
Dear Conference Delegate

Welcome to the US Business School at the event of the 34–th Annual Conference of the Operations Research Society of South Africa. At this conference we are honoured by the visit of Professor Alexander Verbraeck, from the Delft University of Technology, who flew in from the Netherlands especially for our conference. In addition we have been fortunate in that many delegates have been doing a lot of interesting Operational Research work during the intervening year since our last meeting in Pretoria about which they will report during the conference. The number and quality of the papers were such that we were forced to run two parallel sessions for virtually the whole duration of the conference. Although we have tried to group the topics under general themes, it will be possible for delegates to switch between sessions so as to attend presentations of their choice. A detailed conference programme and abstracts of all the talks are included in this document.

We hope that you will enjoy the hospitality of the Business School and the beautiful surroundings of the Western Cape. May the conference be an enriching time for all, and an opportunity to meet new friends and renew old acquaintances.

Wim Gevers

Beste Konferensie Afgevaardigde

Welkom by die US Bestuurskool vir die 34–ste Jaarlikse Konferensie van die Operasionele Navorsingsvereniging van Suid–Afrika. By hierdie konferensie word ons vergas deur die teenwoordigheid van Professor Alexander Verbraeck, van die Delft Tegnologiese Universiteit, wat spesiaal vir ons konferensie van die Nederlande gekom het. Verder was ons gelukkig dat baie van die afgevaardigdes interessante Operasionele Navorsingswerk gedurende die afgelope jaar sedert ons laaste konferensie in Pretoria gedoen het, waaroor hulle tydens die konferensie verslag sal doen. Die aantal en kwaliteit van die voordragte was van só 'n aard dat ons twee parallelle sessies gedurende bykans die hele konferensie sal hê. Hoewel die aanbiedings onder algemene temas gegroepeer is, sal u tussen die sessies heen en weer kan beweeg om na die aanbiedings van u keuse te luister. 'n Volledige konferensieprogram sowel as opsommings van al die referate is in hierdie bundel vervat.

Ons hoop dat u die gasvryheid van die Bestuurskool sowel as die pragtige natuurskoon van die Wes–Kaap sal geniet. Mag die konferensie 'n verrykende tyd vir almal wees, en 'n geleentheid om nuwe vriende te maak en om bande met ou kennisse te versterk.

Wim Gevers

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US Business School / US Bestuurskool

Map of Conference Facilities / Kaart van Konferensiefasiliteite

Conference Programme at a Glance /
 Konferensieprogram met 'n Oogopslag

Sunday / Sondag 5 September 2004	
17:00–19:00	Arrival & Conference Registration / Aankoms & Konferensieregistrasie [Lapa]
19:30	Welcoming Function / Verwelkomingsfunksie [Lapa]

Monday / Maandag 6 September 2004	
08:30–09:00	Late Registration / Laat Registrasie [Foyer/Portaal] Coffee / Koffie [Winery]
09:00–10:30	Plenary Session / Sessie I [Room / Lokaal 2058]
10:30–11:00	Tea / Tea [Winery]
11:00–13:00	Parallel Session / Parallele Sessie I [Room 2058] Parallel Session / Parallele Sessie II [Lokaal 2059]
13:00–14:00	Lunch / Middagete [Winery]
14:00–15:30	Parallel Session / Parallele Sessie III [Room 2058] Parallel Session / Parallele Sessie IV [Lokaal 2059]
15:30–16:00	Tea / Tee [Winery]
16:00–17:30	Parallel Session / Parallele Sessie V [Room 2058] Parallel Session / Parallele Sessie VI [Lokaal 2059]
18:00	Whisky Tasting / Whisky-proe [Room / Lokaal 215]

Tuesday / Dinsdag 7 September 2004	
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09:00–11:00	Parallel Session / Parallele Sessie VII [Room 2058] Parallel Session / Parallele Sessie VIII [Lokaal 2059]
11:00–11:30	Tea / Tea [Winery]
11:30–13:00	Parallel Session / Parallele Sessie IX [Room 2058] Parallel Session / Parallele Sessie X [Lokaal 2059]
13:00–14:00	Lunch / Middagete [Winery]
14:00–15:30	Parallel Session / Parallele Sessie XI [Room 2058] Parallel Session / Parallele Sessie XII [Lokaal 2059]
15:30–16:00	Tea / Tee [Winery]
16:00–18:00	Annual General Meeting [Room 2058] / Algemene Jaarvergadering [Lokaal 2058]
19:30	Conference Banquet / Konferensiebanket [Winery]

Wednesday / Woensdag 8 September 2004	
08:30–09:00	Coffee / Koffie [Winery]
09:00–11:00	Parallel Session / Parallele Sessie XIII [Room 2058] Parallel Session / Parallele Sessie XIV [Lokaal 2059]
11:00–11:30	Tea / Tea [Winery]
11:30–13:00	Plenary Session / Sessie II [Lokaal 2058]
13:00–14:00	Lunch / Middagete [Winery]

Sunday/Sondag 5 September 2004

Arrival & Registration / Aankoms & Registrasie

(17:00–19:00) [Lapa]

Welcoming Function / Verwelkomingsfunksie

(19:30) [Lapa]

Monday/Maandag 6 September 2004

Registration/Registrasie (08:30–09:00) [Foyer]

Coffee/Koffie (08:30–09:00) [Winery]

Monday/Maandag 6 September 2004: Plenary Session / Sessie I (09:00–10:30) Chair/Voorsitter: Paul Fatti [Room/Lokaal 2058]	
09:00–09:10	Walter Claassen (Vise-Rektor: Navorsing, US) <i>Welcome Address / Verwelkoming</i>
09:10–09:15	Wim Gevers (ORSSA 2004 Conference Chair) <i>Announcements / Aankondigings</i>
09:15–09:30	Wim Gevers (ONSA President) <i>Presidential Address / Presidensiële Toespraak</i>
09:30–10:30	Alexander Verbraeck (Keynote Speaker) <i>Distributed Web-based Modelling and Simulation Services</i>

Tea/Tee (10:30–11:00) [Winery]

Monday/Maandag 6 September 2004: (11:00–13:00)	
Parallel Session / Parallele Sessie I Chair/Voorsitter: Alexander Verbraeck [Room/Lokaal 2058]	
11:00–11:30	Mandy Lebides , <i>The Breakdown of Project Implementation in Business: The Role of Language</i>
11:30–12:00	Nthabiseng Ntene , <i>An Overview of Exact and Heuristic Algorithms for Packing Problems</i>
12:00–12:30	Paul Fatti , <i>Pallet Supply Chains</i>
12:30–13:00	Willem Fouché , <i>Simulating Random Strings by Arithmetic Means</i>
Parallel Session / Parallele Sessie II Session Theme: Mathematical & Statistical Modelling Chair/Voorsitter: Theodor Stewart [Room/Lokaal 2059]	
11:00–11:30	Thinus du Plessis , <i>Aspects of Model Selection and Data Discarding for Linear Regression</i>
11:30–12:00	Jeanne le Roux , <i>Inventory and Location Decisions in a Blood Service System</i>
12:00–12:30	Lynette Frick , <i>Advance-Order Systems: Lot-sizing over Infinite & Finite Horizons</i>
12:30–13:00	Clemens Dempers , <i>From System Dynamics & Discrete Event to Practical Agent Based Modelling</i>

Lunch/Middagete (13:00–14:00) [Winery]

Monday/Maandag 6 September 2004: (14:00–15:30)	
Parallel Session / Parallele Sessie III Session Theme: The South African Fresh Fruit Supply Chain <i>Chair/Voorsitter:</i> Marthi Harmse [Room/Lokaal 2058]	
14:00–14:30	Esbeth van Dyk , <i>Modelling Infrastructure Capacity for the South African Fruit Industry — Part I</i>
14:30–15:00	Frank Ortmann , <i>Modelling Infrastructure Capacity for the South African Fruit Industry — Part II</i>
15:00–15:30	James Bekker , <i>Modelling Infrastructure Capacity for the South African Fruit Industry — Part III</i>
Parallel Session / Parallele Sessie IV Session Theme: Credit Risk & Credit Scoring <i>Chair/Voorsitter:</i> Wim Gevers [Room/Lokaal 2059]	
14:00–14:30	Barbara Swart , <i>Modelling Credit Risk: Some Ideas and Some Applications</i>
14:30–15:00	Darin Kent , <i>Credit Scoring in a Business Environment — Part I: Overview of Credit Scoring</i>
15:00–15:30	Darin Kent , <i>Credit Scoring in a Business Environment — Part II: Discussion on a Typical Scorecard Building Process</i>

