RECENT ADVANCES

NOVEMBER 17 2010

PROGRAMME

08:45 – 9:00   Registration

09:00 – 9:10   Opening remarks

09:10 – 9:35   **D Foster**   *Personal Operations Research and OR in the Voluntary Sector*

09:35 – 10:00   **R Snyder**   *Intermittent demand forecasting with exponential smoothing*

10:00 – 10:25   **Andreas Schutt**   *Solving RCPSP and RCPSP/max by Lazy Clause Generation*

10:25 – 10:45   Morning Tea

10:45 – 11:10   **Damon Gulczynski** *A Worst Case Analysis for the Split Delivery Vehicle Routing Problem with Minimum Delivery Amounts*

11:10 – 11:35   **Sebastian Ruther** *A multi-commodity flow problem for the integrated aircraft routing, crew pairing, and tail assignment problem*

11:35 – 11:55   **Mohsen Reisi Ardali** *Nurse Scheduling With Column Generation*

11:55 – 12:20   **Lanbo Zheng** *Planned Maintenance Scheduling for the Hunter Valley Coal Chain*

12:20 – 13:20   LUNCH

13:20 – 13:45   **Matthew Baxter** *Decision Support System for Machine Replacement in Forestry*

13:45 – 14:10   **Tristan Barnett** *Applying Mathematics To Poker Machine Regulations To Increase Consumer Protection*

14:10 – 14:35   **Andreas Ernst** *A Hybrid Lagrangian Particle Swarm Optimization Algorithm for the Degree-Constrained Minimum Spanning Tree Problem*

14:35 – 14:55   Afternoon tea

14:55 – 15:20   **Moshe Sneidovich** *Fooled by Robustness: A Perspective from the Land of the Black Swan*

15:20 – 15:55   **Leorey Marquez** *Modelling Centrelink customer network pathways*

16:00   CLOSING REMARKS

Personal Operations Research and OR in the Voluntary Sector
Dudley Foster, NORCA Consulting / Rotary Club of Leven

Some 4 years ago, at a time of great personal change in his life, the author found himself having to make complex, emotionally charged, decisions in conditions of great uncertainty, a situation in which he consciously set out to apply the OR approach and scenario planning concepts. He was somewhat surprised to discover a general reluctance to endorse this approach. In particular, many people showed a strong preference for attempting to make predictions with inadequate data rather than collaborating in the search for robust solutions to problems. The author also found that implementation skills acquired over a lifetime of professional experience were very useful in getting things done – and done in a detached manner, and helped him to maintain a more or less objective stance in emotionally charged situations.

Building on these experiences, the author has continued to pursue this *micro OR* approach in his involvement with Rotary over the past four years. Two or three projects will be described in some detail to illustrate the application of these concepts.

Intermittent demand forecasting with exponential smoothing

Ralph Snyder

A new method of forecasting, suitable for intermittent demand time series, is introduced in this presentation. Based on a marriage between exponential smoothing and the negative binomial probability distribution, it may be used to generate lead-time demand distributions for inventory control purposes. It is applied to a database of intermittent car parts demand time series and is shown to be much more effective than the current standard approach called the Croston method.

TITLE: **Solving RCPSP and RCPSP/max by Lazy Clause Generation**

SPEAKER: **Andreas Schutt**

JOINT WORK WITH:
Thibaut Feydy, Peter J. Stuckey, Mark G. Wallace

ABSTRACT:
Over the past years no significant improvement had been published to solve the Resource-constrained Project Scheduling problem (RCPSP) with an exact method in order to minimise the project duration. RCPSP is a fundamental scheduling problem which occurs in a specialised or extended form in many applications. The goal is to find an optimal schedule for given activities so that all resource constraints and all precedence constraints between activities are satisfied.

Our method uses lazy clause generation, i.e., a hybrid of finite domain and Boolean satisfiability solving, in order to apply nogood learning and conflict-driven search to the solution generation. Our experiments on RCPSP and RCPSP/max, i.e., an extension of RCPSP in which the precedence relations are relaxed to arbitrary precedence, show the benefit of lazy clause generation for finding an optimal solution and proving its optimality in

comparison to other state-of-the-art methods.

