Dear Conference Delegate

Welcome to the 38th annual conference of the Operations Research Society of South Africa (ORSSA), which this year coincides with the 40th anniversary of the founding of ORSSA in Johannesburg in 1969. For this anniversary conference, we welcome in particular our keynote speaker, Professor John J Bartholdi, III (Georgia Institute of Technology, United States of America), and two founding members of ORSSA, Emeritus Professor Gerhard Geldenhuys and Mr Dave Masterson. It is perhaps fitting that ORSSA should be back in Stellenbosch for these anniversary celebrations, where in 1962 Gerhard Geldenhuys was the first person in South Africa to present formal operations research courses at a tertiary institution. We are delighted to make use of the excellent facilities and to enjoy the tranquility of the Wallenberg Centre, which forms part of the Stellenbosch Institute for Advanced Study.

Opening and closing plenary keynote addresses on the fascinating topics of self-organising logistics systems and stocking the forward picking area of a distribution centre will be given by John Bartholdi. A 40th anniversary plenary session will also be chaired by Emeritus Professor Paul Fatti, during which some of our founding members, regular members and student members will engage each other in the form of a panel discussion on the topic of the past, present state and future expectations of ORSSA. On the social side of the programme, the Wine Tasting (Monday evening, presented by *Simonsig Wine Estate*) and Celebration Banquet (Tuesday evening) are sure to be highlights.

We also welcome all other delegates from within South Africa and from Namibia, Zimbabwe and the United Kindom. Without your valued inputs and participation we would not have a conference at all. The programme contains a rich mix of exciting applications and new theory, as we have become accustomed to seeing at ORSSA conferences. We trust that you will have a productive few days, exchanging experiences, learning new tricks of the trade, renewing old acquaintances and making new friends. May you enjoy this special anniversary conference of ORSSA in the beautiful surroundings of the Cape winelands!

Best wishes

Jan van Vuuren, Stephan Visagie and Isabelle Nieuwoudt
Organising Committee

– *Internet & Technical Support* –

Delegates may access the internet for email purposes via two desktop computers at the registration desk. The university firewall will already be open on these machines (*i.e.* no username or password is required); delegates are requested merely to close the internet browser after use — **not to log off or restart the computers**.

Delegates who have brought their own laptops may access the internet via laptop using the wireless internet connection of the Wallenberg Centre. The connection is an unsecure network with ID 'ORSSA' — no password is therefore required.

There are many different ways of activating the wireless facility on a laptop, depending on the make and model. On Dell laptops (and those of some other brands) one has to press `Fn` + `F2` (some others use `Fn` + `F1`, `F5`, `F8`, `F10` or `F12`). On Acer and HP laptops one must typically press a button, while Toshiba laptops require the flick of a switch (so that an LED light is illuminated) to active the wireless facility. If you are uncertain which keys, buttons or switches are related to the wireless facility of your laptop, look for an icon resembling the one above. The method of wireless activation of further makes and models may be found at `http://forums.speedguide.net/showthread.php?t=214308` (accessible from the desktop computers at the registration desk). Once the wireless facility is activated one is typically informed via an information balloon appearing from the task bar. A list of available wireless networks will appear if you click on this balloon. Select the one named 'ORSSA' and click on the button labelled 'Connect.' If the laptop has already connected to the wireless network, then the button will be labelled 'Disconnect.'

A student member will be available in each venue on the half hour to provide technical support and to help delegates start up their slide presentations. In case of problems, please ask for:

- Basie Kok [Auditorium 1],
- Jason Matthews [Auditorium 2], or
- Johan Janse van Rensburg [Breakaway Room].

Delegates are encouraged to use the desktop computers that are available and already connected to a data projector in each venue for their presentations (rather than using their own laptops), and to copy their presentations onto these computers **before the start of the session in which they are due to talk**.

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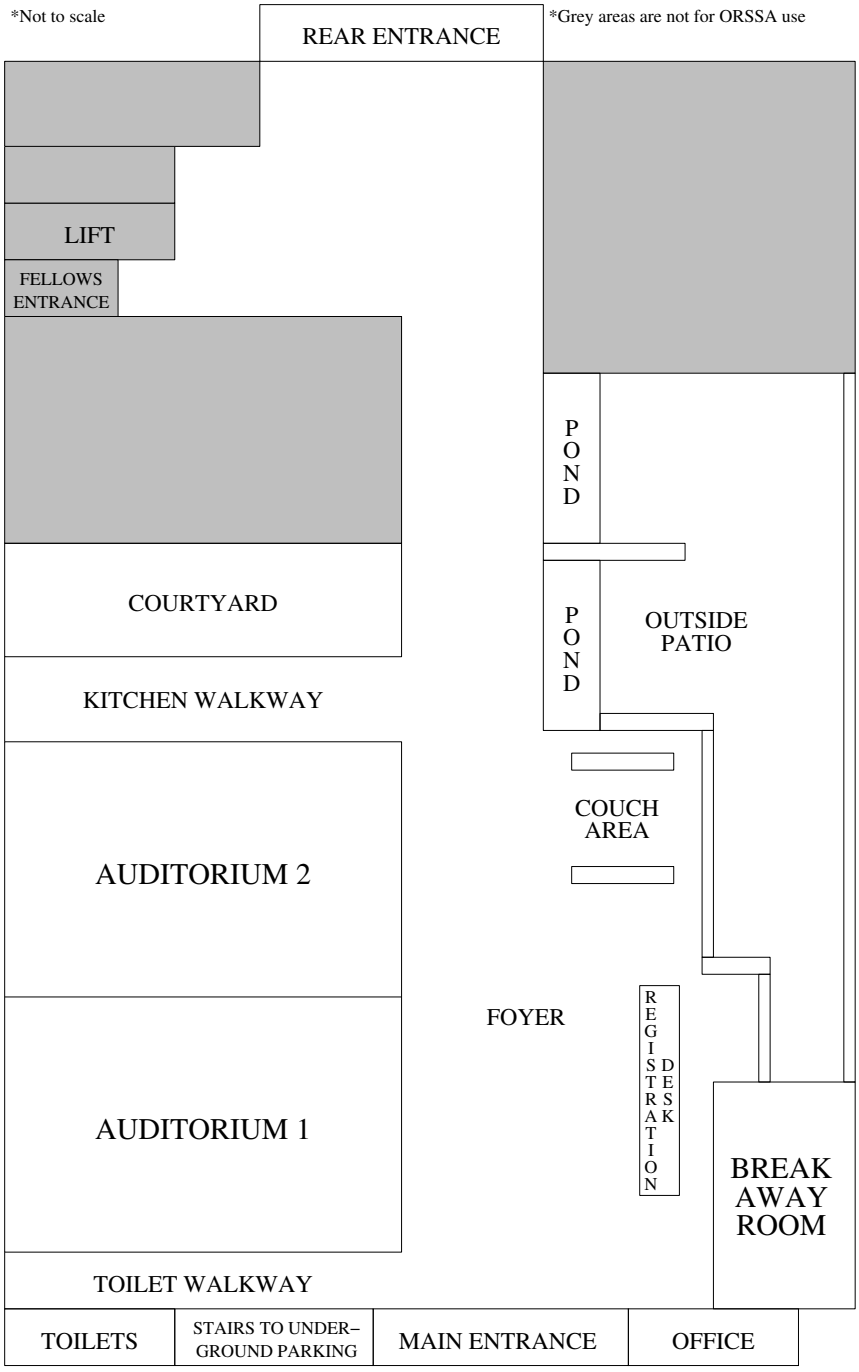

— Programme at a Glance —

Monday 21 September 2009

08:00–08:30	*Tea/Coffee & Registration (Foyer)*	
08:30–10:00	**Opening Plenary Session (Auditorium 1)**	
10:00–10:30	*Tea/Coffee (Foyer)*	
10:30–12:30	I: Supply Chain Management (Auditorium 1)	II: Combinatorics (Breakaway Room)
12:30–13:30	*Lunch (Auditorium 2)*	
13:30–15:00	**40th Anniversary Plenary Session (Auditorium 1)**	
15:00–15:30	*Tea/Coffee (Foyer)*	
15:30–17:30	III: Transport & Transportation (Auditorium 1)	IV: Combinatorial Optimisation (Breakaway Room)
17:30–18:30	*Wine Tasting (Auditorium 2)*	

