Math. Program., Ser. B 105, 157–160 (2006)

Digital Object Identifier (DOI) 10.1007/s10107-005-0646-8

Thomas M. Liebling · Denis Naddef · Laurence A. Wolsey

Combinatorial Optimization: Theory and Computation

The Aussois Workshop 2004

Received: July 11 2005 /
Published online: 10 November 2005 –

The present issue contains selected papers presented at the 2004 Aussois Workshop on Combinatorial Optimization. This workshop has become a well-known institution: that brings together senior and younger researchers who share their enthusiasm for the field. It is an occasion for fruitful encounters, exciting presentations and quiet work in ad-hoc groups leading to lasting partnerships. This is why this workshop has been integrated into the activities of the network *ADONET* gathering members from ten countries and sponsored by the 6th Frame Program of the European Union. Thus Aussois has indeed become an important and highly appreciated contact surface for the young researchers from that network, a fact reflected by several of the present papers.

Furthermore, the papers collected in this issue nicely illustrate that the year 2004 brought many exciting new developments to combinatorial optimization. The papers were grouped into the two categories *theory* and *computation*. The first includes contributions to the advancement of the theory of combinatorial optimization and related fields, in particular polyhedral combinatorics, optimization on graphs and other finite structures, as well as complexity issues. The second group contains contributions addressing issues in modeling and computation, an area of immediate practical impact. In particular several papers describe advances in mixed integer programming, others include novel applications in biology and finance as well as the more traditional but in no-way easier ones stemming from logistics in particular. However, it is worth noting that most papers in both groups propose or are motivated by models approaching real life problems. Indeed, such problems are an important, if not the most important, driving force of the discipline. This certainly doesn't mean that the reader will not find beautiful mathematics in the following pages, indeed the opposite is true. Here is a quick overview of the contents:

Theory

– Recognizing Balanceable Matrices by M. Conforti and G. Zambelli
  This paper deals with recognizing balanceable 0/1 matrices, that can be signed such that they become balanced. A polynomial time algorithm is proposed that explicitly

T.M. Liebling: EPFL Lausanne, Switzerland

D. Naddef: INPG Grenoble, France

L.A. Wolsey: UCL CORE Louvain-la-Neuve, Belgium

Mathematics Subject Classification (2000): 20E28, 20G40, 20C20

finds one of the forbidden submatrices characterizing balanceable graphs or proves that none exists.

- Network Reinforcement by F. Barahona
  This paper considers the problem of determining an optimal set of (copies of) supplementary weighted edges to be added to a given graph to make it contain k disjoint spanning trees. An algorithm is proposed that has the same complexity as solving k minimum cut problems.
- Independent Packings in Structured Graphs by K. Cameron and P. Hell
  This paper shows that the independent $\mathcal{H}-$packing problem, which is NP-complete in general, can be solved in polynomial time for every family $\mathcal{H}$ of connected graphs, provided the input graph belongs to a number of well known structured classes.
- Polyhedra related to integer-convex polynomial systems by Michaels D. and R. Weismantel
  This paper deals with polynomially constrained integer programs and their linear relaxation via polyhedra associated with non-linear functions. A new class of polynomials (integer convex polynomials) and associated polyhedra are investigated. First numerical examples for this novel approach are presented.
- On Balanced Graphs by F. Bonomo, G. Durán, M. Chih Lin and J.L. Szwarcfiter
  This paper studies balanced graphs, introduced by Berge. It gives new characterizations of them by forbidden subgraphs and clique-subgraphs. Sub-classes of balanced graphs are proposed whose 0/1 metrics can be recognized in polynomial time and for some of which combinatorial algorithms solving stable set, clique-independent set and clique transversal are given.
- Projection Results for Vehicle Routing by A. Letchford and J.J. Salazar-González
  The paper gives many results on relations between various formulations of vehicle routing problems.
- On the complexity of the planar directed edge-disjoint paths problem by D. Müller
  The result of the paper is not just one of many NP-completeness results, but an important information for future research in the field; it settles the complexity of a basic multiflow problem which is the easiest in a large class, so its NP-completeness is a most general new result containing many previous ones.
- Critical extreme points of the 2-edge connected spanning subgraph polytope by J. Fonlupt and R. Mahjoub.
  This paper deals with a particular ordering of the extreme points of $P(G)$, the linear relaxation of the 2-edge connected spanning subgraph polytope. Necessary conditions are given for a non-integer extreme point of this polytope to be minimal. This allows to characterize perfectly 2-edge connected graphs that is those graphs, whose polytope $P(G)$ is integral.
- Almost all webs are not rank-perfect by A. Pécher and A.K. Wagler
  This paper studies facets of the stable set polytope. It is shown that almost all webs with clique-number > 5 admit non-rank facets.
- A linear programming formulation for the maximum complete multipartite subgraph problem by D. Cornaz.
  This paper studies the problem of finding a maximum complete multipartite subgraph and its weighted version. A binary linear programming formulation with possibly

exponentially many constraints is given. However, its linear relaxation can be solved polynomially.

