51st ANNUAL CONFERENCE OF THE OPERATIONS RESEARCH SOCIETY OF SOUTH AFRICA

11-14 September

2022

Protea Hotel, Breakwater Lodge

Cape Town, South Africa

Welcome from the Society President

Dear ORSSA delegates, welcome to the 51st Annual Conference of the Operations Research Society of South Africa (ORSSA). After two years of unprecedented disruption, it is a great privilege to once again hold the event in person in the beautiful city of Cape Town.

The conference has been organized under the watchful eye of the Department of Statistical Sciences at UCT and led by the LOC chair Leanne Scott to whom a special thanks must go for the many hours of work needed to pull everything together. To the members of the LOC team for their hard work and commitment, as well as to the many reviewers and award judges for their time and contribution, thank you.

On behalf of the Society, a warm welcome to our three acclaimed keynote speakers, Professors Lisa Scholten (Assistant Professor, Policy Analysis at the Faculty of Technology, Policy, and Management, TU Delft), Helena Ramalhinho Lourenço (Economics and Business Department, University Pompeu Fabra) and Sara Grobbelaar (Professor, Department of Industrial Engineering at Stellenbosch University). We look forward to hearing your keynote addresses, and it's fantastic to have you here.

Transdisciplinary OR: Agile, Actionable and Inclusive! The theme of this year's conference comes at a pivotal time as we learn from the previous two years of worldwide change affecting many routines and processes requiring new thinking and quick action to keep them on track. Understanding the full impact of the pandemic and its resulting consequences will no doubt still take many years to appreciate fully, but it again highlights the importance of OR decision-making skills that modern complex environments will continue to need.

A big thank you to all our sponsors for your generous support: UCT Statistical Sciences, UNISA Decision Science, Elytica, Discovery Limited, SACNASP, BMI at NWU, SU Industrial Engineering, SA System Dynamics Chapter and SU School for Decision Science. The adjustment back to in-person events has been an equally challenging move in many respects. We appreciate the continued support that the Society has received as it adapts and evolves to cater to all our members from many backgrounds and throughout South Africa.

This year is the first that the talks will be available to those of you who cannot make it to the conference in person. Physical distance should no longer be a barrier to participation. While much is still to be learned in providing hybrid formats, we hope to keep the knowledge presented at the conference as widely accessible as possible.

I hope you had a chance to warm up with our two pre-conference tutorial sessions. To our many speakers from a wide range of disciplines, industries, and departments; thanks for sharing your work and experiences with us. My thanks go out to all of you. May good memories, inspiring conversations, renewed acquaintances, and new collaborations result over the next few days.

All the best for an exciting conference, which I now declare open.

David Clark, President
Operations Research Society of South Africa

Welcome from the Chair of the Organising Committee

A warm welcome to the 51st Annual Conference of the Operations Research Society of South Africa. We are particularly happy to be able to welcome you back to an in-person format, after two years of socially distanced conferences! While we do have a few online delegates (a positive legacy of the past few years), the bulk of our delegates are with us in person. A special shout-out to one very special online attendee, Hans Ittman, who I am told, joined ORSSA in 1973 and since then has attended every single ORSSA conference!

We at the Department of Statistical Sciences of the University of Cape Town are excited to be your hosts for the next few days as together we explore the theme of "Transdisciplinary OR: Agile, Actionable and Inclusive"!

We are particularly honoured to welcome Professor Helena Ramalhinho from Universitat Pompeu Fabra (Barcelona), Professor Lisa Scholten from TU Delft and (our own) Prof Sara Grobbelaar from Stellenbosch University, as our keynote speakers. We are confident that the breadth and depth of experience they collectively bring to our conference will go a long way to embracing transdisciplinarity amongst our OR community. We have been privileged to be able to offer two pre-conference tutorials : Prof Ramalhinho (Iterated local search : applications and extentions) and Prof Fanie Terblanche (Solving real world optimisation problems with mixed-integer LP technology). Our grateful thanks to each of our tutorial and keynote speakers for their willingness to give of their time and their expertise so generously.

Apart from an impressive line-up of conference papers we have tried to maximise on opportunities for delegates to mingle and socialise. The social programme kicks off with a welcome breakfast at registration on the first day of the conference; time to re-connect over coffee and a continental breakfast on the rooftop venue of the conference centre. At the end of the first day of OR stimulation, we have arranged informal drinks and snacks at Mitchell's Scottish Ale House (an old favourite watering hole of Capetonians, in walking distance of the conference venue). This year's gala event will be a cocktail evening on the rooftop terrace of the Conference Centre, at which we recognise our top practitioners during the National Student Competition Medal ceremony, the recognition award ceremony, and the Tom Rozwadowski Medal ceremony.

I would like to extend a special word of thanks to my fellow LOC members who ably supported the organisation and shaping of this conference. A particular thanks to Theo Stewart for compiling the conference schedule, to Ian Durbach for putting the conference programme together, to Neil Watson as Treasurer and to Beverley King for bookings and liaison. And last, but not definitely not least, a huge thank you to Lieschen Venter, without who's organisational knowledge and super-efficient, super helpful and all round wonderful support, nothing would happen!

I hope that you will have a memorable conference experience and that we each go away having glimpsed something of the view of the world from each other's shoes!

Leanne Scott,
Chair, ORSSA 2022 Local Organising Committee

— *The ORSSA 2022 Local Organising Committee* —

(1) Leanne Scott, Chair (Department of Statistical Sciences, University of Cape Town)

(2) Theodor Stewart, Programme Coordinator (Department of Statistical Sciences, University of Cape Town)

(3) Neil Watson, Treasurer (Department of Statistical Sciences, University of Cape Town)

(4) Beverley King (Department of Statistical Sciences, University of Cape Town)

(5) Fadzai Munyanyi (Department of Statistical Sciences, University of Cape Town)

(6) Freedom Gumedze (Department of Statistical Sciences, University of Cape Town)

(7) Georgina Rakotonirainy (Department of Statistical Sciences, University of Cape Town)

(8) Ian Durbach (Department of Statistical Sciences, University of Cape Town)

(9) Isabel Meyer (Department of Statistical Sciences, University of Cape Town)

(10) Juwa Nyirenda (Department of Statistical Sciences, University of Cape Town)

(11) Sheetal Silal (Department of Statistical Sciences, University of Cape Town)

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SACNASP
South African Council for Natural Scientific Professions
Integrity in science

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12 CONTINUING PROFESSIONAL DEVELOPMENT – ONLINE LEARNING

Suite L4 and U13, Enterprise Building
Innovation Hub, Pretoria
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— *Directions to Conference Facilities* —

GPS coordinates: $-33.907065, 18.415537$

Directions from Cape Town International Airport:

- Take the N2 from the Airport to Town
- Carry on straight past the Southern Sun Waterfront Hotel on your left and at the second set of traffic lights, turn right into Helen Suzman Boulevard
- Take the right hand lane that leads to a small set of traffic lights leading into Portswood Road
- Turn right into Portswood Road
- The GSB Conference Basement Parking can be reached by taking the first road on one's right hand side.
- Please follow the GSB signs until you reach the security boom
- Hotel Guest Parking can be reached by taking the 2nd entrance on one's right hand side when coming down Portswood Road (towards the Waterfront)

Parking:

- Parking is available in either the **Hotel Guest Parking** or the **GSB Conference Basement Parking** (see map on next page)

Directions to venues:

- Venue **GSB LT7** is in the Graduate School of Business building;
- Venue **Auditorium** in the UCT Academic Conference Centre (ACC)

PROTEA HOTEL
MARRIOTT
Cape Town Waterfront
Breakwater Lodge

Directions to UCT Graduate School of Business Conference Parking & Protea Hotel by Marriott® Cape Town Waterfront Breakwater Lodge

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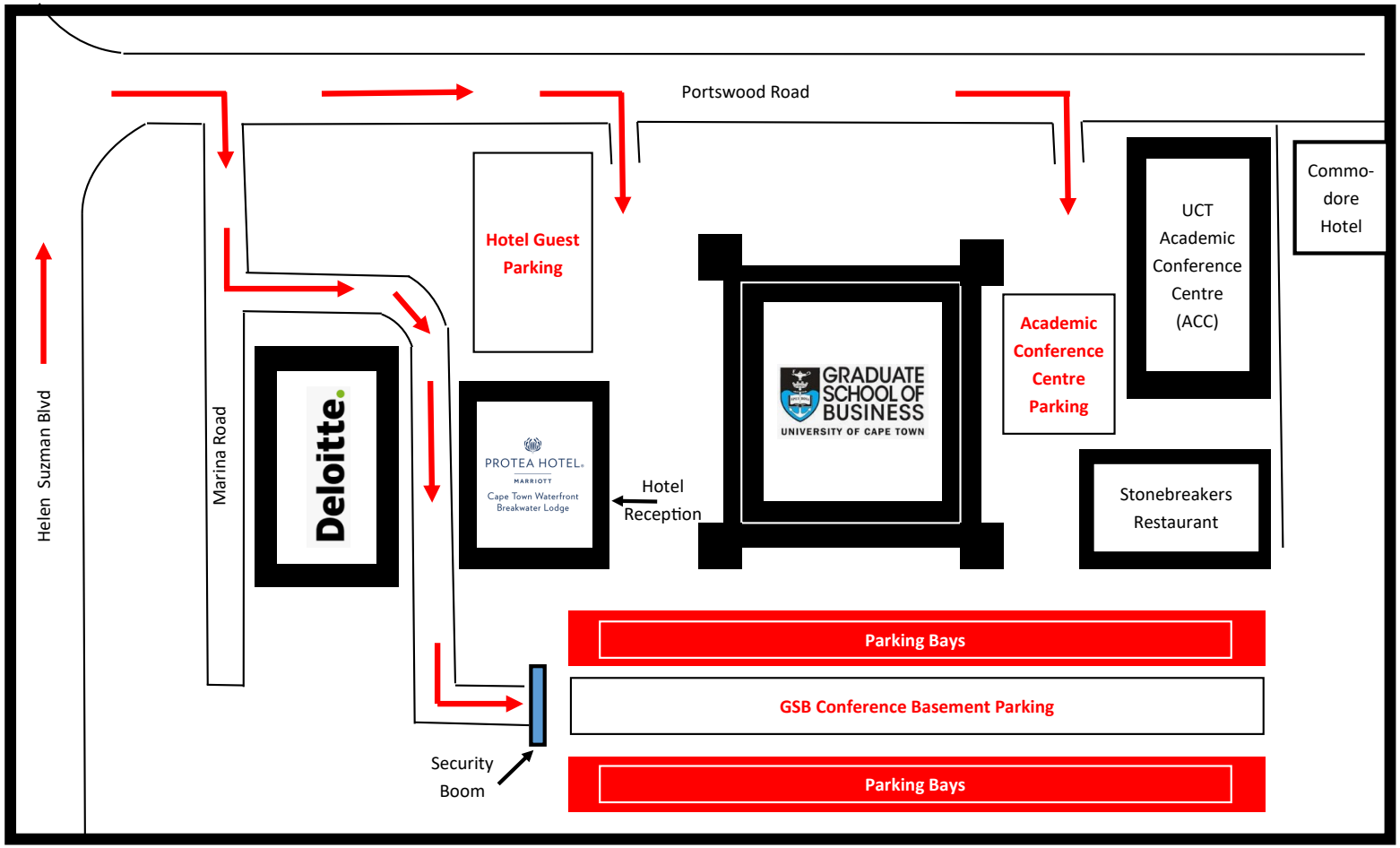