Tuesday 22 September 2009

08:00–08:30	*Tea/Coffee (Foyer)*		
08:30–10:30	V: Heuristics, Metaheuristics & Hyperheuristics (Auditorium 1)	VI: Logistics, Warehousing & Distribution (Auditorium 2)	VII: OR in the Military (Breakaway Room)
10:30–11:00	*Tea/Coffee (Foyer)*		
11:00–12:30	VIII: Multicriteria Decision Analysis (Auditorium 1)		IX: Communications & Information Technology (Breakaway Room)
12:30–13:30	*Lunch (Auditorium 2)*		
13:30–16:00	X: Statistics, Stochasticity & Forecasting (Auditorium 1)		XI: OR in Business, Industry & Service Delivery (Breakaway Room)
16:00–16:30	*Tea/Coffee (Foyer)*		
16:30–18:00	**Annual General Meeting (Auditorium 1)**		
19:00–	*40th Anniversary Banquet (Auditorium 2)*		

Wednesday 23 September 2009

08:00–08:30	*Tea/Coffee (Foyer)*		
08:30–11:00	XII: Equity, Poverty Alleviation & Humanitarian OR (Auditorium 1)	XIII: General Topics (Auditorium 2)	XIV: Natural Resource Management & Agriculture (Breakaway Room)
11:00–11:30	*Tea/Coffee (Foyer)*		
11:30–13:00	**Closing Plenary Session (Auditorium 1)**		
13:00–14:00	*Lunch (Auditorium 2)*		

— *Conference Programme* —

Sunday 20 September 2009

Arrival & Registration
(16:00–18:00) [Foyer]

Welcome Reception
(18:00) [Foyer & Outside Patio]

Monday 21 September 2009

(08:00–08:30)
Tea/Coffee & Registration [Foyer]

Monday 21 September 2009: (08:30–10:00)	
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08:40–08:45	**Jan van Vuuren (ORSSA 2009 Conference Chair)** *Announcements*
08:45–09:00	**Sarma Yadavalli (ORSSA President)** *Presidential Address*
09:00–10:00	**John Bartholdi, III (Keynote Speaker)** *Self-organising logistics systems* (p. 16)

Tea/Coffee (10:00–10:30) [Foyer]

Monday 21 September 2009: (10:30–12:30)	
Parallel Session I: Supply Chain Management *Chair:* Wessel Pienaar [Auditorium 1]	
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11:00–11:30	**Ozias Ncube**, *Supply chain risks: Perspectives on private-public sector partnership for the benefit of SMMEs in South Africa* (p. 72)
11:30–12:00	**Esbeth van Dyk**, *Thoughts on supply chain complexity* (p. 75)
12:00–12:30	**Caston Sigauke**, *Strategic supply chain planning under uncertainty: A literature review* (p. 70)

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Monday 21 September 2009:(13:30–15:00)	
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13:35–14:15	**Panel members**, *Short presentations by each member*
14:15–15:00	**Audience**, *Floor discussion*

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Monday 21 September 2009: (15:30–17:30)	
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Presented by *Simonsig Wine Estate*, Stellenbosch

Tuesday 22 September 2009

Tea/Coffee (08:00–08:30) [Foyer]

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40th Anniversary Banquet (19:00) [Auditorium 2]

Wednesday 23 September 2009

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Wednesday 23 September 2009: (08:30–11:00)	
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12:30–12:45	**Wim Gevers**, *A brief reflection on papers read at the conference*
12:45–13:00	**Sarma Yadavalli**, *Final announcements & good bye*

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— *Invited Paper Abstracts* —

Opening Plenary:
Self-organising logistics systems

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john.bartholdi@isye.gatech.edu

Abstract

The social insects, such as bees or ants, operate complex logistics systems that are efficient even though no agent is in charge. Instead of a centralised control, each agent follows a simple local rule and an efficient global organisation emerges spontaneously.

This idea has been successfully adapted to coordinate workers on an assembly line, and, with particular success, order-pickers in a warehouse. Under a protocol called *bucket brigades*, each worker follows a simple rule; and without conscious intention or even awareness of the workers, the flow of work is smoothed and bottlenecks are removed. Furthermore, this happens without the advice of engineers, consultants, or management.

In more recent work, we have shown that, while this phenomenon is robust in practical applications, there exist pathological cases in which an improperly configured bucket brigade can exhibit provably chaotic behaviour.

We close by speculating on the social insects as models for human logistics systems.

40^{th} Anniversary Panel Discussion: *The past, present and future of ORSSA*

Chair: *L Paul Fatti*
University of the Witwatersrand, and Fellow of ORSSA
paulfatti@gmail.com

Panel Members:
Gerhard Geldenhuys (Founding Member and Honourary Member of ORSSA)
Dave Masterson (Founding Member and Fellow of ORSSA)

Marthi Harmse (SASOL Technology, and Member of ORSSA)
Hans Ittmann (CSIR — Built Environment, and Fellow of ORSSA)

Ian Durbach (University of Cape Town, and Student Member of ORSSA)
Jacomine Grobler (University of Pretoria, and Student Member of ORSSA)
Darian Raad (Stellenbosch University, and Student Member of ORSSA)

Abstract

This plenary session will take the form of a panel discussion in which members will have the opportunity to share their views on ORSSA and OR, both in South Africa and in general. Founder members on the panel will reflect on OR in South Africa back in 1969 and the vision and passion that drove them to establish the Society. Senior practitioners will discuss their views on the state of OR, the challenges it faces and what role ORSSA can play to promote it, and younger members will share their hopes for their future careers in OR and where they see the discipline and the Society going. Contributions from the floor will enrich the discussion and hopefully provide pointers for the future.

Closing Plenary:
How to stock the forward-pick area of a distribution centre

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Abstract

The forward-pick area of a distribution centre is a small region of the most convenient storage, from which are picked the fastest-moving items. This area typically includes a plurality of the labour in the facility.

What items should be picked from the forward area and in what quantities should they be stored?

If an item is allocated too little space, then it must be restocked more frequently; and if it is allocated too much space, then less room available for other items. Standard industry practice is wrong on this issue. Operations research clarifies the decision.

— Contributed Paper Abstracts —

An application of linear programming in advertising

Vivian A Atud
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Abstract

Companies spend considerable amounts of money on advertising their products. This talk is a report on work in progress aimed at advising the breakfast cereal companies in South Africa on how to spend their money wisely with respect to advertising.

The objective is to develop a linear programming model that relates the number of television advertisements on various shows to the level of exposure to various viewer groups, and to find a minimum cost advertising strategy that meets minimum exposure constraints.

Data on given advertising costs during different shows are used. The advertisement costs vary as a function of the shows during which they are screened and the viewers of these shows. Potential customers are segmented into six mutually exclusive groups. Each viewer is called an exposure. The required number of exposures per day are determined based on the objectives of the company and its budget. A spreadsheet model is developed and Excel's *Solver* plug-in is used to determine an optimum solution.

Applying fuzzy logic to humanitarian operations research problems

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Abstract

A decade or two ago phrases such as *humanitarian operations research* or even *humanitarian logistics* would have had a slightly confused if not downright disbelieving reception. However, the magnitude of recent disasters, both natural and manmade, and the inadequacy of international relief efforts have cast a spotlight on these phrases, emphasising them not only as crucial links in the humanitarian relief chain, but as fields of study in their own right.

Defining what qualifies work as humanitarian is often controversial. Van Wassenhove [1] developed a triangular model to depict the humanitarian space with impartiality, neutrality and humanity as its vertices. Work performed within these guiding principles is regarded as humanitarian.

Paradigmatic humanitarian operations research problems are thus dissimilar to paradigmatic problems in business and military. Differing objectives are an obvious dissimilarity, but the inescapable subjectivity in determining costs and benefits, and the qualitative, complex relations between parameters widen the chasm further.

This presentation focusses on the basic principles of fuzzy logic and its ability to handle the approximate reasoning contained in problems of a humanitarian nature. *Fuzzy logic* emerged from the theory of fuzzy sets introduced by Lotfi Zadeh in 1965, where set membership is based on degrees of truth ranging (inclusively) from 0 to 1, which is a generalisation of binary logic where set membership is either 0 or 1. Attention is given to previous applications of fuzzy logic in the humanitarian arena and topics for further study are proposed.

Reference

[1] Van Wassenhove LN, 2006. *Humanitarian aid logistics: Supply chain management in high gear*, Journal of the Operational Research Society, **57**, pp. 475–489.

An assignment model for passenger check-in counters in an airport terminal building

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Abstract

The specific operations of an airport as well as the mix of passengers and their needs affect the design of the airport terminal building. The purpose of this study is to develop an assignment model for passenger check-in counters to be used as decision making tool in this regard. The desired number of service desks required to meet service level is influenced by stochastic factors such as arrival and service rates. Due to various flight patterns and service types, a traditional queuing system cannot be assumed. Hence, a simulation model is set up in *ARENA* to enable trade-off scenarios that involve the number of check-in counters and availability of these check-in counters. Factors considered by the simulation model include

(1) the different airlines, destinations and service rates,

(2) the arrival time distributions specific to a time of day/week, and

(3) different requirements corresponding to the different service levels.