Tea/Tee (15:30–16:00) [Winery]

Monday/Maandag 6 September 2004: (16:00–17:30)	
Parallel Session / Parallele Sessie V Session Theme: Scheduling <i>Chair/Voorsitter:</i> Theo Stylianides [Room/Lokaal 2058]	
16:00–16:30	Marinda Swart , <i>Putting MINLP Scheduling to Work: Continuous Time Formulation for Operational Scheduling at Sasol Coal Supply</i>
16:30–17:00	Marthi Harmse , <i>Applying MINLP to Optimise a Production and Transportation Schedule for a Multipurpose Facility</i>
17:00–17:30	Johan Janse van Rensburg , <i>Periodic Event Scheduling Problem</i>
Parallel Session / Parallele Sessie VI Session Theme: Voting & Identification <i>Chair/Voorsitter:</i> Willem Fouché [Room/Lokaal 2059]	
16:00–16:30	Chris Swanepoel , <i>AFIS and Ethics</i>
16:30–17:00	Hans Ittmann , <i>Prediction of the 2004 National Elections in SA</i>
17:00–17:30	Hennie de Kock , <i>Tel Elke Stem?</i>

Whisky Tasting/Whisky-proe (18:00) [Room 215]

Tuesday/Dinsdag 7 September 2004

Coffee/Koffie (08:30–09:00) [Winery]

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09:30–10:00	Jorg Schmid , <i>Applying Dijkstra's Algorithm in Naval Routing</i>
10:00–10:30	Olof de Wet , <i>Characterisation of Rectilinear Steiner Minimal Trees and the Steiner Ratio</i>
10:30–11:00	No Talk Scheduled
Parallel Session / Parallele Sessie VIII Session Theme: Linear & Multiple Objective Programming <i>Chair/Voorsitter: Hennie de Kock [Room/Lokaal 2059]</i>	
09:00–09:30	Moeti Ramokgadi , <i>Decision Support for Multi-objective Programming Problems</i>
09:30–10:00	Makaya Makaya , <i>Development of Interactive Methods for Multi-objective Linear Programming in Decision Support</i>
10:00–10:30	Stephan Visagie , <i>Plaasbestuur en -beplanning met in agneming van Risiko</i>
10:30–11:00	Ozias Ncube , <i>Sensitivity Analysis and Extension to Protean Modelling and Analysis of Fractional LPs</i>

Tea/Tee (11:00–11:30) [Winery]

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Parallel Session / Parallele Sessie IX Session Theme: Software <i>Chair/Voorsitter: Leo Tomé [Room/Lokaal 2058]</i>	
11:30–12:00	Neil Manson , <i>Open Source Software — Part I: Is it a Good Thing?</i>
12:00–12:30	Neil Manson , <i>Open Source Software — Part II: Demonstration</i>
12:30–13:00	Clemens Dempers , <i>Delivering Technical Computing Applications with webMathematica: A South African Case Study</i>
Parallel Session / Parallele Sessie X Session Theme: Electricity & Telecommunications Service Provision <i>Chair/Voorsitter: Hennie Kruger [Room/Lokaal 2059]</i>	
11:30–12:00	Stephen Davis , <i>Mathematical Modelling and Risk Management in the Deregulated South African Electricity Market</i>
12:00–12:30	David van der Merwe , <i>Modelling and Solution Strategies for Tree Knapsack Problems for Local Access Telecommunication Networks</i>
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Lunch/Middagete (13:00–14:00) [Winery]

Tuesday/Dinsdag 7 September 2004: (14:00–15:30)	
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14:30–15:00	Jaco Roux , <i>Ground Based Threat Evaluation of Fixed Wing Aircraft</i>
15:00–15:30	Stephen Benecke , <i>Higher Order Protection Strategies for Graphs</i>
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14:00–14:30	Jean-Pierre Luhadjula , <i>Fuzzy Random Variables: Mathematical Properties and Applications to Mathematical Programming Problems</i>
14:30–15:00	Kabongo Kantu , <i>Weight Restrictions in Data Envelopment Analysis</i>
15:00–15:30	Theodor Stewart , <i>A Multicriteria Decision Analysis Approach to Rights Allocation in Fisheries</i>

Tea/Tee (15:30–16:00) [Winery]

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09:00–09:30	Neil Jacobs , <i>Vervoermodellering vir die Benutting van Afgekapte Indringerplante in die Wes-Kaap</i>
09:30–10:00	Paul Potgieter , <i>A Survey of Non-standard Methods in Finance</i>
10:00–10:30	Theo Stylianides , <i>Development of a Model to Forecast Container Growth at City Deep</i>
10:30–11:00	Nicky Pantland , <i>A Three-Dimensional Numerical Technique for Determining the Foot of a Continental Slope</i>
Parallel Session / Parallele Sessie XIV Session Theme: Education & Development <i>Chair/Voorsitter: Esbeth van Dyk [Room/Lokaal 2059]</i>	
09:00–09:30	Ilze du Plooy , <i>Challenges in Teaching OR at the Undergraduate Level in a Distance-learning Environment</i>
09:30–10:00	Paul Kruger , <i>The “Spreadsheet Revolution in Education” and the Future of OR</i>
10:00–10:30	Killian Manyuchi , <i>Corporate Sustainable Development: Emerging Challenges and the Road Ahead</i>
10:30–11:00	Hans Ittmann , <i>OR in Africa and Developing Countries</i>

Tea/Tee (11:00–11:30) [Winery]

Wednesday/Woensdag 8 September 2004: Plenary Session / Sessie II (11:30–13:00) <i>Chair/Voorsitter: Wim Gevers [Room/Lokaal 2058]</i>	
11:30–12:30	Alexander Verbraeck (Keynote Speaker) <i>Applying Distributed Simulation for Analyzing Port Extensions</i>
12:30–13:00	Wim Gevers , <i>Conference Closing / Konferensie Afsluiting</i>

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– *Notes* –

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Opening (Keynote) Lecture

Openingslesing

Distributed Web-based Modelling and Simulation Services

Alexander Verbraeck

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THE NETHERLANDS

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Abstract

During the past years, several internet based web service architectures have been introduced that promise to streamline inter- and intra-organizational communications. These developments allow organizations to integrate their systems fast and effective and, as a result, improve performance of and control over their business processes. A corresponding movement towards open interaction standards has not yet gained momentum in the field of simulation. Most simulation packages have limited and incomplete capabilities for interaction with other systems, effectively limiting the potential of linking simulations to other types of information systems, such as ERP systems and databases. In spite of the introduction of the High Level Architecture, standards for interoperable simulation systems are not yet widely accepted, limiting the development of multi-model simulation systems.

For some, Web-based simulation is equivalent to Java-based simulation, but the advantages of Java-based simulation environments are not always clear. Simulation remains a difficult task, which has to be carried out by specialists, and cannot be carried out by 'plain' Java programmers. Many Java-based simulation languages are the output of research projects, and have not been turned into complete and extensible simulation environments. There is a clear need for new simulation environments that fully use the characteristics of open exchange and communication.

DSOL, the Distributed Simulation Object Library, has been developed at Delft University of Technology as a research library consisting of several packages with Java object classes for open, interoperable simulation model development¹. It is an example of a fully distributed and Internet enabled simulation platform. Introduced on Wintersim '02, the platform has now evolved into a firm and thoroughly tested

¹DSOL is an open-source project; information may be found on <http://www.simulation.tudelft.nl>. The sources and executables can be downloaded from SourceForge: <http://sourceforge.net/projects/dsol>.

distributed simulation core. The DSOL framework offers more than a possibility for integration, it is also a basic DEVS simulator with many extensions such as statistics, animation and visualization, and process modelling. In contrast to many other approaches, though, these extensions are not tightly coupled to the DSOL core, but loosely coupled, enabling other implementations of these additions as well. The heavy use of Java interfaces in the implementation ensures that users extending or creating their own implementation of a certain functionality, do not have to change pieces of code that make use of the newly created software.