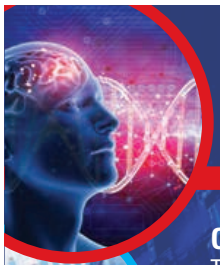

RESEARCH:

OPERATIONAL RESEARCH

This research group focuses on the development of decision modelling and support tools, including both "hard" (e.g. optimization and simulation) and "soft" (e.g. problem structuring and systems modelling) approaches, relevant to critical national decision and policy making.

DATA SCIENCE

Data science is an exciting new field that uses computer-intensive statistical methods to identify patterns and make predictions using large volumes of data. The applications of data science are diverse, ranging from predicting fraudulent transactions before they occur to extracting marketing insights from unstructured social media data.

BIOMEDICAL STATISTICS

This interdisciplinary group brings together researchers involved in the analysis of medical and biomedical data with a focus on advanced methodology applicable to bioinformatics, infectious disease modelling, longitudinal and time-to-event modelling, growth curve modelling, causal modelling, methods for incidence estimation and multivariate analysis.

STATISTICS IN ECOLOGY, ENVIRONMENT & CONSERVATION

The Centre for Statistics in Ecology, Environment and Conservation focuses on conservation, animal and plant demography, climate change, understanding of biodiversity patterns, evolutionary ecology and macroecology, with an overarching theme of structured decision support.

STATISTICAL FINANCE

This is a transdisciplinary research group working on the intersection of the statistical analysis in data-intensive finance and mathematical statistics that considers various data-informed approaches to both practical and theoretical problems in low and high-frequency finance.

DEPARTMENT OF STATISTICAL SCIENCES

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STATISTICAL SCIENCES

WHO WE ARE:

The Department of Statistical Sciences at the University of Cape Town is committed to the development of the statistical sciences within and beyond the university. In its teaching, the department recognises that there are needs both to train professionals in the statistical sciences, and to provide quantitative and decision-making skills to students in other disciplines. In its research, the department seeks to maintain a balance between the development of theory and applications of that theory with a focus on supporting policy and decision-making.

The Department of Statistical Sciences was established in 1965 as the Department of Mathematical Statistics under the headship of the late Professor Cas Troskie. It assumed its current name at the beginning of 1991 to reflect its broader teaching and research activities. Located in the south wing of the PD Hahn building, the department is situated at the heart of the beautiful UCT upper campus at the foot of Table Mountain.

DEPARTMENT OF STATISTICAL SCIENCES

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— *Conference at a Glance* —

Sunday 11 September 2022

09:00–10:00	*Onsite Registration (Conference Centre Foyer)*
10:00–13:00	Conference Tutorial 1 (Prof Fanie Terblanche and Dr Richard Oberdieck) (GSB LT7)
13:00–14:00	*Lunch (Stonebreakers)*
14:00–17:00	Conference Tutorial 2 (Prof. Helena Ramalhinho) (GSB LT7)

Monday 12 September 2022

07:30–09:00	*Onsite Registration (Conference Centre Foyer) and Welcome Breakfast (Conference Centre Rooftop Terrace)*	
09:00–10:30	Plenary Session 1: Opening Keynote Address by Dr. Lisa Scholten (Auditorium)	
10:30–11:00	*Tea/Coffee (Conference Centre Foyer)*	
11:00–13:00	I: Optimization: Principles and Theory (Auditorium)	2: Social and Behavioural Modelling 1 (GSB LT7)
13:00–14:00	*Lunch (Stonebreakers)*	
14:00–16:00	3: National Student Competition (Auditorium)	4: Finance (GSB LT7)
16:00–16:20	*Tea/Coffee (Conference Centre Foyer)*	
16:20–17:50	5: Miscellaneous (Auditorium)	6: Applications: Production and Logistics (GSB LT7)
18:30–20:00	*Social Mixer* (Mitchell's Scottish Ale House)	

Tuesday 13 September 2022

09:00–10:00	Plenary Session 2: Mid-Conference Keynote Address by Prof. Helena Ramalhinho (Auditorium)	
10:00–10:30	*Tea/Coffee (Conference Centre Foyer)*	
10:30–12:30	7: Data Science and Learning (Auditorium)	8: Decision Support Systems (GSB LT7)
12:30–13:30	*Lunch (Stonebreakers)*	
13:30–15:00	9: Inference and Statistics (Auditorium)	10: Health Management (GSB LT7)
15:00–15:30	*Tea/Coffee (Conference Centre Foyer)*	
15:30–17:30	ORSSA Annual General Meeting (Auditorium)	
18:30–21:00	*Gala Cocktail Event (Conference Centre Rooftop Terrace)*	

Wednesday 14 September 2022

09:00–11:00	11: Applications: Miscellaneous (Auditorium)	12: Social and Behavioural Modelling 2 (GSB LT7)
11:00–11:30	*Tea/Coffee (Conference Centre Foyer)*	
11:30–12:45	Plenary Session C: Closing Keynote Address by Prof. Sara Grobbelaar (Auditorium)	
12:45–13:45	*Lunch (Stonebreakers)*	

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Student projects

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- Sichel medal for the best published research in 2015
- SAS Academic Intelligence Award 2005

For detailed information, please visit BMI's website:

http://natural-sciences.nwu.ac.za/bmi

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— *Detailed Conference Programme*—

Sunday 11 September 2022

On-site Registration (09:00–10:00)
[Conference Centre Foyer]

Conference Tutorial 1 (10:00–13:00)
Sponsored by *Elytica*,
[GSB LT7]

Lunch (13:00–14:00)
[Stonebreakers]

Conference Tutorial 2 (14:00–17:00)
Sponsored by *Elytica*,
[GSB LT7]

Monday 12 September 2022

On-site Registration (07:30–09:00)
[Conference Centre Foyer]
Welcome Breakfast (07:30–09:00)
Sponsored by *Discovery*
[Conference Centre Rooftop Terrace]

Monday 12 September 2022 (09:00–10:30)	
	Plenary Session A: Conference Opening *Chair: Leanne Scott* [*Venue:* Auditorium]
09:00–09:10	**Leanne Scott** (Chair, Local Organising Committee) *Welcome & announcements*
09:10–09:30	**Dave Clark** (ORSSA President) *Presidential address*
09:30–10:30	**Lisa Scholten** (Keynote Speaker) *Transdisciplinary OR to improve decision-making in the water sector.* (p. 24)

Tea/Coffee (10:30–11:00)
[Conference Centre Foyer]

Monday 12 September 2022 (11:00–13:00)

Parallel Session 1: Optimization: Principles and Theory
Chair: Neil Watson [*Venue:* Auditorium]

11h00–11h30	**Jan Van Vuuren**, *A unified, linear meta-algorithmic framework for computing parameters related to (super)hereditary properties of trees.* (p. 28)
11h30–12h00	**Alexia Van Wyk**, *Exact solution approaches to the minimum colour cut problem.* (p. 28)
12h00–12h30	**Bowen Heinrich**, *Metaheuristic and heuristic approaches to the concave knapsack problem.* (p. 28)
12h30–13h00	**Greg Harmse**, *A vehicle routing problem with time windows, compulsory, and optional nodes.* (p. 29)

Parallel Session 2: Social and Behavioural Modelling 1
Chair: Theo Stewart [*Venue:* GSB LT7]

11h00–11h30	**Khwezi Kunene**, *The impact of pandemic control on the Early Childhood Development system of South Africa.* (p. 29)
11h30–12h00	**Lieschen Venter**, *Systems thinking for an education crisis.* (p. 30)
12h00–12h30	**Josephine Kaviti Musango**, *Applied Systems Thinking in Operations Research.* (p. 30)
12h30–13h00	**Isabel Meyer**, *Complexity in Social Development Projects.* (p. 30)

Lunch (13:00–14:00)
[Stonebreakers]

Monday 12 September 2022 (14:00–16:00)