Once the number of service desks is determined, a deterministic approach is followed by means of integer programming to optimise the availability of check-in counters. *Lanseria* airport is used as case study. Data, captured through physical time studies and activity sampling at this airport, are used in combination with data captured from transactional information systems to enable verification and validation of this assignment model.

Automated construction of generalised additive neural networks to detect spam

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Abstract

In the past few years, internet users and e-commerce have grown rapidly and with it the problem of spam has become even bigger. Consequently, it has become more important for internet service providers to identify and filter spam efficiently in order to keep their client base satisfied.

A *generalised additive neural network* (GANN) is the neural network implementation of a generalised additive model. The basic structure of a GANN consists of a separate *multi-layer perceptron* with one hidden layer for each input. The number of units in this hidden layer may differ for each input. Each input may also have a direct connection, called a *skip layer*.

When GANNs are constructed interactively, human judgement is required to interpret partial residual plots. This can be time-consuming for a large number of input variables. Also, human judgement may be subjective, which leads to suboptimal models being created.

The *AutoGANN system* is used for the automated construction of GANNs. It uses objective model selection criteria or cross validation to search for the best GANN model in a GANN search space. To speed up the search, an intelligent starting point is utilised. No human interaction is required while building GANN models and the partial residual plots are not used as a primary method for model selection, but rather to provide insight into the models built.

The *AutoGANN system* is applied here to the *Spambase* data set in order to construct a GANN that is able to recognise spam messages accurately. The best GANN model found is then compared to the results obtained from eight techniques found in the literature. Only one technique, the *ensemble decision tree*, achieves superior results. Accordingly, a GANN model may be used to detect spam accurately.

Characteristics of high-level military decision analysis

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Abstract

Decision making in the military environment is illustrated in this talk, focussing on high-level or strategic decision analysis. Are normal analytical methods effective for this purpose and, if not, what is appropriate at these levels?

The nature of decisions required at high levels are not necessarily appropriate for the application of traditional "hard" operations research methods, because the availability of appropriate data at those levels is often not good. In a military environment personal (or service) interests may overpower logic in high-ranking individuals.

According to Paparone & Crupi [1] four different decision making styles exist and are applicable under certain conditions of decision making, namely the *analytic*, the *programmatic*, the *participative* and the *emergent*. Paparone & Crupi argue that all of them are present to a varying degree in any situation, and they should be considered simultaneously.

The *Cynefin categorisation* of the complexity of decisions provides insight into the levels of decision analysis and difficulty in making them. Furthermore, the influence of systems methodology on the level of decision making can aid understanding.

Possible methods or approaches that are effective will be discussed.

Reference

[1] Paparone & Crupi, 2006. *Humanitarian aid logistics: Supply chain management in high gear*, Journal of the Operational Research Society, **57**, pp. 475–489.

Comparisons between largest remainder methods in voting systems

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Abstract

Proportional representation (PR) systems are used throughout the democratic world in elections. Numerous methods are available for allocating seats to parties in PR systems in a bid to convert votes into seats. The main focus of this presentation is on a family of seat allocation methods known as *largest remainder methods* (LRMs). Various electoral outcomes are simulated to test the results of three LRMs, namely the *Hare quota*, the *Hagenbach-Bischoff quota*, and the *Droop quota* – the latter is used in South African elections. LRMs use a number, obtained from the specific quota, expressed as an integer part and a remainder part, to assign a number of seats to each participating party. Different measures of disproportionality are used to calculate the deviation from the ideal situation where each party is allocated the same percentage of votes as the percentage of votes it received. These measures are influenced by variances in the total number of votes and seats in the election, as well as by the number and distribution of the parties participating in the election. If the ideal proportions are not achieved, the question of fairness and bias towards certain parties may be raised. The presentation will focus on different aspects of fairness and bias that arise in these three methods.

Constraint programming: A powerful tool to solve combinatorial optimisation problems

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Abstract

The aim in this talk is to highlight the advantages of combining *operations research* (OR) techniques with *constraint programming* (CP) techniques to solve combinatorial problems.

A *constraint satisfaction problem* (CSP) is a set of variables together with a finite domain for each variable, and a set of constraints which represent relations between the variables. A solution to a CSP consists of a value for each of the variables such that every constraint is satisfied. CP refers to computational systems for solving CSPs. Constraint satisfaction originated in the field of *artificial intelligence* (AI).

Combinatorial optimisation problems, such as scheduling, sequencing, timetabling, cutting stock, and vehicle routing problems, have been formulated as CSPs and have been solved successfully via CP techniques. There is an increasing awareness of the advantages of combining OR and CP techniques. The well-known commercial constraint solver *ILOG* provides both CP and OR techniques. There are also international conferences and journals that focus on the integration of OR and AI approaches. A number of comparison studies have been performed where OR techniques are measured against CP techniques when applied to the same problem.

The objective in this talk is to increase awareness of CP in the local OR community. A brief introduction to CP will be followed by a discussion on comparison studies and attempts to combine the techniques. A constraint satisfaction approach towards solving combinatorial optimisation problems in the defence domain will also be considered.

Coordinated production and distribution scheduling

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Abstract

It is a well-known fact that the landscape in which supply chains operate has changed dramatically over the past few decades. It is generally accepted that globalisation, mass customisation and developments information technology are some of the main contributing factors to the change experienced. Operations research techniques are widely used as decision support tools and are also employed in enterprise resource planning systems and advanced planning systems. The aim of modelling using operations research techniques is to arrive at an abstract description of reality. It follows that should reality change, the models that describe reality should also be revisited and amended to better encapsulate reality.

One case that stands to benefit by realignment with reality is the well-known *economic lot-scheduling problem* (ELSP). In the ELSP a number of products have to be produced using a single machine/facility. The model calculates a feasible, least cost, production schedule to meet the demand specified for each product. The problem attracted considerable research interest during the 1960s and 1970s, with various formulations and solution procedures being developed. The generic formulation of the ELSP assumes that finished goods inventories are depleted at a uniform rate. This is clearly out of sync with modern supply chains where finished goods are usually shipped in bulk to downstream stages.

A model for linking the scheduling of production and outbound shipments of finished goods has been developed. The model focuses on cases where logistics costs are such that truckload shipments are considerably more economic than less-than-truckload shipments. As of yet the model has only been evaluated theoretically by applying it to a numerical example. Application to a case study from the South African industry is expected to point out areas for improvement and demonstrate the practical value of the model.

Data envelopment analysis: Integrating economic and sustainability factors in performance management

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Abstract

The earth's natural resources are currently declining rapidly due to population growth, vast global economic development and various destructive agricultural techniques. In order to decrease the deterioration, more emphasis ought to be placed on sustainable development. In this talk we discuss the need to consider sustainability factors in the evaluation of an operating unit's efficiency. *Data envelopment analysis* (DEA) is a non-parametric methodology used to evaluate the relative efficiency of homogenous decision making units.

A model was built for agricultural practices, which integrates economic factors (such as financial performance indicators) with ecological factors (such as a farm's soil quality, water and energy usage). The resulting DEA model may be implemented as a sustainable awareness indicator and a planning aid for managerial decision making. The results of the model identify practices operating far from the efficiency frontier that should be encouraged to improve natural resource management. It also proves that farms with high efficiency indices are more likely to be efficient in the long run.

These results may be of interest to the government's agricultural sector, food manufacturers, private consumers, as well as agricultural societies. Further work may include the expansion of the model to be applicable to all business sectors.

Decision support for FoodBank Cape Town on the allocation of food resources

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Abstract

FoodBank Cape Town (FBCT) is an NPO which opened its doors on 2 March 2009. Its core business is collecting excess food from retailers, manufacturers and farmers, and re-distributing this food to agencies (NGOs with feeding programmes). FBCTs policy is to take agencies on a one year contract, for which it makes a commitment to give food on a weekly basis. Due to the unfortunate level of poverty in South Africa, FBCT receives many more applications than it can satisfy and is therefore faced with the problem of deciding which agencies to give food to and how much — with the goal of making as large a contribution as possible to poverty alleviation.

As a starting point to this problem it was assumed that there is a certain set of agencies that have applied for food support from FBCT. These agencies have certain food needs and the food bank possesses a fixed amount of food, both measured by weight. An additive model was built to capture the total "value" of a given food allocation, and to subsequently maximise this value. There were two components to this value function, namely the effectiveness of the service that an agency provides and the level of poverty of its recipients. The former was modelled using multi-criteria decision analysis techniques, whereby agencies are scored according to their preference for food support. This scoring system was developed through a series of workshops with representatives from the NGO community. Poverty statistics by area were used as a proxy for the latter. A heuristic was then developed to maximise this value function. Finally, the planned implementation of the model is discussed.

