Optimisation Algorithms for Planning and Scheduling Workplace Training

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A thesis submitted in partial fulfilment of the requirements for
the degree of Doctor of Philosophy

University of Technology, Sydney – 2017

CERTIFICATE OF ORIGINAL AUTHORSHIP

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This research is supported by an Australian Government Research Training Program Scholarship.

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Abstract

This thesis is concerned with a number of related mathematical optimisation problems in, or closely related to, the fields of scheduling, timetabling, and rostering. The studies are motivated by real world problems routinely faced at an Australian electricity distributor. Due to the computational complexity of the problems considered and typical real-world problem sizes, solution by direct application of mathematical programming is not possible in practically acceptable time. Therefore, we propose a variety of heuristic, metaheuristic, and matheuristic approaches to obtain good quality solutions in acceptable time.

The first study is concerned with a large-scale class timetabling and trainer rostering problem. The problem is formulated as two Integer Programs: one for class timetabling and one for trainer rostering. A three-stage approach is presented, consisting of a timetable construction stage, a timetable improvement stage, and a trainer rostering stage.

The second study investigates a variation of the timetabling problem considered in the first study, but from an analytical perspective. The problem is presented in the context of batch scheduling. Conditions that lead to NP-hardness are shown, and a previously-known NP-hardness result is strengthened. A polynomial time algorithm is presented for a particular case. Simulated Annealing and Genetic Algorithm based metaheuristics are compared by means of extensive computational experimentation.

The third study is of a partitioning problem concerned with optimising the composition of study groups, which is related to, but distinct from, several well-known problems in the literature. The problem is shown to be NP-hard in the strong sense. Four approaches are proposed: the first is based on Lagrangian Relaxation, the second is based on Column Generation, the third encapsulates Column Generation within a fix-and-optimise Large Neighbourhood Search framework, and the fourth is a Genetic Algorithm amalgamated with Integer Programming.

The fourth study is concerned with the timetabling of practice placements. The problem is shown to be NP-hard in the strong sense. Two approaches are presented: the first approach improves an initial timetable by means of a Simulated Annealing metaheuristic, and the second approach constructs and improves a timetable by means of a fix-and-optimise Large Neighbourhood Search procedure.

The aim of this research is to study these related optimisation problems encountered at the electricity distributor from both analytical and practical perspectives, and to design successful solution approaches to them.

The research presented in this thesis has been published in several refereed publications [39, 37, 40, 41, 42, 38, 43].

Acknowledgements

I thank my wife, Anastasia, whose constant support and patience throughout my research made this work possible. I also extend my profound gratitude to my supervisors: Hanyu Gu, Feng-Jang Hwang, and Mikhail Y. Kovalyov, and to my advisor Yakov Zinder. All their encouragement, advice, experience, attention to detail, and expertise helped keep my work to a high standard. Finally, I thank Aaron J. Russell and Tom Emeleus for giving me this opportunity to work on these fascinating real-world problems.

To my son, Maxwell.

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