Parallel Session 3: National Student Competion Finalists
Chair: Lieschen Venter [*Venue:* Auditorium]

14h00–14h30	**Fazail Dawood**, *Modelling control strategies for the invasive tree species Prosopis in the Northern Cape.* (p. 31)
14h30–15h00	**Willem Moore**, *A machine learning approach towards solving the invoice payment prediction problem.* (p. 31)
15h00–15h30	**Hans Jurie Zietsman**, *A framework for decision support in inventory management pursuant of economies of scale.* (p. 32)
15h30–16h00	**Alexander Flemming**, *A framework for modelling spatio-temporal competition and spread of invasive biological species.* (p. 32)

Parallel Session 4: Finance
Chair: Robert Benetto [*Venue:* GSB LT7]

14h00–14h30	**Jakubose Sibanda**, *Modelling stock markets intergration: A case between South Africa and G7 countries.* (p. 32)
14h30–15h00	**Mesias Alfeus**, *Toward A General Framework for Modelling Roll-Over Risk.* (p. 33)
15h00–15h30	**Kyle Harrison**, *Predicting movements in financial markets with support vector machines.* (p. 33)
15h30–16h00	**Kanshukan Rajaratnam**, *Scoring and Regulatory Capital Decisions in the Context of Economic Uncertainty.* (p. 34)

Tea/Coffee (16:00–16:20)
[Conference Centre Foyer]

Monday 12 September 2022 (16:20–17:50)

Parallel Session 5: Miscellaneous
Chair: Georgina Rakotonirainy [*Venue:* Auditorium]

16h20–16h50	**Marno Du Plessis**, *Designing a more efficient Interactive Voice Response (IVR) system through data analytics and simulation.* (p. 34)
16h50–17h20	**Esranel Becker**, *A game theoretical study of the Sermon on the Mount.* (p. 35)
17h20–17h50	**Robert Bennetto**, *Scaling point in polygon to support false positives with zero false negatives.* (p. 35)

Parallel Session 6: Applications: Production and Logistics
Chair: Isabel Meyer [*Venue:* GSB LT7]

16h20–16h50	**Ashley Nunkissor**, *Wagon Project: The wagon loads and false positives, distinguishing between leads and lags.* (p. 35)
16h50–17h20	**Chupisha Saasa**, *A Brief History of Rail in South Africa.* (p. 36)
17h20–17h50	**Annelie Wessels**, *Die evaluering van die produksievloei by 'n jogurtfabriek in Suid-Afrika.* (p. 36)

Social mixer (18:30–20:00)
Sponsored by the *Department of Industrial Engineering at Stellenbosch University*,[Mitchell's Scottish Ale House]

Tuesday 13 September 2022

Tuesday 13 September 2022 (09:00–10:00)

Plenary Session B
Chair: Linke Potgieter [*Venue:* Auditorium]

09:00–10:00	**Helena Ramalhinho** (Keynote Speaker) *Optimisation for Social Good* (p. 25)

Tea/Coffee (10:00–10:30)
[Conference Centre Foyer]

Tuesday 13 September 2022 (10:30–12:30)

Parallel Session 7: Data Science and Learning
Chair: Sunday Oladejo [*Venue:* Auditorium]

10h30–11h00	**Matshidiso Marengwa**, *Data Cleaning using OpenRefine: A Case of Blast Incidents and Explosives Research Data Extraction from Social Media Platforms.* (p. 37)
11h00–11h30	**Tiny Du Toit**, *Using deep learning and affective computing to acquire sentiment on information security policies.* (p. 37)
11h30–12h00	**Robert Bennetto**, *Machine Learning in online environments.* (p. 38)
12h00–12h30	**Rupert Spann**, *Lessons learnt from neurochemistry as a framework for information transfer, be it a switch or the Universe to the mind.* (p. 38)

Parallel Session 8: Decision Support Systems
Chair: Jan van Vuuren [*Venue:* GSB LT7]

10h30–11h00	**Annette Van Der Merwe**, *Teaching vs learning DSSs* (p. 38)
11h00–11h30	**Mareli Botha**, *A Decision Support System for Decentralised Waste Utilisation in South Africa* (p. 39)
11h30–12h00	**Richard Ball**, *Self-organising maps for feature interpretation in anomaly detection.* (p. 40)
12h00–12h30	*No talk scheduled*

Lunch (12:30–13:30)
[Stonebreakers]

Tuesday 13 September 2022 (13:30–15:00)

Parallel Session 9: Inference and Statistics
Chair: Jess Rees [*Venue:* Auditorium]

13h30–14h00	**Winnie Pelser**, *Investigation into a Surrogate Test System for Kinetic Energy Less Lethal Projectile Validation.* (p. 41)
14h00–14h30	**Jaco Visagie**, *On the conditional distribution of the mean of the two closest among a set of three observations.* (p. 41)
14h30–15h00	**Stefany Bam**, *Optimal crop grouping using clustering algorithms with/without outliers.* (p. 41)

Parallel Session 10: Health Management
Chair: Elzanie Botha [*Venue:* GSB LT7]

13h30–14h00	**Marno Du Plessis**, *The design and implementation of an affinity matching model at Discovery Health.* (p. 42)
14h00–14h30	**Theresa Viljoen**, *'n Stelselsperspektief van die impak van COVID-19 op 'n reeds wankelrige onderwysstelsel.* (p. 42)
14h30–15h00	**Sunday Oladayo Oladejo**, *LongCovid: A Data Science Perspective.* (p. 43)

Tea/Coffee (15:00–15:30)
[Conference Centre Foyer]

ORSSA AGM (15:30–17:30)
[Auditorium]

Gala cocktail event (18:30–21:00)
[Conference Centre Rooftop Terrace]

Wednesday 14 September 2022

Wednesday 14 September 2022 (09:00–11:00)

Parallel Session 11: Applications: Miscellaneous
Chair: David Clark [*Venue:* Auditorium]

09h00–09h30	**Ruan Luies**, *Towards optimal route planning for solar-powered battery electric vehicles.* (p. 43)
09h30–10h00	**Ebrahim Steenkamp**, *Examination timetabling at the University of Cape Town: a tabu search approach to automation.* (p. 44)
10h00–10h30	**Wasim Ghoor**, *A hypothesised Solution to UCT's Timetabling problem.* (p. 44)
10h30–11h00	*No talk scheduled*

Parallel Session 12: Social and Behavioural Modelling 2
Chair: Stephan Visagie [*Venue:* GSB LT7]

09h00–09h30	**Kurt Marais**, *Towards an infodemiological analysis of social media & mental health.* (p. 45)
09h30–10h00	**Sha-Abaan Slamang**, *Towards a graduate success analysis model.* (p. 45)
10h00–10h30	**Philip Prinsloo**, *The development of an Eldana Risk Index.* (p. 45)
10h30–11h00	**Samantha Downing**, *Determining the size of refuge areas required in Bt sugarcane when combined with sterile insect releases.* (p. 46)

Tea/Coffee (11:00–11:30)
[Conference Centre Foyer]

Wednesday 14 September 2022 (11:30–12:45)

Plenary Session C: Conference Closing
Chair: Leanne Scott [*Venue:* Auditorium]

11:30-12:30	**Sara Grobbelaar** (Keynote Speaker) *Opening the black box: Systems thinking and the dynamics of innovation* (p. 26)
12:30–12:45	**David Clark** (ORSSA President) *Final announcements, thank yous & good bye*

Lunch (12:45–13:45)
[Stonebreakers]

Interested in making GOOD DECISIONS?

The department offers:

- BCom Honours Degree in Financial Modelling
- BSc Honours Degree in Operations Research
- Master of Commerce in Quantitative Management
- Master of Science in Operations Research
- Doctor of Philosophy in Operations Research

Admission requirements

Students should have a mathematical background equivalent to that of a typical undergraduate major in Operations Research, Financial Modelling, Mathematical, Physical or Engineering Sciences. The achievement should be above the 60% level for final-year modules in these fields.

Financial support

Top students have the opportunity to apply to the department as academic assistants while studying. The payment will cover a basic salary and tuition fees. The university's Student Funding Directorate (DSF) administers donor funds, in the form of study loans and bursaries, according to donors' criteria. The main aim is to assist financially needy and academically deserving students.

Contact

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— *List of Sessions & Chairs* —

	Day	Time Slot	Topic	Chairperson	Venue
A	Mon	09:00–10:30	Opening Plenary	Leanne Scott	Auditorium
B	Wed	09:00–10:00	Mid-conference Plenary	Linke Potgieter	Auditorium
C	Wed	11:30–12:45	Closing Plenary	Leanne Scott	Auditorium
1	Mon	11:00–13:00	Optimization: Principles and Theory	Neil Watson	Auditorium
2	Mon	11:00–13:00	Social and Behavioural Modelling 1	Theo Stewart	GSB LT7
3	Mon	14:00–16:00	National Student Competition	Lieschen Venter	Auditorium
4	Mon	14:00–16:00	Finance	Robert Benetto	GSB LT7
5	Mon	16:20–17:50	Miscellaneous	Georgina Rakotonirainy	Auditorium
6	Mon	16:20–17:50	Applications: Production & Logistics	Isabel Meyer	GSB LT7
7	Tue	10:30–12:30	Data Science and Learning	Sunday Oladejo	Auditorium
8	Tue	10:30–12:30	Decision Support Systems	Jan van Vuuren	GSB LT7
9	Tue	13:30–15:00	Inference and Statistics	Jess Rees	Auditorium
10	Tue	13:30–15:00	Health Management	Elzanie Botha	GSB LT7
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12	Wed	09:00–11:00	Social and Behavioural Modelling 2	Stephan Visagie	GSB LT7

