

Welcome from the President



Honoured guests, operations researchers and delegates, it is my great pleasure to welcome you all to the 2011 National Conference of the *Operations Research Society of South Africa* (ORSSA).

As many of you will be aware, ORSSA has been developing its Africa Outreach efforts now for several years, going back to its hosting of the International Conference on OR in Development in 2001. This year's conference has been very deliberately sited in Zimbabwe as an additional, conscious step in this programme.

The *National University of Science and Technology* (NUST), our co-hosts for the conference, have been both teaching and promoting operations research in Zimbabwe for many years, and we are proud to be able to work with them, both on the conference and we hope on future operations research related activities.

There has been a previous ORSSA conference which took place outside the borders of South Africa — in Swaziland, in 1995 — so this one cannot claim that honour, but in terms of the number of non-South African delegates, and the spread of countries they represent, this conference is a very definite and positive first, and we are delighted by the breadth of your presence here. We look forward to more such interventions in due course, and to working with operations researchers in Africa wherever we can.

ORSSA would like to express its deep gratitude to EURO and IFORS for their generous sponsorship of the conference. IFORS is the International Federation of OR Societies, and EURO is the equivalent for European OR Societies. ORSSA is a member of both. To assist ORSSA in spreading the OR message to the wider community of potential practitioners in Africa, both societies have very kindly contributed sponsorship funding, which we are very grateful for.

Our *Local Organising Committee* (LOC) based at NUST have done an excellent job of coordinating and setting up this end of the conference, and I would like to thank Edward Chiyaka, who has chaired the LOC, Philemon Nyamugure, Dorothy Musekwa, and the rest of the team here. The programme management and registration was handled in South Africa by ORSSA, and I would like to particularly single out Jan van Vuuren, Elias Willemse and Marthi Harmse, as well as the wider team, for all their efforts — I know the demands it has placed on them.

We have a very full and exciting programme, excellent conference facilities at the Elephant Hills Hotel here and one of the seven natural wonders of the world on our doorstep — what more can we ask for? For the first time attendees, ORSSA conferences have been famous for decades for a convivial social side, as well as outstanding papers, so relax, contribute, participate and enjoy yourselves — I'm looking forward to three stimulating days, as well as some sightseeing.

Best wishes,

Dave Evans, President
Operations Research Society of South Africa

Welcome from the Chair of the Organising Committee



It is my pleasure to welcome you to the 40th annual conference of the *Operations Research Society of South Africa* (ORSSA) which is this year held outside the borders of South Africa, in Victoria Falls, Zimbabwe.

ORSSA envisages fostering greater collaboration and cooperation across operational research communities in Southern Africa, and accelerating the expansion of operational research applications and education in Southern Africa and eventually the whole of Africa.

With the conference theme of *Spreading operations research across Africa*, ORSSA is moving in its stated direction and working to expand the awareness, understanding, and use of operations research across the wider region. Researchers and educators are encouraged to take this opportunity to maximize collaboration, communication and awareness of operations research across Africa.

The *National University of Science and Technology* is honored to host a conference of this magnitude. We are proud to present a rich scientific programme characterized by more than 90 presentations covering a wide range of applied operational research topics. We are also proud of the fabulous Zimbabwean hospitality of the Elephant Hills Hotel!

Perhaps you have seen postcards, or film footage of the seventh natural wonder of the world, *Victoria Falls*. But have you actually been fortunate enough to stand beside the “smoke that thunders,” watching and listening as the roar of 546 million cubic meters of water, minute by minute, plunge down into a 100-metre deep gorge below? This is your opportunity. Enjoy!

Best wishes,

Edward Chiyaka, Chair

ORSSA 2011 Local Organising Committee

Welcome from the Chair of the Programme Committee



Welcome to the highlight on the calendar of the *Operations Research Society of South Africa* — its annual conference — held in Zimbabwe for the first time! Our conference programme this year boasts an impressive array of diverse presentations on the development of new theory, on the application of operational research techniques in business and industry, on topical issues in operations research, and on the philosophy, teaching and marketing of operations research. Our rich programme, comprising a total of 92 papers and a workshop, have been organised into three plenary sessions and twenty-six contributed sessions, running in three or four parallel streams for virtually our entire stay at the Elephant Hills Hotel. This exciting scientific programme promises to cater for every delegate, no matter what his/her particular tastes and preferences might be!

We welcome, in particular, our keynote speaker, Professor Dag Ericsson (School of Engineering, University of Borås, Sweden), who will be delivering both the opening and closing plenary lectures of the conference on the fascinating topic of *demand chain management*. We also welcome our visiting guest speaker, Dr Erica Klampff (Head of the Strategy and Sustainability Analytics group at Ford Research and Advanced Engineering, United States of America), who will be delivering the mid-conference plenary lecture on the wide variety of operational research problems encountered at Ford Motor Company.

Finally, a warm welcome also to all other delegates from outside the borders of South Africa (Zimbabwe, Botswana, Nigeria, Pakistan and Finland) who, together with the South African members of the Society, have contributed papers. Without your valued inputs and participation we would not have a conference at all!

We trust that all delegates will have a productive few days here at the Elephant Hills Hotel, exchanging experiences, learning new tricks of the trade, renewing old acquaintances and making new friends. May you enjoy the conference in the beautiful surroundings of the majestic Victoria Falls!

Best wishes,

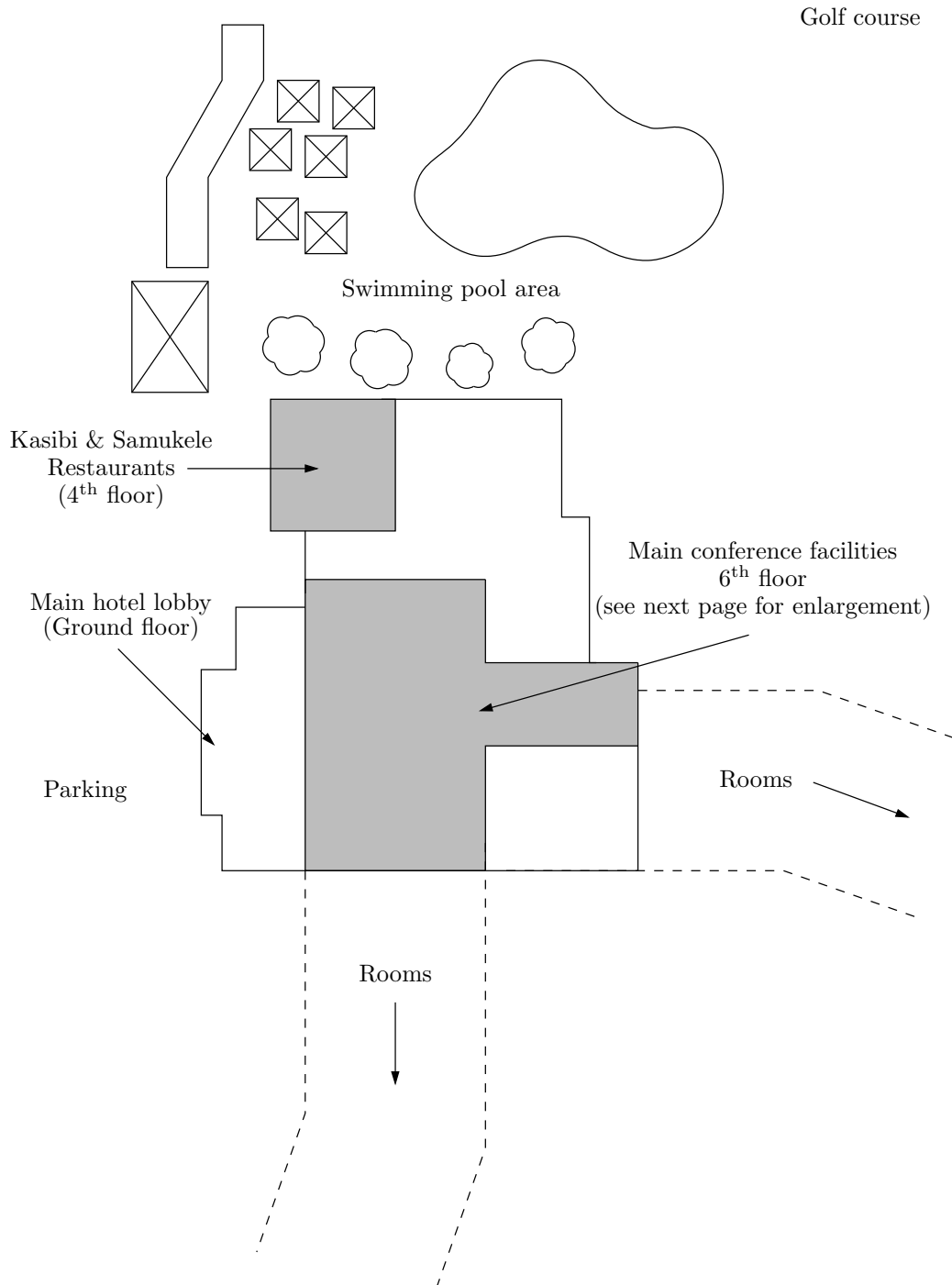
Jan van Vuuren, Chair
ORSSA 2011 Programme Committee

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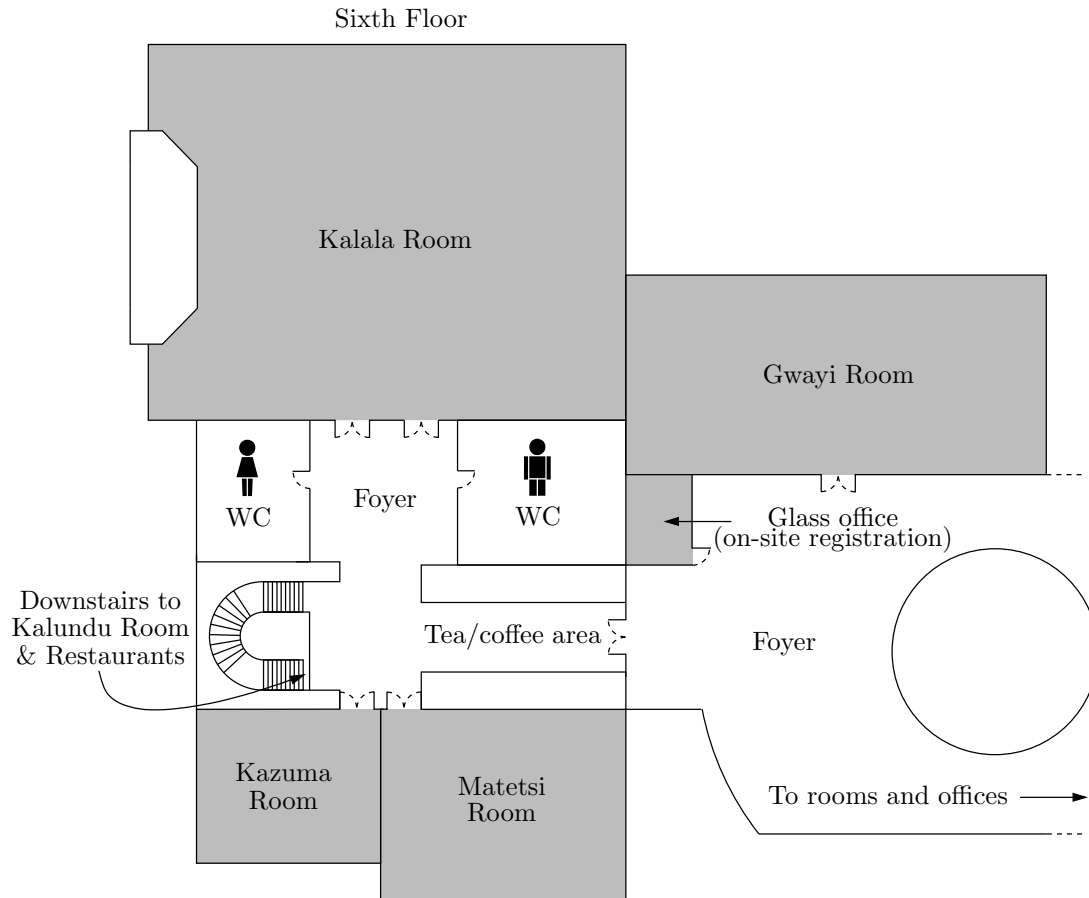
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— *Overview Map of the Hotel* —



— *Map of Conference Facilities* —



— *Notes* —

— Programme at a Glance —

Sunday 18 September 2011

14:00–16:00	<i>Arrival & On-site Registration. (Main Hotel Lobby)</i>
16:00–18:30	<i>Sunset Cruise on the Zambezi River (Departing from the Main Hotel Lobby)</i>

Monday 19 September 2011

<i>On-site Registration. (Glass Office in the Foyer between the Kalala Room and the Gwayi Room)</i>	
08:00–08:30	Plenary Session A: Opening Keynote Address by Professor Dag Ericsson (Kalala Room)
<i>Tea/Coffee (Foyer between the Kalala Room and the Gwayi Room)</i>	
10:00–10:30	I: Miscellaneous Topics (Kalala Room)
10:30–12:30	II: Financial & Investment Analysis (Gwayi Room)
12:30–13:30	III: Decision Making (I) (Matetsi Room)
<i>Lunch (Kasibi Restaurant)</i>	
13:30–15:00	IV: OR at Sasol (Kazuma Room)
15:00–15:30	V: Agriculture & Water (Gwayi Room)
15:30–18:00	VI: Decision Making (II) (Matetsi Room)
19:00–	VII: Risk Solver Workshop (Kazuma Room)
<i>Tea/Coffee (Foyer between the Kalala Room and the Gwayi Room)</i>	
08:30–11:00	VIII: Health Care & Hospital Management (Matetsi Room)
11:00–11:30	IX: Data Sampling and Analysis (Gwayi Room)
11:30–12:30	X: Health Care & Hospital Management (Matetsi Room)
12:30–13:30	XI: ORSSA Executive Meeting (Kazuma Room)
<i>Barbecue (In Front of the Hotel)</i>	

Tuesday 20 September 2011

08:30–11:00	XII: Supply and Demand Chain Management (Kalala Room)	XV: Modelling of Serious Diseases (Matetsi Room)
<i>Tea/Coffee (Foyer between the Kalala Room and the Gwayi Room)</i>		
11:00–11:30	Plenary Session B: Visiting Lecture by Dr Erica Klampff (Kalala Room)	
<i>Lunch (Samukele Restaurant)</i>		
11:30–12:30	XIII: Production, Lot Sizing and Inventory Control (Kalala Room)	XVIII: OR in Zimbabwe (I) (Matetsi Room)
12:30–13:30	XIV: Scheduling Problems (Gwayi Room)	
13:30–16:00	XV: Applications of Metaheuristics (Gwayi Room)	
16:00–16:30	<i>Tea/Coffee (Foyer between the Kalala Room and the Gwayi Room)</i>	
16:30–18:00	Annual General Meeting (Kalala Room)	
19:00–	<i>Conference Banquet (Kalundu Room)</i>	

Wednesday 21 September 2011

08:30–10:00	XVI: Poverty Relief (Kalala Room)	XX: OR in the Energy Sector (Gwayi Room)	XXI: OR in Zimbabwe (II) (Matetsi Room)	XXII: Miscellaneous Topics (Kazuma Room)
<i>Tea/Coffee (Foyer between the Kalala Room and the Gwayi Room)</i>				
10:00–10:30	XXIII: Election Results (Kalala Room)	XXIV: Simulation (Gwayi Room)	XXV: Security & the Military (Matetsi Room)	XXVI: Statistical Modelling Software (Kazuma Room)
10:30–11:30	Plenary Session C: Closing Keynote Address by Professor Dag Ericsson (Kalala Room)			
11:30–13:00	<i>Lunch (at the Swimming Pool)</i>			
13:00–14:00				

