**Hybrid Approaches based on Lagrangian Relaxation**

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Lagrangian relaxation is a fundamental technique in discrete optimization and operations research, with numerous practical and theoretical applications on a variety of problem classes. In this talk we present a novel way on how Lagrangian-based concepts can be applied to naturally link distinct solution methods, in particular mathematical programming, constraint programming, and decision diagram-based optimization. Our technique assumes a constraint programming framework where constraints are processed one at a time and can explicitly represent richer substructures, such as an assignment subproblem. The underlying idea of the method is to perceive the constraint programming model as a natural decomposition of the problem, where each constraint reasons on its own set of variables. The communication between constraints is then achieved by introducing Lagrangian penalty costs between pairs of constraints. The role of these penalties is to force linking conditions among constraints, such as that the variable assignments in each of the constraints should correspond to one another. The multipliers are then used to deduce new constraints (or cuts) by performing sensitivity analysis on a linear programming or a generic decision diagram relaxation of the problem.
We discuss theoretical properties of this model, and show that propagating Lagrangian cost information can help improve the overall bound computation as well as the solution time on scheduling and other classes of problems.