In spite of the fact that the Internet seems to hold a tremendous potential for simulation projects, true Web-based simulation environments are still scarce. The DSOL simulation project has been started as an open-source project to create an open, extendible simulation platform that can be used over the internet to create and run simulation models using multiple formalisms. The components of the platform have been set-up as loosely coupled services to enable easy exchange of services and to improve extendibility. The fact that DSOL is an open source project will hopefully stimulate simulation specialists to create other services and implementations of other formalisms for this Java-based simulation framework.

Closing (Keynote) Lecture

Afsluitingslesing

Applying Distributed Simulation for Analyzing Port Extensions²

Alexander Verbraeck

Policy and Management Systems Engineering Section

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Abstract

Complex interorganizational problem solving is one of the most promising applications for distributed simulation. The Port of Rotterdam has to analyze, optimize, and discuss future extensions and changes of the port together with many participants. Many of the planned extensions will occur on the 2nd Maasvlakte, a land reclamation project for the outermost part of the port in the North Sea. This area will be used mainly for container handling, as the depth of the sea allows for the biggest container ships to be handled. The involved organizations intend to apply recent technical innovations and attempt to avoid the problems of the present container terminals. One of the difficulties that terminals are faced with is the handling of the truck arrivals, which are hard to plan. The current situation sometimes results in large number of trucks waiting in excessively long queues, as they arrive more frequently than they are served. All organizations are looking for possible solutions to avoid these problems in the future. Combinations of a good infrastructure, better logistics, and better use of IT and planning systems should prevent these problems in the new parts of the port. This is, however, easier said than done, due to the large number of trucking companies, and the different organizations that are involved in container handling.

Several simulation models, some of which are very detailed, in different simulation languages had already been developed at the start of the project to analyze several aspects of this problem. A specialized company was building a prototype of an agent-based negotiation and slot-planning system. Integration and interoperability were a major concern in this project. The design and development of the whole complex model could be done monolithically (one big model using one simulation

²The author thanks TRAIL and the Port of Rotterdam for the project funding, and thanks his project co-workers Csaba Boer (EUR), Arjen de Waal (TBA), Bas van Eck (Illyan), Jerry Saeger (Illyan), and Bastiaan v/d Rakt (Initi8).

package) or in a distributed way (well-distinguished models designed and developed in one or more packages). Choosing a monolithic approach would result in a lot of work, as several models should be rewritten in order to integrate them with other models. Furthermore, it would be extremely difficult to implement the agent based negotiation system in a simulation language — and actually again a waste of resources, as this system was already being built as a prototype system in the case we were studying. As an alternative, a fully distributed approach was chosen, using the FAMAS Simulation Backbone as middleware to link the different components. This lightweight architecture proved to be very effective and efficient for the implementation of the overall model for testing and experimentation.

In the project, several variants of a detailed container terminal model, a truck generator model, actual interactive trucking company interfaces, a simulation model of the road system, and the agent based planning and scheduling prototype were integrated using the FAMAS Simulation Backbone. The models of these systems came from different background disciplines and some of them already existed. Although we needed a number of joint meetings with the participating organizations, most parties could work without further coordination, and their internal information remained hidden as it was only required to share the relevant information that was needed for the interoperability process.

Abstracts of Contributed Papers

Opsommings van Referaatbydraes

Advance-Order Systems: Lot-sizing Over Infinite and Finite Horizons

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Abstract

A model describing an inventory system where customer demand is known in advance is called a deterministic model. When no customer demand is known with certainty, lot sizes are based on the probability distribution of the unknown demand. Models for such systems are called stochastic inventory systems.

In some applications, customers may arrive unannounced, but place orders for products to be delivered at some point in future. Such systems are called advance-order systems. For best performance, lot-sizing decisions are based on the demand information that is known with certainty as well as the probability distribution of orders yet to arrive.

This paper is concerned with advance-order systems. A comprehensive model that includes all of the available information is developed. The optimal policy is obtained through an iterative procedure. This procedure is computationally feasible for very small problems only. When the system is modelled for a finite planning horizon the optimal policy is obtained through a backward dynamic programming approach. The finite horizon approach can handle marginally larger problems.

Due to the computational complexity of the optimal solution, heuristic approaches that capture most of the cost saving involved are often more appealing to practitioners. Heuristic procedures that make use of all or some of the available demand information are proposed for the infinite and finite horizon models.

AFIS and Ethics

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Abstract

In the process of voter registration in Nigeria, an *Automated Fingerprint Identification System* (AFIS) is used to eliminate duplicate registrations. In a first phase the fingerprints of all voters in a district were compared against each other. The AFIS equipment purchased by the company responsible for voter registration can handle up to about 100 000 fingerprint records at a time. In the next phase the fingerprints of all voters in a state must be compared against each other. Due to (obvious) cost implications the same computer equipment and software should be used. Since there are up to 4 870 000 voters in a single state, this necessitates finding an algorithm to effectively partition the processing into manageable subprocesses. This implies the finding of subsets of size around 100 000, in such a way that when all subsets are processed, all comparisons will be done with a minimum of overlap. There should be a guarantee that every fingerprint will be compared to every other while keeping the redundancy in the comparisons to a minimum. From available literature and own research the company could reduce the unavoidable overlap to around 97,5%. A considerable improvement is possible, and will be illustrated.

Application of Dijkstra's Algorithm in Naval Routing

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Abstract

Naval operations (as many other military operations) can be seen as problems of risk management and optimisation. The challenge is to find solutions which fulfil the operational requirement within an acceptable risk envelope. Routing is a typical example of such an operation. Whether it is finding a route through a naval minefield or routing ships in such a way that their exposure to submarine or other attack is minimised, the principle of finding the best route under the operational and environmental constraints is universal.

Dijkstra's Algorithm is a well-known method for shortest path optimisation. It has been used here to optimise paths, not only with respect to their path length, but more importantly in relation to path risk. The challenge was to find a methodology with which risk can be quantified and mathematically manipulated. The combined risks are then associated with arcs or nodes on the routing network. Dijkstra's Algorithm next optimises the path according to parameters controllable by the user and returns the path with smallest total risk.

The methodology has been implemented in a block-based simulation modelling environment called *Extend*.

The principles that were followed will be described and some examples will be discussed.

Applying MINLP to Optimise a Production and Transportation Schedule for a Multipurpose Facility

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Abstract

A division of Sasol Chemical Industries investigated the possibility of producing a new product at a Sasolburg site. During basic engineering, the viability of the proposed multipurpose facility had to be determined and a realistic supply chain plan had to be developed. In order to develop a cost effective solution, a mathematical model was needed which would inform the design of the new facility in terms of an optimal production and transportation schedule that minimises operational and capital costs for the facility. Results are produced by simultaneously minimizing the total operational and capital costs for the multipurpose facility. A high-level model is developed and, even though the granularity of one week is applied as a simplifying assumption, it is a continuous-time model. This allows the discrete events involved in the transportation from Sasolburg to Durban harbour to be captured with relative exactness compared to discrete-time formulations. In this paper, the objective of the production and transportation scheduling model is discussed. The approach is also explained, including the scope of the project, assumptions made and data received. The main part of the paper is dedicated to the structure of the continuous-time mixed integer non-linear mathematical model that is developed. The paper is concluded by discussing the results obtained, conclusions and recommendations made.

Aspects of Model Selection and Data Discarding for Linear Regression

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Abstract

The simultaneous regressor selection and data selection problem is considered. Models are investigated to solve such problems. The work is motivated by the multitude of applications of linear models in practice and also by the evolving technology for data mining applications. Some algorithms for aggregating regressor are also considered. These contributions towards robust linear regression techniques are presented with some results based on empirical work.

***The Breakdown of Project Implementation in Business:
The Role of Language***

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Abstract

Project implementation fails to be effective in the business context. Large sums of money are spent acquiring systems and expertise to ensure effective implementation only to be wasted when the project implementation fails dismally. Some of the questions examined include:

- (1) Does the high rate of failure reflect an inability of the two systems to connect and interact with each other effectively?
- (2) If the connections between these systems are not efficient, what are some of the factors that contribute to this breakdown?
- (3) Does this ineffective interconnection of systems apply to other sectors?

In this paper it will be illustrated, from a systemic perspective, why systems of different disciplines struggle to interact and illustrations will be substantiated with real life examples. Reference will be made to some of the factors that are involved in such a lack of alignment. The idea of language and metaphor being a salient factor in the inability of systems of different disciplines to connect will be highlighted. The ideas presented in the paper were developed in the context of IT. We end with a discussion of the postulate that this framework may also explain implementation failures in other technology areas such as Operations Research.