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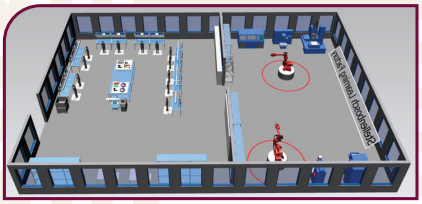
INDUSTRIAL ENGINEERING

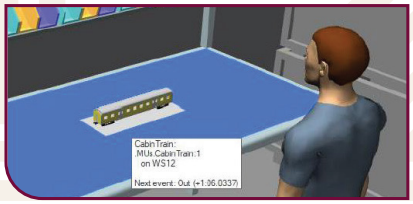
OPERATIONS AND SUPPLY CHAIN MANAGEMENT

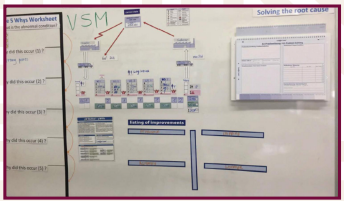
PROF JAN VAN VUUREN, DR STEPHAN NEL, PROF JAN HAVENGA AND DR ZANE SIMPSON

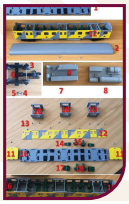
Digitilisation and Automation in Operations

The work life and the organisational world is changing very fast. Digitilisation and the fourth industrial revolution are accelerating these changes. A key research focus is on the digitalisation of operations and value chains in manufacturing and service environments. Digitilisation has touched all aspects of businesses, including supply chains and operating models/ business models. Today, new technologies have enabled organizations to transform their existing hybrid structures (combination of paper-based and IT-supported processes) into more flexible, open, agile and collaborative digital models. Digital value chains enable business process automation, organizational flexibility and digital management of corporate assets.





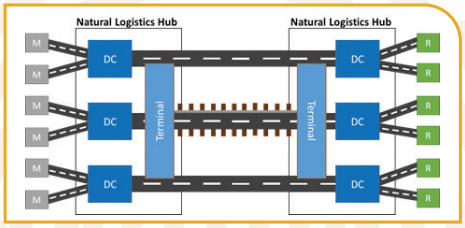


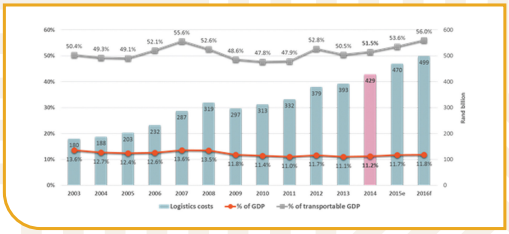


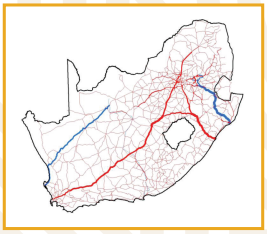
Macrologistics Management and their impacts

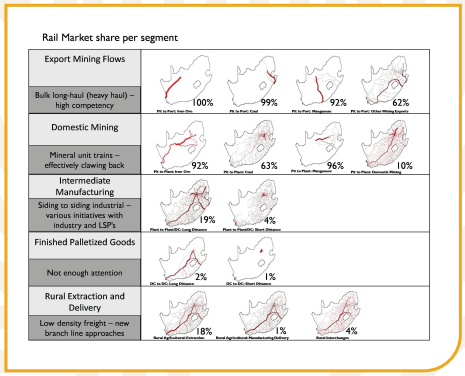
Macrologistics is the scoping and prioritizing of national policy, projects and macrologistics performance measurement. Macrologistics involves a complex group of interrelated economic, infrastructure and organizational systems that could be analyzed and improved using a systems engineering approach. This has been done to some extent within the Logistics Management domain through modelling sub-systems and research in micrologistics, but a vast number of research opportunities exist from the systems engineering perspective. This opportunity spans across engineering disciplines with applications on both detail level but also at strategic or even national level. These include but are not limited to the supply chain in general, logistics, systems modelling, operational research, financing and costing, infrastructure development, equipment design and policy environments with large scale benefits for a South Africa in need of growth and development.

Macrologistics improvement is possible through a multidisciplinary hierarchical system, i.e. on the first level by avoiding unnecessary inputs (macroeconomics), on the second level by avoiding unnecessary activity (industrial engineering and logistics) and on the third level by improving the efficiency of infrastructure (civil engineering) and equipment (mechanical engineering) used in logistics.









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1. Capture models using LaTeX

```
bin x, forall n in N;
bin y, forall c in C, forall n in N;

max sum{i in N}{ v_{i}*x_{i} };

constr x_{i} <= 0, forall i in E;
constr x_{i} <= x_{j}, forall i in L, forall j in A(i);
constr x_{i} >= sum{j in J(i)}{ x_{j} } - 3, forall i in NH;
constr x_{i} <= x_{j}, forall i in I, forall j in B(i);
constr sigma_{0}*x_{i} <= sum{j in D(i)}{ x_{j} }, forall i in S;
```

2. Simulate/Predict using Python

```
import elytica
import simpy
import numpy
import math
import pandas as pd
import networkit as nk

SIMULATION_RUN_HOURS=100
network_nodes = json.loads((pd.read_excel("simulation
node_xyz = {i["id"]:[ float(i["x"]), float(i["y"]), f
network_arcs = json.loads((pd.read_excel("simulation.
arc_distances = { i["from_id"]: { j["to_id"]: float(j
trucks = json.loads((pd.read_excel("simulation.xlsx",
truck_type_info = json.loads((pd.read_excel("simulati
truck_type_efficiency = json.loads((pd.read_excel("si
truck_type = {i["id"]: i["type_id"] for i in trucks}
```

3. Inspect models visually

$$\text{Maximize} \sum_{i \in N} v_i x_i \quad : 25$$

$$x_i \le 0, \quad \forall i \in E \quad : 27$$

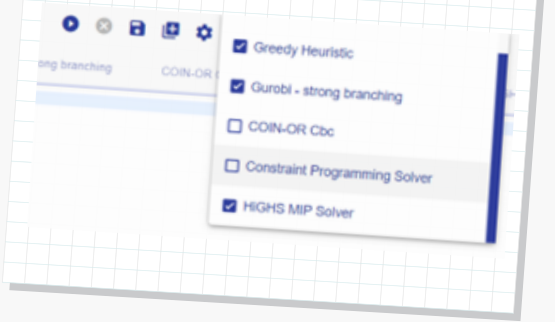
$$x_i \le x_j, \quad \forall i \in L, j \in A(i) \quad : 28$$

$$x_i \ge \sum_{j \in J(i)} x_j - 3, \quad \forall i \in NH \quad : 29$$

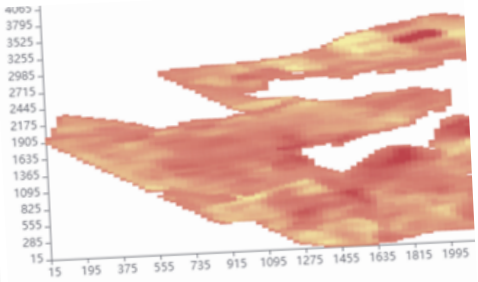
$$x_i \le x_j, \quad \forall i \in I, j \in B(i) \quad : 30$$

$$\sigma_0 x_i \le \sum_{j \in D(i)} x_j, \quad \forall i \in S \quad : 31$$

4. Select solvers for collaborative optimization



5. Graph & export results



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— *Plenary Paper Abstracts* —

Opening Plenary Speaker: *Lisa Scholten*

Transdisciplinary OR to improve decision-making in the water sector

Over the years, and with support of many collaborators, my work has combined scientific approaches across disciplinary divides with the aim to improve decision-making in the water sector. By now, the portfolio spans an unlikely combination from water science and engineering, statistics and computer science to MCDA, problem structuring and group facilitation work, with more recent additions from the behavioural sciences and serious gaming. No consolidated scientific body of knowledge has been more inspiring, instructive, and useful in this endeavour than that of OR in its aspiration to be "the science of better". Yet, being faced with the undisciplined practical realities of water challenges ranging from 'tame' to 'super-wicked', we have had to overcome many limitations of the OR toolbox, common-sense assumptions about decision-making, and a paucity of design guidance when using OR in transdisciplinary multi-stakeholder interventions. A probably undue amount of trial and error was involved in bridging disciplinary tensions and methodological gaps when blending OR with other fields to expand into inter- and transdisciplinary territory. Looking back at the rich interdisciplinary history of OR and its real-world problem-solving orientation, it seems surprising that such degree of muddling through would still be necessary today. In this talk, I will map the types of problems encountered against common OR approaches, and illustrate some of the gaps and solutions with both successful and failed OR interventions in water sector decision-making. Zooming out, I will propose that stretching current perspectives to (re-)include and build upon insights from systems thinking and systems analysis, behavioural science, and process design for social change, the OR community can address some of these gaps and increase its impact as a more actionable science of better.

Biography of the speaker:

Professor Lisa Scholten's work focuses on Decisions in Water Systems. She holds an Engineering Degree (Dipl.Ing.) in Urban and Industrial Water Resources Management with a minor in East Asia/China studies from TU Dresden, Germany, a PhD degree from ETH Zürich, Switzerland, and recently completed an Executive MSc in Behavioural Science at LSE, United Kingdom."In my work, I develop knowledge, methods and processes for systemic interventions that aim to facilitate better decision making in the water sector. I endorse systems thinking and operations research as well as insights from the social and behavioural sciences. The direct engagement of stakeholder into research and the training of current and future water managers in a way that enables them to embrace complexity are key priorities to me."