— *Detailed Conference Programme* —

Sunday 18 September 2011

Arrival & On-site Registration (14:00–16:00)
[Main Hotel Lobby]

Sunset Cruise on the Zambezi River (16:00–18:30)
[Departing from the Main Hotel Lobby]

Monday 19 September 2011

On-site Registration (08:00–08:30)
[Glass Office in the Foyer between the Kalala Room and the Gwayi Room]

Monday 19 September 2011: (08:30–10:00)	
Plenary Session A: Conference Opening <i>Chair:</i> Edward Chiyaka [<i>Venue:</i> Kalala Room]	
08:30–08:40	Edward Chiyaka (Chair, Local Organising Committee) <i>Welcome & Announcements</i>
08:40–08:45	Jan van Vuuren (Chair, Programme Committee) <i>Programme Announcements</i>
08:45–09:00	Dave Evans (ORSSA President) <i>Presidential Address</i>
09:00–10:00	Dag Ericsson (Keynote Speaker) <i>Demand Chain Management — The Evolution (p. 24)</i>

Tea/Coffee (10:00–10:30)
[Foyer between the Kalala Room and the Gwayi Room]

Monday 19 September 2011: (10:30–12:30)	
Parallel Session I: Miscellaneous Topics <i>Chair:</i> Wessel Pienaar [<i>Venue:</i> Kalala Room]	
10:30–11:00	Elias Munapo , <i>A new approach to the Quadratic Assignment Problem (p. 92)</i>
11:00–11:30	Kudakwashe Hove , <i>Choosing an appropriate transformation for experimental data in the case of violated ANOVA assumptions (p. 44)</i>
11:30–12:00	Martin Kidd , <i>Enumeration of sets of orthogonal Latin squares (p. 61)</i>
12:00–12:30	Wessel Pienaar , <i>The coherence between logistics management, operations research and systems analysis (p. 46)</i>

Parallel Session II: Financial & Investment Analysis <i>Chair: Dorothy Hove-Musekwa [Venue: Gwayi Room]</i>	
10:30–11:00	Abel Maeteletsa , <i>Bankruptcy prediction</i> (p. 41)
11:00–11:30	Rhoda Makhwiting , <i>Modelling volatility and financial market risk of shares on the JSE</i> (p. 91)
11:30–12:00	Jan Kruger , <i>Measures for share selection</i> (p. 84)
12:00–12:30	No Presentation Scheduled

Parallel Session III: Decision Making — Part I <i>Chair: Winnie Pelser [Venue: Matetsi Room]</i>	
10:30–11:00	Ian Durbach , <i>Post-catastrophe decision making</i> (p. 100)
11:00–11:30	Leanne Scott , <i>Is a bird in the hand worth two in the bush?</i> (p. 77)
11:30–12:00	Raimo Hämmäläinen , <i>Utilisation of multicriteria influence diagrams in simulation metamodeling</i> (p. 116)
12:00–12:30	David Zvipore , <i>Applications of the analytical hierarchy process and statistical decision theory in commercialisation</i> (p. 38)

Parallel Session IV: Operations Research at Sasol <i>Chair: Marlize Meyer [Venue: Kazuma Room]</i>	
10:30–11:00	Marthi Hamse , <i>Spreading operations research across a large company</i> (p. 104)
11:00–11:30	Hentie van den Berg , <i>Decision support for a new stability enhancement system at the Sasol Synfuels Air Separation Unit</i> (p. 53)
11:30–12:00	Lieschen Venter , <i>Human resources decision support using Sasol Technology's Employment Equity Target Assessment Model</i> (p. 71)
12:00–12:30	Marlize Meyer , <i>Operations research at Sasol — The making of an INFORMS prize winning team</i> (p. 95)

Lunch (12:30–13:30)
[Kasibi Restaurant]

Monday 19 September 2011: (13:30–15:00)	
Parallel Session V: Vehicle Routing Problems <i>Chair: Hans Ittmann [Venue: Kalala Room]</i>	
13:30–14:00	Relita Pretorius , <i>Constraints driving the development of rich vehicle routing problems</i> (p. 47)
14:00–14:30	Angela Rademeyer , <i>Algorithmic approaches to solving multi-period delivery vehicle master routing problems</i> (p. 33)
14:30–15:00	Elias Willemse , <i>Constructive heuristics for the Residential Waste Collection Problem</i> (p. 48)

Parallel Session VI: Agriculture and Water Management <i>Chair: Anton de Villiers [Venue: Gwayi Room]</i>	
13:30–14:00	Emilia Masenda , <i>Observed trends in the use of cereal straws and cotton seed hulls as sole substrates in the cultivation of Pleurotus ostreatus mushrooms in Zimbabwe</i> (p. 94)
14:00–14:30	Stephanie Bester , <i>Estimating the threat of water scarcity in the Breede River Valley: A forecast-based analysis</i> (p. 62)
14:30–15:00	Philemon Nyamugure , <i>Application of linear programming in water distribution using pumps</i> (p. 37)

Parallel Session VII: Decision Making — Part II <i>Chair: Ian Durbach [Venue: Matetsi Room]</i>	
13:30–14:00	Erich Essmann , <i>Solving a multi-objective micro milling problem using simulated annealing</i> (p. 103)
14:00–14:30	Tanya Lane-Visser , <i>Finding the optimal South African freight energy management strategy with archived multiobjective simulated annealing</i> (p. 68)
14:30–15:00	Muriel Chinoda , <i>A behavioural-based multi-objective decision making framework for corporate climate change response</i> (p. 42)

Parallel Session VIII: Risk Solver Workshop <i>Presenter: Wim Gevers [Venue: Kazuma Room]</i>	
13:30–15:00	<i>Teaching operations research using RISK SOLVER PLATFORM FOR EDUCATION</i> (p. 109)

Tea/Coffee (15:00–15:30)
[Foyer between the Kalala Room and the Gwayi Room]

Monday 19 September 2011: (15:30–18:00)	
Parallel Session IX: Miscellaneous Topics <i>Chair: Erica Klampfl [Venue: Kalala Room]</i>	
15:30–16:00	Hausitoe Nare , <i>Credit rating mechanisms using multivariate adaptive regression splines</i> (p. 50)
16:00–16:30	Kolentino Mpetta , <i>Data envelopment analysis in the fast food industry</i> (p. 52)
16:30–17:00	Ephraim Makoni , <i>Winning the impatient customer — Weighing the trade-offs in waiting line situations</i> (p. 117)
17:00–17:30	Aderemi Adewumi , <i>Heuristic applications to the Hostel Space Allocation Problem</i> (p. 69)
17:30–18:00	No Presentation Scheduled

Parallel Session X: Data Sampling and Analysis <i>Chair: Philemon Nyamugure [Venue: Gwayi Room]</i>	
15:30–16:00	Theophilous Mathema , <i>Time series analysis of the volume of manufacturing data</i> (p. 111)
16:00–16:30	Simon Monyai , <i>Application of factor analysis to the 2009 General Household Survey of South Africa</i> (p. 36)
16:30–17:00	Rampedi Mothapo , <i>Using logistic regression to predict poverty in South Africa</i> (p. 114)
17:00–17:30	Kudakwashe Hove , <i>Analysis of data from an agrosite experiment using GENSTAT AND SPSS</i> (p. 34)
17:30–18:00	Paul Fatti , <i>Random sampling: An essential tool for the operations researcher</i> (p. 101)

Parallel Session XI: Health Care and Hospital Management <i>Chair: Tanya Lane-Visser [Venue: Matetsi Room]</i>	
15:30–16:00	Alwyn van Zyl , <i>Operations research in telemedicine</i> (p. 96)
16:00–16:30	Nothabo Dube , <i>The impact of media coverage on the transmission dynamics of human influenza</i> (p. 74)
16:30–17:00	Ilse van Zyl , <i>Paving the way for the use of prediction modelling in a hospital environment</i> (p. 99)
17:00–17:30	Ruan Daffue , <i>An evaluation of the implications of predictive patient admission algorithms on African healthcare systems</i> (p. 65)
17:30–18:00	Maria Treurnicht , <i>A nurse rostering algorithm for a district hospital in South Africa</i> (p. 93)

Parallel Session XII: ORSSA Executive Committee Meeting (15:30–18:00) <i>Chair: Dave Evans [Venue: Kazuma Room]</i>	
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Barbecue (19:00–) [In Front of the Hotel]

Tuesday 20 September 2011

Tuesday 20 September 2011: (08:30–11:00)	
Parallel Session XIII: Supply and Demand Chain Management <i>Chair: Dag Ericsson [Venue: Kalala Room]</i>	
08:30–09:00	Moreblessings Taremba , <i>Demand chain analysis for better planning in the steel foundry industry</i> (p. 56)
09:00–09:30	Khesani Chilumani , <i>Supply chain management information systems: An artificial intelligence perspective</i> (p. 107)
09:30–10:00	Ozias Ncube , <i>Using stochastic modelling to investigate supply chain disruptions</i> (p. 115)
10:00–10:30	Tawanda Mhuri , <i>Enhancing supply chains through implementing transport management systems in Zimbabwean industries</i> (p. 60)
10:30–11:00	Moses Dowart , <i>Effective logistics and supply chain management: A theoretical analysis</i> (p. 59)

Parallel Session XIV: Scheduling Problems <i>Chair: Elias Willemse [Venue: Gwayi Room]</i>	
08:30–09:00	Martin Kidd , <i>Balancing home and away matches in league sports tournaments: A case study</i> (p. 40)
09:00–09:30	Amon Masache , <i>Locomotive scheduling in freight at Mpopoma Train Station</i> (p. 81)
09:30–10:00	Juwa Nyirenda , <i>Job shop scheduling to minimise tardiness</i> (p. 78)
10:00–10:30	Aderemi Adewumi , <i>Minimizing the (weighted) number of tardy jobs: A review</i> (p. 87)
10:30–11:00	Aderemi Adewumi , <i>Scheduling jobs on parallel machines to minimize a weighted number of early and tardy jobs</i> (p. 102)

Parallel Session XV: Modelling of Serious Diseases <i>Chair: Sarma Yadavalli [Venue: Matetsi Room]</i>	
08:30–09:00	Edward Chiyaka , <i>Theoretical assessment of the transmission dynamics of Leprosy</i> (p. 110)
09:00–09:30	Dorothy Hove-Musekwa , <i>Modelling the effect of stress on the dynamics and treatment of tuberculosis</i> (p. 89)
09:30–10:00	Edinah Mudimu , <i>Modelling HIV/AIDS in a mixed population using an agent-based approach</i> (p. 90)
10:00–10:30	Grace Chingwe , <i>An analysis of the impact of HIV/AIDS on the recruitment of children into the orphaned and vulnerable children category (OVC) in Zimbabwe</i> (p. 31)
10:30–11:00	Chipo Mufudza , <i>The importance of HIV specific Cytotoxic T cells on HIV and Myco-tuberculosis coinfection dynamics</i> (p. 75)

Tea/Coffee (11:00–11:30)

[Foyer between the Kalala Room and the Gwayi Room]

Tuesday 20 September 2011: (11:30–12:30)	
Plenary Session B: Visiting Lecture <i>Chair: Michele Fisher [Venue: Kalala Room]</i>	
11:30–12:30	Erica Klampfl , <i>Operations research at Ford Motor Company</i> (p. 26)

Lunch (12:30–13:30)

[Samukele Restaurant]

Tuesday 20 September 2011: (13:30–16:00)	
Parallel Session XVI: Production, Lot Sizing & Inventory Control <i>Chair: 'Maseka Lesaoana [Venue: Kalala Room]</i>	
13:30–14:00	Tanyaradzwa Nzvengende , <i>Using the economic order quantity model in managing inventory: The case study of NOCZIM</i> (p. 113)
14:00–14:30	Kelvin Chirenje , <i>An inventory management system for optimising product availability and capacity utilisation</i> (p. 76)
14:30–15:00	Nicholas Tayisepi , <i>Coordinating price and capacity decisions in inventory systems with stochastic demand: A case study in a chemical processing plant in Zimbabwe</i> (p. 49)
15:00–15:30	Mthokozisi Nkala , <i>Optimal production lot size models with rework and scrap</i> (p. 98)
15:30–16:00	Ademola Adewara , <i>A minimax multivariate control chart using a nonlinear polynomial function</i> (p. 86)
Parallel Session XVII: Applications of Metaheuristics <i>Chair: Martin Kidd [Venue: Gwayi Room]</i>	
13:30–14:00	Donald van Blommestein , <i>Exposing the hidden dynamics of metaheuristics through visualisation</i> (p. 67)
14:00–14:30	Anton de Villiers , <i>Metaheuristic approaches for order sequencing in a directed picking line</i> (p. 85)
14:30–15:00	Tanya Lane-Visser , <i>Determining the optimal log position during primary breakdown, using simulated annealing</i> (p. 57)
15:00–15:30	Wiehahn Carstens , <i>Estimation of multivariate proportional hazards model parameters through artificial bee colony optimisation</i> (p. 63)
15:30–16:00	Aderemi Adewumi , <i>Swarm intelligence algorithms for OR problems: Successes and trends</i> (p. 108)
Parallel Session XVIII: Operations Research in Zimbabwe — Part I <i>Chair: Ozias Ncube [Venue: Matetsi Room]</i>	
13:30–14:00	Daniel Maposa , <i>Operations research in Zimbabwe: Origins, development and the way forward</i> (p. 97)
14:00–14:30	Caston Sigauke , <i>An econometric study of currency crises in developing economies: A case study</i> (p. 58)
14:30–15:00	Dumisani Dube , <i>Modelling and analysing the price structure of houses in the dollarised economy of Zimbabwe</i> (p. 88)
15:00–15:30	Lenyora Sihwa , <i>The impact of the liquidity crunch on the manufacturing sector during the period 2009-2010</i> (p. 73)
15:30–16:00	Desmond Mwembe , <i>A linear programming approach to sustainable poultry production in the small farms of Makwa Hwange, Zimbabwe: A human-poultry food production case</i> (p. 79)

Tea/Coffee (16:00–16:30)

[Foyer between the Kalala Room and the Gwayi Room]

Tuesday 22 September 2009: (16:30–18:00)

ORSSA Annual General Meeting

Chair: Dave Evans [*Venue:* Kalala Room]

Conference Banquet (19:00–)

[Kalundu Room]

Wednesday 21 September 2011

Wednesday 21 September 2011: (08:30–10:00)

Parallel Session XIX: Poverty Relief & Humanitarian OR

Chair: Marthi Harmse [*Venue:* Kalala Room]

08:30–09:00	Hildah Mashira , <i>Humanitarian operations research in Southern Africa</i> (p. 72)
09:00–09:30	Ernest Lanz , <i>Decision support with respect to facility location and fleet composition for FoodBank Cape Town</i> (p. 54)
09:30–10:00	Murendeni Nemukula , <i>Analysis of factors affecting academic performance of the disabled students at the universities in Limpopo province, South Africa</i> (p. 35)

Parallel Session XX: Operations Research in the Energy Sector

Chair: Caston Sigauke [*Venue:* Gwayi Room]

08:30–09:00	Bernard Schlünz , <i>Decision support with respect to generator maintenance scheduling in the energy sector</i> (p. 55)
09:00–09:30	Ntiyiso Makukule , <i>Daily electricity demand forecasting in South Africa</i> (p. 51)
09:30–10:00	Happy Maluleke , <i>An analysis of price indices of electrical appliances in South Africa</i> (p. 32)