Effective supply chain strategy formulation and implementation

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Abstract

Formulating an appropriate strategic response has become a competitive necessity for most organisations to ensure long-term success. A business strategy aims to build on the core competencies of an organisation with specific goals or objectives in mind. Businesses need to undertake periodic reviews in order to initiate the strategic changes required. Analytical and decision-making processes are followed during strategy formulation.

Derived from the business strategy, a supply chain strategy defines how the supply chain should be configured and operated in order to be competitive. Organisations have started to examine their supply chain and logistics strategies more closely than ever before. Initially, the supply chain approach started with a cost and customer service focus. A strategic focus has now emerged. The need to think strategically about logistics and the supply chain has never been more important.

The success of a strategy is only as good as an organisation's ability to fully implement and properly execute it. Poorly implemented strategies frequently result in businesses not achieving their set objectives. Less than 10 per cent of effectively formulated strategies are implemented successfully.

This paper provides a practical framework and approach to follow for the development and implementation of a logistics and supply chain strategy.

Content of the paper:

- What strategy and strategic management mean
- Organisational strategy linked to supply chain strategy
- The strategy formulation process
- Developing a logistics and supply chain strategy
- Implementing a logistics and supply chain strategy.

An empirical study of factors that influence GDP growth with special reference to attributes like telecommunication proliferation

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Abstract

In this paper the effect of a number of variables on GDP growth are considered. There is a widespread belief that telecommunications proliferation has a positive effect on economic growth in a country. The relationship between wealth and telecommunications proliferation is complex on account of the chicken/egg effect.

Some aspects of these relationships are considered in this talk, based on an empirical study of international data.

Employing morphological analysis and system dynamics as complementary modelling methods for PSO planning in a military environment

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Abstract

PSOs are increasingly expected to function in highly complex, multi-faceted and volatile situations, in which the focus of involvement and protection is often unclear. This raises the need for informed planning processes that will enhance decision making in the process of performing PSO. Through an improved understanding of the gendered, social, cultural, dynamic nature and religious nuances of situations, peacekeeping personnel should be able to strengthen their relations with local populations, enhance their ability to respond to specific needs, bolster their planned responses, and uphold the rights of local populations, especially women and children.

A complex system is any system featuring a large number of interacting components, whose aggregate activity is nonlinear and typically exhibits self-organisation under selective pressures. *System dynamics* (SD) has been proven to be the solution in understanding complex systems. System dynamics is an approach used to understand the behaviour of complex systems over time. It deals with internal feedback loops and time delays that affect the behaviour of the entire system. *Morphological analysis* (MA) is a method for structuring and investigating the total set of relationships contained in multi-dimensional, usually non-quantifiable, problem complexes.

SD has been used in some military activities, such as supply chain management, but has not been used in the context PSO. We believe that combining MA and SD as two phases in a modelling process will allow us to gain the benefits of these methods. An improved understanding of the above-mentioned factors may not only help peacekeeping personnel; it can also optimise resource usage and cost both economic and time. This talk is a short presentation of MA and SD, focusing on how these two computer-aided methods may be combined to better facilitate modelling procedures.

An estimate of optimal buffer size in the theory of constraints with deteriorating work in progress

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Abstract

The determination of the ideal buffer size to support the critical resource when applying the theory of constraints is a challenge that was well highlighted by the proponent of the theory. This problem has received considerable attention, but the solutions have mainly been heuristic, based on experiential judgments. A popular theoretical solution has been proposed based on queuing theory. The intent is for the model to produce a solution to the optimal buffer size problem in the theory of constraints, or at least, a means of generating a seed solution that may render the use of experiential judgments more efficient.

One assumption of such documented theoretical approaches is that the value of the work in progress does not change with time. This is not always true, however. Our work seeks to contribute to this field by showing how to determine the optimal buffer size theoretically for a drum-buffer-rope system when the work in process inventory is deteriorating.

In this work, various types of deterioration models and forms are explored in a system represented as a queue existing in a Markovian environment.

Evaluation of a threat evaluation and weapon assignment system in a ground-based air defence environment

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Abstract

The evaluation of a fully-fledged *threat evaluation and weapon assignment* (TEWA) system in a ground-based air defense context is essential, not only to prove viability of such a system, but also to understand in which situations such a system would assist military decision makers most. The conceptual development of such a system poses several challenges. One of these objectives is pursuing a careful balance between model abstraction and fidelity, and another is the attempt to quantify performance measures which may be very subjective, even to veteran military experts.

The process of TEWA begins by measuring the threat of an incoming aircraft. This is achieved on a primitive level by monitoring aircraft attributes (such as speed) and by flagging the operator when any extreme deviations in these attribute values occur. More sophisticated threat models which monitor aircraft characteristics (such as bearing and range to defended asset) are typically employed in such a system (known as deterministic models). Finally, a probabilistic threat evaluation technique is presented which uses ballistic trajectory modelling to evaluate the impending threat of an aircraft assuming a certain payload and weapon delivery technique.

Once the threat of an aircraft has been estimated, the process of assigning weapons to the most dangerous targets commences. This resource allocation problem is well known, and is a generalisation of the classical assignment problem. Solution techniques to this problem, however, are often computationally expensive and heuristics are required in order to perform good real-time assignments.

The purpose of this project is to evaluate the performance of different threat evaluation and weapon assignment techniques under different conditions by means of discrete-event simulation and other analytical methods.

The exact-fit n-mino tiling problem

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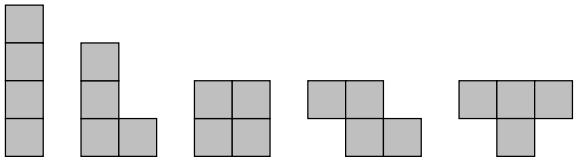
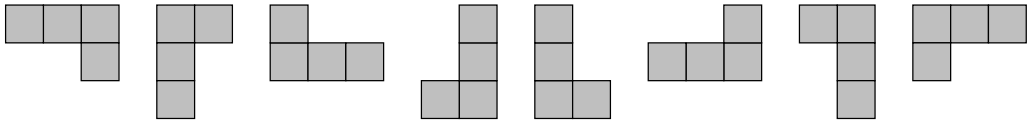
Abstract

An n-mino is a two-dimensional shape comprising n squares joined orthogonally by means of complete edges, leaving no holes surrounded completely by squares. For example, there are five distinct 4-minos when one disregards rotation and reflection symmetries, as shown below.



However, these shapes may be oriented in various ways. For example, the second shape above (L) may be oriented in eight distinct ways by rotation and reflection, as shown below.



The following exact-fit tiling problem is considered in this talk: Given a set of P (not necessarily distinct) n-minos, find an orientation (*i.e.* reflection and/or rotation) and a placement for each n-mino on a rectangular $M \times N$ grid so that no two n-minos overlap and so that no n-mino overshoots the grid boundaries, where $nP = MN$.

We consider both an integer programming approach and a back-tracking algorithmic approach towards solving this tiling problem exactly, and compare the time-efficiencies of the approaches with respect to a set of benchmark problem instances. We are also interested in the number of distinct solutions to the tiling problem, disregarding grid rotations and reflections.

Exact solution approaches to concave knapsack problems

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Abstract

Exact solution approaches to a variant of the *concave knapsack problem* (CKP) are presented in this talk. Our variant may be described as the maximisation of a separable nonlinear knapsack problem with a linear constraint. Furthermore, all the separated functions in the objective function are convex and increasing. A novel algorithm, based on dynamic programming, for solving the CKP is introduced. In addition, exact algorithms using branch-and-bound, 0-1 programming and set partitioning techniques are presented. All the algorithms were coded in the same environment and a set of test instances was generated to compare the algorithms on an equal basis. To generate the set of test instances five different properties of the problem that influence the solution times were identified. These properties are the number of functions, the average gain per item, the size of the knapsack, the size of the domain and the distribution of the domain size. Different permutations of these properties were used to generate a total of 2 700 test instances. The solution times for all these algorithms are compared to determine their strengths and weaknesses with respect to the five properties mentioned above.

Forecasting index price changes of the Johannesburg Stock Exchange with artificial neural networks — An empirical evaluation

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Abstract

Artificial neural networks (NN) are regularly employed as a contender in stock market forecasting due to their ability of linear and nonlinear semi-parametric modelling, data driven approximation of any continuous or discontinuous data-generating process, and their ability to generalise the learned model on unseen data for out-of-sample prediction. Despite optimistic findings, many studies lack the necessary scientific rigor in evaluating the performance across multiple time series origins, relevant forecasting horizons and employing robust error metrics in order to determine the conditions under which NN can outperform linear statistical benchmark methods.