Mid-Conference Plenary Speaker: *Helena Ramalhinho*
Optimisation for Social Good

The challenges related with the wellbeing of the People and the Planet as high pollution, increasing aging and risk population, health issues and pandemics, depopulation of rural areas and overpopulation in cities, food security, natural disasters, war conflicts, etc. require a better response from the governments and the society. Analytics and Optimization should be part of these general response, helping making better decisions. In this talk, we present the optimization methodologies, models, algorithms and tools applied to Non-Profit Organizations (NPO) and Non-Governmental Organizations (NGO) in areas as health, social and environmental that had led to a positive impact on the society. We describe real applications on home health and social care logistics and personnel scheduling; circular economy of assistive technology; location of the primary health care centers or schools in high growing population areas; food security and distribution; planning the humanitarian logistics and health aid distribution; planning a sustainable transportation and scheduling special transportation for persons with reduced mobility. The problems related with the wellbeing of the People and Planet require a new set of models and algorithms that consider aspects as social value, uncertainty, adaptability and resilience. Therefore, this leads to a new line of research considering the social impact aspects on the optimization tools to be able to provide good response to the People and Planet challenges.

Biography of the speaker:

Helena Ramalhinho Dias Lourenço is a Full Professor at Universitat Pompeu Fabra (UPF). She has a B.A. and Master degree in Statistics and Operations Research from the University of Lisbon, Portugal, and a Ph.D. in Operations Research from Cornell University, New York, USA. She has been involved in different research projects and consulting for firms in the area of Operations Research, Transportation, Operations Management and Logistics. Helena has published many articles in prestigious international scientific journals and has presented her work at international conferences. She also has been serving as a reviewer for several journals and a member of the program committees of several international conferences. Helena teaches at various undergraduate, master's and PhD's programs in the UPF, Barcelona School of Management (UPF) and several European universities. She is currently the director of the Business Analytics Research Group (UPF). Her research interests include Operations Research, Business Analytics, Combinatorial Optimization, Metaheuristics, Iterated Local Search, Vehicle Routing, Scheduling, Supply Chain Management, Logistics, Production and Operations Management. Her most well-known paper (co-authored with Olivier Martin and Thomas Stützle) is the Iterated Local Search article, with the foundations of this metaheuristics. Her more recent projects are on the topic: Analytics for Social Good, with applications in Social and Health Care sector, collaborating with several organizations as the Barcelona City Council.

Closing Plenary Speaker: *Sara Grobbelaar*
Opening the black box: Systems thinking and the dynamics of innovation

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Models of innovation for inclusive development (I4ID) consider the nature and dimensions of inclusion where the socioeconomically marginalised are potential customers, co-creators, business partners and knowledge producers. Conceptualisations of 'inclusion' in innovation entail knowledge production processes such as problem definition, innovation processes, adoption or absorption of innovation outputs, and economic benefit gained. Improving our understanding of the I4ID models from a systems perspective could provide added value as both an analytical framework and a guide to developing policy instruments. This presentation reflects on multi-disciplinary and analytical methods to open the "black box" of the dynamics of I4ID. We explore how our work contributes to three aspects of innovation systems strengthening, namely (1) operationalising innovations (2) identifying systemic failures in innovation systems and designing interventions to address them (3) supporting policy-learning, and ensuring planning and design are well integrated.

Biography of the speaker:

Professor, Department of Industrial Engineering at Stellenbosch University, Sara Grobbelaar is also a research associate at the Centre for Research on Evaluation, Science and Technology (CREST), Stellenbosch University. Professor Grobbelaar is highly effective at developing research partnerships and research programs focusing on innovation for inclusive development. She has initiated and secured major grants and research partnerships with various companies and funders such as global pharmaceutical company GlaxoSmithKline, The Bill & Melinda Gates Foundation, the CSIR, and various private companies that operate in the healthcare sector. She co-established the Health Systems Engineering and Innovation Hub and established the Innovation for Inclusive Development research group at Industrial Engineering at Stellenbosch University. Professor Grobbelaar's academic qualifications and background uniquely position her to contribute to debates on how innovation for inclusive development may be realised through policy interventions and innovation programmes in the African context. She holds an MPhil in Technology Policy (with distinction) from the University of Cambridge, a B.Eng (electronic) (with distinction) (University of Pretoria), M.Eng (computer)(with distinction) (University of Pretoria), PhD in (Engineering) (University of Pretoria) and a Post Graduate Diploma in Monitoring & Evaluation methods (with distinction) (Stellenbosch University).

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— *Contributed Paper Abstracts* —

Parallel Session 1: Optimization: Principles and Theory

A unified, linear meta-algorithmic framework for computing parameters related to (super)hereditary properties of trees

Jan Van Vuuren, Alewyn Burger

Department of Industrial Engineering, Stellenbosch University

A number of disparate linear-time algorithms are available in the literature for computing graph parameters associated with hereditary properties of trees, such as vertex independence, vertex packing and irredundance, as well as superhereditary properties of trees, such as domination and total domination. It is shown in this presentation that the computation of all these parameters can be unified under a single meta-algorithmic framework for generating algorithms capable of computing cardinalities of smallest maximal vertex subsets and largest vertex subsets of trees satisfying any hereditary property, as well as smallest vertex subsets and largest minimal vertex subsets of trees satisfying any superhereditary property. The algorithms derived according to the meta-algorithmic framework are also validated and it is shown that these algorithms can be implemented in linear time.

Keywords: (Super)hereditary properties of trees, algorithmic computation, graph parameters. *Status*: Complete results

Biography of the speaker: The speaker is professor and head of operations research within the Department of Industrial Engineering at Stellenbosch University.

Exact solution approaches to the minimum colour cut problem

Alexia Van Wyk, Stephan E Visagie

Department of Logistics, Stellenbosch University

In this presentation a problem that arises in real life is investigated. The problem arises in a distribution centre (DC). In the DC products are placed around conveyor belts in picking lines. Pickers walk in cycles around the conveyor belt, selecting products for each store – one store at a time. This picking process can potentially be optimised by, instead of having one long picking line, placing a gate in the middle of the picking line that divides the products into two smaller equally sized picking lines. If a certain store only needs products from one half of the divided picking line, a picker does not need to cross the gate and would be able to complete the picking for that store using only one half a cycle. Ideally the products on the picking line should be divided in such a way that the number of stores that require a picker to cross the gate between the two halves is minimised. This problem can be set in a graph theory context as the minimum colour cut problem. Consider a graph in which the nodes are connected with lines of different colours. Each colour connects a subset of nodes. Such a subset on its own forms a complete subgraph (or clique). The problem then becomes to split the set of nodes into two equally sized groups in such a way that the minimum number of colours connect the two groups. The colours connecting the two groups represent the number of stores that requires a picker to cross the gate – and these crossings should be minimised. This problem was solved by building different integer programming models. These models are implemented in LINGO to find the exact solutions. The different models are compared over a generated data set. The instances in the data set have different properties. Instances vary on number of nodes, number of colours and clique size. The models are compared to investigate how the variations in these properties influence solution time.

Keywords: Minimum colour cut, integer programming, picking optimisation. *Status*: Complete results

Biography of the speaker: I am an Operations Research honours student at the University of Stellenbosch. In 2021, I graduated with my Bachelor's degree in Mathematical Science. For me operations research is a good balance between solving a problem to make money and caring for humanity

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Metaheuristic and heuristic approaches to the concave knapsack problem

Bowen Heinrich, Stephan E Visagie

Department of Logistics, Stellenbosch University

Concave knapsack problems are a type of non-linear optimisation problem in which a concave objective function is to be minimised subject to a single constraint, along with bounds on the variables. Most research into non-linear knapsack problems focuses on minimising convex objective functions, as minimising convex functions over

a convex set makes the problem easier to solve. Non-linear knapsack problems have applications in a wide range of fields including portfolio selection, traffic equilibrium, production and inventory management and many more. Solution approaches to concave knapsack problems in which the objective function is separable and increasing are presented.

The performance of three metaheuristics, namely variable neighbourhood search and two tabu searches, as well as a new heuristic based on dynamic programming are compared by means of test instances. The test instances were generated with characteristics, such as number of variables, average slope of the objective function and upper bounds on variables to test the solution approaches under different conditions. While the implementation of the first of the two tabu searches resulted in an algorithm that performs well even with large upper bounds, it becomes unreasonably slow as the number of variables increases. The opposite is seen in the dynamic programming heuristic, in which large numbers of variables are handled efficiently, while the algorithm struggles with large upper bounds. The variable neighbourhood search and the second tabu search both tend to perform worse than the two aforementioned algorithms but run significantly faster.

Keywords: concave knapsack problem, metaheuristics. *Status*: Work in progress

Biography of the speaker: An operations research Masters student in the Department of Logistics at Stellenbosch University with an interest in metaheuristic and heuristic solution approaches. I obtained my BSc in Mathematical Sciences and my BComHons in Operations Research from Stellenbosch University, the latter of which involved a research project applying metaheuristics to the minimum colour cut problem.

A vehicle routing problem with time windows, compulsory, and optional nodes

Greg Harmse, Stephan E Visagie

Department of Logistics, Stellenbosch University

Distribution centers are responsible for the distribution of goods to many retail outlets. A distribution center may have up to a few hundred retail outlets to serve. These outlets are partitioned into smaller delivery groups of roughly 25 to 30 outlets to simplify the distribution planning. An analysis and an optimization method are presented focusing on the routing of the vehicle fleet to satisfy the outlets' demand for goods within a delivery group. Each outlet has a hard time window for delivery and a specified number of times per week that a delivery must be made to replenish stock. For a given day there may be outlets that must be visited (compulsory) while others that may be visited (optional). Optional outlets may be included in vehicle routes to increase the utilization of the capacity of the vehicles along the routes and thus decrease transport cost. The unutilized space within a vehicle is penalized to encourage the utilization of the vehicle's capacity. This is a dynamic problem but is modelled and solved each day as a static problem. The static problem is to find which outlets should be visited on a specific day and to find a routing solution for these outlets such that the sum of the penalty for underutilization and the distance travelled by the vehicle fleet is minimized.