Challenges in Teaching Operations Research at the Undergraduate Level in a Distance-learning Environment

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Abstract

The University of South Africa, which specialises in distance education, is the only university in South Africa that offers Operations Research as an undergraduate major subject. The Department of Quantitative Management offers Operations Research in the University College of Science as well as in the University College of Economic and Management Sciences. No formal classes are presented and students receive a complete package of study material in either Afrikaans or English. This means that the primary medium of instruction is the written word and for most students, in a language (English) that is at best their second language. The challenge is to teach our subject in such a way that the language itself is not an obstacle to students. The fact that students can enrol for a degree in commerce without having mathematics as a subject during the last three years of their schooling, presents a further major challenge. An increasing number of these students are from previously disadvantaged backgrounds. The mathematics they learnt during their formative years is also questionable. These students do not have the necessary mathematical skills fundamental to mastering Operations Research. Another point of concern is that Operations Research practitioners today cannot be effective unless they make use of computers. We as teachers of OR will fail in our duty if we do not expose our students to such technology and train them to use it. In a distance-learning environment this poses a problem. Assessing their progress in this regard is an even larger problem. In this paper we will explain the approach that our department uses in attempting to overcome the problems that arise when trying to teach a technology-driven discipline like OR to second language learners with a poor mathematical background.

Characterisation of Rectilinear Steiner Minimal Trees and the Steiner Ratio

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Abstract

Given a set of terminals in the plane, we are interested in interconnecting the terminals through a network using only vertical and horizontal line segments. We discuss a simple proof of Hwang's characterisation of rectilinear Steiner minimal trees and how this is used in proving that the Steiner ratio is $3/2$. The Steiner ratio is the largest ratio of the length of a minimum spanning tree to that of a Steiner minimal tree. Its importance lies in the fact that the minimal spanning tree problem can be solved in polynomial time, while the Steiner minimal tree problem is in **NP**.

***Corporate Sustainable Development: Emerging Challenges
and the Road Ahead***

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Abstract

Sustainable development is broadly defined as development that meets today's needs without compromising those of future generations. Its pursuit is perceived to be good for business, the planet and its people. Since its official inception Rio 1992, followed by Johannesburg Summit 2002 (WSSD), there has been growing realisation of the need for meaningful partnerships amongst government, civil society and business to bring about sustainable development as broadly defined by the goal of fighting poverty, protecting the environment and supporting entrepreneurs.

It is noteworthy that the debate on sustainable development has been gaining credibility as a result of a number of key stakeholders fully embracing the principals it stands for; through the creation and capacitation of public and private multilateral institutions; and a growing desire and commitment to reporting, accounting and conforming to legislation and standards. This is partially unpinned by the understanding that the cost and risk of failure to move towards sustainable development cannot be justified. However, there is growing need for scientific rigour if this debate is to be sustained and implemented to bring the desired outcomes and impact.

This paper seeks to appraise some of the recent developments around the debate and walk towards sustainable development. These will be approached primarily from a corporate perspective. An attempt will also be made to present a futuristic outlook of what form and texture the debate is likely to take. A couple of broad based and practical implementation approaches will also be explored.

*Credit Scoring in a Business Environment — Part I:
Overview of Credit Scoring*

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Abstract

Credit scoring has become an integral part in providing a data driven solution to the various business problems associated with granting credit to individuals. Problems range from:

- understanding new account and existing business risk,
- preventing accounts from closing,
- identifying which accounts are most likely to spend,
- which poorly paying accounts have a higher probability of paying, and many others.

Although developers use a variety of modelling techniques to solve these problems, the main issue of data quality forms a key component in creating the scorecard. Setting up a scorecard project requires that the developer understands the current business as well as future changes that could impact the predictive power of the scorecard when it is implemented. The presentation will cover all these issues and has been designed to give the attendees a better understanding of how theoretical knowledge is merged with practical business understanding to produce a scorecard that adds value to the business.

The presentation will focus on identifying and discussing the reasons for scoring and how they are used in business. The presentation will cover the concept of odds and the various types of scorecards available. This session is intended as a foundation to the next presentation that describes how a typical scorecard project is put together.

***Credit Scoring in a Business Environment — Part II:
Discussion on a Typical Scorecard Building Process***

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Abstract

A high level overview of how a scorecard project is planned, this will include the various phases within the scorecard development. Key issues such as data validation, business sign off of the project specification and final delivery of the scorecard will be covered.

Decision Support for Multi-objective Programming Problems

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Abstract

Energized by the fact that concrete real-life decision problems take place in conditions of conflicting goals, the last two decades saw a rapid development of multi-objective programming methods. Most existing multi-objective programming approaches call for many restrictions on the objective functions involved and on the feasible set. In this paper we develop a less demanding approach based on *Genetic Algorithms* (GA) methodology. This approach is then intergrated with others into a user-friendly Decision Support System (DSS) able to effectively support decision makers faced with multi-objective programming problems. For the sake of illustration we present a small-size, but meaningful case study connected with water management of a real-life water resource system in the context of South Africa.

Delivering Technical Computing Applications with webMathematica: A South African Case Study

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Abstract

Understanding the significance of a technology plays a crucial role for being an active player in today's very tough world-market competition. To be able to deliver environmental, financial, transportation, water, industrial, or scientific projects, users are, usually, not aware how much mathematical, applied mathematical, statistical, as well as optimization techniques are embedded in all phases of business processes.

Web-enabled technology (Internet, Intranet) has bridged a large gap in IT implementation. It is no longer important what computer or operating system is in use. To be able to use a web-enabled application, all the user needs is a web browser and Internet/Intranet connection. In a few years time, use of web technology will not require computers. It will be an integral part of many communication devices (TV, cell phones).

The majority of web-based applications are developed using languages like *VB Script* (ASP), *Perl*, *Java* or *Java Script*. These web technologies, so powerful in many areas, are not well-suited for precision computation, because mathematical, statistical analysis or optimization is simply not their main focus. There is, however, a technical environment which enables seamless integration of symbolic and numeric abilities and which is designed specifically for technical computing via the web. It is called *webMathematica*.

A case study will be presented of an implementation of *webMathematica* in the South African Environmental and Disaster Management Centre. Environmental data are read from a terabyte database and the application allows users to compute and visualize results on the fly from any web browser. The authors will also indicate how this technology can be applied to a range of disciplines, including pollution monitoring, human resource management and medical aid fraud detection.

Development of a Model to Forecast Container Growth at City Deep

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Abstract

South Africa places considerable emphasis on economic growth and exports. The major economically active province in the country is Gauteng, which accounts for over 36% of the total Gross Geographical Product of all provinces and for almost 50% of all exports and 60% of all imports of the country. The movement of goods from and to the seaports increasingly takes place in the form of containers. The main inland terminal for receiving and despatching containers is City Deep in Johannesburg. A study is currently underway to develop a land and infrastructure development plan for this terminal. The envisaged increase in container freight traffic should, if the right conditions apply, lead to an increase in land requirements and impact the local infrastructure needs in the City Deep area and vicinity. This paper describes a model developed to indicate the envisaged growth in container throughput at the City Deep terminal. The first part of the model (*Gravity Model*) begins with available container forecasts at the country's ports and determines the demand for containers in Gauteng based on the economic strength (imports and exports) of the nine provinces and on the distance between ports and the centroids of provinces. The second part of the model uses *Share Analysis* to determine the container throughput at City Deep based on the rail to road split and on the competition between City Deep and other terminals within Gauteng. The third part of the model calculates the land requirements for a container terminal at City Deep based on various parameters. All three parts of the model were coded in an Excel spreadsheet which enables the user to perform "what-if" analyses by modifying parameters. Three scenarios (*Low*, *Middle* and *High*) were formulated and forecasts were obtained for each scenario.

Development of Interactive Methods for Multi-objective Linear Programming in Decision Support

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Abstract

Processes of evaluation and decision making with multiple criteria/objectives are common in people's daily living and work experiences. The environment in which many of these decisions have to be made is often unstructured and the consideration of multiple conflicting criteria/objectives is the rule rather than the exception. Multiple criteria decision making (MCDM), as it is known today, has evolved in response to these practical needs. Our study essentially deals with multiple objective linear programming (MOLP), which is a subset of MCDM. MOLP falls under the continuous types of MCDM where the set of alternatives is defined implicitly. The primary objective of the present study is to build an interactive decision support system (DSS) using the concepts of multiple objective linear programming. The paper will describe the features being built into the design. The intention is to provide the user with options to use any of a number of MOLP techniques including reference point, value function and weighted Tchebycheff approaches. The DSS is being built within an Excel spreadsheet framework, and some user interfaces will be demonstrated.