Parallel Session XXI: Operations Research in Zimbabwe — Part II

Chair: Elias Munapo [*Venue:* Matetsi Room]

08:30–09:00	Tichaona Mazuru , <i>An aid to decision making using analysis of variance in a protective clothing industry in Zimbabwe</i> (p. 30)
09:00–09:30	Shingirai Svinurai , <i>Assessment of the maternal mortality rate in Zimbabwe</i> (p. 39)
09:30–10:00	Simbarashe Mubaira , <i>Maximising production of an in-store bakery using linear programming</i> (p. 83)

Parallel Session XXII: Miscellaneous Topics <i>Chair: Jan Greben [Venue: Kazuma Room]</i>	
08:30–09:00	Tiny du Toit , <i>Tracking concept drift in spam filtering with generalized additive neural networks</i> (p. 112)
09:00–09:30	Jan Kruger , <i>The causal structure may be different from the highest posterior probability structure if it is not a tree structure</i> (p. 43)
09:30–10:00	Martijn van der Merwe , <i>Evolutionary games on graphs</i> (p. 66)

Tea/Coffee (10:00–10:30)

[Foyer between the Kalala Room and the Gwayi Room]

Wednesday 21 September 2011: (10:30–11:30)	
Parallel Session XXIII: Forecasting of Election Results <i>Chair: Paul Fatti [Venue: Kalala Room]</i>	
10:30–11:00	Jan Greben , <i>The 2011 municipal elections in South Africa and new trends since the 2009 national elections</i> (p. 29)
11:00–11:30	Hans Ittmann , <i>Local government elections 2011: Some personal perspectives</i> (p. 80)
Parallel Session XXIV: Simulation <i>Chair: Liezl van Dyk [Venue: Gwayi Room]</i>	
10:30–11:00	Mark Einhorn , <i>An evaluation of the efficiency of self-organising versus fixed traffic signalling paradigms</i> (p. 64)
11:00–11:30	Samson Mhlanga , <i>Maintenance and production planning using LP and simulation at NFA Oil Plant</i> (p. 82)
Parallel Session XXV: Security and the Military <i>Chair: Leanne Scott [Venue: Matetsi Room]</i>	
10:30–11:00	Winnie Pelser , <i>How to measure military readiness?</i> (p. 70)
11:00–11:30	Jacques du Toit , <i>Coastal threat evaluation decision support</i> (p. 45)
Parallel Session XXVI: Software for Statistical Modelling <i>Chair: Wim Gevers [Venue: Kazuma Room]</i>	
10:30–11:00	Graham Barr , <i>Spreadsheet-based methods for the teaching of statistical and OR methodologies and technologies</i> (p. 105)
11:00–11:30	Kudakwashe Hove , <i>Statistical modelling using Genstat discovery in experimental work</i> (p. 106)

Wednesday 21 September 2011: (11:30–13:00)	
Plenary Session C: Conference Closing <i>Chair: Dave Evans [Venue: Kalala Room]</i>	
11:30–12:30	Dag Ericsson (Keynote Speaker) <i>Demand Chain Management — The Implementation (p. 27)</i>
12:30–12:45	Paul Fatti (Fellow of ORSSA) <i>Reflection on Papers Read at the Conference</i>
12:45–13:00	Dave Evans (ORSSA President) <i>Final Announcements, Thank Yous & Good bye</i>

Lunch (13:00–14:00)
[At the Swimming Pool]

— *List of Sessions & Chairs* —

Session	Day	Time Slot	Topic	Chairperson	Venue
A	Mon 19 Sept	08:30–10:00	Opening Plenary	Edward Chiyaka	Kalala Room
B	Tue 20 Sept	11:30–12:30	Mid-conference Plenary	Michele Fisher	Kalala Room
C	Wed 21 Sept	11:30–13:00	Closing Plenary	Dave Evans	Kalala Room
I	Mon 19 Sept	10:30–12:30	Miscellaneous Topics	Wessel Pienaar	Kalala Room
II	Mon 19 Sept	10:30–12:30	Financial & Investment Analysis	Dorothy Hove-Musekwa	Gwayi Room
III	Mon 19 Sept	10:30–12:30	Decision Making (Part I)	Winnie Pelser	Matetsi Room
IV	Mon 19 Sept	10:30–12:30	OR at Sasol	Marlize Meyer	Kazuma Room
V	Mon 19 Sept	13:30–15:00	Vehicle Routing Problems	Hans Ittmann	Kalala Room
VI	Mon 19 Sept	13:30–15:00	Agriculture & Water Management	Anton de Villiers	Gwayi Room
VII	Mon 19 Sept	13:30–15:00	Decision Making (Part II)	Ian Durbach	Matetsi Room
VIII	Mon 19 Sept	13:30–15:00	RISK SOLVER Workshop	No Chairperson	Kazuma Room
IX	Mon 19 Sept	15:30–18:00	Miscellaneous Topics	Erica Klampfl	Kalala Room
X	Mon 19 Sept	15:30–18:00	Data Sampling & Analysis	Philemon Nyamugure	Gwayi Room
XI	Mon 19 Sept	15:30–18:00	Health Care & Hospital Management	Tanya Lane-Visser	Matetsi Room
XII	Mon 19 Sept	15:30–18:00	Executive Committee Meeting	Dave Evans	Kazuma Room
XIII	Tue 20 Sept	08:30–11:00	Supply Chain Management	Dag Ericsson	Kalala Room
XIV	Tue 20 Sept	08:30–11:00	Scheduling Problems	Elias Willemse	Gwayi Room
XV	Tue 20 Sept	08:30–11:00	Modelling of Serious Diseases	Sarma Yadavalli	Matetsi Room
XVI	Tue 20 Sept	13:30–16:00	Production, Lot Sizing & Inventory	Maseka Lesoana	Kalala Room
XVII	Tue 20 Sept	13:30–16:00	Applications of Metaheuristics	Martin Kidd	Gwayi Room
XVIII	Tue 20 Sept	13:30–16:00	OR in Zimbabwe (Part I)	Ozias Ncube	Matetsi Room
XIX	Wed 21 Sept	08:30–10:00	Poverty Relief & Humanitarian OR	Marthi Harmse	Kalala Room
XX	Wed 21 Sept	08:30–10:00	OR in the Energy Sector	Caston Sigauke	Gwayi Room
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XXIII	Wed 21 Sept	10:30–11:30	Forecasting of Election Results	Paul Fatti	Kalala Room
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XXV	Wed 21 Sept	10:30–11:30	Security & The Military	Leanne Scott	Matetsi Room
XXVI	Wed 21 Sept	10:30–11:30	Statistical Modelling Software	Wim Gevers	Kazuma Room

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— *Plenary Paper Abstracts* —

Opening Plenary:

Demand Chain Management — The Evolution

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Abstract

Logistics is a fascinating discipline which is undergoing continual evolution based on interaction between changes in the environment, the development of new tools and techniques, and the introduction of concepts, strategies and business models to adapt to and exploit the development.

The focus on *evolution* rather than *revolution* means that these concepts are not replacing, but complementing each other. The logistics concept focuses on the physical flows and efficiency in the “order to delivery” or *Time to Cash* (TTC) process. *Supply Chain Management* (SCM) broadens the view by also including other core interorganizational processes in the approach. *Time to Market* (TTM), *Supplier Creation and Retention* (SCR) and *Customer Creation and Retention* (CCR) are three of the most important of these interorganizational processes.

SCM relationships span from very loose, transaction-oriented connections, via more or less stable supplier/customer relationships to long term, partnership relations. This broad span is one of the main reasons for the lack of a common, agreed upon definition and the difficulty in measuring the results of application of the concept.

The trend in today’s market is that competition moves from *company versus company* to *channel versus channel*. This increases the necessity of a shift from looking at individual companies and their actions in the channel to focusing on channel performance in a holistic way. It is very difficult for a company to act autonomously in an increasingly global, intertwined and competitive world. Hence, there is a development toward a holistic view of the chain and the development of partnership.

However, *chains* may not be the best analogy for describing the interrelationships between units in a complex and dynamic economic environment. *Networks* may be a more appropriate term, and *Demand Chain Management* (DCM) can be seen as one step in that direction. Chains and relationships are the links between the nodes in such a network. The stability of these links may vary from rather loose,

transaction oriented relations to stable, long lasting partnerships in demand chains. A focal company is involved in all sorts of relationships and leaders must learn how to manage and govern this portfolio of relationships.

It is hard enough to manage ownership based, hierarchical structures, and it is even more difficult to synchronize and align autonomous units. It requires a change of mindset from conflict and competition to cooperation, collaboration and co-opetition. In these networks, links are developed consisting of companies that have decided to work in close partnership to create added customer value. Unique competence is created by the interaction and interdependence in the chain as a whole and cannot be attributed to any specific company. The distinctive competence is based on the entire channel the demand chain. Success with such an approach is built on trust among the partners in the network and the creation of win/win situations. The mental move from mutual competition to mutual cooperation is a major tumbling stone for the development. However, competition increases and forces the creation of new visions, new business models and new mind sets. The tools for integration and collaboration, for example within *Information and Communication Technology* (ICT), are here; the challenge is to create acceptance for new mindsets and new ways of behaviour. The DCM concept is designed to fit this new environment by explicitly focusing on the consumer and aligning interorganizational processes.

With this frame of reference, the demand chain may be defined as “An integrated and aligned chain built on trust, partnership and mutual interdependence aiming at creation of a unique competence to identify and satisfy customer perceived value” and “Demand Chain Management is the effort to create, retain and continuously develop a dynamically aligned demand chain.”

Mid-conference Plenary:
Operations research at Ford Motor Company

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Abstract

I will provide an overview of the types of *Operations Research* (OR) problems that the Systems Analytics & Environmental Sciences department within Ford Research & Advanced Engineering addresses in areas such as Sustainability, Manufacturing, Purchasing, Product Development, Marketing, and Finance. We provide data-driven scientific solutions to five core Ford Business Strategic questions:

- What do we make?
- Who are our customers?
- How do we make it?
- How do we sell it?
- How do we profit?

Additionally, we apply an analytical approach to understand the environmental implications of our products, enhance the sustainability of our business, and provide sound scientific input for corporate strategy and regulatory interactions.

Closing Plenary: *Demand Chain Management — The Implementation*

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Abstract

New theories and concepts come and go. One of the most important characteristics behind lasting concepts and business models is that they are developed in close interaction between business and academia. Concepts are rather easy to create, but quite hard to implement. Change management is just as important in implementing new concepts and business models as it is in applying operations research and ICT methods, tools and techniques. The formula *Results (R) = Systems efficiency (S) multiplied by Acceptance (A)*, that is, $R = S \times A$, is applicable in all these situations.

“The proof of the pudding is in the eating.” This statement is valid for testing the usefulness of theoretical concepts as well as for puddings. The question is whether we can see any practical proof that business is working along *Demand Chain Management (DCM)* lines, even if the terms used may be different. It was within *Fast Moving Consumer Goods (FMCG)* that the first signs of the development toward increased collaboration and integration emerged. A lot of methods and techniques were developed as a result of changes in competition — *Quick Response (QR)*, *Efficient Consumer Response (ECR)*, *Collaborative Planning, Forecasting and Response (CPFR)*, and *Vendor Managed Inventory (VMI)* are examples of this.

Walmart, *IKEA*, *Benetton*, *Zara*, *H&M*, *BAMA* and others, are examples of firms that were not fighting volatility but taking advantage of it. The ball bearing company *SKF* is perhaps the best example of continuous rethinking and logistics innovation in traditional industry. *SKF* has always been a spearhead and pioneer in terms of development and implementation of state of the art logistics. Electrolux’ concept of *Demand Flow Leadership* is another example of process oriented, consumer focused approaches.

As mentioned, companies may not always use the term DCM, but the approaches are similar. One of the most important characteristics of the new approach is the shift from a focus on the technical infrastructure and cost efficiency to a focus on people as the driving forces in development and implementation. The DCM concept, as it is used here, is one step towards a “Value Network” approach. Different sets of relationships make up the links in the network. The nodes consist of all sorts of organizations and individual consumers. In a more and more turbulent environment, resilience is an increasingly important concept in building relationships. The term supply chain envisions a sequence of activities, functions and organizations.

Sometimes there is a tendency to forget that even in organizations, decisions are made by individuals with their specific strengths and weaknesses. The key ingredients in modern supply chains are not the trucks, the equipment or the digital infrastructure. The most important ingredient is the people who design, develop and run them. Only people can drive and implement change. It becomes increasingly evident that supply chains are living organizations driven by “people power.” This is one of the main characteristics of the demand chain approach and it will be further accentuated in the future.

Some common characteristics may be identified in successful change processes:

- The transformation is led by a “soul of fire”, an entrepreneur and pioneer who takes charge and infuses the organization with his values. These change leaders have the ability to create enthusiasm and positive energy among the employees. They are pioneers who walk in front of the troops, but not so far in advance that people lose sight of them. They also know how to avoid being caught in the old definition of a pioneer as “the one who walks first, with an arrow in his back.”
 - Real change leaders also have a holistic view of the entire flow and an ability to convince partners that synchronization and alignment is a win/win concept.
 - Consumers or end users are focused and taken as the starting point for the development of differentiated and customized chains. Consumer insight, deep and thorough knowledge of the consumers’ implicit and explicit needs and wishes, is the basis and core of the approach.
 - The approach is based on “state of the art” technologies and techniques, when this is appropriate, but the trick is to know when not to use them. Management by Fad — jumping on the latest hype, without understanding the underlying theory and circumstances — is a certain road to chaos.
 - They are people powered in the true sense of the words.
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— *Contributed Paper Abstracts* —

The 2011 municipal elections in South Africa and new trends since the 2009 national elections

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Abstract

The CSIR has been involved in South African election night predictions since 1999. Our prediction model is based on a segmentation of the electorate according to voting behaviour by introducing 20 election clusters. Early results can be used to predict the voting behavior in each cluster, and then these predictions are extended over the uncounted voting districts. This methodology leads to an early determination of the final election results as it counters the bias in the incoming results. Early results usually favour parties that are dominant in urban areas. This bias often leads to unjustified expectations by politicians and analysts who are following the actual results at the *Independent Electoral Commission* (IEC) headquarters on election night.

Municipal elections offer new challenges over the national and provincial elections. In these elections both proportional and “ward” votes are cast, and the allocation of seats is a complex process involving both votes. We will address the specific challenges of municipal elections and their relationship to the national elections. The experience is that the municipal elections are often not an exact mirror of the national elections and that certain parties fare better (worse) in the national elections. We will analyze this phenomenon in terms of turnout. We also discuss the convergence of the predictions as a function of the percentage of votes cast.

A further outcome of our election software is trend prediction. Trends are expressed through a trend matrix which correlates previous and current results. This matrix yields information about party loyalty and transfer of voter support between parties. They can also be applied to separate segments of the electorate. These applications prove the value of a mathematical modelling tool in an environment dominated by political analysts with subjective views.

An aid to decision making using analysis of variance in a protective clothing industry in Zimbabwe

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Abstract

In this paper we consider how plant capacity in protective clothing company can be measured and how decisions are made. In a normal working environment several company sections process a job. These sections have different levels of importance and the jobs must be undertaken whilst considering targets, time worked and output produced. In doing so, we are to consider three factors: plant availability, quality rate and performance in each of the company sections. Analysis of variance and hypothesis testing is used to find out which of the plant sections have done better in addressing the three factors named above.