Two solution approaches are developed and implemented. The first is a heuristic using clustering to find the outlets to include and a branch and bound algorithm to find the optimal routing within the cluster. The second solution approach is an ant colony metaheuristic to solve the cluster and routing problem together. Additional artificial pheromones are added to encourage the inclusion or exclusion of certain optional outlets. These solution approaches are tested and compared on generated static test cases using 25 outlets. A simulation of the dynamic problem is run to compare the solution approaches to each other and to compare these solutions to the base case of the routing problem where only compulsory outlets are used within the routes.

Keywords: vehicle routing, branch-and-bound, ant colony optimisation. *Status*: Complete results

Biography of the speaker: Greg Harmse is a student in the Department of Logistics at Stellenbosch University. He has completed a BSc degree in Operations Research and is currently studying towards an honours in Operations Research. His research interests include the use of heuristics and metaheuristics to solve large scale real-world problems.

Parallel Session 2: Social and Behavioural Modelling 1

The impact of pandemic control on the Early Childhood Development system of South Africa

Khwezi Kunene, Lieschen Venter

Department of Logistics, Stellenbosch University

The life of an average person can be divided into multiple phases and at the end of each phase, one is expected to have reached specific milestones. The Early Childhood Development COVID-19 Impact Analysis Model (ECD-CIAM) simulates the progress of children towards school readiness with a focus on the early childhood phase for children aged two to six years. By the end of this phase a child is expected to communicate their immediate needs,

recognise letters and numbers, have basic social skills and be within healthy weight for their age and height due to adequate nutrition. However, this is not the reality for all South African children. The COVID-19 pandemic has altered the reality of millions but affected these young children differently. Some children were born during the pandemic and others experienced life-altering changes at critical development ages. The South African ECD system is simulated for children of different socio-economic status to analyse how well those systems prepare them for enrolment into primary school. System dynamics simulation modelling is used to analyse the effects of the pandemic, specifically the impact of the pandemic control measures from 2020 to 2021 on these young children.

Keywords: Early childhood development, basic education systems, system dynamics, simulation modelling, policy analysis. *Status*: Work in progress

Biography of the speaker: Khwezi Kunene is enrolled to complete her BCom Honours degree in Operations Research and a member of the Systems Thinking for Education Policy (STEP) research group at the Department of Logistics, Stellenbosch University. Her research interest include mathematical behavioural modelling for humanitarian interventions and she is passionate about the eradication of inequality in socio-economic realities.

Systems thinking for an education crisis

Lieschen Venter

Department of Logistics, Stellenbosch University

South Africa has one of the highest measures of economic inequality and one of the worst performing basic education systems in the world. The Systems Thinking for Education Policy (STEP) group brings together a team of mathematical and simulation modellers to uncover the hidden dynamics of this broken black box of poor academic performance. STEP researchers use modelling paradigms for the analysis of complex systems to gain insight into these and to provide decision support for education policy setting. In this lecture the STEP research group is introduced and an overview of the research outcomes it has achieved since its inception in 2018 is presented.

Keywords: simulation modelling, education, systems thinking, socio-economic decision support. *Status*: Complete results

Biography of the speaker: Dr Venter is a senior lecturer and researcher of operations research and business analytics. Her research focus is on the mathematical simulation modelling of complex social systems for improved policy setting.

Applied Systems Thinking in Operations Research

Josephine Kaviti Musango

Graduate Business School, University of Cape Town

Understanding complex real-world challenges require rigorous, innovative and holistic tools and techniques. Operations research consists of a logical strategy that helps investigate management problems. However, with the complex societal challenges facing the world today, there are limitations to operational research application. Systems thinking helps understand how things are connected and affect each other in a feedback loop mechanism. Systems thinking is, therefore, continuously becoming relevant in operations research to address the root cause of problems rather than their symptoms. This paper presents why and when systems thinking is relevant for operations research. Further, the paper offers two practical systems thinking techniques, the 5-Why approach and the 6-hats, that can help improve problem conceptualisation in operations research. The paper argues that to improve the understanding of management problems, we require tools that help with higher-order thinking and decision making in a changing world.

Keywords: Systems Thinking; System Dynamics; complex problems; Managing change. *Status*: Complete results

Biography of the speaker: Josephine Kaviti Musango is a Professor at the Graduate Business School, University of Cape Town. She is a skilled resource economics and system dynamics professional and a transdisciplinary researcher. Josephine's research interest entails using system dynamics in managing change and policy-related challenges in the energy transition, the green economy and urban African energy issues. She has worked with professionals in other academic disciplines, governments at multiple levels, industry and the community. She is one of the founding members of the South Africa System Dynamics Society and a Donella Meadows Fellow of the Balaton Group.

Complexity in Social Development Projects

Isabel Meyer, Leanne Scott

CSIR and UCT

This talk aims to address the interconnectedness of project process and structure with method in facilitating impactful solutions to complex social development projects. Traditionally, OR has focussed on complexity of method, with little attention to project structure, project process, or implementation; a focus which runs the risk of rendering even the most elegant of solutions ineffectual, usually because they are never implemented. We propose the integration of multiple lenses to facilitate working in a complex problem environment. We discuss recent results in two contrasting social development projects using the lenses of Innovation, Sustained Benefit and Trans-disciplinarity. We believe each of these lenses allows project teams to reveal challenges as well as promote learning and leverage resilience. The two projects, one urban and one rural, focussed broadly on community-based animal welfare, each with very different scopes, objectives and team dynamics. Through these projects we learned how to weave what are arguably fashionable buzzwords into substantive and usable tools. Ackoff, in his seminal paper of 1979, in identifying the causes for the decline in OR as including an obsession with "... the use of mathematical models and algorithms rather than the ability to formulate management problems, solve them, and implement and maintain their solutions in turbulent environments", encouraged OR practitioners and researchers to "design a desirable future and invent ways of bringing it about." That's the OR road we are looking to be on!

Keywords: Trans-disciplinarity, Sustained benefit, Innovation. *Status*: Work in progress

Biography of the speaker: Dr Isabel Meyer is an operations researcher and veterinarian, with experience in modelling, research, and analysis of complex systems. She is passionate about making systems work, and in particular when those systems involve animals and/or people in resource-constrained communities.

Isabel's research and consulting portfolio includes modelling and analysis of business and organizational systems, development initiatives, and supply chains and networks. A specific interest is the design of rural economic development projects and the associated project structures in such a way that sustained benefit is delivered within communities.

Isabel holds PhD (Information Systems), MSc (Industrial Systems), MBA, and BVSc degrees. She works with CSIR's Smart Mobility Cluster in Pretoria as principal researcher, and has associate roles at the Universities of Cape Town (Statistical Sciences) and Stellenbosch (Industrial Engineering). She is a board member of the Society for Animals in Distress and a member of the Animal Ethics and Welfare committee of the South African Veterinary Association.

Parallel Session 3: National Student Competion Finalists

Modelling control strategies for the invasive tree species Prosopis in the Northern Cape

Fazail Dawood, Alexander Flemming, Jan Van Vuuren

Department of Industrial Engineering, Stellenbosch University

Invasive biological species threaten biodiversity and economies worldwide, often resulting in devastating environmental and socio-economic effects. As a result, there has been a growing realisation of the importance of understanding and effectively managing the complex interactions that arise from biological invasions. A prerequisite for launching such a management strategy, however, is an effective means of predicting the expected effects of the strategy over time. To this end, a spatio-temporal model proposed in this paper for predicting the extent to which a particularly problematic invasive plant species, Prosopis, spreads when confronted with a threshold-triggered control method. In particular, a spatial analysis is advocated during which the study region is discretised and a data set constructed. Thereafter, the power of machine learning algorithms is leveraged to predict habitat suitability for Prosopis. Finally, a cellular automaton is adopted to simulate the spatial spread and temporal growth of Prosopis within discretised study region. The practicality of our modelling approach is illustrated by means of a real-world case study in the Northern Cape region of South Africa.

Keywords: biological invasive species, Prosopis, machine learning, cellular automaton. *Status*: Complete results

Biography of the speaker: Fuzail Dawood is an industrial engineering graduate from Stellenbosch University, currently pursuing his master's degree.

A machine learning approach towards solving the invoice payment prediction problem

Willem Moore, Louis Schoonbee, Jan Van Vuuren

Department of Industrial Engineering, Stellenbosch University

Companies routinely experience difficulties in collecting debt incurred by their customers. As an alternative to reactive techniques typically employed to increase a company's ability to collect debt, preventative techniques can be employed to predict the payment behaviour of regular customers. Such a preventative technique, in the form of a machine learning model embedded within a decision-support system, is proposed in this paper with a view to assist companies in prioritising debt collection resources to invoices most likely to be paid late. The system is

capable of predicting payment behaviour outcomes linked to invoices as anticipating payment receipts during one of three intervals: 1-30 days late, 31-60 days late, or at least 61 days late. The underlying model of the decision support system is identified by selecting a suitable algorithm from among a pool of candidate machine learning algorithms. This selection process requires the adoption of a methodological approach. A machine learning development roadmap is proposed for this purpose and applied in a practical, illustrative case study involving real industry invoice data.

Keywords: machine learning, invoice payment prediction problem, preventative decision support. *Status*: Complete results

Biography of the speaker: Louis is a final year undergraduate industrial engineer at Stellenbosch University. Mr Willem Moore is his supervisor.