– Polyhedral description of the integer single node flow set with constant bound by A. Agra and M. Constantino
The integer single node flow problem with constant lower and upper bounds on the variables is addressed in this paper, a problem which appears as a subproblem in some integer programs. A complete description of the convex hull of the feasible solution set is given. The result is based on facet-defining inequalities for the convex hull of integer knapsack sets with two variables.

Computation

– Conditional value-at-risk in stochastic programs with mixed integer recourse by R. Schultz and S. Tiedemann
The authors study the two-stage stochastic integer programming problem with a conditional value-at-risk objective, deriving properties of the objective function, an explicit mixed integer linear programming formulation and proposing a Lagrangean based algorithm.
– Aligning multiple sequences by cutting planes by E. Althaus, A. Caprara, H.-P. Lenhof and K. Reinert
The authors propose a cutting plane approach for the allignment of multiple sequences, a central problem in computational biology. They develop an integer programming model that includes arbitrary gap costs in addition to the alignment costs. The solutions obtained produce better alignments from the biological point of view than earlier approaches.
– An algorithmic framework for the exact solution of the prize-collecting Steiner tree problem by I. Ljubic, R. Weiskircher, U. Pferschy, G.W. Klau, P. Mutzel and M. Fischetti
This computational paper presents a powerful branch-and-cut algorithm for the prize-collecting Steiner tree problem combining several state-of the-art methods, allowing the solution of all the outstanding benchmark instances, including instances in the design of fiber optic networks.
– Computational experience with a bundle approach for semidefinite cutting plane relaxation of Max-Cut and Equipartition by I. Fischer, G. Grüber, F. Rendl and R. Sotirov
This paper presents an innovative approach to solve combinatorial problems with a very large number of inequalities. It is illustrated on the Max-Cut and Equipartition problems.
– A new ILP-based refinement heuristic for Vehicle Routing Problems by M. Fischetti and R. de Franceschi and P. Toth
This paper presents a new heuristic for the Distance and Capacity constrained Vehicle Routing Problem. This heuristic is derived from one developed for the Traveling Salesman Problem.
– Approximate extended formulations by M. Van Vyve and L.A. Wolsey
This computational paper addressing mixed integer programming studies extended formulations involving new variables. The authors define approximate extended

formulations whose degree of approximation is parameterized. Computational experience tends to show that small parameter values (weak but compact approximations) often suffice.

- Sequence independent lifting for mixed integer programs with variable upper bounds by S. Shebalov and D. Klabjan
  The mixed integer programming model consisting of a single constraint with upper bounds is generalized to allow bound of the form $x \leq u + vy$, $y \in \{0, 1\}$ with v either positive or negative. Valid inequalities are derived by lifting traditional flow cover inequalities extending results for the single node flow polyhedron.
- Mixed integer models for the stationary case of gas network optimization by A. Martin, M. Möller and S. Moritz
  Upon formulating the relevant optimization problem as a nonlinear mixed integer program, the authors use piecewise linear approximations to derive a linear mixed integer program whose formulation is then tightened by studying small polyhedra that arise from linked piecewise approximations. Finally results are obtained by combining appropriate bounding strategies and separation algorithms for the small polyhedra.
- Controlled rounding and cell perturbation: statistical disclosure limitation methods for tabular data by J.J. Salazar-Gonzàles
  A new model for controlled rounding, a widely used technique to protect data confidentiality when distributing data tables, is presented. A method called "cell perturbation" is shown to have several advantages and is tested computationally on real data from European statistical offices.

Referees We want to acknowledge the careful, fair and swift work carried out by the referees of the various papers submitted to this issue K. Aardal, F. Barahona, Ch. Buchheim, K. Cameron, M. Conforti, G. Dahl, V. Deneiko, G. Durán, M. Fischetti, M. Fortz, A. Frank, M. Goemans, L. Gouveia, Z. Gu, D. Gusfield, N. Hall, D. Hartvigsen, Ch. Helmsberg, D. Hochbaum, K. Jensen, S. Kuller, M. Labbé, G. Laporte, J.B. Lasserre, M. Laurent, J. Lee, C. Lemaréchal, T. Liebling, F. Louveaux, A. Lucena, F. Maffray, R. Mahjoub, F. Margot, A. Martin, D. Naddef, J. Orlin, M. Penn, M. Preissmann, A. Prodon, T. Ralphs, J.-P. Richard, J.-J. Salazar-González, M.G. Scutellá, A. Sebö, Y. Smeers, G. Stauffer, D. Vandenbussche, M. Van der Vlerk, M. Van Vyve, K. Vuskovic, L. Wolsey.

Lausanne, Gtenoble, Louvain-la-Neuve, June 2005