In comparison to other approaches our method is able to prove optimality for more problems in a similar time frame. Our method closes over 600 open RCPSP and RCPSP/max problems.

Title: **A Worst Case Analysis for the Split Delivery Vehicle Routing Problem with Minimum Delivery Amounts**

Speaker: **Damon Gulczynski**

ABSTRACT: In the vehicle routing problem (VRP), a fleet of vehicles must service the demands of customers in a least-cost way. In the split delivery vehicle routing problem (SDVRP), multiple vehicles can service the same customer (i.e., they can split deliveries). By allowing split deliveries, savings in travel costs of up to 50% are possible. In the split delivery vehicle routing problem with minimum delivery amounts (SDVRP-MDA), we allow split deliveries only if at least a minimum fraction p of a customer's demand is delivered by each visiting vehicle. When minimum delivery amounts are enforced, some well-known properties of the SDVRP (such as the k-split cycle property) no longer hold true. However, concerning a worst-case analysis, we show that, when $0 < p < .5$, the possible cost savings in the SDVRP-MDA are independent of p and can be as large as 50%. That is, the same savings are possible as in the SDVRP. For the case when $p = .5$, we show savings can only be as large as 33.3%.

Title: **A multi-commodity flow problem for the integrated aircraft routing, crew pairing, and tail assignment problem**

Speaker: **Sebastian Ruther**

ABSTRACT: The integrated aircraft routing, crew pairing, and tail assignment problem consists of simultaneously finding a minimum cost set of aircraft routes and crew pairings such that each flight is covered by one aircraft and one crew.

A common problem when integrating airline planning stages is the long planning horizon of the crew pairing problem. We propose an approach in which crews initially are only told when they work. This enables us to generate an overall schedule much closer to the start of the planning horizon. Therefore, along with a short planning horizon, much more detailed and accurate overall schedules can be generated.

Due to the tail assignment aspect of the problem maintenance requirements have to be satisfied for each aircraft. Robustness of solutions is increased by using penalties on short connections.

We propose a mixed integer multi-commodity flow formulation and report results for small instances.

Title: Case Study: **Nurse Scheduling With Column Generation**

Speaker: **Mohsen Reisi Ardali**

ABSTRACT: We presents a binary column generation model with a resource constrained shortest path subproblem problem for nurse scheduling. The master problem finds a configuration of individual schedules to satisfy the hospital demand coverage constraints while minimizing salary costs and maximizing both employee preferences and team balance. A feasible solution of the subproblem is an acceptable schedule for a given nurse, with respect to nurse satisfaction and also some constraints such as workload, and night shift based on the level of the nurse. Our problem is a case study about the Namazy hospital one of the biggest hospital in Shiraz-fars(Pars)-Iran.

Title: **Planned Maintenance Scheduling for the Hunter Valley Coal Chain**

Speaker: **Lanbo Zheng**

ABSTRACT: In the Hunter Valley Coal Chain, planned maintenance activities on rail tracks, terminal machines are essential to keep the coal exporting system working in a satisfactory level. However, the system capacity is largely reduced due to maintenance such that those activities need to be well aligned to achieve a demand of the total throughput. In the first part of the talk, we focus on presenting a more realistic model to evaluate the impact of a given maintenance schedule on the system capacity as well as a prototype optimization model for automated (re-)scheduling of planned maintenance to release more capacity. In the second part of the talk, we introduce a dynamic network flow problem abstracted from the real-world problem. The problem is shown to be NP-hard and a local search heuristic is proposed.

Title: **Decision Support System for Machine Replacement in Forestry**

Name: **Matthew Baxter**

Abstract:
While managing forests for diverse and conflicting outcomes requires great care and patience over many years, the largest expense associated with producing timber products is the cost of harvesting. The contractors responsible for this task must invest in several types of expensive harvesting machinery with limited lifespans, with the goal of minimising their operating cost per tonne including machine ownership costs. Much work has been done on calculating the approximate total cost of owning a machine, given its expected lifespan and other parameters. While extremely useful, these calculations neglect several effects that can only be seen by considering a machine as a part of the larger operation and by treating the lifetime as a decision. We describe several mixed integer linear programming models, with varied levels of complexity, developed to make decisions regarding equipment replacement. We further describe a prototype decision support tool to be used by machine owners.