A framework for decision support in inventory management pursuant of economies of scale

Hans Jurie Zietsman, Jan Van Vuuren

Department of Industrial Engineering, Stellenbosch University

The success of any business depends on how well it is able to satisfy customer demand, while remaining financially viable. Globalisation and the growth of e-commerce have resulted in retail businesses having to manage increasing numbers of products. As the number of products sold increases, so does the complexity of the corresponding inventory management problem.

High-quality decision making, in this regard, necessitates the utilisation of computerised decision support systems capable of accommodating the complexity presented by a large number of products. Existing frameworks for decision support in inventory management are mainly focused on a single facet of the inventory management problem — generic, integrated frameworks seem to be absent from the literature. In this paper, a holistic framework design is proposed which integrates all of the major components expected to form part of a generic framework for inventory management. The objective of the framework is to provide decision support in respect of various inventory management operations, such as product segmentation, demand forecasting and determining the sizes and timings of replenishment orders, in pursuit of a desirable balance between the conflicting objectives in inventory management.

Keywords: framework design, inventory management, decision support. *Status*: Complete results

Biography of the speaker: Hans Jurie Zietsman is a PhD candidate in Industrial Engineering at Stellenbosch University as part of the Stellenbosch Unit for Operations Research and Engineering.

A framework for modelling spatio-temporal competition and spread of invasive biological species

Alexander Flemming, Jan Van Vuuren

Department of Industrial Engineering, Stellenbosch University

Invasive alien species are non-native introduced species that negatively impact the natural species of an area. The spread of these species cause natural functioning ecosystems to break down, leading to further invasions and can ultimately lead to the extinction of the indigenous species of the area. The application of automated processes aimed at the construction of a generic framework capable of conducting three facets of invasive species modelling is pursued in this paper. The first is to conduct spatial analyses of ecosystems in South Africa containing invasive species and to construct spatial data sets that map the distribution of these species in selected study regions. The second is a machine learning algorithmic approach aimed at determining which environmental characteristics within a study region may be attributed to the distribution of invasive species within the ecosystem thereof. This approach is applied to predict areas that may require investigation due to likely unmapped occurrences or predicted future spread of invasive species, based on the area's capability to sustain these species. Finally, a grid-based spatio-temporal modelling approach, known as cellular automata, is applied to simulate the spatio-temporal competition between, and spread of, invasive species over a desired period of time.

Keywords: ecosystem management, framework design, machine learning. *Status*: Complete results

Biography of the speaker: Alexander Flemming is enrolled at the Department of Industrial Engineering at Stellenbosch University and a member of the Stellenbosch Unit for Operations Research and Engineering.

Parallel Session 4: Finance

Modelling stock markets intergration: A case between South Africa and G7 countries.

Jakubose Sibanda, Jones Odei Mensah

University of Witwatersrand & TSIBA Business School

This paper investigates stock markets integration between South Africa and G7 countries. Should there be shocks to the South African stock market this could cause financial instability. The degree of integration between South Africa stock markets and G7 stock markets is studied using wavelet-based method and frequency domain spillover index. The study utilises daily stock market data obtained from Data Stream of the period from 7 January 2005 to 22 December 2021. The knowledge will be critical given that shocks to South African markets can be detrimental to the success of the South African economy. The coherence plot and the multiple cross correlation of stock markets indicated a high degree of all markets co-moving together in the long term. The extreme scales indicate no market as the leader in the market maximising multiple correlations against a linear combination of assets within the investment portfolio. The findings recommend investing in countries that were characterised with low correlations zones within the multiple cross-correlation of stock market and high frequency bands typified by low wave multiple correlation. These results provide insights on the degree of market integration that will be critical in decision making for portfolio managers, regulators and policy makers on risk mitigating strategies.

Keywords: South Africa and G7 stock markets; Integration; Wavelet; Spillover. *Status*: Work in progress

Biography of the speaker: Jakubose Sibanda is a Doctoral candidate at the University of Witwatersrand his training is within the financial economics field. He holds two masters degree. The first one is a MSc in Operations Research from NUST, Zimbabwe and the second one is MM Finance and Investment from the University of Witswatersrand. He has been practicing as a lecturer for approximately 10 years in mathematical; statistical; econometrics; finance; risk management and investment management courses. His research interests are asset markets nexus; financial markets microstructure and corporate finance. He is currently a full time faculty member at TSIBA Business School in Capetown where he teaches Corporate Finance; Entrepreneurial Finance and Enterprise Risk Management in the Bachelor of Business Administration and Postgraduate Diploma in Business Administration programmes. He is also a programme convenor for a Higher Certificate in Business Administration. He is also contracted to supervise applied resarch projects for Masters of Business Administration students at the University Witwatersrand in Johannesburg, South Africa.

Toward A General Framework for Modelling Roll-Over Risk

Mesias Alfeus

Stellenbosch University

Quantitative Finance underwent significant development over the past decade. For example, modelling the term structure of interest rates after the GFC poses a unique challenge. The persistent phenomena of market basis spreads are an indication that markets are pricing various risks which are not captured in classical models. We pioneer a roll-over risk modelling framework to provide empirical evidence to the observed basis spreads, i.e., a spread between LIBOR of different tenors and LIBOR-OIS spread. This roll-over risk consists of two components, a credit risk component due to the possibility of being downgraded and thus facing a higher credit spread when attempting to roll over short–term borrowing, and a component reflecting the (systemic) possibility of being unable to roll over short–term borrowing at the reference rate (e.g., LIBOR) due to an absence of liquidity in the market. The modelling framework is of "reduced form" in the sense that the source of credit risk is not modelled (nor is the source of liquidity risk). We show how such a model can be calibrated to market data, and used for relative pricing of interest rate derivatives, including bespoke tenor frequencies not liquidly traded in the market.

Keywords: Roll–Over Risk, Basis Spread, LIBOR–OIS, Funding Liquidity risk, Multiple Tenors. *Status*: Work in progress

Biography of the speaker: Dr Alfeus is a Senior Lecturer in the Department of Statistics and Actuarial Science at Stellenbosch University, South Africa. He has a PhD in Quantitative Finance from the University of Technology Sydney (UTS) in Australia with a dissertation entitled "Stochastic Modelling of New Phenomena in Financial Markets". He is a Mathematician by training with a BSc degree in Mathematics and Physics from the University of Namibia. He holds masters and honours degrees in Financial Mathematics both with Cum Laude from Stellenbosch University, South Africa. He holds a long list of academic awards, and he was the winner of the 2018 International Young Investigator Training Program (YITP) prize at the XIX Workshop on Quantitative Finance held at the University of Rome Tre in Italy. He held an academic visiting position at the University of Padova, northern Italy. He previously worked as a Risk Analyst at Namibian Financial Institutions Supervisory Authority (NAMFISA), a Research Associate at UTS Finance, a Lecturer of Financial Mathematics at the University of Wollongong Australia, and AIFMRM Postdoctoral Research Fellowship at the University of Cape Town. His current research interests focus on Computational and Mathematical Finance, more specifically in numerical methods for pricing of options and model calibration including model empirical analysis.

Predicting movements in financial markets with support vector machines

Kyle Harrison, Stephan Visagie

Department of Logistics, Stellenbosch University

Machine learning has been successfully applied across multiple disciplines from transport to advertisements and of course the prediction of financial markets. Many traders use technical indicators to make trading decisions. In this presentation price history together with technical indicators are investigated as possible features to predict profitable trade opportunities.

A model is presented that uses simple moving averages as a base indicator to signal trades. The aim of the model is to accurately identify when the simple moving average signals a buy/long or sell/short trade accurately. An accurate signal is when the value of the commodity's price moves by more than 2 percent – the take profit level – in the direction of the predicted trade. A stop loss is also implemented and is triggered when the price moves 1 percent in the opposite (than predicted) direction. This limits the losses made when the price moves against the trade.

The problem is modelled by two support vector machines, one for buy trades and one for sell trades. The support vector machines are trained over a period of 6 months. A range of technical indicators is also given as features to the support vector machines. The support vector machine should identify from the values of the technical indicators, profitable and non-profitable trades.

The support vector machines are then tested in a walk forward manner. The model predictions are then compared on historical data to investigate overall accuracy. The models' predictions are also tested against common trading strategies such as the naïve method, buy and hold method and the simple moving average method. Test are performed on gold prices, Bitcoin prices and Microsoft Corporation share prices. Support vector machines slightly increase profits across the different financial markets but perform best in periods of consistently trending market prices.

Keywords: support vector machines, technical indicators, trading, financial markets, machine learning. *Status*: Complete results

Biography of the speaker: Kyle Harrison is currently doing his honors in operational research through the Stellenbosch University logistics department. He completed his undergrad studies in BCom with a focus in mathematical sciences. His interests include financial markets, business analytics and exploring new innovative investment opportunities.

Scoring and Regulatory Capital Decisions in the Context of Economic Uncertainty

Kanshukan Rajaratnam, Peter Beling, George Overstreet

School for Data science and Computational Thinking

When granting loans, each applicant's associated default probability determines both the profitability and the required minimum regulatory capital. However, this capital amount is dependent on the prevailing economic condition during the loan period. Suppose, the portfolio manager retains capital at acquisition stage adequately for any future economic scenario.In this paper, we show methods to improve the computational efficiency of simulation used to determine pareto-optimal decision points.

Keywords: Credit risk, simulation. *Status*: Complete results

Biography of the speaker: Kanshukan Rajaratnam is the director of the School for Data Science and Computational Thinking at Stellenbosch University. His research interests are in applying Operations Research and Data Science methods to Finance and Banking problems.

