Course Syllabus OIDD 916, spring 2018.

Textbook

The textbook used is "Integer Programming",

by M. Conforti, G. Cornuejols and G. Zambelli, Springer.

Additional reading material will be distributed during the semester.

List of topics to be covered (among others):

Course overview. Examples of problems with large integrality gaps, and with feasible rounded solutions yielding large relative gaps.

Review of LP duality, and of the primal and dual simplex methods, with emphasis on re-optimization after the addition of violated cuts. The dual simplex method for LPs with upper bounds. Additional readings:

http://iems.northwestern.edu/~4er/WRITINGS/index.html#dual

http://www.ifors.ms.unimelb.edu.au/tutorial/simplex_dual_engine/index.html

Branch-and-bound and enumeration. Driebeck penalties, Tomlin penalties.

0-1 knapsack problems. Their LP solutions. BB. Cover inequalities.

Primal relaxation and Lagrangean relaxation. For this section, download the tutorial from the website. Geometric interpretation, integrality property. Integer linearization property, application to the capacitated p-median problem. Analysis of Lagrangean relaxation schemes and quality of bounds from the viewpoint of the geometric interpretation. Application to the GAP and review of all possible constraint dualizations. Integer linearization property for the capacitated facility location problem when the demand constraint is dualized. The bi-knapsack problem. Construction of the Lagrangean function for the total Lagrangean relaxation. Integrality property. Properties of the Lagrangean function. Examples. Contours, subgradient method. Convex nondifferentiable functions and subgradients. Extensions of Lagrangean relaxation: Lagrangean decomposition and substitutions. Examples.

Dantzig-and-Wolfe decomposition algorithm, solution of the Lagrangean dual by column generation: example of the multi-item capacitated lotsizing problem and the GAP.

Valid inequalities. Chvatal-Gomory procedure.

Linear programming relaxation and Gomory cuts for pure and mixed-integer problems.

Lifting, covers, lifted covers.

Modeling integer programming problems: choice of decision variables and of constraints, simple strengthening techniques. Examples: SPLP, CPLP, lotsizing, with and without disaggregation. Integrality gaps. Model tightening (see paper). (throughout the semester)

Variable fixing, cliques and implication tables, probing.

Total unimodularity. Relationship with integer feasible solutions for integer programming problems. Special cases of network flow problems.

Benders partitioning for mixed-integer problems. Examples. Initialization. Gams coverage of Benders. Benders inequalities of types I and II, obtained from simplex tableau and their use outside of the partitioning algorithm. Special examples with and without dual extreme rays.

Other relaxations. Surrogate relaxation and surrogate duals

Applications: airline crew scheduling, lotsizing, facility location, production scheduling... (throughout the semester).

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