An analysis of the impact of HIV/AIDS on the recruitment of children into the orphaned and vulnerable children category (OVC) in Zimbabwe

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Abstract

The *orphaned and vulnerable children* (OVC) pandemic is a global concern, which requires each country to devise its own tools to tackle it. OVC incidence and recruitment into the OVC category are terms that will be used interchangeably to refer to the case of a child becoming an orphaned and vulnerable child. There are a number of factors that can cause any child to be recruited into the OVC category. However this project delved on the HIV/AIDS factor, as 67% of OVC's in Zimbabwe are orphans and 70% of the orphans are infected with HIV/AIDS (National Action Plan for Orphans and Vulnerable Children, 2009). Analysis and simulations of the basic HIV/AIDS model developed by Ejigu Ayele coupled with calculations of orphanhood were done. Then an HIV/AIDS model with treatment was considered, whereby the infectives, treatment and aids classes experienced disease induced deaths in addition to the natural death rate in each class. This was a development made on Muhammad Yau's model which contained susceptibles, infectives and treatment classes. Results obtained showed that treatment decreases adult mortality which, in turn, causes an age related pattern to the duration of exposure to the risk of losing a parent due to the long incubation period of HIV coupled with the impact of treatment. Thus children in their teens are the ones that are at risk of being orphaned due to HIV/AIDS. Calculations were also performed applying knowledge of survivorship from life-tables to obtain proportions of orphanhood per defined age cohort which subsequently led to computation of rates of recruitment for OVC's that was found to be 36.4%, which is almost equal to the published OVC prevalence which sits at 37%. This shows clearly that the OVC pandemic may be controlled — that is, a reduction in the incidence rate will directly reduce OVC prevalence.

An analysis of price indices of electrical appliances in South Africa

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Abstract

An analysis of price indices of electrical appliances in South Africa is performed in this paper. Monthly data from *Statistics South Africa* for the period January 1998 to December 2010 is used. Two statistical techniques, namely canonical correlation and time series analysis, are used for modelling the data. Canonical correlation is applied to test the relationship between sets of dependent variables (electrical appliances) and the set of independent variables (year and time). Time series analysis is employed in developing forecasting models. The developed ARIMA models are then used for out of sample predictions of price indices of electrical appliances.

Algorithmic approaches to solving multi-period delivery vehicle master routing problems

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Abstract

Many companies are confronted with the problem of creating fixed master routes for a period of more than a day for their fleet of heterogeneous delivery vehicles operating from a single depot. This involves the assignment of the company's customers to clusters as well as service profiles (a profile represents a valid combination of visit days for a customer as well as a proportion of workload/mass for each visit). Clusters must then be assigned to vehicles which can perform multiple trips per day. This combinatorial optimisation problem is addressed using exact and heuristic algorithms. Master routing achieves more predictable customer service, often with significant cost savings. It also provides a platform for re-optimizing routes with minimal interruption when new customers are added, existing ones close or service frequencies and requirements change. Results of real world data sets with different constraints are shown. Application areas include waste collection, recycling, couriers, food and beverage retailers and van sales. The aim is to reduce the gap between existing academic models for such *nominated delivery day* (NDD) problems and the complex requirements of real applications.

Analysis of data from an agrosite experiment using GENSTAT and SPSS

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Abstract

Agricultural experiments are in most cases conducted in more than two sites to see the effects of, say, varying agro-ecological zones. This is true in the case of varietal trials where, for instance, the performance of a variety may be affected by temperature, humidity and soils in a particular location. For the purposes of generalising the results from such an experiment, single site analyses are usually conducted first, followed by a combined analysis. In this paper, a so-called “Agrosite data analysis flow” is demonstrated. This is a flow diagram showing the various steps to be followed in order to reach a final conclusion. At each stage results are interpreted and the purpose of the stage is clearly explained.

Across site data for a cotton varietal trial is used as a demonstrational case study. The overall data derive from four sites, namely Kadoma Cotton Research Institute, Chisumbanje, Gwebi and Makhaholi. Single site analysis is conducted using the usual Fisher’s Analysis of variance and in the case where treatment effects were found to be significantly different. Furthermore, Duncan’s multiple range test is used for the purpose of final recommendations on site and surrounding areas. A combined analysis was then performed in order to generalise results to the greater Zimbabwe. The research shows that treatment effects may be significant on site one, but fail to be significant in site two, while in a combined analysis the null-hypothesis is rejected in the face of overwhelming statistical evidence. The important part then to show how to make final recommendations under these circumstances.

Apart from merely explaining a series of steps to be followed in the analysis of an agrosite experiment, the research further highlights some important statistical considerations in line with the number of sites and the generalising population.

Analysis of factors affecting academic performance of the disabled students at the universities in Limpopo province, South Africa

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Abstract

This study identifies factors affecting the academic performance of disabled students studying at the universities in Limpopo Province during the 2010 academic year. The potential respondents are students from the University of Limpopo (Turfloop), the University of Venda and Tshwane University of Technology (TUT, Polokwane campus). The study mainly focuses on the academic challenges directly facing disabled students.

Questionnaires were administered to 77% of the disabled students in the Province. Data were analysed by applying binary logistic regression with the use of SPSS (version 17). Disabled students who attended ordinary high schools performed 4.32% better than those who matriculated in special schools. The following factors were found to be negatively and significantly influential towards disabled students' pass rates: (1) absence of extra consultations for disabled students — especially those with sight disabilities; (2) rendering of unimproved and non-effective services by the *disabled students unit* (DSU); (3) inappropriate cooperation of the institutions which contained the target groups; (4) lecturers' lack of understanding of how to assist students with disabilities; (5) length of time (years) which students spend without enrolling at tertiary institutions, after completing matric; and (6) poor cooperation, assistance and support by the *Students Representative Council* (SRC) towards academic challenges facing the disabled students.

However, pass rates of the disabled students in Limpopo Province is approximately 54%. Adjustments in the barriers mentioned above are believed to result in higher academic performance of the disabled students in the province.

Application of factor analysis to the 2009 General Household Survey of South Africa

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Abstract

The use of factor analysis to describe covariance relationships among 154 variables in the 2009 *General Household Survey* (GHS) of South Africa is investigated. Due to the high number of variables in the survey it has become difficult to analyze the data holistically due to high correlations that exist among the variables, making it impossible to apply traditional methods such as multivariate regression and multivariate analysis of variance. Factor analysis is used to identify whether an observed variable can be explained by a few unobservable quantities called factors. The variability among the 154 variables in the five core areas of the GHS is described by only 32 factors even though these factors are not measured directly. The results of this study are useful in further parametric analyses, such as multivariate regression, ANOVA, MANOVA and ANCOVA, to produce better and more reliable results. *Statistics South Africa*, the primary collector of the data used in this study may utilize the results in their future GHS in both questionnaire designing and data collection.

Application of linear programming in water distribution using pumps

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Abstract

This paper investigates the distribution of water to reservoirs at high points from two different sources, that is underground wells and rivers. The pumping of water uses electricity which has a cost that varies throughout the day. Considerable savings in electricity costs can be made by choosing when pumping is done, but pumping patterns are constrained by the necessity to safeguard supplies. A linear programming model is formulated for minimising the pumping cost in terms of the time each pump is switched on and in terms of the volume of water that each pump pumps to the reservoirs in a specific town. Load shedding is common and electricity is not available at all times throughout the day. A schedule that meets the town's demand is formulated and was recommended for implementation.

Applications of the analytical hierarchy process and statistical decision theory in commercialisation

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Abstract

Commercialisation is the process of introducing a new product into the market at the final stage of product development. Apart from considering all the goals and involving key stakeholders, commercialisation involves a funnelling process, *i.e.* considering many ideas resulting in one or two products that can be sustained on a long-term basis. Commercialisation may be highly risky because of fierce competition, as well as rapid technological and market changes, which results in high rates of project failure. Project screening is thus a critical activity adopted in early product development stages to enhance the success rate of commercialisation projects. Industrial research and development companies thus demand more intelligent and advanced tools that can advance decision making in commercialisation.

The commercialisation process may be modelled as a multi-criteria decision problem in which companies need to develop their new products with better and safer performance, higher quality, reliability and consider demand, cost of production, profitability and environmental-friendliness. Such multiple criteria have to be considered and assessed at early product project screening stages, involving a group of cross functional experts. Due to a large number of quantitative and qualitative criteria and a lack of sufficient and concrete data, it is often the case that group members have to make decisions in uncertain situations. It is therefore a considerable challenge for experts to move from experience-based decision making in favour of adopting optimization in decision making.

This paper proposes a novel methodology by integrating the *Analytical Hierarchy Process* (AHP) and *Statistical Decision Theory* (SDT), which can help manufactures in handling multi-criteria factors in commercialisation. A case study using *Scientific and Industrial Research Development Centre* (SIRDC) products from its various institutes is conducted to demonstrate how the AHP-SDT methodology and decision support system can be used to support the commercialisation process.

Assessment of the maternal mortality rate in Zimbabwe

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Abstract

Maternal mortality remains a challenge to health systems worldwide. Reliable information about the rates and trends in maternal mortality is essential for resource mobilization, planning and assessment of progress towards *Millennium Development Goal 5*, the target for which is a 75% reduction in the *Maternal Mortality Ratio* (MMR) from 1990 to 2015. Levels and trends of maternal mortality in Zimbabwe were assessed for the period 2000 to 2009 in order to identify the major causes of maternal deaths, and to come up with the national MMR and the national trends of maternal mortality.

Maternal deaths that occurred in Zimbabwe during the period 2000 to 2009 were analyzed through a clinical case discussion in order to identify the major causes of deaths. Data used were collected from a sample of 1 000 women who were pregnant during the period 2000 to 2009 using stratified random sampling, taking each one of the ten provinces in Zimbabwe as a stratum, to come up with the proportion of births attended by skilled health personnel. Time series analysis was used in coming up with the national trends for maternal mortality.

Results show that the leading direct causes for maternal deaths are HIV and AIDS, abortion complications, eclampsia, puerperal sepsis and hemorrhage. An increased rate of maternal deaths was found for women between the ages of 35 and 49, versus 15 to 24 years. Health facilities for pregnant women should be widely available at affordable rates in all corners of the country and the world as a whole to minimise loss of life from maternal complications. By so doing HIV and AIDS education, medication and counseling will be accessed by pregnant women who are infected and also advanced family planning methods will be available to all women so as to minimise unwanted pregnancies which leads to unsafe abortions.

Balancing home and away matches in league sports tournaments: A case study

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Abstract

In this talk the problem of scheduling a sports tournament consisting of a number of leagues (which are played simultaneously over a fixed time period) is considered, where each participating team takes part in one of the leagues and where teams may share the same home ground (*i.e.* some teams belong to the same club). In each league a round-robin tournament is played among the participating teams, *i.e.* each team opposes each other team exactly once, and the objective is to balance each team's home and away matches subject to limited playing grounds. A simulated annealing algorithm will be presented as a possible metaheuristic solution approach to this problem. The algorithm makes use of so-called partial round-swaps and partial team-swaps (which are perturbation moves from the literature which may be applied to round-robin tournaments) as well as home and away swaps in order to explore the solution space. As a case study the scheduling of the Boland Tennis Society's annual league tournament is considered. This tournament sees roughly 40 teams from 16 different clubs taking part each year, and five leagues are played simultaneously over a seven week period. The generation of various classes of benchmark instances and solutions obtain via the simulated annealing algorithm will also be discussed.

Bankruptcy prediction

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Abstract

Bankruptcy prediction modeling and studies are known to have existed since the 1960s. In this talk a brief overview is given of the theory with reference to Altman's use of Multivariate Discrimination in the formulation of his Z score model. We also consider the impact of time in the classification or prediction accuracy. Two sets of 71 failed and non-failed companies listed on the Johannesburg Stock Exchange are used. The companies come from various sectors and range from the period of 1998 to 2007. The data are subdivided into three parts according to periods and the models were formulated and tested with five multivariate discriminate functions and one classification tree algorithm. The results show that there is no impact in the classification or prediction accuracy due to the specific time period the model is used. It is further verified that the classification accuracy is independent of whether the model is chronologically closer or further than the test sample. The third test verified that the classification accuracy is independent of whether the time period is relatively narrow or wider. The overall result implies that the time period the model is created has no effect on the classification or prediction accuracy. This view is best when limited to a specific business cycle.

A behavioural-based multi-objective decision making framework for corporate climate change response

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Abstract

Finding practical, workable and cost-efficient solutions to the problems posed by climate change is now a business priority. A number of studies have modelled the economics of climate change at national or sectoral levels, but very little has been done for individual corporations who are struggling to come to grips with the many risks and opportunities that climate change presents. Climate change response presents corporate challenges with an assortment of diverse and often conflicting objectives. Often these objectives cannot be represented or measured in monetary units alone. Executives in organisations are faced with judgments that cannot be reduced to indubitable financial numbers. There is no single solution to such problems; instead multiple objectives and parameters have to be met or optimised before a solution can be arrived at. Because climate change is influenced by an assortment of variables, the search for solutions to this complex challenges ought to be multi-dimensional and seamlessly integrated into corporate strategy. In this talk a behavioural-based multi-objective model is proposed for decision making, allowing executives adequate regard for the interconnectedness of climate change systems, constraints in time, knowledge, computational abilities that humans face. It also allows for decisions where compliance and social justifications have value other than monetary.

The contribution of this presentation is to build on and advance the study and application of bounded rationality and multi-objective decision modelling in a corporate setting with climate change as a real-life problem in order to ascertain whether such principles are beneficial.

The causal structure may be different from the highest posterior probability structure if it is not a tree structure

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Abstract

A theorem is proven that a star decomposable structure is a clique. A method is presented for testing whether the model found by the Cooper and Herskovits posterior probability is, in fact, the correct causal model, by moving from an actual causal model, to a frequency distribution, to a correlation matrix and back. This method is demonstrated with a tree model, to show that for a tree structure it is the same.

Choosing an appropriate transformation for experimental data in the case of violated ANOVA assumptions

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Abstract

Motivated by the realisation that most experimental data fail to satisfy the assumptions of Sir Ronald Fisher's *Analysis of Variance* (ANOVA) and thus require transformation of the data if ANOVA is to be used, guidelines on selecting the best transformation method for any given data set are presented. Actual experimental data were used to demonstrate the outlined guidelines.

We suggest that a simple functional relationship of the mean of the data and its standard deviation can guide researchers in the selection of an appropriate transformation method. If the mean is proportional to the square of the standard deviation, such data can be modelled by a poisson distribution and as such the square root transformation will reduce the multiplicative effects inherent in the data into additive effects, which is desirable or brings it more closely to the Gaussian distribution.

Coastal threat evaluation decision support

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Abstract

Research is currently being conducted into a persistent ubiquitous coastal surveillance system capable of providing real-time situational awareness. Using data collected from sensors within such a system, a contribution may be made to coastal safety and security through the analysis of the spatio-temporal patterns of observed sea vessel activities so as to predict future behaviour and detect illegal activities.

Methods for analysing behavioural patterns in vast collections of data will be presented in this talk. Pertinent features that reliably characterise vessel trajectories will be discussed and these features will be used in classifying novel trajectories as exhibiting anomalous or normal behaviour. Furthermore, clustering methods will be touched upon as a means to discover structure within a given feature space.

Such data-driven approaches to sensor data-processing form the basis of a decision support system which may ultimately aid operators in their duties.

The coherence between logistics management, operations research and systems analysis

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Abstract

This paper outlines the analytical basis of logistics and explains the meaning thereof as a contemporary field of study. The concept of logistics management is described in a business context and the strategic, tactical and operational tiers thereof are discussed. The relationship that exists between systems analysis and logistics management is indicated. The seven consecutive steps in the systems analysis process are outlined. These steps are: (1) problem identification, (2) systems modelling, (3) generating alternative solutions, (4) evaluation of alternatives, (5) system selection, (6) implementation, and (7) monitoring and review. The role and essence of operations research in systems analysis and logistics decision-making are described. The most pertinent operations research topics in the field of logistics as well as the analytical competencies a logistician should possess, are identified.