EVA — A Mathematical Approach to Warhead Design

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Abstract

During the design or acquisition of missile systems the effectiveness of the system needs to be evaluated. Often actual testing is not possible and therefore mathematical models need to be constructed and solved with the aid of software. The aim of this project was to investigate the current simulation model and develop a mathematical model to aid in the design of the detonic payload. The problem is confined to the end-game scenario with the developed simulation model focusing on the last milliseconds before warhead detonation. The model, that makes use of the ray-tracing methodology, models the warhead explosion in the vicinity of a target and calculates the probability of kill for the specific warhead design against the target. Using the data generated by the simulation model the warhead designer can make the necessary design changes to improve the design. There is, however, a large population of possible designs. Heuristic methods are currently being investigated to search through this large search area and to help confine the manual search to a considerably smaller search area. The simulation model, as well as optimising technology, has been incorporated into a windows-based software package known as *EVA* (Effectiveness and Vulnerability Analyser). Previous designs required the use of various *DOS* programs, and manipulated the generated data in packages like *Notepad* and *Excel*. *EVA* provides them with one environment that incorporates the whole design process. This talk will discuss the simulation model as well as the proposed heuristic technique.

From System Dynamics and Discrete Event to Practical Agent Based Modelling: Reasons, Techniques & Tools

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Abstract

This paper may be considered a practical reference for those who wish to add (now sufficiently matured) *Agent Based modelling* to their analysis toolkit and may or may not have some *System Dynamics* or *Discrete Event modelling* background. We focus on systems that contain large numbers of active objects (people, business units, animals, vehicles, or even things like projects, stocks, products, *etc.* that have timing, event ordering or other kind of individual behavior associated with them). We compare the three major paradigms in simulation modelling: *System Dynamics*, *Discrete Event* and *Agent Based modelling* with respect to how they approach such systems. We show in detail how an *Agent Based model* can be built from an existing *System Dynamics* or a *Discrete Event model* and then show how easily it can be further enhanced to capture much more complicated behaviour, dependencies and interactions thus providing for deeper insight in the system being modelled. Commonly understood examples are used throughout the paper; all models are specified in the visual language supported by AnyLogicTM tool. We view and present *Agent Based modelling* not as a substitute for older modelling paradigms, but as a useful add-on that can be efficiently combined with *System Dynamics* and *Discrete Event modelling*. Several multi-paradigm model architectures are suggested.

Fuzzy Random Variables: Mathematical Properties and Applications to Mathematical Programming Problems

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Abstract

Fuzzy random variables is one of the most successful mathematical tools for taking an intellectual step towards situations where randomness and fuzziness co-occur. A fuzzy random variable is nothing but a measurable mapping from a probability space to the set of fuzzy numbers. Such a hybrid structure allows it to adequately account for both randomness and fuzziness.

In this paper we present this half-fuzzy, half-probabilistic concept, highlighting its mathematical properties and showing how it can be used for dealing with mathematical programming under uncertainty. Numerical examples are supplemented for the sake of illustration. The paper ends with some concluding remarks along with perspectives on potential research directions.

Ground Based Threat Evaluation of Fixed Wing Aircraft

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Abstract

In a military environment, ground based air defence system operators are required to evaluate the tactical situation in real-time and to protect the assets on the ground against aerial threats by assigning the available weapon systems to engage in a combined defence strategy. Since the aerial environment typically requires rapid operational planning and decision-making under stressful circumstances, these responsibilities are usually divided among a number of operators as well as computerized systems that aid these operators by proposing possible, realistic solutions and supporting decision-making.

In this talk a model for one such system is developed. The purpose of the model is to evaluate threat behaviour and to construct a prioritised list of the enemy aircraft threatening the assets in the operator's area of responsibility. The scope of the model is narrowed down by only evaluating fixed wing aircraft, already identified as enemy aircraft. Since relations between the behaviour of aircraft are required, generalised factor models need to be determined. The problem is solved by differentiating between two types of factors: (1) Primary or prediction factors and (2) Secondary or threat value factors. Factors investigated include weapon delivery profiles, aircraft bearing, aircraft course, *etc.* The results of the threat evaluation system are strongly dependent on the pre-defined data (tactical database) and the real-time data received from radar sensors. Problems with data typically include small ranges at which aircraft are detected, insufficient radar refresh rates and the lack of restricted or classified data for the construction of realistic weapon delivery profiles.

Higher Order Protection Strategies for Graphs

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Abstract

Practically any layout of inter-related service points may be represented by means of a graph or network. If this network requires protection by a limited number of resources against a specified number of attacks, one is typically interested in the minimum number of resources able to offer such protection (as well as an optimal deployment strategy for such resources across the network). The purpose of this talk is to provide an introduction to the notion of higher order domination in graphs and its applications. Various characteristics of protection strategies against both a finite and an infinite number of attacks are discussed and illustrated by means of examples.

Inventory and Location Decisions in a Blood Service System

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Abstract

The South African National Blood Service (SANBS) was established in 2002, when nine previously independent provincial blood transfusion services in South Africa merged. Two administrative regions were formed. The Inland Region has its regional head office in Roodepoort. The East Coast Region, combining Eastern Province, Border, and Kwa-Zulu Natal, has its regional head office in Pinetown, Natal. The Western Province Blood Transfusion Service still operates independently and separately from the SANBS. This newly established centralisation of blood transfusion services necessitates implementation of new cooperative management policies and operational decision systems. A national inventory manager has recently been appointed. His brief is to examine the current inventory systems of the blood service. Current facility and collection locations, and inventory routing and stock holding policies must be reconsidered. New restructuring decisions must be made in order to achieve a more efficient blood service delivery. The blood service operations are split into two divisions: the collection division, and the processing, testing and issuing division. Blood is collected at fixed donor centres and satellite sites within regional branches. Mobile blood drives are organised from each branch. Collected blood is tested and processed at processing units, from where safe blood is issued to blood banks. If a patient at a hospital needs a blood transfusion, crossmatched blood is obtained from a blood bank. The authors of this paper saw the opportunity of applying operational analysis as a scientific basis for the SANBS restructuring decisions. Meetings were held with top managers of SANBS. A collaborative research proposal was formulated. We report on the progress made in the analysis of relevant data in the blood demand-supply chain. We also present a mathematical programming formulation of a facility location decision problem within the blood demand-supply chain.

Mathematical Modelling and Risk Management in the Deregulated South African Electricity Market

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Abstract

The global restructuring of electricity markets has rapidly become a subject of great interest across a broad spectrum of mathematically oriented disciplines. In particular, power generation companies are faced with the problems of building an appropriate hourly bidding strategy and mitigating their exposure to the many risks associated with the production, sale and ultimate dispatch of electricity to the grid. The fact that electricity may not be stored like other commodities results in uncertainties that are not widely understood. Consequently, new approaches are required to model the complexities that arise. We focus on the South African industry and discuss a short-term simulation approach for decision analysis and risk management in a dynamic industry. Our study is refined through the selection of crucial variables, and the power market — from the perspective of a single price-taking generation company in the Eskom Power Pool — is simulated. We model the mechanism by which electricity is offered and accepted into the Pool. Some existing techniques for choosing the optimal bid as well as methods for industry simulation are reviewed, and some preliminary results of our simulation model are presented and discussed.

Modelling and Solution Strategies for Tree Knapsack Type Problems for Local Access Telecommunication Network Design

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Abstract

Tree Knapsack problems can be used to model *Local Access Telecommunication Networks* (LATNs). Enhanced modelling methods is investigated to use standard operational research software to solve tree Knapsack models. The tree knapsack problem can be seen as an extension to the normal knapsack problem where a general tree structure is present and a node in the tree can only be added if the parent node of the specific node has been included in the current configuration. It can thus be seen that the tree knapsack problem serves as a model for LATNs. Building on this, the Extended Tree Knapsack Problem presents a more complex model for the LATN, also incorporating flow into the model. The main idea of the research is to use standard operations research software more efficiently in solving network design problems. This is achieved by implementing a partitioning scheme using standard software. The goal is to use information already present to speed up the solution process.

