutertre]



Research Directions

- **Efficiency:** Algorithms, Heuristics, Abstractions, Explanations, Propagation, Hacks.
- **Expressiveness:** More theories (nonlinearity), Combination techniques, Soft constraints, Model counting, Interfaces, Optimization, Models, Proofs.
- **Meta-Constraints:** Invariants, Interpolants, Ranking functions, Strategies, Programs, Processes, Constructions.
- **Applications:** Program analysis and optimization, CAD/CAM, cryptography, Cyber-Physical Systems (Medical, Transportation, Energy, Environment), Education.