Applying Mathematics To Poker Machine Regulations To Increase Consumer Protection

Tristan Barnett

www.strategicgames.com.au

Abstract

The regulations for poker machines in Australia and New Zealand are documented in the Australian/New Zealand Gaming Machine National Standard (Standard). Using mathematical and logical reasoning, suggestions are given for amendments to the Standard with the purpose to increase consumer protection. These possible amendments consist of the following results: the probabilities associated with the payouts be displayed on the gaming machine, win amounts refer to profit payouts rather than return payouts, for gaming machines to allow players to withdraw amounts less than $1, the total number of gaming machines at each venue be proportioned by different denominations, the standard deviation be regulated on gaming machines with a fixed initial cost that is consistent across all machines and regulations for the coefficients of skewness and excess kurtosis.

Author(s): **Andreas Ernst**
Title: **A Hybrid Lagrangian Particle Swarm Optimization Algorithm for the Degree-Constrained Minimum Spanning Tree Problem**
Abstract:
This talk presents a new hybrid heuristic combining particle swarm optimization with a Lagrangian heuristic along the lines first proposed by Wedelin. We will refer to this as a Combinatorial Lagrangian Particle Swarm Optimization Algorithm (CoLaPSO). It uses a problem representations that works simultaneously in the dual space (Lagrangian multipliers) and the primal space in the form of cost perturbations. The CoLaPSO method is applied to solving the degree constrained minimum spanning tree problem. This NP-hard problem consists of finding a minimum cost spanning tree on a graph such that none of the vertices is connected to more than a fixed number of edges. The hybrid heuristic inherits from the Lagrangian parent an ability to calculate lower bounds on the objective and from the particle swarm optimization the ability to effectively parallelise the algorithm. Empirical evaluation using standard test problems from the literature show that the new method outperforms previously published heuristics for this problem and also computes useful lower bounds.

Title: **Fooled by Robustness: A Perspective from the Land of the Black Swan**

Speaker: **Moshe Sniedovich**, Department of Mathematics and Statistics, The University of Melbourne, moshe@unimelb.edu.au

Abstract: In his two best selling books "Fooled by Randomness" and "The Black Swan: The Impact of the Highly Improbable", Nassim Taleb makes a strong case for the proposition that we have a propensity to be fooled by randomness and by models and theories that were developed for risk management under uncertainty. The latest edition of "The Black Swan" features a new section on "On Robustness and Fragility". It is argued (Preface, p. xxiv) that: "It is much easier to deal with the Black Swan problem if we focus on robustness to errors rather than improving predictions." This may well be true, but ... in this presentation I show/demonstrate/prove that it is (almost) as easy to be fooled by robustness as it is to be fooled by randomness. This rather gloomy conclusion is based on the research that I have been doing in connection with the campaign that I had launched at the end of 2006 to contain the spread of info-gap decision theory in the Land of the Black Swan (see http://info-gap.moshe-online.com).

Modelling Centrelink customer network pathways

Mark Horn, Gordon Sutton, **Leorey Marquez**, David Sier, Stuart Woodman, Warren Jin, Ross Sparks,

CSIRO Mathematics, Informatics & Statistics

Abstract

Patient pathways are used to manage treatment in many areas of the Health Care system. Patient pathways map the sequences of treatments that are most appropriate for patients at different stages of their episode of care and are used to to plan effective medical interventions.

As part of a Research Alliance with Centrelink, CSIRO is investigating the application of pathways to Human Service delivery programs.

The aim of the project is to formulate a conceptual framework describing the complex relationships between Centrelink's customers and service delivery programs, Government policies and programs, and the broader social environment.

The modelling framework is based on two main ideas:

1. A Human Services Ecosystem. The ecosystem is used to: classify the different groups in the system, describe their interactions, and trace their evolution over time in response to changes in the broader socio-economic environment.

2. Customer Pathways. The ecosystem "world" is identified by short-term and long-term pathways that customers traverse as they move through the Centrelink environment.