Modelling Credit Risk: Some Ideas and Some Applications

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Abstract

Risk management is the range of activities by which a firm optimizes the taking of financial risk. It involves, among other practices, the quantification of the different types of risk. One can broadly distinguish between market risk, credit risk and operational risk. We focus on credit risk — *i.e.*, the risk that the contractual counterparty who is obliged to make a scheduled payment to another party fails to do so. A debt contract such as a corporate bond which involves a certain amount of credit risk (a possibility of default) must provide a higher return than a comparable government bond. The question is: how much cheaper should the risky bond be, or what should the credit spread (risk premium) be? Analytical models have been developed to quantify such credit risk. This is important for various reasons: the worldwide movement towards better supervisory standards (Basel); the need to hedge contracts exposed to credit risk; and the need to price credit derivatives. The dominant frameworks for the modelling of credit risk, are the structural (firm-value) and reduced-form models. Black and Scholes (1973) and Merton (1974) laid the foundations for these models. We give a brief overview of some of the credit risk models available and show our results for three structural type models applied to South African firms.

Modelling Infrastructure Capacity for the SA Fruit Industry - Part I

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Abstract

Towards the end of 2002 the Deciduous Fruit Producers Trust initiated a national fruit logistics infrastructure study on behalf of a range of role players in the fruit industry and its logistical chain. One of the aims of this study was to determine whether investment in additional logistics infrastructure would be necessary in the foreseeable future. The study was completed in March 2004. This paper is the first in a series of three that will report on different models that were developed during the project. Therefore, this paper will provide an overview of the project and then discuss an Excel model that was developed to determine whether the various dedicated fruit terminals and container terminals in the SA ports have sufficient capacity to handle the volumes of fruit forecast to be exported in 2010.

Modelling Infrastructure Capacity for the SA Fruit Industry - Part II

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Abstract

This paper is the second of three about the Fruit Logistics Infrastructure Capacity Optimisation Study undertaken by the CSIR in collaboration with the University of Stellenbosch. In this paper, various methods of solving maximum flows are presented that aid in the detection of bottlenecks in the South African fruit export infrastructure (packhouses, cold stores and ports). Graph theoretic methods for finding the maximum flow are compared to mathematical programming methods, and some results are presented and discussed.

Modelling Infrastructure Capacity for the SA Fruit Industry - Part III

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Abstract

This paper is the third of three about the Fruit Logistics Infrastructure Capacity Optimisation Study undertaken by the CSIR in Stellenbosch. In this paper, a simulation model of pallet flow at the Durban Fresh Produce Terminal will be discussed. Issues pertaining to input data acquisition and modelling will be discussed, while some results will be presented and discussed.

A Multicriteria Decision Analysis Approach to Rights Allocation in Fisheries

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Abstract

The determination of sustainable exploitation levels for fishing stocks has long been subject to a wide variety of mathematical modelling techniques, and has become part of the process of setting total allowable catches (TACs). There has been a much lower level of involvement of OR in the often more contentious issues of allocating rights within the bounds of the TAC to different stakeholders, however. Especially in a developing country context, if such rights allocations are not perceived to be fair and just, then extensive poaching is likely to render the official TAC irrelevant. This rights allocation process is inherently multicriteria in nature. This paper describes recent work on a project forming part of a Dutch-funded programme on Poverty Reduction and Environmental Management (PREM). Workshops were held with representatives of fishing communities in the Western Cape. In spite of the fact that many of these representatives had low levels of formal education, problem structuring methods led to clearly defined “cognitive maps” and to useful “value trees” of social, environmental and economic objectives. A high level of distrust of government officials was also revealed, and yet there was considerable convergence between criteria identified by the communities and those used in scoring systems by the Chief Directorate of Marine and Coastal Management (MCM). Existing scoring systems have been unpacked to reveal the implicit underlying criteria and value trade-offs. These systems are being refined to incorporate community views, and to avoid known pitfalls in the use of simple additive value functions. In addition, alternative multicriteria approaches have been developed for dealing with political transformation objectives (which operate at a group rather than at an individual level). A spreadsheet template is being developed for use by MCM, which will allow them to undertake future rights allocation processes in a consistent and auditable manner.

New Heuristics for the Rural Postman Problem

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Abstract

A local search framework for the (undirected) *Rural Postman Problem* (RPP) is presented. The framework allows local search approaches that have been applied successfully to the well-known *Travelling Salesman Problem* also to be applied to the RPP. New heuristics for the RPP, based on this framework, are introduced and these are capable of solving significantly larger instances of the RPP than have been reported in the literature. Test results are presented for a number of benchmark RPP instances in a bid to compare the efficiencies and solution qualities of these heuristics against known methods.

Open Source Software — Part I: Is it a Good Thing?

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Abstract

Open–Source Software (OSS) is more than just software which is freely available, and for which the source code is accessible. It is also a culture that “promotes software reliability and quality by supporting independent peer review and rapid evolution of source code.” Open Source is becoming a significant software development model, as well as a source of low cost, high quality software tools for many fields. Companies like IBM, SAP, Sun, Intel, Hewlett–Packard, Silicon Graphics and Novel are committed to using Open Source. This movement is impacting not only software development, but many fields that use software, for example medical computing.

This presentation will describe OSS and the differences between the Open Source and the traditional proprietary software models. The impact of OSS in South Africa and other developing economies, as well as OSS in Operations Research and in Education will be discussed.

Open Source Software — Part II: A User's Perspective & Demonstration

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Abstract

This presentation will also look at the advantages and disadvantages of using OSS from the perspective of various computer users. A developer's perspective on when it might be a good idea to open up a software project will also be discussed. Some examples of popular OSS and repositories will also be demonstrated.

OR in Africa and Developing Countries

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Abstract

Various activities of the international OR community, and in particular IFORS and EURO, are aimed at raising the awareness, use and application of OR in developing countries. Over the last few years the emphasis has been on Africa and various initiatives have been launched to get OR activities going in Africa. What are these initiatives, what is the progress and where are things going? This paper will focus on all these aspects and provide a status quo report from the author's perspective. Emphasis will be placed on the need for more value added activities, for more direct and active involvement and for greater participation. What are the needs of people in Africa and how can individual OR people assist, what can organisations do and also what role can ORSSA play in this regard?

An Overview of Exact and Heuristic Algorithms for Packing Problems

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Abstract

In *packing problems* one is required to pack a collection of items into a defined region, without overlapping. This region does not necessarily have to be a container; it may represent a general resource (such as space, time or surface area). The main objective in packing problems is to make efficient use of the resource. Packing problems have numerous applications in industry, such as storing merchandise in a warehouse or scheduling of independent tasks in a computer program, each requiring memory locations for a certain time duration. Depending on the application area, certain constraints are imposed — the common ones being orientation and placement restrictions.

When executing an algorithm for solving packing problems, it is important to know how the dimensions of the items to be packed will be specified, *i.e.* whether specification of the entire set of items is known before packing commences (offline packing problems), whether information about the next item to be packed will only be known once the previous item has been packed (online packing problems) or whether partial information about the entire collection is available (almost on-line packing problems). Packing problems are, in general, NP-hard and therefore one typically seeks to develop approximate or heuristic algorithms for such problems, instead of costly exact algorithms. Some of these heuristics and exact algorithms for various packing problems are presented and compared.

Pallet Supply Chains

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Abstract

A supplier of pallets to users (manufacturers, distributors and retailers) around the country needs to understand the dynamics of its supply chain in order to analyse the profitabilities of individual customers and optimize its fee structures. This talk shows how a Markov Chain analysis of the supply chain is able to provide answers in the form of average residence times of pallets at individual customers, average cycle times and percentage throughput. The talk will describe the model and show how it can be used to solve the pallet supplier's pricing problem.

Periodic Event Scheduling Problem

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Abstract

The periodic event scheduling problem was first introduced in 1989 and has since been applied to airline scheduling, traffic light scheduling and job-shop scheduling. It has recently also been applied to periodic train scheduling. In a cyclical timetable, train connections are operated regularly with respect to a cycle time. Trains for a certain destination leave a certain station at the same time instant during every cycle time, say every half an hour, every hour, or every two hours. Cyclical timetables are mainly used for passenger railways. This paper will look at some solution methods for the periodic event scheduling problem applied to train scheduling.