This study seeks to evaluate the adequacy of different candidate architectures in specifying a feedforward NN to predict the price changes of a composite index on the *Johannesburg Stock Exchange* (JSE) one and five days into the future. The out-of-sample forecasting accuracy is compared to statistical benchmark methods using robust statistical error measures.

Finding good solutions to the multiple bin size bin packing problem by modifying strip packing heuristics

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Abstract

Two-dimensional packing problems involve an orthogonal allocation of items, without overlapping, into a well-defined region with the aim of utilising the smallest amount of space. While many heuristics exist to solve the strip packing (items are packed into a bin of fixed width and unlimited height – the aim is to minimise the packing height) and single bin size bin packing problems (items are packed into identical bins of fixed width and height – the aim is to pack the items into as few bins as possible), these have not been generalised to solve the multiple bin size bin packing problem (items are packed into bins that may not be uniform in size – the aim is to minimise wasted space). In this talk we present methods of combining existing and new heuristics for the strip packing problem with heuristics for the one-dimensional multiple bin size bin packing problem in order to find good solutions for the two-dimensional case.

Fleet composition for fuel distribution

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Abstract

This project is concerned with finding an optimal composition of a fleet of vehicles for a central depot which is responsible for supplying fuel to customers who are dispersed over a certain geographic area. Vehicles in the fleet each belong to a configuration type with specific capacity and manoeuvrability characteristics, while customers demand various order sizes that need to be fulfilled with vehicles that are able to access their sites.

The objective is to devise a methodology that will help find a fleet composition minimising the total cost of deliveries to a given set of customer orders over some period in time.

The cost of deliveries by various candidate fleets are assessed against the same set of simulated demands. In order to arrive at a realistic cost associated with a candidate fleet, the challenge is to implement a routing algorithm assigning open orders to routes and routes to vehicles in the candidate fleet, thus simulating the activity of delivery.

Heuristic and metaheuristic approaches to blending problems

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Abstract

Blending problems involve the determination of a "best" blend of available ingredients to form a certain quantity of a product. This product should adhere to strict quality specifications. The best blend means the least-cost blend of ingredients (input) required to meet a minimum level of product (output) specifications. The most prevalent methods to solve blending problems in the industry are by means of spreadsheets, simulators and mathematical programming. While there may be considerable benefit in using these types of tools to identify potential opportunities and infeasibilities, there is a potentially even greater benefit in searching automatically for alternative solutions that are more economical and efficient. Heuristics and metaheuristics are useful as alternative solution approaches.

In this talk different (meta)heuristic techniques are applied to two typical blending problems of varied size taken from the petrochemical industry. Heuristics are developed intuitively, while classical metaheuristics are adopted from the literature. Random search techniques, such as a local random search and a blind random search, deliver fair results. Within the class of genetic algorithms the best results for both problems were obtained using ranked fitness assignment with tournament selection of individuals. Good results are also obtained by means of tabu search approaches — even considering the continuous nature of these problems. A simulated annealing approach also yielded fair results. A comparison of the results of the different heuristics shows that the tabu search technique delivers the best result with respect to solution quality and execution time for both problems under consideration.

How many cars can you fit on an auto-carrier? A decision support system for Auto Carrier Transport

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Abstract

Auto Carrier Transport (ACT) is the motor ferrying division of Grindrod South Africa (Pty) Ltd and is contracted to transport the product of 15 different vehicle manufacturers. The division is responsible for ensuring that the combined annual volumes of each contract, totalling over 300 000 vehicles per year in 2007, are delivered to the right place, at the right time, and in the right condition. ACT's operating mandate thus focuses on the outbound logistics of new vehicles, which implies moving cars from either the local manufacturing plants, or from the import facilities at the ports, to the respective dealer networks all across Southern Africa.

One of the key operational processes regarding the transportation of vehicles is the allocation of cars to carrier loads, also known as load building. Once cars have been allocated to a load, a carrier is then used to transport the load. The existing load building operation is completely manual, with operators simply assigning cars to loads as best they see fit. No support systems exist. Thus, given the complexity of the load building problem, and the manual processes used, existing load building practices result in suboptimal payload performances.

A linear programming model was developed to improve the manner in which vehicles are categorised, and then assigned to loads. When compared against the results of load building operators, it was found that the model could potentially improve the company's contribution margin by up to 6%.

A hybrid multi-risk model for asset pricing using regression analysis: A case study

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Abstract

A hybrid multi-risk model for asset pricing using multiple regression analysis is developed in this paper. Some of the asset pricing and risk management tools that led to the supremacy in the fields of financial asset pricing are of limited relevance in other areas of finance and in recent years the methodologies of modern multiple regression asset pricing theory has been seen to be superior to traditional methods of asset pricing methods involving future uncertainty and risk.

Hyperheuristics for improved decision support

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Abstract

This presentation focuses on the use of hyperheuristics for improving the quality of decision making in an organisation. Hyperheuristics may loosely be defined as heuristics for choosing heuristics. A particle swarm optimisation-based hyperheuristic is introduced and comparisons against related algorithms are provided. Finally, the use of hyperheuristics as a decision support tool are discussed with reference to existing optimisation methodologies.

Infrastructure and governance as key elements to equity and economic growth in sub-Saharan Africa

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Abstract

Africa, a continent endowed with immense natural and human resources as well as great cultural, ecological and economic diversity, remains underdeveloped. Most African nations suffer from deep poverty and underdevelopment.

Numerous development strategies have failed to yield the expected results. Although some believe that the continent is doomed to perpetual poverty and economic slavery, Africa has immense potential.

In this paper we analyse infrastructural development and good governance as two important factors for economic growth and equity in sub-Saharan Africa.

An investigation into the economic viability of utilising invasive plant material

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Abstract

Due to South Africa being a water scarce land, projects have been put in place by the Department of Water Affairs and Forestry, through their Working for Water program, to remove invasive plant species in order to increase the ground water available. However, the mass of invasive plant material that stands on these removal sites causes serious fire hazards and affects the growth of indigenous plants. Hence there is a need to utilise the invasive plant material in such a manner as to at least cover the cost of the removal process.

In this talk we consider the economic viability of using this plant material as a biofuel source for small scale electric power production. Fifty-three harvesting sites along an area of the West Coast and their invasive plant tonnage are considered. Due to road transport of raw wood over long distances being relatively expensive it is proposed that the energy produced from the biofuel be transported in the form of electricity through the electric power grid. This requires a network of small-scale electric power plants to be set up in the area. From the harvesting sites suitable candidate sites are chosen using a decision-making model. Then the candidate sites are used in a facilities placement problem in order to determine a realistic network for the small scale electric power plants. This realistic network is then used to determine the total cost of the operation in order to help evaluate the economic viability of using the invasive plant material as a biofuel source for small scale electric power production.

A life in operations research

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Abstract

This is the 40th anniversary of ORSSA. It is possibly also opportune to reflect back over this time period. Operations research provides one with the opportunity to become involved in a wide variety and spectrum of different problems. After a lifetime involvement in OR the speaker will share some of the more exciting projects he was involved in as well the successes and failures experienced in the process. Lessons learned will also be highlighted.

A linear programming model used in the log marketing process of a forestry company

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Abstract

We developed a linear programming model which is used to allocate timber to customers as part of the annual log marketing process of the South African forestry company, Komatiland Forests (Pty) Ltd. The model maximises revenue by taking into account a large number of quotes for more than twenty products over eighteen geographically dispersed plantations. The model has been refined over a period of four years since the 2006/2007 financial year of Komatiland and has led to a significant improvement in planned revenue. It has furthermore contributed to the objectiveness and fairness of the allocation process.

Logistics cost measurement for South Africa: Understanding current realities and future risks

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Abstract

The objective in this talk is to measure the cost of logistics in South Africa, determine the major cost drivers and assist both the country to manage those drivers and logisticians to manage logistics in this context. A quantitative approach is followed, based on a gravity-orientated freight flow model, road transport cost model, real transport costs for other modes, warehousing cost survey and inventory delay calculation for the economy.

The resulting model is extensive, detailed and backdated for five years to establish trends and identify underlying cost drivers. This leads to specific items that can be considered by industry and managed by government. In the recent past the sensitivity of logistics costs to fuel and interest rates is disconcerting as both items are "administered" costs on an industry level and even on a national level for economies relying on imported fuel to move freight over long transport distances.

Logisticians manage inventory delay downward relentlessly, but the "Tragedy of the Commons" effect is overlooked and trade-offs on a national and even industry level are often not managed effectively. Collaboration does not only contribute to micro improvements, but may counter negative trends on a macro level. Eventually the trade-offs between specialisation, growth and sustainability come into play. The relationship between energy optimisation and environmental consciousness is illustrated and solutions are suggested.