Constraints driving the development of rich vehicle routing problems

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Abstract

Since Dantzig and Ramser first studied the *vehicle routing problem* (VRP) in 1959 much research and time has been spent on developing solutions that incorporate the real-life constraints and requirements of distribution management in practice. The basic VRP depends on a number of assumptions like no delivery windows, homogeneous fleet, single deliveries to customers, single trips, known demand, single depot etc. A lot of literature studies focus on these standard constraints, but unfortunately there are considerably more non-standard constraints and influences in the logistics world that are not researched and considered in the basic VRP algorithms. The basic VRP algorithms need to be continuously adapted and modified to cater for these constraints and it is often difficult to understand the influence of a combination of these constraints on a schedule. The purpose of this paper is to introduce some constraints and requirements that are becoming more frequent as distribution management and optimisation are becoming more demanding in the 21st century.

Constructive heuristics for the Residential Waste Collection Problem

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Abstract

The *Residential Waste Collection Problem* (RWCP) is a realistic extension of the classical *Capacitated Arc Routing Problem* (CARP), with application in municipal waste collection. Surprisingly, the problem and its extensions have not been solved in literature. Three heuristics that are capable of solving the RWCP are described in this talk.

The heuristics are based on modifications of the classical *Path-Scanning*, *Augment-Merge*, and *Ulusoy-Partitioning* heuristics for the CARP. The modified heuristics are tested on benchmark problems for the *Mixed Capacitated Arc Routing Problem* (MCARP), which is an extension close the RWCP, and the results are compared to the best published solutions. New benchmark problems are created for the RWCP and these are also solved using the modified algorithms. Results show that the algorithms are capable of quickly generating good solutions for the MCARP and the RWCP.

Coordinating price and capacity decisions in inventory systems with stochastic demand: A case study in a chemical processing plant in Zimbabwe

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Abstract

During the economic crisis in Zimbabwe many firms focused on price alone as a tool to improve profits. However, to a manufacturing engineer the coordination of price decisions with other aspects of the supply chain, such as production and distribution, is not only useful but also essential. The coordination of these decisions means an integrated approach that optimises the system rather than individual elements, improving both the efficiency of the supply chain and of the firm. The manufacturing company used in this case study was faced with a problem of how to price its products and services so as to remain competitive in the market, increase plant capacity utilisation and maximise bottom line profit. A multiple period, single non-perishable product problem was considered, where demand is a function of price and is stochastic and backlogging is not allowed. A mathematical model for the problem was developed and was cascaded down to an algorithm with Monte Carlo simulation and linear programming. The decision support system comprises a *graphical user interface* (GUI), a database, a knowledge base and a model base, and was developed using MICROSOFT EXCEL and VBA. Results obtained from the decision support system were compared with the method that was being used to price the case study product, and the results showed that a significant increase of profit of about 30% could be realized via the decision support system.

Credit rating mechanisms using multivariate adaptive regression splines

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Abstract

The credit worthiness of a potential client is critical to the fortunes of a company dealing in issuing credit. It is therefore important that anyone applying for credit is correctly classified for them to be granted or denied facilities. This paper seeks to come up with a mechanism that will select the most important attributes that must be considered in giving credit rating to a potential client. *Multivariate Adaptive Regression Splines* (MARS) are implemented on some credit data obtained from a micro-finance institution in Zimbabwe. The results obtained compare very well with the actual classifications done by the micro-finance institution.

Daily electricity demand forecasting in South Africa

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Abstract

The paper investigates the impact of day of the week, holidays and other seasonal effects on daily electricity demand in South Africa using regression, SARIMA and RegSARIMA models for the period 2001 to 2009. The results from the study show that the SARIMA model produces better forecast accuracy with a *mean absolute percent error* (MAPE) of 1.36%. The RegSARIMA model achieves a MAPE of 1.75%. From these model results one may conclude that holidays play a major role in determining the demand of electricity.

Data envelopment analysis in the fast food industry

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Abstract

For a business venture to prosper there is a need for the management to have adequate information about the performances of its *Decision Making Units* (DMUs). In that case performance of the DMUs must be closely monitored. Purposeful and effective business management cannot take place in the absence of properly compiled information with regards to the DMUs. Companies have relied on market research to find out how their business is behaving. It has, however, been noted that very little quantitative analyses have been carried out to observe relationships that exist among the DMUs from the same peer group and their performance trends. In most cases these analyses have either overestimated or underestimated the real potential of the DMUs of a company. This paper seeks to analyse how *Data Envelopment Analysis* (DEA) can be used in the fast food industry to quantitatively study the performances of the DMUs so as to achieve the efficient frontier.

Decision support for a new stability enhancement system at the Sasol Synfuels Air Separation Unit

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Abstract

Oxygen supply interruptions cause discontinuity in the Sasol Synfuels production process and lead to pure gas and reformed gas shortfalls. Some of these losses can be eliminated or minimized by providing *gaseous oxygen* (GOX) through the evaporation of *liquid oxygen* (LOX) from a storage/buffer LOX tank. This *stability enhancement system* (SES) will consist of a liquid vapouriser, a storage tank and a liquefier. The key driver is to prevent losses through stability enhancement. The operations research group in Sasol has developed a stochastic model to assess and size the new equipment capacity required for more stable operation. A stochastic simulation approach enabled the project team to optimise the new equipment sizing to allow for operations benefit without spending unnecessary capital.

Decision support with respect to facility location and fleet composition for FoodBank Cape Town

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Abstract

FoodBank South Africa is a non-profit organisation formed to establish a nationwide network of community foodbanks in urban and rural areas of South Africa, with all participants working towards the common goal of eliminating hunger and food insecurity. *FoodBank Cape Town* (FBCT) was the first of these community foodbanks launched in South Africa in 2009. The operations of FBCT include sourcing food and redistributing this food to agencies (social services organisations running feeding programmes). Currently the majority of the food is sourced from the retail sector and distribution centres, and the food is then redistributed to approximately 300 agencies to which FBCT supply.

The logistics involved in both sourcing and distributing food are vital to the functioning of FBCT. Since the costs associated with these logistic operations are very high, streamlining these operations has been identified as a priority area for efficiency improvement. In this presentation we look at progress made with respect to improving the efficiency of FBCT's logistical setup, focusing on the distribution of food to agencies. We present on both a facilities location model and the comparison of candidate vehicle fleet compositions. The implementation of the location model, fleet comparisons and associated results achieved are reviewed, together with recommendations to FBCT in terms of the location of their distribution depots and vehicle fleet composition.

Decision support with respect to generator maintenance scheduling in the energy sector

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Abstract

Power generating units operate continuously to provide electricity for a country or region. Due to safety standards and output-efficiency, each unit has to be shut down for maintenance after a certain number of operating hours. If the different shut-down times for the power generating units are not properly coordinated, electricity shortfalls may occur, leading to economic losses to industry and considerable frustration on the part of the public. The need therefore arises for decision support as to when a power utility should schedule maintenance downtime for its various power generating units.

The resulting *Generator Maintenance Scheduling* (GMS) problem may have a number of objectives subject to various constraints, depending on the complexity of the mathematical modelling process. In this talk, the objective is maximise the reliability of the power system, subject to each unit's maintenance window and duration, the system load demand together with safety margin, the availability of service personnel and general exclusions with respect to simultaneous unit maintenance.

A formulation of the GMS problem will be given in the form of a mathematical programming model, together with a motivation for why it is impossible to adopt an exact solution approach. A local search heuristic and a simulated annealing approach have been implemented to solve the problem approximately. A new neighbourhood move operator within the GMS context has been utilised in the above-mentioned methods which will be described and its results presented. The ultimate aim is to implement these metaheuristics into a computerised decision support tool for use by an electricity provider, such as Eskom. This is still work in progress.

Demand chain analysis for better planning in the steel foundry industry

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Abstract

This paper outlines the application of demand analysis in production planning in steel foundry industry as well as the benefits of using such an approach in planning. A case study of a local steel foundry will be used for illustrative purposes. The improvement brought about by forecasting accuracy on demand and maximizing both supply and demand chain visibility while automating operational processes will be reported with respect to key performance indicators.

Determining the optimal log position during primary breakdown, using simulated annealing

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Abstract

Forestry plantations cover approximately 1.3 million hectares of South Africa's land surface. The production from these plantations in the 2009 financial year amounted to 4.4 million cubic metres of sawlogs. The value of sales of sawn timber from these logs amounted to R4.2 billion.

The purpose of this project was to evaluate the potential of increasing value recovery at sawmills through optimisation of the positioning of a log at the primary workstation by considering the internal knot properties. The external profiles and the internal knot properties of ten pine logs were measured and the whole log shape was digitally reconstructed.

By using the sawmill simulation program SIMSAW, explicit enumeration was performed to gather data. This data include the monetary value that can be earned from sawing the log in a specific log position. The metaheuristic technique of *simulated annealing* was used to arrive at a near optimal solution in a much shorter time than that required when simulating all possible log positions. Results showed that an increase in product value of up to 8% was possible compared to using conventional log positioning rules.

An econometric study of currency crises in developing economies: A case study

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Abstract

The paper discusses the modelling of currency crises in a hyper-inflationary economy with Zimbabwe as a case study for the period 1991 to 2005 using logistic regression. A comparative analysis is done by means of a probit model. The results from this study show that lax monetary policy and deterioration in economic fundamentals can contribute to currency crises; large devaluation may be perceived as currency crisis; macroeconomic and financial variables are important determinants of currency crises. The variables are budget deficit, gross domestic product, inflation, stock price index, exchange rate and money supply. The results are useful in modelling a currency crisis in an unstable and hyper-inflationary economic environment.

***Effective logistics and supply chain management:
A theoretical analysis***

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Abstract

Effective supply chain management is a developmental constraint for developing countries like Zimbabwe. The fact that Zimbabwe is a landlocked country means that the cost-effective use of transport and logistics as a tool for global market penetration is very important. Supply chain management is the continuous planning, developing, controlling, informing and monitoring of actions within and between supply chain links. Effective supply chain solutions are a key to international competitiveness. In this paper we discuss issues of logistics and supply chain management and how they affect every business regardless of size, age and sector.

Enhancing supply chains through implementing transport management systems in Zimbabwean industries

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Abstract

The manufacturing and services sectors of the country are showing signs of recovery from the economic downturn of the past decade. During this critical phase of the recovery, every penny counts for the enterprises. All across the supply chain, from procurement, manufacturing, warehousing, and distribution, it is imperative that proper systems be put in place to realise growth and profitability so as to remain competitive on the market. One such tool is a *Transport Management System* (TMS). According to the APICS Dictionary (13th Edition), a transport management system is a “a computerised system to manage the operation of transportation systems including deciding on modes of transportation, planning imports and exports, planning and controlling fleet service activities and load planning and optimisation.”

During the years of economic slump, the distribution arm of the supply chain was almost extinct. Commodities and services were in short supply. Due to the high demand of products, customers literally waited for products by the gates of manufacturing plants, leaving most companies with no need for distributing products. The environment has since changed. Every company must get its products out there in the most efficient way in order to have a competitive edge over the other myriad competitors.

With most companies already with existing ERP systems, TMS integration is achievable. Implementation of a TMS in such a competitive environment will no doubt offer many benefits. These include better utilisation of fleet, increased load consolidation, increased visibility in the supply chain, better optimised routes, real-time tracking of shipments (track and trace) and lower administrative costs. All these benefits will improve customer service levels while enhancing the profitability of the organisation.

This paper outlines the potential that lies in implementing a TMS as a tool to improve the current supply chain processes for Zimbabwean companies.

Enumeration of sets of orthogonal Latin squares

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Abstract

A *Latin square* of order n is an $n \times n$ array containing each symbol from a set of n distinct symbols exactly once in every row and every column, and two Latin squares \mathbf{L} and \mathbf{L}' are *orthogonal* if the set of n^2 ordered pairs $(\mathbf{L}(i, j), \mathbf{L}'(i, j))$ are all distinct as i and j vary. Since these designs were first studied by Leonard Euler in the late 1700s, orthogonal Latin squares have found numerous useful applications in various areas, such as experimental design and sports tournament scheduling. In this talk we consider the problem of counting sets of k *mutually orthogonal Latin squares* of order n (abbreviated as k -MOLS of order n) for various integer values of k and n . An equivalence relation on the set of all k -MOLS of order n is defined, and the resulting equivalence classes are enumerated using a branch-and-bound backtracking tree-search approach. A number of pruning rules are introduced which are able to reject branches that would otherwise not have led to any new solutions (in terms of the equivalence relation considered), thereby ensuring that only one k -MOLS of order n from each equivalence class is generated. We present results for $n \leq 8$ and $2 \leq k \leq n - 1$, of which only the number of 2-MOLS of order $n \leq 8$ had previously been established.

Estimating the threat of water scarcity in the Breede River Valley: A forecast-based analysis

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Abstract

Water supply and distribution systems are under strain in terms of capacity in the Western Cape. A number of studies have suggested that the pressure to supply enough water of suitable quality is constantly increasing. In these studies, urban development and the effects of global warming are listed as key factors affecting the problem. The expectations are that the current water infrastructure, which is already spread thin, will not be able to cope with growing demand unless new investments are materialised and water is consumed more judiciously. Access to clean water is a life-sustaining requirement for humans, animals and plants. Inadequate water supply levels also negatively impact agriculture, which, in turn, translates into negative impacts on food security, ultimately affecting human and animal welfare.

Many factors influence the availability of water. On the supply side there are weather patterns, along with infrastructure design, infrastructure conditions and infrastructure availability issues to contend with. Demand, in turn, is influenced by population growth, agricultural activity levels (which are also related to population growth) and access conditions (such as pricing and infrastructure architecture), to name but a few. The paper commences with a forecast of the expected changes in the supply and demand variables, based on expected changes in their underlying components. Multiple regression and other forecasting methods are used, resulting in an estimate of the severity and timeframe of the onset of water scarcity in the region. The ultimate idea is to investigate the expected simultaneous changes in these two variables and the net impact on water availability that results. Another output of the paper is to indicate key potential causes of water scarcity that need to be managed.

Estimation of multivariate proportional hazards model parameters through artificial bee colony optimization

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Abstract

Over the years industry has seen an increased interest in physical asset management to improve competitiveness. As part of physical asset management, maintenance management is used to maximize asset utilization and performance. Many companies perform condition monitoring on physical assets, but lack the knowledge to exploit this information to their full advantage. Condition monitoring information, integrated with previous failure histories of equipment through a mathematical model such as the *Proportional Hazards Model* (PHM), can be used to derive very useful management information, including the estimation of asset deterioration rates, residual life and/or the risk of operation. The PHM is widely used in the field of reliability modelling and uses the flexible Weibull distribution as parameterization. Fitting the PHM involves maximizing the likelihood of the function, thereby estimating the model parameters. Maximization of the likelihood is often complex and often involves eight parameters that need to be optimized in a large search space. Knowing these parameters makes it possible to exploit the condition monitored information to its full potential. This paper discusses the development of a metaheuristic to maximize the multivariate likelihood function of the PHM, based on the artificial bee colony optimization algorithm. The paper concludes with a reflection on the validity and success of solving this problem through artificial bee colony optimization.