Plaasbestuur en –beplanning met in agneming van Risiko

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Opsomming

Wisselbou word al geruime tyd gebruik om die langtermyn volhoubaarheid en winsgewendheid van boerdery–eenhede te verseker. Wisselbou is ook uiters nuttig om verskillende bedryfsvertakkings op ’n boerdery–eenheid te integreer, byvoorbeeld deur voer vir die diere te saai. Daar is al wiskundige modelle ontwikkel wat poog om ’n wisselboustelsel in so ’n geïntegreerde boerdery–eenheid te optimeer. Min van hierdie modelle kan egter die risiko in die ontwikkeling van ’n optimale boerdery–strategie verreken. Die model wat in hierdie referaat aangebied word, sluit wel risiko, as die negatiewe afwyking van ’n boerdery–aktiwiteit vanaf sy verwagte inkomste, in.

’n Tipiese boerdery–eenheid waarop geïntegreerde gewas– en dierproduksie plaasvind, word as gevallestudie bespreek. Die model sluit die plant van gewasse in ’n monokultuur of wisselboustelsel, die koop en verkoop van wolskape, sowel as melkbeeste en die voeding van hierdie diere in. Relevante data van ’n plaas in die Swartlandgebied word gebruik in die gevallestudie. Oplossings van die model toon onder andere aan dat die verwantskappe tussen gewasse en diere, sowel as die risiko wat die boer bereid is om te neem, ’n groot invloed het op hoe die plaas beplan en bestuur moet word. Die tipe gewasse en die hoeveelheid daarvan wat geplant word, asook die aantal diere wat aangehou word, word noemenswaardig deur risikovlakke beïnvloed. Integrasie van gewasse met diere (deur byvoorbeeld weiding en/of voer aan te plant) is van kardinale belang om risiko te verminder en om winsgewendheid te verhoog.

Prediction of the 2004 National Elections in South Africa

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Abstract

In 1999 the CSIR developed and implemented a model for predicting the final results of the 1999 South African National Elections as the individual voting district results became available. This model was based on the segmentation of the voting districts according to their demographic characteristics as recorded in the 1996 census. In 2000 we applied a similar model to the 2000 Municipal Elections. However, in this case we based our segmentation on the 1999 voting patterns, rather than on demographics. 20 clusters of voting districts (VDs) were constructed, which displayed similar voting behaviour. The same model has now been used in the 2004 elections, after updating it in terms of the new VD structures and adding a few extra features to the analysis system. This latest work was sponsored by the SABC. In this paper we will briefly discuss the background of the model and the system used during election night. We employed independent models for each of the nine provincial elections. Results will be shown as they evolved during election night. In most cases the convergence to the final results is quite quick. For example, for the national elections we predicted the ANC final result of 69% to within 1% when only 5% of the votes had come in, while the actual results at that time were still at 60%. The same accuracy (1%) was reached for the Democratic Alliance when 20% of the votes were in, at a time that the actual results were still deviating by 6%. This predictive power is similar to our predictions in the 2000 Municipal Elections. Of special interest is the interaction with the SABC and the operation of partially untested software during such a real-time application. We shall illustrate this interaction by means of a number of anecdotes and comment on the real-time problems during such an exercise.

Putting MINLP Scheduling to Work: Continuous Time Formulation for Operational Scheduling at Sasol Coal Supply

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Abstract

A general scheduling problem is concerned with the determination of the optimal sequence, allocation and duration of events using available resources. In recent years the continuous time formulation (with event points, rather than discrete time intervals) was developed to improve scheduling efforts. This paper is concerned with the operational application of this continuous time formulation at the coal handling facility of Sasol Mining, namely Sasol Coal Supply.

Sasol Mining consists of six coal mines supplying coal to Sasol Synfuels, to be used in the continuous coal-to-fuels process. Coal is transported via a conveyor network from the mines to a central coal handling facility. At Sasol Coal Supply the coal is either conveyed directly to the factory, blended on any of 24 stockpiles before it is conveyed to Sasol Synfuels, or stored as inventory.

Sasol Coal Supply has the following daily objectives:

- (1) To minimise operating cost.
- (2) To optimise the coal quality supplied to Sasol Synfuels.
- (3) To optimise conveyor and stockpile logistics (given certain infrastructure restrictions).
- (4) To synchronise daily operations and maintenance activities.

Currently, the scheduling model focuses on objectives 1, 3 and 4. Future expansion of the model will include objective 2. The scheduling problem for Sasol Coal Supply was formulated as a Mixed Integer Non-Linear Programming (MINLP) problem, using General Algebraic Modelling System (GAMS) software from GAMS Development Corporation, the Discrete and Continuous Optimiser (DICOPT) programme and CONOPT and CPLEX as solvers.

Included in this paper are the following:

- The initial continuous time formulation of the scheduling problem.
 - The shortcomings of this method when applied to industrial sized problems.
 - Formulation improvements to ensure operational use of the scheduling model.
 - The final operational scheduling model and its benefits for Sasol Coal Supply.
-

Sensitivity Analysis and Extension to Protean Modelling and Analysis of Fractional Linear Programs

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Abstract

In this paper, we analyze how sensitivity analysis is carried out on a Fractional Linear Programming model which has been solved using a simplex based approach. We determine the significance of the dual variables and attempt to interpret their meaning. This sensitivity analysis approach is extended to solve a Protean Fractional Linear Programming model.

Simulating Random Strings by Arithmetic Means

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Abstract

We discuss a probabilistic algorithm for simulating a random binary string by using only a logarithmic number of truly random bits. The algorithm is of polynomial time complexity. The proof of correctness of the algorithm is based on Weil's proof of the Riemann conjecture for algebraic curves over finite fields. The time complexity follows from the recent result by Agrawal, Kayal and Saxena who showed that primality of a natural number can be established algorithmically in polynomial time.

The “Spreadsheet Revolution in Education” and the Future of OR

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Abstract

Operations Research techniques and models have been and are being applied quite widely and with significant success and there seems to be a long term and sustainable upward trend in this regard. However, the “fortunes” of the discipline have gone through a series of “ups and downs” throughout its history for which a number of reasons may be identified. The introduction, and associated hype, of new theory, techniques and technology and the almost inevitable letdown seems to be one the important driving forces behind this cyclical behaviour. Furthermore, it appears as if the continued well-being of the discipline may, to some extent, be dependent on these periodic “waves” of renewal.

This paper will propose that the increasing modelling capabilities of spreadsheet software have already served as the impetus for starting such a “new wave” and will continue to do so in the near future. Specifically, the paper will claim that the effective use of spreadsheet software to enhance the educational process may make significant contributions to the future growth of the discipline of Operations Research. The paper will also argue that the use of such spreadsheet-based teaching aids may be especially valuable for effectively teaching the basic principles of Operations Research to students who may not have the required background to fully assimilate and appreciate the more traditional mathematical/algorithmic based approach.

Several examples that are being used for teaching aspects of optimisation theory, simulation modelling and mathematical statistics, will be utilized and displayed in an effort to demonstrate the validity of these assertions and to provide a platform for further discussion.

*Ignorance is like a delicate exotic fruit; touch it and the bloom is gone.
The whole theory of modern education is radically unsound. Fortunately,
in England, at any rate, education produces no effect whatsoever.*

— Oscar Wilde (1854–1900)

A Survey of Non-standard Methods in Finance

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Abstract

Abraham Robinson's nonstandard analysis allows us to extend real analysis in such a way that the concepts of infinitesimals and infinite numbers may be applied in a mathematically rigorous way. The accompanying theory of probability admits a very intuitively satisfying description of certain stochastic processes, such as Brownian motion. We survey applications of this approach to finance, *e.g.* the use of nonstandard methods in option-pricing models.

Tel Elke Stem?

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Opsomming

Die huidige stelsel in die RSA om groepverteenvoordinging te bepaal volgens die aantal stemme wat in 'n verkiesing verkry is, word ondersoek. Die probleem word ook as 'n heeltallige programmeringsprobleem gemodelleer en opgelos vir die 1999 en 2004 Nasionale en Provinsiale verkiesings. Die oplossings soos verkry, word vergelyk en bespreek.

A Three Dimensional Numerical Technique for Determining the Foot of a Continental Slope

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Abstract

The objective determination of the foot of a continental slope is one of the essential criteria in claiming an extended continental shelf by any coastal state as part of its commitment to the United Nations Convention on The Law of the Sea (UNCLOS). Many coastal states (including South Africa) are signatories to UNCLOS and are thus bound by the articles contained therein. A time limit of 10 years from signing of the agreement in 1998 is currently in place and South Africa is required to submit a once-off, professional and scientifically substantiated claim on an extended continental shelf — bringing with it increased mineral rights. In the case of South Africa, a significant area of seafloor estate has been identified as potential claim material. In this talk it will be demonstrated how the ridge of maximum curvature of a surface may be used to suggest a possible location for the foot of a continental slope.