The research proves that cost of logistics measurement for most economies is viable and useful. Researchers in the same field in other countries are invited to attempt the same work so that a global benchmarking system may be developed.

The model described here is used by Government to assess the state of logistics in South Africa, infrastructure owners to guide investment plans and may be extended for use by logisticians to benchmark on an industry level.

The management of deferred revenue in the prepaid value channel of emerging market mobile phone networks

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Emerging market mobile phone networks face specific challenges with regards to the implementation of services within their organisations. These challenges are now becoming more prominent within the organisational structure, specifically where group organisational structures are involved. The vast expansion and growth of these networks over the past decade have made these challenges more acute. Until now, network penetration was the main focus, but because it is limited by a country's population the focus is shifting towards other areas in the company. In particular, the management of their prepaid systems is one of these new focus areas, because it accounts for a large proportion of their business.

A novel approach to the management of the prepaid system, and specifically the calculation of the deferred revenue thereof, is presented in this talk. Deferred revenue has an important effect on revenue generated from the prepaid value channel and the prepaid value channel comprises more than 95% of the revenue generated through mobile phone networks in emerging markets. The effectiveness of this new method is measured against the existing (traditional) method by means of the *analytical hierarchy process* (AHP). A specific mobile phone network located in Cote d'Ivoire is used as a case study.

A mixed integer optimisation solution to long rotation harvest scheduling

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Abstract

Harvest scheduling in forests has become increasingly complex over the past few years, especially after the impact of disastrous fires. A fresh approach to harvest scheduling has been implemented in the South African forestry company, Komatiland Forests (Pty) Ltd. A mixed integer programming model is used to select a harvesting strategy per compartment from a set of pre-determined feasible strategies. The selection is performed in such a way that normalisation is achieved within a maximum of two rotations. The model has been implemented in *AIMMS* and experiments have been performed with *CPLEX* and *XA* as solvers.

Model development for robust regression with minimal assumptions: An empirical study

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Abstract

Regression models are often employed to assist with decision making activities. The success of a regression model, however, relies heavily on assumptions made by the model builder. In addition, the model may also be influenced by the presence of outliers. In this talk robust techniques for regression models with minimal assumptions are explored. Mathematical programming techniques are used to formulate a nonlinear regression model, and smoothing and mixed integer linear programming techniques are included to address robustness. The results of empirical experiments are presented.

Modelling neural networks for forecasting high frequency data — An empirical evaluation of input variable selection methodologies

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Abstract

Neural networks (NN) have been successfully applied in several time series forecasting applications. Past forecasting competitions, including the *NN3*, *NN5* and the transportation competitions, have shown an increasing relative accuracy of NN against statistical benchmark models as the data frequency of time series increases, *e.g.* from monthly to weekly and daily data. While modelling NN for a given time series remains challenging, most methodologies to specify NNs were developed exclusively on low frequency data, in particular monthly time series. In contrast, high frequency data exhibit different properties of multiple overlying seasonalities, large amounts of data, and stronger influence of external influences and outliers. Therefore, modelling tools of lower frequencies do not readily apply to these datasets. For example, the selection of the input variables for a NN (generally considered one of the most important determinants of NN accuracy) is usually based on tools developed for low frequency problems, like the *analysis of autocorrelation* (ACF) and *partial autocorrelation functions* (PACF) that fail as the amount of data increases with the frequency.

This analysis seeks to empirically evaluate how several ACF and PACF, regression and heuristic approaches, which are most widely used to specify the input vector of NN, perform when applied to high frequency data. Two different real data sets of different length are used to evaluate the competing input variable selection methodologies, using the established standards of valid empirical evaluation, *i.e.* using rolling origin evaluation, robust error measures and statistical tests. Our objective is to provide objective evidence to determine the relative performance of these methodologies against a set of established statistical benchmark methods for high frequency forecasting problems. Furthermore, it is assessed whether the performance based ranking of these methodologies changes for different data frequencies.

Modelling students through a South African higher education institution

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Abstract

> "[T]he best functioning universities and colleges in the 21st century will be those that make the most aggressive use of data ... a student that tracks student performance and career development."
>
> — Trevor Manuel at his installation at the Cape University of Technology, 2008.

Shah & Burke [1] conducted various studies to model the flow of students through the Monash University system. In this talk we primarily draw upon their work on a discrete-time survival analysis model for student departure to model student flow at Stellenbosch University between 2000 and 2008. The probability of completing, and the time to complete an undergraduate course are likely to vary by attributes such as age, gender and the field of study undertaken. Given attributes such as these, our model provides estimates of the probability of students completing their courses. It is also provides estimates for the mean time that a student takes to complete his/her course, and the mean time (s)he spends in the higher education system.

Student registration data are drawn from Stellenbosch University's *Tracking System* and are aggregated to an appropriate format in order to replicate the attempt by Shah & Burke. To conclude, the usefulness and appropriateness of the approach is evaluated. Model improvements and adaptations are suggested accordingly.

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Multiobjective auto-algorithms: Parameter-free self-adaptive multiobjective metaheuristics

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Abstract

Is it possible to develop a multiobjective metaheuristic that is entirely self-contained in the sense that it does not require any user-defined parameter values, and can automatically adapt its search mechanism to the fit the optimisation problem at hand?

The question of multi-objective 'auto-algorithms' is addressed in this talk by examining an initial attempt at such an algorithm, named *Anima*, which works within an evolutionary optimisation framework. Operational parameters which affect search behaviour are encoded together with solution genes, and propagate using the same mechanisms of selection, crossover and mutation. The self-adaptive components of *Anima* will be discussed in detail and the results of its application to an engineering design problem will be presented, where its performance is compared to several other successful metaheuristics.

The nonlinearity of African stock indices: An empirical investigation of linear and nonlinear models

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Abstract

An increasing amount of evidence suggests that emerging stock markets lack orderliness and simple linear behaviour, and are thus better described as nonlinear dynamic systems. Consequently, the linear models engraved in the theory of market efficiency should be inappropriate to capture and exploit the unique chaotic market microstructures of the emerging African stock markets.

In this paper, the predictive performance of linear time series models is compared to the accuracy of several nonlinear univariate models, employing a valid and reliable empirical out-of-sample evaluation in order to analyse the conditions under which the models perform well. The random walk and *autoregressive integrated moving average* (ARIMA) models serve as linear statistical benchmarks. These are compared to several nonlinear models, including *generalised/nonlinear autoregressive* (GAR/NLAR) models, *bilinear* (BL) models, *threshold autoregressive* (TAR) models, *smooth transition autoregressive* (STAR) models, *Markov-switching autoregressive* (MSA) models and a variety of feedforward *artificial neural networks* (ANN). Their out-of-sample forecasting accuracy is evaluated using robust statistical error metrics and a regression-based evaluation method, the Granger-Newbold test and the Diebold-Mariano test.

Operations research applications in deprived communities

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Abstract

It has been observed that operations research (OR) in South Africa has been servicing the needs of the developed sections of the country, to the neglect of deprived communities. Already in 1996, then president of ORSSA, Erica Ferreira, pointed out failures of the OR community to contribute towards defining developmental issues contained in the *Reconstruction and Development Programme* (RDP). In fact, as attested to by Hans Ittmann, not only did operations research fail to orientate towards problems of deprived communities, it has been exclusively orientating towards what he termed issues of the 'first world component.'

This bias in research focus persists in spite of mounting evidence with respect to a need for OR practitioners to contribute unique insights into better ways to plan for optimisation of resources around service delivery. To be in a position to remedy this situation, we attempt to unravel factors that produce and perpetuate this imbalance in the research focus of OR practitioners. To accomplish this, we examine factors that shape research in this area so as to understand the incentives and obstacles that produce the current research orientation. This is very central to imagining ways to reverse the current neglect of deprived communities.

In this talk we undertake a preliminary study of these factors by focusing on a number of researchers in ORSSA and a survey of articles in its journal, *ORiON*. The study will examine both the structural and individual factors underpinning the current research orientation. Critical questions will include: Who commissions research in OR? Who influences major research themes? What is the value of research orientated towards deprived communities? What is the profile of OR practitioners? What kind of training do OR practitioners get?

We hope to generate some insight into why the voice of OR has been so soft.

The optimisation of a single-aisle picking line

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Abstract

A case study of a consumer-goods company is presented in this talk. Order-picking is the most labour-intensive activity within their *distribution centre* (DC) and accounts for most of the operating expense. More than half the time spent on order-picking is made up of pickers travelling between product bays to pick the orders. This is both time consuming and forms part of the labour cost and is thus an area open for improvement in the DC. The company uses a picking line system to fulfil all orders for the different stores and wants to improve the efficiency of the picking line system, *i.e.* to pick all orders in a shorter amount of time.

