Integer Programming Down Under: Theory, algorithms and applications

University of Newcastle 6–8 July 2011

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Summary and purpose of the workshop

The IPDU (Integer Programming Down Under) workshop was designed to bring together researchers with an interest in the theory, algorithms and applications of integer programming so as to facilitate an exchange on the latest ideas and developments in the area, and to provide a venue and environment for informal interaction and collaborative engagements.

- The workshop program was composed of a limited number of invited talks.
- The talks were organized in a single track and scheduled so as to leave ample time for discussion and interaction among the participants.

The workshop was held in Newcastle in the week immediately preceding IFORS 2011, which took place in Melbourne on 10–15 July, 2011.

Organising committee

- Professor Natashia Boland, University of Newcastle (Chair)
- Professor Martin Savelsbergh, CSIRO
- Dr Hamish Waterer, University of Newcastle

Topics covered

- Integer programming
- Quadratic programming
- Supply chain management
- Transportation
- Production planning

Special presenters

Professor Matteo Fischetti (University of Padova). Matteo Fischetti is a Professor in Operations Research at the University of Padova. He received his degree in

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Electronic Engineering cum laude in 1982 and his PhD 1987 from the University of Bologna. His research interests include Mixed Integer Programming, Combinatorial Optimization, Vehicle Routing and Scheduling Problems, Graph Theory, Design and Analysis of Combinatorial Algorithms, Polyhedral Combinatorics, 2-D Nesting Problems.

Professor Fischetti is known world wide as a foremost exponent of computational and applied aspects of integer programming, in addition to his highly respected theoretical contributions. Both a finalist and winner of the Edelman prize, he was a plenary speaker at the most recent Mathematical Programming Society Symposium, where he deduced deep mathematical insights in integer programming from computational experiments.

Professor George Nemhauser (Georgia Tech). George Nemhauser is the A. Russell Chandler Chaired Professor in ISyE. He received a PhD in operations research from Northwestern University in 1961, and joined the faculty of Johns Hopkins University where he remained until 1969. In 1970, he joined Cornell University as a professor in operations research and industrial engineering and served as school director from 1977 to 1983. He has held visiting faculty positions at the University of Leeds, UK, and the University of Louvain, Belgium. Professor Nemhauser was co-director of the Logistics Engineering Center at Georgia Tech. He has served the Operations Research Society of America (ORSA) as council member, president, and editor of Operations Research, and he is past chair of the Mathematical Programming Society. He is the founding editor of Operations Research Letters, and co-editor of Handbooks of Operations Research and Management Science.

Report

The workshop covered a wide range of topics within integer programming, including applications, primal heuristics for both general problems and applications, nonlinear problems, cutting planes for structured problem, reformulation, multiple objectives, stochastic elements, duality, computation, hybrid techniques and instance space characterization.

Applications in mining were well represented, and indicative of this internationally fast-growing area of research in integer programming. Whilst integer programming has traditionally played a strong role in supply chain management applications, the workshop illustrated how more complex and challenging logistics problems are now being successfully tackled, for example in cross-docking, truck load planning and delivery routing. In line with recent trends in this area, workforce planning was strongly represented, for example in vehicle routing, shift construction, and shift-work scheduling (e.g. for nurses).

The emerging trend of IP-based heuristics also received some attention, demonstrating some of the powerful capabilities of this approach, on both large-scale applications and in general-purpose settings. Variations on recent successful general integer programming heuristics were also shown to have promise in improving strike rate and quality of solutions.

Polyhedral theory and cutting planes have for a number of years now been a major success story in integer programming, credited over the last 5–10 years by the founder of two of the world's best commercial solvers, Bob Bixby, as the primary factor in the enormous advances made in this technology. A number of new ideas in cutting planes emerged from the workshop. For general integer programming, the idea of summarizing (and hence reducing) parts of the branch-and-bound tree by cutting planes was shown to be an effective approach. For structured problems that would have wide-ranging applications (piecewise linear structures, stochastic scenario trees and fixed charge flow), new classes of cutting planes were considered, and their relationships with known classes investigated.

Whilst cutting planes offer one approach to automate reformulation of integer programs to more tractable form, extended formulations derived from polyhedral analysis have been shown in recent years to be potentially effective alternatives. New extended formulations for network design were presented, and more effective techniques based on column generation ideas proposed for solving them. Reformulations via second-order cone programming were also demonstrated to be highly effective in tackling stochastic problems with chance constraints.

Nonlinear problems have arisen over the last five years as the new frontier for integer programming, with hopes that now the success in reliable technology can be extended to these problems. The workshop considered a particularly significant form of nonlinear problem, with quadratic objectives. These model a surprising range of settings. In addition to cone programming reformulation for problems arising in probabilistic settings, both the classical and a three-dimensional quadratic assignment problem were tackled. In perhaps one of the most exciting results of the workshop, exploiting symmetry was shown to be pivotal in obtaining remarkable advances in solving long outstanding quadratic assignment problems.

Organisers' opinion of success

The workshop was a great success. The scientific program, as expected, was excellent with a perfect balance of methodological and applied presentations as well as a perfect balance of senior and junior researchers presenting. The invited plenary speakers (Matteo Fischetti and George Nemhauser) gave insightful and memorable presentations. Because of its relatively small size (in terms of number of participants) and because there was just a single stream of presentations, participants had a great opportunity to network and pursue collaborations. The workshop format was especially valuable for the PhD students and post doctoral students, as it gave them an opportunity to observe and interact with leading researchers from all around the world in their area of study. Participant feedback was unanimously positive; they commented positively on the venue, the quality of the audio and presentation equipment, the social activities, the conference dinner, and, especially, the quality of all the speakers and the balance and variety of the program.