CO 452/652: Integer Programming

Winter 2009 MWF 12:30-1:20pm

http://www.math.uwaterloo.ca/~cswamy/courses/co652/

Instructor: Chaitanya Swamy

Prerequisite: Knowledge of linear programming at the level of CO350 or higher.

Course Outline

Integer programs are optimization models that provide a great deal of flexibility and modeling power, but are are often notoriously hard to solve and are much less understood compared to linear programs in terms of solution methods. This course will cover the theory of integer programming, which has its roots in elegant polyhedral theory and duality, its applicability in modeling optimization problems, and algorithms for solving integer programs. A significant subset of the following main topics will be covered.

1. **Cones, convexity, Farkas' lemma and its geometric interpretation.**
2. **Polyhedral theory.**
   - Polytopes, faces, dimension of polyhedra
   - Integral polyhedra: total unimodularity, total-dual-integrality
   - Algebraic and optimization techniques for proving integrality of polyhedra
   - Applications of polyhedral theory to combinatorial optimization
3. **Modeling and formulations, strengths of formulations.**
4. **Valid inequalities and procedures for generating them.**
   - Chvátal-Gomory cuts
   - Lift and project methods: the Balas-Ceria-Cornuéjols, Sherali-Adams, and Lovász-Schrijver procedures
   - Rank of a valid inequality
5. **Algorithms for solving integer linear programs.**
   - Cutting-plane algorithms
   - Branch and bound
   - Duality in integer optimization and its algorithmic consequences
   - Complexity of integer programming
   - Algorithms for special classes of problems
6. **Separation vs. optimization.**