The DC is situated in Durban and services 1 200 stores nationwide. The objective is to minimise the total distance travelled by all pickers along the picking line. An exact integer programming formulation of the problem is presented as well as a metaheuristic approach. The metaheuristic approach determines how products should be allocated to bays such that the distance travelled by the pickers within (*i.e.* to pick) an order is minimised, over all orders. In addition, it determines how the orders should be sequenced such that the total distance travelled between orders is minimised over all orders.

Organisational transformation

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Abstract

According to Morgan [3], commoditisation and saturation forces many companies to transform. A prerequisite for success is addressing the organsiational core, context as well as capability. Dostal *et al.* [2] refers to ethos, aims, processes, structures, governance, environment and resources. Barrett [1] calls this a whole-system approach.

In 2006, *SASOL Technology* embarked on such a transformation as part of the larger SASOL Group. In this talk it is stated why and in which way this transformation is conducted. The author concludes by reflecting on the current results, both for herself as an operations research practitioner, and for operations research itself.

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Ranking of decision making units based on their robustness profiles

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Abstract

We examine different ranking methods in data envelopment analysis and their shortcomings, and propose ways of dealing with these shortcomings. We also present a method for ranking decision making units based on their robustness profiles. The method combines the robustness analysis based on weight restrictions and the outranking method.

Real-time decision support for military operations other than war

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Abstract

South Africa currently has the strongest military force in Africa and is seen as a major role player with respect to peacekeeping in Africa. In addition to the role of peacekeeping, military forces and technology in South Africa are being used for safety and security purposes in support of the *South African Police Service* during large international events such as the Rugby World Cup (1995), the All Africa Games (1999), the World Summit on Sustainable Development (2002), the Cricket World Cup (2003) and the Soccer World Cup (2010). Furthermore, military forces are also utilised during other interoperability operations, such as border patrol operations, operations against illegal fisheries, poaching (*e.g.* abalone poaching) and smuggling. These operations are often referred to as *operations other than war* (OOTW).

The operators responsible for the coordination of these operations are often required to make real-time decisions within rapidly changing environments and stressful situations. Consequently, real-time *decision support systems* (DSSs) are required to organise and evaluate information, and to propose appropriate action(s) to the operator during OOTW.

This talk will commence with an introduction of a DSS within the *ground-based air defense* (GBAD) environment, which forms the foundation of the research towards real-time decision support for OOTW. The main differences between the GBAD and the OOTW environments are discussed, focusing on the impact that these differences have on the DSS and its underlying models. The talk will be concluded highlighting examples of OOTW where real-time DSSs may be beneficial.

Recursive compound word decomposition

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Abstract

In *natural language processing* (NLP), it is essential to split compound words into their constituent parts. This simplifies and/or enhances NLP tasks such as machine translation, speech recognition, text classification, information extraction, information retrieval, *etc.* Also in word processing it is necessary for accurate hyphenation.

The algorithm presented during this talk identifies the constituent parts of a compound word based on a comprehensive word list in the same language. To decompose a word, all subwords are extracted from the word list. These are then used recursively to identify the parts of the word. Factors that are taken into account are, for example, joining letters, prefixes, suffixes and word complexity.

A list of decomposed words is used to train machine-learning techniques such as neural networks and decision trees as a step in the development of a hyphenation tool.

Residential waste collection routing optimisation

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Abstract

Many motorists have had the pleasure of being caught behind a waste collection vehicle duly loading waste from bins situated on the side of the road, reducing traffic flow to a snail's pace. Many of us have been woken by a waste collection vehicle, only to realise that you have forgotten to place the waste bin at the side of the road. Yet, as obnoxious as waste collection may seem, municipal strikes tend to remind us that the lack or improper provision of waste collection is far more obnoxious than the activity itself.

Waste collection is necessary but expensive, and it is well recognised as the most costly component of the waste management function: even a small improvement in the waste collection and transfer operations can lead to significant overall savings. A promising and obvious way to improve collection operations is by designing better waste collection routes, a task that seldom receives attention within South African municipalities. In this presentation we show how the problem of designing collection routes may be modelled as a *capacitated arc routing problem*. The presentation focuses on the development and evaluation of optimisation algorithms capable of solving the problem, taking unique South African challenges into account.

Risk modelling and multicriteria decision analysis

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Abstract

Decision making with single or multiple objectives typically also involve various risk components. Simple expectation or mean-variance models do not adequately represent decision maker preferences in many contexts. In this talk we discuss a number of structures for representation of risk components in multicriteria modelling terms. These structures are compared on the basis of the implicit biases each may introduce into the decision process, and recommendations are made concerning the use of scenarios and/or different values at risk.

The role of statistics in operations research

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Abstract

Traditionally texts on operations research (OR), after a chapter on problem solving methodology and possibly one on Linear Algebra, move immediately on to Linear Programming and the Simplex Algorithm, progressing to its various specialisations (transportation, assignment, networks, *etc.*) and its variants (integer, nonlinear, advanced topics in optimisation, *etc*). All this presupposes a deterministic universe where parameter values are known and the future outcomes of today's actions can be predicted with certainty. Only towards the middle of the book (or even later) are the concepts of probability and statistics introduced, which allow the student to approach problems in a more realistic world where uncertainty prevails: decisions with uncertain outcomes, queueing problems where both arrivals and service times are random, inventory planning where demand and supply is uncertain, forecasting and so on.

I propose that this order be reversed and that instead students be introduced to OR via problems in which uncertainty prevails, and their solution is approached through the methods of probability and statistics. Deterministic models are seen as approximations to reality in circumstances where uncertainty is low. Even for these models parameter values usually need to be estimated from data, requiring tools from estimation theory and experimental design. These models can be made more realistic by incorporating uncertainty, but at a cost of increased complexity. The talk will be illustrated by examples emanating from my personal experience as a practitioner in OR and Statistics.

Selecting subsets of foods to measure nutrient exposure: A genetic algorithm using the max_r method

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Abstract

In this talk a genetic algorithm is used to find a subset of foods of specified cardinality that maximises the Pearson correlation of the nutrient intake based on the chosen foods with the total nutrient intake based on all the foods. This method is referred to as the *max_r method*, which was shown to be an exact method for choosing a subset of foods so as to measure specific nutrient exposures, especially when the effect of the nutrient on some disease risk is established.

In dietary intake questionnaires, subjects are asked how much and how often certain food items are consumed. The daily intake per subject of a given nutrient is calculated for each food item, as illustrated in the table below. The objective is to determine which (say 5) food items will best represent iron intake, for example.

Subject	Full cream milk	Cheddar cheese	Non-diary creamer	Skimmed milk	Fried egg	Minced beef	Polony	Fillet beef	⋯
1	0.00	0.06	0.00	0.00	1.80	0.58	0.00	0.77	⋯
2	0.13	0.00	0.00	0.04	0.00	0.58	0.15	0.18	⋯
3	0.13	0.06	0.00	0.01	0.26	0.14	0.00	0.77	⋯
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	

The problem may be defined more generally as follows. Let $\mathbb{V}$ be the sample variance-coviariance matrix for a particular nutrient, for all the foods in a given dietary questionnaire. Define an indicator vector $\boldsymbol{r} = [r_1, \ldots, r_t]$ where $r_i = 1$ if the i-th food item is included in the set, or 0 otherwise. Suppose $\sum_{i=1}^{t} r_i = k$ and let $\boldsymbol{u} = [u_1, \ldots, u_t]$ be the complement of $\boldsymbol{r}$, so that $\sum_{i=1}^{t} u_i = t - k$. If G is the sum of the $t \times t$ elements of $\mathbb{V}$, then the problem is to find $\boldsymbol{r}$ from $\binom{t}{k}$ possible vectors which maximises

$$\frac{\boldsymbol{r}'\mathbb{V}\boldsymbol{r} + G - \boldsymbol{u}'\mathbb{V}\boldsymbol{u}}{2\sqrt{G\boldsymbol{r}'\mathbb{V}\boldsymbol{r}}}.$$

This constrained combinatorial optimisation problem is difficult to solve conventionally. A genetic algorithm is used to find an optimal combination of foods.

A simulation approach towards solving a two-echelon inventory control problem

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Abstract

This talk focuses on a two-echelon inventory control problem where there are one or two warehouses supplying a product to multiple retailers. The objective is to coordinate inventory decisions in this two-echelon supply chain in such a way that the total cost of the system is minimised. The costs involved are holding costs, ordering costs and penalty costs associated with unsatisfied demand at the retailers. A simulation model is used to explore the impact on these costs and other output variables under various inventory control policies.