Vervoermodellering vir die Benutting van Afgekapte Indringerplante in die Wes-Kaap

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Opsomming

In die Wes-Kaap is die besmetting van natuurlike veld met Port Jackson (*Acacia saligna*) en Rooikrans (*Acacia cyclops*) besig om die biodiversiteit in die natuur te vernietig. Die Departement van Waterwese poog om, deur middel van die Werk-vir-Water-Program, die besmetting van hierdie indringerplante te bestry deur die indringerplante bloot te vernietig op die plek waar dit staan. Daar word erken dat hierdie benadering probleme skep, soos byvoorbeeld die konsentrasie van brandbare materiaal. Daarom is dit wenslik om die afgekapte bome uit die veld te verwyder. Die gevolg is 'n ondersoek na die moontlikheid om dié indringerplante ekonomies te benut en daardeur die finansiële las van uitwissingspoging op die owerheid te verlig. Die benutting van die biomassa in die vorm van houtskool is voorgestel en bestudeer vir finansiële lewensvatbaarheid. As deel van hierdie studie moes 'n beraming gemaak word van die koste om die bome na retorte toe en die houtskool na 'n denkbeeldige industriële verbruiker, soos 'n silikonsmelter, toe te vervoer. Die wye en oneweredige verspreiding van die indringerbome stel groot uitdagings om die hoeveelhede van die beskikbare biomassa per ligging te bepaal, sowel as om die plasing van toekomstige retorte vir die verwerking van die biomassa aan te dui.

Die biomassa per ligging is bepaal deur middel van satellietbeelde en geografiese inligtingstelsels (GIS) en steekproewe wat in die veld geneem is. 'n Gemengde heeltallige programmeringsmodel is gebruik om die optimale liggings vir retorte te bepaal wat die vervoerkoste terselfdertyd beraam en minimeer.

Weight Restrictions in Data Envelopment Analysis

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Abstract

Data Envelopment Analysis (DEA) is a methodology for measuring the relative efficiency of units performing similar tasks in a production system that transforms multiple inputs into multiple outputs. Standard DEA maximizes the efficiency rating of a Decision Making Unit (DMU), subject to all the DMUs having an efficiency score not superior to one and all the weights being positive.

The basic DEA allows total weight flexibility in the selection of input and output weights in order for the DMU under evaluation to achieve maximum efficiency. As a consequence, DEA can rate a DMU as efficient based on an evaluation over a subset of the inputs and/or outputs only. In extreme cases, it may be over a single input and a single output. The question is: is DEA efficiency a result of favourable weights or an inherent efficiency of the DMU? This imposes the need to incorporate weight restrictions. Another problem is that the evaluation does not take into account prior views on the importance of the factors (inputs and outputs) involved in the analysis. In choosing the weights, DEA may assign higher weights to factors of less importance to the decision maker.

Many approaches exist for incorporating weight restrictions in DEA:

- Direct weights restrictions,
- Adjusting the input/output levels of the DMUs,
- Virtual inputs and outputs restrictions and
- Cross-efficiency.

There are many methods related to the different approaches in order to determine bounds on the weights. These will be reviewed and a new approach called “Simultaneous DEA” will be introduced, in which weight profiles for different DMUs cannot deviate too much from each other.

***Can you help us with the following?
Kan u ons met die volgende help?***

Photographs of the following people are sought for the ORSSA webpage. Do you have a pic of any of these people (perhaps from an old album, departmental or annual report)? If so, please contact Jan van Vuuren at (021) 808 4213 or at vuuren@sun.ac.za. / *Foto's van die volgende persone word vir die webtuiste van ONSA gesoek. Het u dalk 'n foto van enigeen van hierdie mense (moontlik uit 'n ou album, jaarblad of departementele verslag)? Indien wel, kontak asb vir Jan van Vuuren by (021) 808 4213 of by vuuren@sun.ac.za.*

- (1) Dr H Sichel (past president of ORSSA: 1970)
- (2) Dr G Rudolph (oud-president van ONSA: 1973)
- (3) Mr J Miller (past president of ORSSA: 1974)
- (4) Mr K Sandrock (oud-president van ONSA: 1975)
- (5) Mr HID du Plessis (past president of ORSSA: 1976)
- (6) Mr L Eales (oud-president van ONSA: 1977)
- (7) Dr MJ Venter (past president of ORSSA: 1980)
- (8) Dr AH Money (oud-president van ONSA: 1981)
- (9) Mr MA de Vries (past president of ORSSA: 1986)
- (10) BJK Smith (Tom Rozwadowski medalje-wenner, 1976)
- (11) PJ Vermeulen & DCJ de Jongh (Tom Rozwadowski medalists, 1977)
- (12) PJS Bruwer (Tom Rozwadowski medalje-wenner, 1982)
- (13) JC Lawson (Tom Rozwadowski medalist, 1983)
- (14) KC Jordi (Tom Rozwadowski medalje-wenner, 1987)
- (15) M Sniedovich (Tom Rozwadowski medalist, 1988)
- (16) R de Jongh, K Carden & N Rogers (Tom Rozwadowski medalists, 1994)
- (17) L van Coller (studentekompetiesie-wenner: 1992)
- (18) M Krafft (student competition winner: 1993)



- (19) H Fülle (studentekompetsisie-wenner: 1994)
 - (20) AJ Maitland & MR Britton (student competition winners: 1995)
 - (21) C Ardington (studentekompetsisie-wenner: 1996)
 - (22) R Bernstein (student competition winner: 1998)
 - (23) PJ Theron (studentekompetsisie-wenner: 2001)
 - (24) J Lejaha & WT Van Schalkwyk (student competition winners: 2003)
-

Instructions for Access to the Internet

Conference delegates may use the computing facilities of the USB to access the Internet or e-mail. Delegates may use the personal computers in the *Cyber Café* or in *USBI* (the Information centre) on the campus. Delegates who wish to use the facilities of USBI, should announce themselves as “ORSSA Conference Delegates” at the reception and access will be given. The facilities are located on the left hand side of the passage when moving from the lecture theatres to the *Winery* (where refreshments and meals will be served) — see map on page 4.

In order to access the Internet, the following procedure should be followed:

GUIDE FOR INTERNET USE

- Click on the *Logins* icon and a sub-menu will open. 
- Click on the *Internet Firewall* icon. 
- At the username prompt, type: **BPCVIS**
- At the password prompt, type: **ORSSA** ← this needs to be in capitals.
- The *Internet Firewall* will minimize.
- Click on the *Internet Explorer* icon.
- Provide the URL of the website you wish to visit.



It is important that you close the *Internet Firewall* when you have completed your session.

Instruksies vir Toegang tot die Internet

Afgevaardigdes mag die rekenfasiliteite van die USB in die *Kuberkafee* of in die *USBI* (die USB Inligtingsentrum) op die kampus gebruik om toegang tot die internet en e-pos te verkry. Afgevaardigdes wat van hierdie fasiliteite gebruik wil maak, moet hulself as “ONSA Konferensie Afgevaardigdes” by ontvangs identifiseer, en toegang sal verleen word. Hierdie fasiliteite is aan die linkerkant van die gang geleë wanneer vanaf die lesingsale na die *Winery* (waar etes en verversings bedien sal word) beweeg word — sien kaart op bladsy 4.

Om toegang tot die internet te verkry, moet die volgende prosedure gevolg word:

GIDS VIR INTERNET GEBRUIK

- Klik op die *Logins* ikoon, en ’n sub-spyskaart sal oopmaak. 
- Klik op die *Internet Firewall* ikoon. 
- Tik **BPCVIS** wanneer om ’n gebruikersnaam gevra word.
- Tik **ORSSA** wanneer om ’n wagwoord gevra word ← moet hoofletters wees.
- Die *Internet Firewall* sal minimeer.
- Klik op die *Internet Explorer* ikoon.
- Verskaf die URL van die webtuiste wat u wil besoek.

Dit is belangrik dat u die *Internet Firewall* toemaak voordat u die rekenaar verlaat.

List of Delegates (in alphabetical order)
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