An evaluation of the efficiency of self-organising versus fixed traffic signalling paradigms

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Abstract

Traffic congestion is a major problem in South African cities, resulting in significant costs in terms of man hours lost and excessive fuel consumption, thereby also having an adverse environmental effect. A proposed solution to ease congestion in complex road networks is the implementation of a decentralised self-organising traffic signal system, allowing the system to “discover” for itself the most effective traffic signal timings as a function of the current traffic situation and to adjust itself accordingly. Recent developments in technology have seen the introduction of radar systems which, when mounted on traffic lights, effectively allow the traffic lights to “see” a certain distance down a stretch of roadway, enabling them to “perceive” the local traffic state on the road as well as the number of vehicles approaching the intersection and their respective velocities. We report on an investigation into various self-organising techniques for various road network layout topologies and their effectiveness to optimise traffic flow, and how they compare to optimised fixed-time schedules, using a specialised traffic simulation tool which was built to test and compare the various traffic control techniques.

An evaluation of the implications of predictive patient admission algorithms on African healthcare systems

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Abstract

Prediction algorithms, forecasting models and similar *operations research* (OR) tools have been practically applied in numerous service delivery sectors, with great success. Although many healthcare systems have benefited from the practice of OR internationally, OR's imprint on African healthcare systems is very faint. A lack of information management structures and systems, data management processes and communications infrastructure has inhibited development in this area. However, recent developments in healthcare technologies and informatics have rendered these barriers to entry traversable.

Health systems across Africa are fraught with resource management issues, for which acceptable, realistic solutions are required to improve service delivery. The development of *Predictive Patient Admission Algorithms* (PPAAs), inspired by the *Heritage Health Prize Competition*, is a step towards improved management and resource utilization in healthcare. A PPAA typically needs to accurately predict whether a patient will be admitted to hospital in the coming year and specify the estimated duration of admission, given the patient's medical history. The overall objective of a PPAA is to eliminate unnecessary hospital admissions, which, for example, resulted in healthcare expenditures of around \$30-billion in the United States in 2010.

Implementation of a PPAA can be beneficial for both healthcare practitioners (now enabled to schedule resources more efficiently and effectively, and to become more profitable) and society in general (healthcare professionals are enabled to intercede with patients early on, providing the required medical attention as a preventive measure, ultimately resulting in healthier societies).

The focus of this paper is to explore the feasibility of implementing PPAAs in African healthcare systems. The awareness and understanding of organizational cultures, the state of healthcare informatics, the role and requirements of management structures for the successful implementation and operation of OR tools, similar to the PPAA, as well as the associated potential benefits, will be addressed in this paper.

Evolutionary games on graphs

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Abstract

The presence of cooperation in a society with selfish agents has for a long time intrigued social scientists and game theorists alike. The *prisoners' dilemma* (PD) is the archetypal game often employed to study cooperation. The PD has been applied widely to study problems in economics, evolutionary biology and social sciences. An important question in these studies is: Under which circumstances is persistent cooperation possible among players in the PD? In fact, cooperation in the PD is quite hard to achieve, and very specific conditions are required to facilitate cooperation.

In this talk the PD will be considered within an evolutionary framework. One way of facilitating cooperation in the evolutionary PD may be achieved by adding structure to the manner in which players interact. These structured games may be modelled by placing players on the vertices of a graph; two players are then able to interact if they share an edge in the graph. The investigation focusses on finding the likelihood of persistent cooperation in games played on graphs such as paths, cycles and grid graphs.

It is possible to characterise all those initial game states which lead to persistent cooperation in the case where the underlying graph is either a path or a cycle. When grid graphs are considered as the underlying graph, the number of possible game states grow very quickly as the grid size increases. The possible dynamics also become more complex and an analytical solution to the likelihood of persistent cooperation is not yet known. A simulation approach is therefore used to study games on large grid graphs and other graph types.

Exposing the hidden dynamics of metaheuristics through visualisation

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Abstract

Many metaheuristic algorithms are often inspired by natural phenomena, such as the flocking and swarming behaviours of animals and insects, the hereditary nature of DNA structures and the annealing process in metals. These phenomena often have distinct visual patterns that can be observed. Similarly, the solution process of many metaheuristics can be visualised by making use of a graphic interface. This graphical representation can be useful in the development of the model by clearly indicating what has been coded thus far. The visualisation of an algorithm is a useful tool in verifying and validating the model, debugging the program and assessing the sensitivity of the model. Visualisation is also useful in evaluating the output of the algorithm and it enables investigation of the balance between exploration and exploitation in the metaheuristic. It can also be used to effectively communicate the solution found by the model.

This paper suggests different approaches to visualise various metaheuristics. It explores visualisation concepts for different metaheuristic algorithms (in particular particle swarm, bee-colony and ant-colony optimisation) and for different types of problems (such as discrete, mixed integer and continuous problems), using a variety of commonly used software packages (C++, MICROSOFT EXCEL and MATLAB). The vast majority of software packages these days include built-in visualisation functionality and recent software developments have made the visualisation of models simpler and more effective. By making use of the visualisation concepts discussed, modellers are able to reduce some of the complexities associated with building models, whilst ensuring that their work is captivating and easier to understand. The paper intends to demonstrate the uses and usefulness of the visualisation of metaheuristic models in practice.

Finding the optimal South African freight energy management strategy with archived multiobjective simulated annealing

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Abstract

The development of an optimised freight energy management strategy is a highly complex problem. The range of and variance between proposed freight energy management measures is vast. On one end of the spectrum there is the maintenance of adequate tyre pressure to reduce fuel consumption in trucks and on the other there is modal restructuring of the entire freight sector, for example. A freight energy management strategy consists of a particular combination of these measures and can vary in terms of the inclusion and exclusion of certain measures and in terms of the level of implementation planned for each included measure. There is, thus, an infinite amount of potential strategies that can be formulated. Furthermore, the management of energy use in freight transportation has many stakeholders with widely differing objectives and vested interests. Some of these objectives are positively correlated, some negatively correlated and some completely uncorrelated to each other. In this paper, the different stakeholder objectives are grouped together and combined to form four distinct problem objectives: minimising overall energy use by the freight sector, minimising the negative environmental and social impacts incurred due to strategy implementation respectively and maximising the resulting positive impact on the economy. Finding a single optimal solution (energy management strategy) that simultaneously completely satisfies all of the stakeholder objectives is not possible. The aim of this paper is to find the problem's pareto front using *Archived Multiobjective Simulated Annealing* (AMOS). Establishment of the pareto front will enable further analysis of the problem, through the investigation of structural differences between the solutions best suited to each of the different stakeholder objectives. The problem can be classified as a complex multiple objective constrained, non-linear problem with a very large search space.

Heuristic applications to the Hostel Space Allocation Problem

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Abstract

The *Space Allocation Problem* (SAP) has recently attracted significant interest among metaheuristics researchers. Heuristic solutions to instances of the SAP, such as assigning office space or on-the-shelf space among others, have been investigated with very positive results in terms of efficiency of solving large instances. However, literature is still scarce on the recently defined *Hostel Space Allocation Problem* (HSAP) which deals with the allocation of limited hostel (bed) spaces in tertiary institutions to ever-increasing numbers of students who are demanding such space. The HSAP is currently posing significant challenges for university administration personnel, especially in developing countries, because of an increase in admissions without a corresponding increase in residence space for students. The problem, as with other SAPs, is NP-Hard with a varying number of domain-specific and sometimes conflicting requirements and constraints.

In this paper, we present a detailed description, as well as mathematical models, of a multi-stage HSAP. We have attempted to solve this problem using both global and local search metaheuristic techniques. Results of various heuristics that have been applied successfully will be presented, compared and discussed. Current and possible future research trends in this area will also be highlighted.

How to measure military readiness?

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Abstract

The objective of this talk is to explain a conceptual model that was developed by the *Defence Decision Support Institute* in order to measure readiness in the *South African National Defence Force* (SANDF). The aim of the model is to measure operational readiness of the SANDF in terms of the different services and the constituting force elements.

The SANDF, and specifically the *Chief of Joint Operations* (CJ Ops), is committed to be ready to execute identified *Joint Force Employment* (JFE) missions. The readiness model must measure the actual readiness by using five criteria: equipment, personnel, level of training, deployability and sustainability.

Readiness is measured at the lower levels and then reflected up the defence hierarchy.

Human resources decision support using Sasol Technology's Employment Equity Target Assessment Model

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Abstract

Employees are a company's greatest asset. Historically management systems have captured data on staff. Recent initiatives in talent analytics advocate more sophisticated analysis of these data to support predictive workforce modelling. This analytical approach to talent management of the human capital value chain gives businesses a competitive edge. For a number of years, operations research in *Sasol Technology* has used planning and forecasting models to provide human resources decision support. A recent example is the *Employment Equity Target Assessment Model*. The model uses a system dynamics approach to reflect evolving and interrelated staff movements due to recruitment, promotion, separations and retirements. Future workforce profiles are assessed against targets. The impact of levers and scenarios are investigated.

Humanitarian operations research in Southern Africa

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Abstract

There is a wealth of literature pertaining to the application of hard operations research techniques for determining optimal ordering, inventory and allocation policies within developed economies. In contrast, there is a dearth of research relating to similar applications in developing economies, or more particularly in the unique context of a developing country. The HIV/AIDS pandemic has reached an unprecedented scale in South Africa. The burden that this has placed on the country's already restricted health care resources place a greater emphasis on the value of anti-retroviral drug distribution. The aim in this paper is to design a vehicle routing and scheduling system for the department of health in the Limpopo province. This will seek to present major stages applicable to building effective models and routes that are cost effective.

The impact of the liquidity crunch on the manufacturing sector during the period 2009–2010

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Abstract

It is undisputable that the economy of Zimbabwe is recovering. The state of the economy today is significantly different to that which prevailed little over a year ago. However, it is also indisputable that the economic recovery is a very long and slow process, and that there remains much which continues to ail the economy. The liquidity crunch that came with the adoption of the multiple currencies has lasted for over a year, and there are no signs that the crunch will ease soon. The market's illiquidity greatly hinders Zimbabwe's economic recovery, and must be addressed urgently. This research project aims to bring out the impact of the liquidity crunch on the manufacturing sector, which is one of the major contributors to the *Gross Domestic Product* (GDP), it also aims to examine whether money supply had a significant effect on the manufacturing sector. In order to test the impact, the relationship between money supply (in this case shortage of capital for investment) and monthly output in the manufacturing sector will be considered.

Data have been collected from the Reserve Bank of Zimbabwe and from ZIMSTAT. Observations from secondary data on a monthly basis covering the period January 2009 to December 2010 are used. Simple linear regression analysis is employed to find the above-mentioned relationship using scatter plots. The goodness-of-fit is assessed by R^2 -values and analyses of variance. The anticipated results are that the liquidity crunch is a major drawback to the performance of the sector and its contribution to GDP. The results obtained may help in our understanding of how much the sector needs help and hopefully the beneficiaries of the results, such as the government and major players in the economy, will realize how badly the sector needs help.

The impact of media coverage on the transmission dynamics of human influenza

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Abstract

There is an urgent need to understand how the provision of information influences individual risk perception and how this in turn shapes the evolution of epidemics. Individuals are influenced by information in complex and unpredictable ways. Emerging infectious diseases, such as the recent swine flu epidemic, may be particular hotspots for a media-fueled rush to vaccination; conversely, seasonal diseases may receive little media attention, despite their high mortality rate, due to their perceived lack of newness.

In this paper we formulate a deterministic transmission and vaccination model to investigate the effects of media coverage on the transmission dynamics of influenza. The population is subdivided into different classes according to their disease status. The compartmental model includes the effect of media coverage on reporting the number of infections as well as the number of individuals successfully vaccinated. A threshold parameter (the basic reproductive ratio) is analytically derived and used to discuss the local stability of the disease-free steady state. The impact of costs that can be incurred, which include vaccination, education, implementation and campaigns on media coverage, are also investigated using optimal control theory. A simplified version of the model with pulse vaccination shows that the media can trigger a vaccinating panic if the vaccine is imperfect and simplified messages result in the vaccinated mixing with the infectives without regard to disease risk. We conclude that the effects of media on an outbreak are complex. Simplified understandings of disease epidemiology, propagated through media sound-bites, may make the disease significantly worse.

The importance of HIV specific Cytotoxic T cells on HIV and Myco-tuberculosis coinfection dynamics

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Abstract

A mathematical model for HIV and Mtb coinfection is proposed to model the effects of the HIV specific CTLs presence to the immune system. Reproductive number for the model is determined via numerical analysis to assess the impact of the CTLs on the immune system. We conclude that the presence of the CTLs results in reduced depletion of CD4+ T cells by HIV in coinfection as CTLs hinders replication and hence delayed progression to AIDS.

An inventory management system for optimising product availability and capacity utilisation

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Abstract

This paper is on the design of an effective, simple and affordable inventory management system that can be adopted by any organisation seeking to improve its finished products availability on the market and to extract more capacity from their plant. The paper covers the inventory management of both direct materials inventory and finished products inventory. It provides a design of a system which can be used to determine inventory size requirements of an organisation so as to maximize finished product availability as well as total factory capacity utilization.

Is a bird in the hand worth two in the bush?

Leanne Scott

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Abstract

This talk explores the use of multi criteria decision analysis to support the process of making decisions about how to use scarce resources to protect our environmental assets. Two separate engagements with conservation agencies in South Africa are presented and assessed in terms of whether they represent effective action research. In each of these cases, a value function approach is argued to be able to effectively support public sector decision making in the sense that it has both the necessary rigour and the requisite transparency. The use of a value function approach is contrasted with other approaches that are commonly used to assist environmental managers and custodians to choose where to place emphasis in terms of protecting species, habitats or geographical areas.

Job shop scheduling to minimise tardiness

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Abstract

In this paper a new dispatching rule is proposed for minimising total tardiness in a job shop. The rule is derived from the well-known dispatching rule, the CR+SPT rule. The CR+SPT rule has been shown to be very effective at minimising total tardiness in a job shop at all levels of due dates tightness and shop utilisation. Despite being so effective, in its original form, the CR+SPT rule uses only job information to assign a priority index to a job. In this paper, a slight modification to the rule is introduced, namely a modification that allows the rule to include some shop information via an estimate of waiting time in the calculation of the priority index. The modified CR+SPT rule is tested in terms of performance against the original CR+SPT and two recently proposed dispatching rules, hereafter known as the RR and WR rules, which have been shown to outperform some of the most popular tardiness rules such as COVERT, MOD, ATC, SLACK+SPT and CR+SPT. The results of the simulation study shows that the modified CR+SPT rule is very effective at reducing total tardiness outperforming all the competing rules including the two new rules at all due date tightness and shop load levels.

A linear programming approach to sustainable poultry production in the small farms of Makwa Hwange, Zimbabwe: A human-poultry food production case

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Abstract

This paper shows that in the current economic climate, linear programming is worth considering in equitably allocating the small grain produced from the farm between humans and poultry and also as a post-harvest grain loss minimization technique in farm planning. This is particularly applicable when simple linear programming is used, which allows many of the linear programming problems to be solved. Ninety subsistence poultry producing farmers from Makwa Hwange were studied. These farmers are faced with a myriad of constraints in producing food for their families and also for poultry feeding. Constraints commonly experienced are limited land under cropping due to the land tenure system, limited inputs like seeds and fertilizer, and many more. The research indicated that for a family of six people, with 5 acres of land on average, under small grain production and with a poultry population of 25 birds on average, 69% of the food produced should be used for human consumption. These farmers should use approximately 21% of the food produced to feed poultry and the remaining 10% can be stored for use as seed during the next farming season. In conclusion, farmers can increase their poultry populations if arable land is increased and this will result in increased income and hence easing some of the constraints such as that of agricultural inputs as they can be bought using income generated from poultry.