Single crane optimisation within a distribution centre

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Abstract

The optimisation of crane movement within a *distribution centre* (DC) is an important element in the flow of material within a DC. Often crane movements are DC-specific. The focus of this presentation is on the crane movement in a specific DC owned by *PEP Stores Ltd* (PEP) located in Kuilsriver, South Africa. The first objective is to improve on the management philosophy currently in use by PEP. The problem is modelled as a variation of the travelling salesman problem, namely the *dynamic sequential ordering problem with deadlines* (DSOPD). A re-optimisation approach is implemented to handle the dynamic element of the problem. Tabu search and ant colony metaheuristic methods, as well as combinations of these methods, are used for the dynamic re-optimisation. The test data shows that combining tabu search and ant colony methods yield better re-optimisation results and the proposed model outperforms the original approach used by PEP.

Some empirical results on multicriteria decision making with uncertain outcomes

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Abstract

When making decisions involving outcomes that are uncertain, some choice must be made about how the uncertainty is going to be represented. Probability distributions are popular, but other possibilities include expected values, variances, fuzzy sets, quantiles, or scenarios. This talk investigates the effects that the choice of uncertainty representation can have on decision making. Results are obtained using a controlled choice experiment in which subjects were asked to make a series of hypothetical choices involving multiple conflicting objectives and uncertain outcomes. The way in which uncertainty is represented can affect various aspects of decision making, from the quality of the chosen alternative to the process by which the decision is made.

Stochastic models of manpower planning systems: An overview

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Abstract

The analyses of manpower systems have become a very important component of planned economic development of any organisation or nation. However, manpower planning depends on highly unpredictable human behaviour and the uncertain social environment in which the system functions. Hence the study of stochastic models of manpower systems is very much essential. Several stochastic models of manpower systems have been established in the past (Bartholomew [1], Vajda [2], Vassiliou *et al.* [3], Yadavalli *et al.* [4, 5, 6]). An overview of various stochastic models of manpower systems will be given in this talk. A stochastic model with a promotion policy is studied as a special case.

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Strategic market segmentation of the South African transport market

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Abstract

South Africa faces a spatial challenge regarding the transport requirements of its economy with respect to the dispersed placement of its economic centres. Both this and previous suboptimal service delivery by rail has led to an imbalance in road and rail transport provision and subsequent high transport and total logistical costs. *Accelerated and Shared Growth Initiative for South Africa* (ASGISA) has earmarked the cost, capacity and efficiency of the logistics system as a potential binding constraint on South African growth requirements in overcoming its social challenges. Transport in the high-density commodity export market segment has been completely captured by rail and *Transnet* should retain its efficiency in this focus area.

Transport in the long-distance corridor market segment has mostly been captured by road, with growth in the segment having been completely captured by road over the past few years. This is a market segment that is very suitable for rail transportation and *Transnet Freight Rail* needs to focus on the segment in order to establish itself as a primary player in the field. Such positioning may be achieved by focusing on the high-density corridors identified, specifically on the high-density commodity groups transported along such corridors. Intermodal solutions have proven to facilitate the shift from road to rail on long-distance corridors, while simultaneously maintaining the required service levels and reducing the related transport costs.

Transnet Freight Rail has made clear that it will endeavour to become an acknowledged player in the long-distance high-density transport market segments. *Transnet Freight Rail* may achieve this by collaborating with short-distance distributors at long-distance corridor endpoints and through industry level negotiations aimed at ensuring volume shifts. If it manages to do this, the current road versus rail imbalance will be rectified, reducing total South African transport and logistic costs. Such reduction in costs should increase the competitiveness of South African products in major export markets, overcoming the binding constraint predicted by ASGISA.

Strategic supply chain planning under uncertainty: A literature review

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Abstract

In this paper we review current literature on strategic supply chain planning under uncertainty. Supply chain planning is a complex process which has to cope with operational, tactical and strategic planning. Most of the earlier research work concentrated on describing and solving deterministic supply chain planning problems. The major problem is that these methods do not take into consideration the elements of risk and uncertainty. Uncertainties may arise due to advances in technology, movements in foreign exchange rates, changes in international taxation schemes and resource availability (in particular human resource). We highlight possible future avenues of research.

A strong bound for linear integer models

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Abstract

A technique for determining a strong bound before solving a *linear integer programming* (LIP) model is presented in this talk. Integral limits for the basic variables in the continuous optimal solution are approximated and then used to calculate a bound for the integer model. Assuming a maximisation model, the bound is used as an upper limit before applying a branch-and-bound, branch-and-cut, branch-and-price or branch-cut-and-price algorithm. Search over large numbers of subproblems that are usually associated with the *NP-complete* LIP model may thus be avoided.

Supply chain risks: Perspectives on private-public sector partnership for the benefit of SMMEs in South Africa

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Abstract

This paper investigates the potential supply chain risks that may impede the entry of *small to medium management enterprises* (SMMEs) in supply chains. As part of a deliberate strategy by the South African Government to widen economic participation, we investigate the risks affecting SMMEs' performance in private-public sector partnership. *Systems dynamics* is used to analyse the relationship of all the players within the supply chain. A mutually beneficial relationship with varied degrees of responsibilities is proposed for established partners in the supply chain that mitigates against the risks caused by the enforced presence of SMMEs in the supply chain.

A systems dynamics model of household energy consumption

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Abstract

"Slack" arises in the budget for energy services when energy efficiency technology is introduced — but the slack in a household's budget for energy services may be absorbed by expenditure, either on other energy services or on other items (resulting in rebound effects). What attitudinal, behavioural and awareness conditions will impact the way this slack is absorbed, and the subsequent level of rebound? And ultimately, how can we achieve a situation of zero or negative slack being taken up after the introduction of technical efficiency? The ideal world is one where people not only save money as a result of the technology improvement, but where society benefits from the additional efficiency resulting from increased awareness and behavioural shift in attitudes toward energy use. This presentation covers the method of model development and illustrates the model's usage with some preliminary results.

Tactical sugarcane harvest scheduling

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Abstract

The harvesting season for sugarcane in South Africa usually opens during March or April and closes during November or December. A typical sugarcane farm may consist of tens to hundreds of fields that require sequential harvesting, consistently distributed across the season. As often as every day during the season, a decision of selecting field(s) that should be harvested must be taken. The factors involved are many: wind conditions, temperature and cloud cover, soil moisture content, accessibility of the fields, which fields are to be ploughed out and which fields have received chemical ripening, the state of all fields in terms of estimated yield and overall quality, the variety of sugarcane on each field, the date on which each field was last harvested, the number of times each field has been harvested without being ploughed out (ratoon), the day of the year, whether some fields have been blown down or fallen down due to their own weight (lodging), whether some fields have been subjected to one of several levels of frost, whether some fields have begun flowering or have been invaded by pests, *etc.* In this talk, we show by an example that there is an opportunity to assist farmers and millers in the South African sugarcane industry by providing continuous scheduling of the fields using data that are relatively easy to access. We report results from five months of the 2009 season, where schedules provided biweekly to four sugarcane growers have been criticised on their quality. The results indicate that these schedules provide actual support during the growers' decisions.

Thoughts on supply chain complexity

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Abstract

In this talk we summarise findings from recent logistics and supply chain surveys, and discuss complexity drivers and how to manage complexity in supply chains. The talk will be illustrated with a case study of an agricultural export supply chain.

Tournament design using symmetric and self-orthogonal Latin squares

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Abstract

Since Kirkman [2] posed his famous *schoolgirl problem* in 1850, combinatorial designs have been successfully applied to the problem of scheduling sports tournaments for which fairness and balance are strict requirements. An important example of such a combinatorial design is the Latin square [1, Chapter 3], special types of which are used to schedule, for example, spouse-avoiding mixed doubles round-robin tennis tournaments (self-orthogonal Latin squares with symmetric orthogonal mates), round-robin golf tournaments played on neutral grounds (symmetric idempotent Latin squares) and golf tournaments consisting of three or more players competing in a single round (mutually orthogonal Latin squares).

Three important questions arise regarding tournament design, namely their existence (or otherwise), their enumeration and methods of constructing them. In other words it is important to know that a tournament design is possible, in how many different ways the tournament may be scheduled and how to find these schedules. Answers to these questions are discussed with respect to the above mentioned tournament designs as well as other tournament designs scheduled with symmetric and self-orthogonal Latin squares. Finally, the properties of symmetry and self-orthogonality of Latin squares are generalised in order to include a broader spectrum of possible sports tournament designs and their applications.

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Transport demand planning: Microsimulation versus traditional systems

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Abstract

Agent-based transport simulation promises to address the shortcomings of traditional planning systems by capturing emergent effects resulting from the complexities, interactions and temporal dynamics of the South African transport environment. This study compares results from an equilibrium assignment with those of a large-scale microsimulation for the private vehicle commuter population of Gauteng. In both cases, predicted volumes are compared with actual traffic counts for the base year of 2001.

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