Local government elections 2011: Some personal perspectives

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Abstract

The constitution of South Africa requires that both national and local government elections be held every five years. These elections are not held together and currently the local government elections follow the national elections by two years. In 2011 the 4th local government elections took place. These were possibly the most hotly contested elections since 1994 when South Africa became a democracy. As is the case in many international elections, a forecasting model has been developed to predict the ultimate outcome of the elections based on early results. Such a forecasting model was developed for the 1999 national elections and has been used to predict the results for the last number of national and local government elections. Each election has its own challenges which need to be addressed in the forecasting model. Predictions are computed at national level (“the race for votes”), provincial level and also in the eight metros in the country. Local elections are also different in that there is more than one ballot paper and a voter votes for a candidate in a ward as well as for a party; these votes are used for candidates elected through proportional representation. In cases where municipalities fall in districts there is a third vote for candidates to be elected for district councils. As predictions are computed these need to be shared through radio and television. Operations researchers typically develop models to address complex real life situations. In general one needs to explain these to customers who are familiar with the specific problem area. It is not a general occurrence that such models and results need to be explained to the general public. This in itself has its challenges. This paper will briefly outline the forecasting model used in the elections, what the expectations were, discuss the predictions as these unfolded over time as well as the challenges, experience and interactions in dealing with the media.

Locomotive Scheduling in Freight at Mpopoma Train Station

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Abstract

This paper presents the use of a planning version of the *Locomotive Scheduling Problem* (LSP) where there are multiple types of locomotives in solving delay problems at Mpopoma Train Station. That is, making decisions to which set of locomotives is to be assigned to each train. An integrated mixed integer model that determines a set of active and deadheaded locomotives for each train and light train was developed. Consist-bustings were explicitly considered and 20 restricted decision variables were optimised on 32 constraints. The solution obtained from running the model using LINGO 10.0 saved 40 locomotives which translates to over ten million US dollars per year from the current way of scheduling wagons.

Maintenance & production planning using linear programming and simulation at NFA Oil Plant

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Abstract

There is always a conflict between maintenance and production teams in companies with a need to achieve individual set targets. Looking from a strategic point of view, the goal should be for the growth of the organisation. The development of a production and maintenance system for the Oil Plant at NFA using linear programming and simulation tools is demonstrated in this talk. The Simplex Method was used in production planning and simulation of the plant was done to verify applicability of maintenance and production plans. Through experimentation, significant savings on boiler fuel of up to 27% are shown to be possible with less than 3% reduction in anticipated contribution. In addition, more than a 15% increase in throughput for some plant sections is demonstrated, with a further 7% increase in worker utilisation.

Maximising production of an in-store bakery using linear programming

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Abstract

A certain in-store bakery producing mainly bread and other confectionaries, such as scones, buns and queen cakes, is facing the problem of unannounced power cuts that are currently occurring throughout Zimbabwe. The continued power cuts usually cause a waste of raw materials, or reduced quality in the bread that is being produced. Efforts to ameliorate these power cuts have led to more cost for the company. Almost on a daily basis losses are recorded as far as ideal gross profits, as set by management, are concerned. The main profit yielding product is bread. We considered this problem, mainly considering demand, production processes and times, how long the power cuts occur, working hours and gross profits based on each production run. In this talk a linear programming model will be presented with the main objective of devising an optimal production plan for the in-store bakery, located in the suburbs of Bulawayo, Zimbabwe. By quantifying benefits and how they can be distributed daily, a conclusion was made that the model would work for this bakery. Recommendations are made on how to implement the results of the linear programming model.

Measures for share selection

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Abstract

This talk is a review of companies listed on the Johannesburg Stock Exchange over a ten year period. To find predictors of return, risk measures (standard deviation and beta), firm size and the book to market ratio were calculated over the first five years for each company. The correlation coefficient between the risk and return for the following five years was calculated ($r = -0.1296$, which is not significant at a 5% level of significance). The difference in return between the high risk and low risk samples is not significant ($t = -1.2069$). Small firms significantly outperformed large firms ($r = -0.1995$, which is significant at a 5% level of significant). It is recommended that investors should use firm size when making investment decisions.

Metaheuristic approaches for order sequencing in a directed picking line

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Abstract

Order picking is the most important activity in *distribution centres* (DCs). It involves the process of retrieving products from storage in response to a specific customer request.

The order picking system in a DC used by *Pep Stores Ltd* (Pep), located in Durban, South Africa, is considered. The order picking system in Pep utilises a picking line. The planning of picking lines may be divided into three tiers of decisions. The first tier determines which *stock keeping units* (SKUs) should be allocated to which picking line. The second tier considers the positioning of the various SKUs in a picking line. The final tier considers the sequencing of the orders for pickers within a picking line and is referred to as the *Order Sequencing Problem* (OSP). Collectively, these three subproblems aim to achieve the objective of picking all the SKUs for all the orders in the shortest possible time.

A number of metaheuristic approaches are presented for solving the third tier, namely the OSP. The size of the problem is reduced by means of a relaxation of the problem which may be solved exactly, but is still computationally too expensive. Metaheuristics are therefore introduced to find solutions in a shorter time frame. A local search, simulated annealing, genetic algorithm and a generalised extremal optimisation approach are used to solve the OSP when applied to real live data provided by Pep. The solution quality and computational times of the metaheuristics are compared for the data provided by Pep.

A minimax multivariate control chart using a nonlinear polynomial function

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Abstract

In this paper the multivariate normal distribution is integrated numerically using Simpson's one third rule to obtain a *nonlinear polynomial* (NLP) function. This NLP function is used to obtain the control limits in a minimax sense to overcome the problem of obtaining the joint probability distribution required for the control limits of both the maximum and the minimum statistics for monitoring multivariate process. The results of the minimax multivariate chart for the maximum and the minimum are also compared with the control limit values for maximum and minimum statistics.

Minimizing the (weighted) number of tardy jobs: A review

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Abstract

We provide an overview of the history, the methods and research trends on minimizing the (weighted) number of tardy jobs as a performance measure. The review presents cases on the single machine, parallel machines (including the identical, uniform and unrelated machines), as well as flow shops, job shops and open shops. The review is divided into various sections for proper categorization which include setup time, preemption, batching, on-line and off-line scheduling, and other classifications. The complexity status of the various classifications are enumerated and the corresponding methods are compared by means of available benchmarks. Possible extensions for future work are also highlighted.

Modelling and analysing the price structure of houses in the dollarised economy of Zimbabwe

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Abstract

A systematic overview of property market in home ownership in Zimbabwe is considered in this paper. An analysis of the pricing system of home ownership in a dollarised economy of Zimbabwe is presented with respect to the location of the house, the size of the stand, the structure of the house (number of bedrooms), and the colonial affiliation of the place being considered, using stepwise regression. The analysis resulted in a 96% estimate mathematical model which can be used for calculating the price of a house realistically, given the four variables mentioned above, with the other 4% allowance given for demand, type of building materials used, land-scaping, security, plan of house, developments and other economic factors. We conclude that the main factors which affect price are location, size and structure — an indication that post-colonial empowerment might have removed the effect of colonial affiliation.

Modelling the effect of stress on the dynamics and treatment of tuberculosis

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Abstract

A deterministic mathematical model is proposed and analysed to study the impact of stress on the dynamics and treatment of Tuberculosis. Both qualitative and numerical analysis of the model are done and the impact of health education campaigns to reduce stress is investigated. Qualitative results show that the model has two equilibria: the *disease free equilibrium* (DFE) which is locally asymptotically stable when the effective reproduction number is less than one and the *endemic equilibrium* which is locally asymptotically stable when the effective reproduction number is greater than one. When the effective reproduction number with health education campaigns is less than one, a backward bifurcation occurs. Health education campaigns reduce stress in all the epidemiological classes. Numerical results suggest that, when the rate of stress is high, it is seen that the infected population increases and when the rate is low, the infected population decreases. It is also observed that the reproduction numbers have a direct relationship with the rate of transmission β , that is, when β increases, the reproduction numbers also increase. But when health education campaigns are introduced, the level of stress reduces to low levels. When health education campaigns are introduced, this increases the effect of treatment on the infected individuals because stress has been reduced. The study recommends that TB infected individuals should take health education campaigns since it reduces their level of stress and thus enabling treatment to be more effective leading to high rate of recovery. Treatment with no stress is most effective.

Modelling HIV/AIDS in a mixed population using an agent-based approach

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Abstract

Major advances have been made in modelling HIV progression in a population using compartmental models and stochastic simulations. Microsimulation models which can represent many of the social mechanisms that contribute to the spread of HIV are still in their early stages of development. This research seeks to use agent-based models which is a relatively new class of microsimulation models in modelling the spread of HIV in a population. Sexual interactions between people, the social structure in which people meet and the social norms that constrain sexual behaviour can be well represented in agent-based models, using some basic rules that depend on the state of the system at that time.

Modelling volatility and financial market risk of shares on the Johannesburg Stock Exchange

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Abstract

In this study we develop ARMA-GARCH type models for modelling volatility and financial market risk of shares on the Johannesburg Stock Exchange under the assumption of a skewed Student-t distribution. Monthly data are used for the period 2002 to 2010. The GARCH type models used in this study are symmetric GARCH, TGARCH, GARCH-M and EGARCH models. The results suggest that the monthly returns are characterized by an ARMA(1,0) process. Empirical results show that an ARMA(1,0)-GARCH(1,1) model achieves the most accurate volatility forecast.

A new approach to the Quadratic Assignment Problem

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Abstract

The quadratic assignment problem is a well-known difficult discrete combinatorial optimization problem. The problem seeks to locate N facilities among N fixed locations in the most economical way. In this paper, a new solution technique is presented for this NP-hard problem.

A nurse rostering algorithm for a district hospital in South Africa

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Abstract

An acute shortage of healthcare professionals is the rule rather than the exception in South Africa. Effective scheduling of nurses is critical to ensure good quality of care, while limiting staff-related healthcare costs and abiding by labour laws. South African district hospital nurses are presently scheduled through the manual production of duty rosters on a monthly basis. In this paper, three related *nurse rostering problems* (NRPs) are formulated for a district level public hospital in Stellenbosch (South Africa). The first problem addresses the scheduling of the months during which nurses are on night shift duty. The other two problems address the scheduling of the days that nurses are working night or day shifts within a month, respectively.

A hierarchy of four levels exists among the nursing staff at Stellenbosch Hospital. Distributed over the four levels, the nursing staff totals ninety employees. Due to hospital policy, no casual nurses are employed. Fluctuations in demand are met by scheduling overtime shifts that are limited by current labour legislation. The hospital consists of seven wards, each with separate staff requirements.

The NRP for Stellenbosch Hospital is solved using the genetic algorithm. The algorithm is adapted to specifically adhere to the requirements and constraints given by the formulated NRP. The algorithm outputs good feasible rosters for each problem and provides data required to evaluate the performance of the algorithm. Roster results are interpreted and verified using the initial nursing requirements of the hospital. The robustness of using such an algorithm for sustainable use is also discussed. The paper ultimately aims to promote the use of operations research in healthcare on a practical level in South Africa.

Observed trends in the use of cereal straws and cotton seed hulls as sole substrates in the cultivation of *Pleurotus ostreatus* mushrooms in Zimbabwe

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Abstract

Maize stalks, wheat straw, common thatch grass (*Hyperrhenia filipendula*) and cotton seed hulls were evaluated as sole substrates for growing *Pleurotus ostreatus* mushrooms in three experiments performed at the Crop Science Department of the University of Zimbabwe, Harare. In the first two experiments all four substrates were tested and the experiments were carried out in summer, then in a third experiment performed in winter, maize was compared with wheat and grass. The lowest biological efficiency was recorded on wheat (44.41%) and the highest was on maize stalks (197.98%) on the winter mushroom crop. Biological efficiencies greater than 100% were recorded on maize and cotton seed hulls only. These results indicate that it is possible to have a commercially viable mushroom crop using maize stalks and cotton seed hulls as sole substrates. The time of year to grow this variety of oyster mushroom is important; yields almost double in winter crops.

Operations research at Sasol — The making of an INFORMS prize winning team

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Abstract

For 60 years, Sasol has demonstrated innovation in the energy and chemicals sectors in South Africa and around the world. Sasol's success requires that complex operations be managed across value chains, business units and sites. Building an OR capability to meet this decision support need has been challenging and rewarding. Sasol's OR team has grown from one analyst to over 30 internationally recognized experts in 15 years. This multidisciplinary team applies advanced analytics to improve decision making and impact the bottom-line. The petrochemical company now relies on OR to analyze logistics, simulate plants, improve reliability, model processes and optimize performance. This talk will summarise Sasol's OR journey and showcase five core OR techniques that were key elements in Sasol's winning of the 2011 INFORMS Prize.

Operations research in telemedicine

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Abstract

Telemedicine is the delivery of healthcare, where distance is an issue. Broens (2007) found in a study of 50 international telemedicine projects that most of these projects failed — this observation is confirmed by the low success rate in the implementation of telemedicine projects in the public health sector of South Africa. Contributing to this problem is the fact that few telemedicine specific frameworks exist to support the project team during the development and implementation phases of the project.

Health systems engineering is an academic discipline where researchers and practitioners treat the health care industry as a complex system, and further identify and apply engineering applications in health care systems. Operations research allows us to solve complex decision-making problems, a common phenomenon when developing and implementing a telemedicine system. This paper explores the use of operations research techniques in support of support project managers and their teams, during the development and implementation phases of a telemedicine project.

The first part of this paper is devoted to an extensive study of literature pertaining to the use of operations research techniques within the context of health systems engineering, specifically applicable to telemedicine projects. This is followed by a qualitative and quantitative evaluation of a selection of techniques. The paper concludes with a few examples within the context of the public health sector in South Africa to support findings from the literature study and technique evaluation.

Operations research in Zimbabwe: Origins, development and the way forward

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Abstract

In this paper we look at the origins of operations research in Zimbabwe, and its introduction into some degree and/or diploma programmes at tertiary institutions. In particular, we consider the introduction and development of operations research at the *National University of Science and Technology* (NUST). We review the progression of operations research at NUST from being taught in various courses under the applied mathematics degree programme to the introduction of three degree programmes in operations research that are currently running. The marketing strategies that have been made in order to publicize operations research in Zimbabwe are revisited. In our conclusion, we highlight the challenges that our region is facing in the promotion and advancement of operations research.

Optimal production lot size models with rework and scrap

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Abstract

Manufacturing processes are imperfect, giving rise to some defective products. These defectives may be reworked, scrapped, subjected to other corrective processes or sold at reduced prices, but the result is increased extensive costs in every case. To evaluate an inventory system policy on finished products properly requires determining a optimal production lot sizing model along with setup costs, inventory holding costs, processing costs and shortage costs. In this review paper, we present inventory models in production systems with rework and scrap. We study production systems with scrap detected before and after rework separately. A further study is performed on a system with a finite number of normal production cycles. We also show that the order quantities obtained satisfy both necessary and sufficient conditions for optimality, therefore providing minimum total production costs.

Paving the way for the use of prediction modelling in a hospital environment

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Abstract

The high cost of hospitalisation is a challenge for many health insurance companies, governments and individuals alike. In 2006, studies concluded that well over \$30 billion was spent on unnecessary hospitalisations in the United States of America. Unnecessary hospitalisations are hospitalisations that could have been prevented through early patient diagnosis and treatment. Undoubtedly, there is room for improvement in this regard. It can be agreed that where lives are at stake, prevention is always better than cure; successful hospitalisation prediction may make hospitalisation prevention a realistic possibility. The challenge ahead is to develop successful hospitalisation prediction models.

The *Heritage Provider Network*, a health insurance provider and sponsor of the *Heritage Health Prize Competition*, have come to realise the potential benefits that such a model could effect. The competition launched is aimed at producing an effective hospitalisation prediction algorithm, with a view to ultimately prevent the unnecessary hospitalisation of members in their network. The competition serves as inspiration for this study. Consequently, the aim of the study is to pave the way for model developers by providing insights to and identify possible pitfalls in the development of such an algorithm. The paper consists of two parts. Firstly, a list of contender techniques and technologies is assembled, based on the algorithm's expected input requirements and the techniques' abilities to meet these needs. Typical prediction modelling techniques reviewed include regression analysis and ensemble methods, amongst others. Secondly, promising techniques are applied to representative sample data in order to obtain first-hand insight into the modelling challenge. The paper provides a recommendation on the preferred technique and technology to use in the development of hospitalisation prediction models. Potential pitfalls to be encountered are also highlighted and discussed.

Post-catastrophe decision making

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Abstract

Unexpected high-impact events, popularised as “black swans,” present decision makers with dramatic new information but also highlight their previous state of ignorance about the nature of possible outcomes. Anecdotal evidence from recent financial and environmental crises suggests that these cause changes in behaviour, although it is not yet clear to what extent or for how long.

In this presentation we examine post-catastrophe decision making using an experiment based on a simplified financial context. In the experiment, decision makers predict share prices and experience, for some series, catastrophic falls in prices. We assess the impact of confronting catastrophes on two dimensions of judgement and decision making: the range of future estimates and attitudes towards risk.

Random sampling: An essential tool for the operations researcher

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Abstract

In many circumstances, be it for surveying a population or extracting information from a large database, sampling is the only practical way to proceed. Even when it is possible to use the entire population, sampling may actually give better results. However, the sample has to be representative of the population and the estimates need to be sufficiently precise to satisfy the requirements of the project. This talk will be a discussion on the basic theory of sampling, stressing the importance of random sampling and its derivatives in achieving reliable results. These concepts will be illustrated with applications from the author's experience, ranging across clinical trials, legal matters, employee surveys, pricing of services and estimating carbon credits, emphasising practical problems in achieving reliable samples and suggested solutions.

Scheduling jobs on parallel machines to minimize a weighted number of early and tardy jobs

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Abstract

This paper considers the scheduling of n jobs on m parallel machines to minimize the weighted number of early and tardy jobs. The single machine case of this problem has been shown to be NP-complete in the strong sense. This problem is also NP-complete in the strong sense and finding an optimal solution efficiently appears to be unlikely. The problem is formulated as an integer linear programming model. We propose some heuristics and metaheuristics for solving the problem. Extensive computational experiments are compared with a lower bound on an exact solution.

Solving a multi-objective micro milling problem using simulated annealing

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Abstract

The standard management challenge of balancing the conflicting objectives of time, cost and quality applies to the manufacturing domain in general, and, hence, to the field of machining. Assuming that quality levels are non-negotiable, the time/cost relationship becomes an important consideration. Managers typically want products manufactured at the lowest cost and in the shortest time. This is not always possible, however, because reducing the machining time typically reduces the tool life, which in effect increases the cost. This is especially relevant in the case of micro milling, where tooling costs are relatively high. Understanding the relationship between machining time and machining costs, and how these objectives are influenced by the cutting parameters of the machine will be very useful from a management perspective. Cutting parameters include cutting speed, feed per tooth and depth of cut.

The purpose of this paper is to determine the relationship between machining time and costs for a particular component, calculated in terms of the machine cutting parameters. As the solution space is characterised by all possible combinations of these three parameters and the parameters are all bounded continuous variables, the solution space for this problem is very large. The problem is further complicated by the inclusion of two nonlinear objectives. *Multi-Objective Simulated Annealing* (MOSA) was chosen as the technique to solve this problem approximately. The paper discusses the development of the MOSA algorithm, the shape of the resulting pareto-front and the interpretation of the results in a micro milling manufacturing environment.

Spreading operations research across a large company

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Abstract

An operations researcher is continually challenged to enhance his or her knowledge and practice, as well as to contribute to the development of operations research. This may entail a holistic approach to underpin practice by theory and to test theory in practice, and a large company domiciled in a developing country provides a fertile environment for such activities. This paper provides an overview of such an endeavour of an operations researcher at a South African based petrochemical company over a couple of years. Possible enhancements of the professional's knowledge and practice are reflected upon as well as potential contributions to operations research.

Spreadsheet-based methods for the teaching of statistical and OR methodologies and technologies

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Abstract

In this presentation we report on the use of spreadsheet-based methods for the teaching of statistical and OR methodologies and technologies. These methods, use a simulation-based approach and, where possible, the framework of experience/interest of the learner audience. Our experience at UCT has indicated that the simulation teaching model is an effective tool in facilitating current computer-based approaches for the teaching of such methodologies and, in particular, works well within the MICROSOFT EXCEL spread sheet environment. We illustrate the technique by considering a well-known statistical phenomenon that has particular relevance in the OR arena namely that, when random variables are added or combined together, the resulting variable has a variation which reflects the correlation between the variables. We can demonstrate these ideas succinctly on a spreadsheet by simulating a variable X (with some sample size) and a variable Y with some given predetermined correlation with X . We do this by simulating an X (say from a normal distribution) and then simulating an associated Y with this given correlation using the Cholesky decomposition method. This allows us to demonstrate, using this spreadsheet methodology, an interesting example in the field of financial portfolio theory, namely that we may decrease the total risk (standard deviation) of a portfolio of shares by combining individual shares which have a negative correlation with each other.

Statistical modelling using GENSTAT DISCOVERY in experimental work

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Abstract

The tremendous increase in the application of experimental research to different fields, coupled with the development of advanced application statistical software, have resulted in the need for experimenters to understand both experimental principles in theory and use of such software in the manipulation of data.

The purpose of this paper is to demonstrate how GENSTAT DISCOVERY can be used in experimental work. We demonstrate entirely all the stages, starting from generation of a standard design to analysis of results. The aim is to equip researchers involved in experimentation with hands-on ability in using the software technology for improved research output in both quality and quantity.

Supply chain management information systems: An artificial intelligence perspective

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Abstract

The management of supply chains is the current focus of corporate strategies. Currently, we note that it is not businesses that compete, but supply chains that compete. In order to lead in the corporate race, organisations take advantage of information and communication technologies for e-business. An executive level of strategic management of the supply chain is a requirement in which one of the major ingredients is information that is passed among supply chain constituents. The information is generated, distributed, received and stored in supply chain management information systems of heterogeneous architectures and/or platforms. This poses a challenge in the sharing and understanding of the bits of information. In this paper we present an artificial intelligence approach for supply chain information systems that have heterogeneous architectures enabling them to share information through a common ontology. The supply chain ontology structures a shared formal specification of concepts and the relationships between them, together with their constraints. Intelligent agents in e-business applications may utilise the ontology to seamlessly pass information on heterogeneous information systems and furthermore make inferences helpful in decision making for supply chain executives.

Swarm intelligence algorithms for OR problems: Successes and trends

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Abstract

It is a general belief that nature has an inherent solution to complex and difficult problems, including those that are NP-hard or NP-complete. While exact solutions fail to yield optimal solutions to this class of problems in a reasonable time, researchers have explored concepts and phenomena from nature to develop heuristics for solving large scale combinatorial and/or highly constrained non-linear problems approximately. Swarm intelligence techniques, inspired by the social and behavioural patterns of natural insects and animals, have proved efficient in solving some of these complex optimization problems. Various swarm intelligence meta-heuristics, such *ant colony optimization* (ACO), *particle swarm optimization* (PSO) and bee algorithms, are most prominent. This paper takes a critical look at the successes and perhaps hitches in the application of these techniques to some OR research problems, including transportation, assignment and scheduling problems. Breakthroughs, as well as research trends, both in the algorithms' refinement as well as in their applications, are highlighted. A comparative study of the techniques is presented for some of these problems.

Teaching OR using RISK SOLVER PLATFORM FOR EDUCATION

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Abstract

RISK SOLVER PLATFORM FOR EDUCATION was released late in 2010. The “Solver” part of this product has been part of Excel for many years, and is likely to be familiar to those using spreadsheets for optimisation. In this latest guise it has many advanced features over the standard version supplied in Microsoft’s Excel. The “Risk” part of the product refers to the ability to do risk simulation in the spreadsheet environment, using a common interface. This workshop will focus on various features of this spreadsheet add-in, and will illustrate the use of the software in a teaching environment using a number of optimisation as well as simulation examples.

Theoretical assessment of the transmission dynamics of Leprosy

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Abstract

Leprosy is a communicable disease which can cause hideous deformities to the afflicted and social stigmatization to them and their families. The continued high endemicity of Leprosy in pockets of Sub-Saharan Africa is a source of bafflement to researchers. In this paper, we investigate non-compliant behaviour by patients on treatment and possible inadequacy of the prescribed treatments as the reason for the persistence of the disease in the region. We construct theoretical, deterministic mathematical models of the transmission dynamics of leprosy. These models are modified to encapsulate non-compliance and inadequate treatment. The new model is then analysed to gain insights into the qualitative features of the equilibrium states, which enable us to determine the basic reproduction number. We also employ analytical and numerical techniques to investigate the impact of non-compliance and inadequate treatment on the transmission dynamics of the disease. Our results show that, as long there is treatment, Leprosy will eventually be eliminated from the region and that the disposition under investigation only serves to slow the rate at which the disease is eradicated.

Time series analysis of the volume of manufacturing data

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Abstract

Economic growth is defined as any production increase of a nation. It is usually expressed as an annual growth percentage depicting growth of the national product. An increase in productivity is characterized by a shift of the production function. Hence increased productivity represents greater output per unit of input. Productivity measures are often used to indicate the capacity of a nation to harness its human and physical resources in order to generate economic growth. Productivity measure is a key indicator of economic performance. At the national level, productivity growth raises living standards because more real income improves people's ability to purchase goods.

The aim of this study is to show the trend and forecasts of the volume of manufacturing data with the particular objectives of analysing the trend of the volume of manufacturing production of the years 2009 and 2010 for all economic sectors, and using time series analysis to fit a model that will be used to forecast the future volume of manufacturing.

Tracking concept drift in spam filtering with generalized additive neural networks

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Abstract

With spam filtering both the concept being learned and the data distribution change over time, making it a challenging machine learning task. These changes occur as a result of spammers who attempt to outsmart spam filters. For this presentation a *Generalized Additive Neural Network* (GANN) is utilised to track concept drift in spam filtering. A GANN is the neural network implementation of a *generalized additive model*. Usually neural networks are considered black boxes with respect to interpretation. With this type of neural network a graphical method provides insight into the model constructed. Moreover, feature selection and model selection are performed simultaneously by an automated construction algorithm. Concept drift may be modelled by three approaches: instance weighting; ensemble learning; and instance selection. The latter technique is applied and involves generalising from a window that moves over recently observed instances. The concepts learnt for prediction are used for prediction only in the immediate future. A GANN model is consequently constructed on a spam data set to evaluate the performance of the spam filter over a period of time to determine how it handles the concept drift inherent in spam.

Using the economic order quantity model in managing inventory: The case study of NOCZIM

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Abstract

This talk deals with keeping track of inventory of diesel and petrol in a local state owned petroleum company in Zimbabwe. The main idea is to find the best amount of fuel to be ordered by the company and when to order so as to minimise cost while satisfying demand. The data were collected at one of the company's service stations at the company's regional office for two months. Daily and monthly stocks, sales, and losses are provided. The *economic order quantity model* was used in this project to find the optimal solution. The calculations included provide results that give the procurement manager a general guideline of how to manage the company's inventory.

Using logistic regression to predict poverty in South Africa

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Abstract

Despite the impressive achievement of the current government in South Africa in the delivery of services to the poor, the dividends resulting from increased pro-poor social expenditure by the state have proved disappointing in terms of poverty reduction in South Africa. Although South Africa is having a large number of projects funded by its government with the aim of reducing poverty, poverty levels in South Africa remain high. In this paper we focus on poverty levels in South Africa and examine various geographic and socio-economic factors that have a major impact on poverty. A logistic regression model is used to portray factors that have an effect on income as one of the poverty indicators, and a Chi-Square test is used to test whether there is any relationship between poverty measures such as geographical location and access to services.

Using stochastic modelling to investigate supply chain disruptions

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Abstract

There has been steady growing interest on investigating the impact of supply chain disruption. This paper presents a stochastic model that is used to track supply chain disruption, and to measure impact at strategic, financial and operational levels. Furthermore, key performance attributes are identified, and appropriate mitigation and contingency plans suggested for each attribute.

Utilisation of multicriteria influence diagrams in simulation metamodeling

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Abstract

Multicriteria Decision Making (MCDM) settings may involve systems that are dynamic in nature, contain inherent uncertainties, and exhibit stochastic phenomena. An example of such a setting is the planning of a military operation in which the related system is air combat. The behaviour of these systems is often analysed through stochastic simulation. When representing an MCDM setting with a simulation model, decision variables are associated with simulation inputs and simulation outputs are used to evaluate multiple criteria. However, in real-world applications, performing simulations is computationally expensive and simulation results should be interpreted by using suitable statistic techniques.

Simulation metamodels are auxiliary models constructed based on simulation data. Their purpose is to provide a mapping between the inputs and outputs of a simulation model. Examples of metamodels include regression models, neural networks, and kriging models. The computational requirements of the metamodels are lower than those of the original simulation model, enabling one to use various techniques to analyze simulation results. However, the existing metamodeling literature does not consider the preferences of decision makers on multiple criteria or the multicriteria evaluation of decision alternatives.

We introduce the use of *Multicriteria Influence Diagrams* (MCIDs) in simulation metamodeling. An MCID is a graphical and numerical representation of a decision problem under uncertainty. The structure of the diagram together with conditional probability distributions depict dependencies between decision variables, random variables, and criteria. We demonstrate the estimation of probability distributions from simulation data. Additionally, we present the utilization of MCID metamodels in the analysis of MCDM settings, which includes the calculation of nondominated decision alternatives as well as several sensitivity and what-if analyses.

To summarise, stochastic simulation is applied for analysing systems related to MCDM settings, but the use of a simulation model and the interpretation of simulation results are challenging tasks. On the other hand, an MCID is a versatile MCDM tool, but the elicitation of probabilities (*e.g.* based on expert knowledge) can be onerous. The joint use of these methodologies alleviates their individual shortcomings and combines their beneficial features providing a traceable and transparent way to analyse MCDM settings.

Winning the impatient customer — Weighing the trade-offs in waiting line situations

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Abstract

This paper explores how organizations in various sectors of the economy can win back the impatient customer who could have given the organization business, but eventually walked away and gave his business to the competitor because of unacceptably long waiting the customer had to endure in order to be served. A wide range of operational situations present a mismatch between customer waiting time wishes and service facilities available owing to the service provider's inability to predict accurately the arrival and service times of customers. In service economies, waiting for service is part of daily life. In many waiting line situations, the time spent waiting is often undesirable. The focus of this contribution is on the deliberate use of queuing theory by the manager to solve queuing problems in the public sector, in the private sector and in industry and commerce without excessively delving into rigorous computational models.

The paper takes a sector-by-sector approach to explore options available. It is acknowledged that virtually every queuing situation presents a trade-off decision. The decision maker can weigh the added cost of providing quicker service (more tellers, more nurses, additional printing machines, more checkout points) against the inherent cost of waiting. While queuing models typically consist of mathematical formulas and relationships that can be used to evaluate various performance measures for a waiting line, the current study focuses on the more important day-to-day choices beyond the quantitative computations that organizations can apply to minimize the cost of lost sales and the impact of loss of good will. The suggested recommendations implore managers who believe that "the customer is king" to seriously consider adopting long-term perspectives towards getting rid of the queues.

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