Parallel Session 5: Miscellaneous

Designing a more efficient Interactive Voice Response (IVR) system through data analytics and simulation

Marno Du Plessis

Discovery Health

Interactive Voice Response (IVR) is an automated phone system that allows callers to interact with a menu system via voice or keypad in order to be routed to the correct call centre department, or to access information (without a live agent). At Discovery Health, the largest medical scheme administrator in South Africa, an IVR system is most often the starting point of a customer interaction and it is therefore paramount that each IVR in the business is designed for an efficient customer experience. Additionally, it is imperative that callers get routed from the IVR straight to the correct departments to not only enhance the customer journey, but also to minimise

transfer rates and associated costs. Previously, Discovery Health's attempts to redesign their most popular IVR systems have been hampered by a lack of readily available IVR data, but this has changed in recent years.

In this presentation, an account is given of how Discovery Health now employs data analytics and simulation as tools to inform more efficient designs of its IVR systems. Firstly, the novel process of joining previously unstructured IVR data to structured call centre data to form an invaluable data asset capturing end-to-end caller journeys is described. Techniques for analysing this particular data asset, along with a summary of Discovery Health's main findings and associated redesign suggestions, are put forward. Finally, the use of simulation as a methodology for experimenting with different IVR designs and evaluating each design's effectiveness, is demonstrated.

Keywords: interactive voice response, call centre, simulation, optimisation. *Status*: Complete results

Biography of the speaker: Marno du Plessis started working as a data scientist in Discovery Health's Data Science Lab in 2020, focussing on operational and servicing-related challenges. He obtained his master's degree in operations research in the Department of Industrial Engineering at Stellenbosch University in March 2020. He was awarded the prestigious Gerhard Geldenhuys Medal for the best fourth-year project in operations research in South Africa by the Operations Research Society of South Africa in 2018.

A game theoretical study of the Sermon on the Mount

Esranel Becker, Lieschen Venter

Department of Logistics, Stellenbosch University

Life in community is a constant game of give and take, winning or losing. How does one win in the game of life? The Sermon on the Mount given by Jesus Christ in the Gospel of Matthew can be seen as strategies for life in community according to Christian tenets. At first glance, these strategies may not appear to be a winning approach. In fact, they are contradictory to what intuitive systems view as victory. What is relational and moral victory and how do we quantify it? Are the strategies as set out in the Sermon on the Mount ever preferable especially in repeating games? Game theory gives a new perspective by which to analyse theological concepts. The counter-intuitive strategies of self-sacrifice might be the hidden golden key to unlocking unexpected victories.

Keywords: Game theory, theological modelling, social and behavioural analysis. *Status*: Work in progress

Biography of the speaker: Esranel Becker hails from Namibia and is currently enrolled for a BCom Honours degree at the Department of Logistics at Stellenbosch University. Her research interests include finding innovative ways to quantify complex qualitative concepts and to transform these for mathematical modelling and optimisation.

Scaling point in polygon to support false positives with zero false negatives

Robert Bennetto

Icepack Limited

In this talk we'll discuss some of the computational issues surrounding performing "Point-in-Poly" queries against a global map database. Data structures surrounding improving the query time will be outlined as well as the standards to support arbitrary precision when performing computational geometry tasks. Lastly, we'll talk about the real world application of supporting false positive queries, but with zero false negatives, how the data are manipulated to support such queries, the combinatorial problem involved in the decomposition, the performance gains achieved, the memory trade-off incurred, and how this relates to the management of global hardware infrastructure.

Keywords: Computational geometry, point in poly, algorithmic complexity analysis, decomposition. *Status*: Complete results

Biography of the speaker: (don't read this) *Editor's note: overruled* Rob is an ORSSA stalwart and a founding member of the Order-of-the-computational-complexity - a religious belief that each wasted computational cycle needs to be repaid in the afterlife, by hand. As such, he spends most of his days concerned with polynomial time approximations so that he can have a happy afterlife.

Parallel Session 4: 6: Applications: Production and Logistics

Wagon Project: The wagon loads and false positives, distinguishing between leads and lags

Ashley Nunkissor

Transnet Freight Rail

This research project highlights the role of the railway wagon and the various KPIs that are tracked to optimise the performance of wagons. By grouping the KPIs in terms of leading and lagging, we can determine which are the most appropriate levers in the optimisation of wagon performance. The key objective is to determine the role of accounting for tonnages (output) before operation. This concept removes the pull factor for wagons by their respective flow destination yards, due to the tonnages/loads having already been banked. The impact of this is wagon delays that impedes the fluidity of the network, ultimately resulting in increased operational costs and an overall reduction in volume and revenue performance. To test if this is a behavioural factor, we propose a hypothesis test to determine the impact on operational performance, if we shift the accounting of tonnages from T2. . . ie loading to T3..ie off loading.

Keywords: Railway, Wagon, Hypothesis testing. *Status*: Work in progress

Biography of the speaker: We have collectively worked at TFR for more than 23 years. We have served various roles in ICT, Technology Management and Performance Management. We have formed part of the Enterprise Information and Performance team for the last 4 years where we focus on delivering data driven insights to our CE and EXCO.

A Brief History of Rail in South Africa

Chupisha Saasa, Luciano Naidoo

Transnet Freight Rail

As a State-Owned Company, Transnet's core mandate is to assist in lowering the cost of doing business in South Africa, enabling economic growth and ensuring security of supply through the provision of appropriate ports, rail and pipeline infrastructure. The history of the South African Railway is marked by pioneering; periodic adjustments to changing economic conditions; sustained technical progress in the field of modern transport; and a complex rail network with a route distance of approximately 20 900 km. This presentation will provide an overview of the railway system in South Africa with specific focus on Transnet Freight Rail (TFR), the largest operating division within Transnet . It will cover; The birth of the railway, critical milestones, what brought about its initial need, how it has transformed from pre to post democracy and its objective in more recent times A comparison of South Africa's railway to railways abroad Distinguish between the organisations PRASA and Transnet Freight Rail TFRs size in relation to assets, associated systems and the quantum of data generated by those systems

Keywords: Railways, Railway Benchmarking, Railway asset base. *Status*: Work in progress

Biography of the speaker: We have collectively worked at TFR for more than 23 years. We have served various roles in ICT, Technology Management and Performance Management. We have formed part of the Enterprise Information and Performance team for the last 4 years where we focus on delivering data driven insights to our CE and EXCO.

Die evaluering van die produksievloei by 'n jogurtfabriek in Suid-Afrika

Annelie Wessels, Linke Potgieter

Shoprite Holdings

Jogurt is 'n bederfbare produk en uiters sensitief vir tyd, temperatuur en hantering. Hoe langer dit neem om die produk te vervaardig, te verpak en te versprei, hoe groter is die kans vir beskadiging en terugsendings. Daar is ook verskeie kostes verbonde aan die stoor van die produk terwyl dit afkoel en wag om versprei te word. Die betrokke maatskappy wil 'n groter fokus op intydse verskaffing plaas. Om die vlak van intydse verskaffing te verbeter, moet produkte so vinnig en effektief as moontlik deur die fabriek beweeg. Produkte wat vinniger deur die fabriek beweeg het 'n laer drakoste, skep nuwe stoorspasie vir ander produkte en verlaag die risiko van terugsendings. Die hoofdoel van die studie, sowel as van die maatskappy, is om die tyd wat produkte in die fabriek spandeer, te verminder. 'n Diskrete gebeurtenis simulasiemodel is ontwerp en gebou met die doel om te eksperimenteer met verskillende scenario's wat moontlik kan lei tot die vermindering van die tyd wat produkte in die fabriek spandeer. Kwalitatiewe data is ingesamel deur verskeie gesprekke met die produksiebestuur, koelkamerbestuurder en bedryfshoof te voer. Kwantitatiewe data is ingesamel deur observasies in die fabriek self. Jogurtprodukte se verpakkingstye is geneem en die produkvloei is gedokumenteer. Die model verteenwoordig die verskillende afdelings in die fabriek. Sewe alternatiewe scenario's is met mekaar vergelyk deur toepaslike veranderinge aan die basismodel te maak. Die model se uitslae is gemeet deur drie prestasiemaatstawwe met mekaar te vergelyk, naamlik hantering, tyd en ledigheid. Twee belowende scenario's is geïdentifiseer waar 'n verandering in die huidige produkvloei in die fabriek aangebring is. Hierdie veranderinge sluit in die installering van blaasvrieskaste en 'n bykomende toedraaimasjien by die verpakkingstasies. Die uitslae is aan die produksiebestuurder gekommunikeer deur vergaderings en 'n nie-akademiese verslag. Yogurt, a perishable product, is, amongst other things, sensitive

to time, temperature and the handling thereof. The longer it takes to produce, pack and distribute the product, the greater the chances are of it being damaged or sent back. Other costs like carrying costs are also influenced by the time these products spend in the factory. The chosen company wants to focus on just-in-time delivery. To increase their level of just-in-time delivery, products need to move through the factory as fast and efficient as possible. Faster moving products have less carrying costs, create more space for other products and minimise the risk of returns. The main goal of this study, and of the company, is to shorten the time products spend in the factory. A discrete event simulation model was developed for the purpose of experimenting with different scenarios that may shorten the time products spend in the factory. Qualitative data was gathered through conversations with the production manager, the cold room manager and the chief operating officer. Quantitative data was gathered by observations in the factory by measuring the packing times of the yogurt containers and documenting the product flow. The model represents all the different stations in the factory. Seven alternative scenarios were compared by making appropriate changes to the base model. The simulation results of the model are measured by the three performance indexes: handling; time; and idleness. Two promising scenarios were identified in this study, which will require a change in the current product flow through the factory, namely the installation of blast freezers and the installation of an additional wrapping machine in the packing area. Results were communicated to the production manager through various meetings and a non-academic technical report.

Keywords: diskrete gebeurtenis simulasie, jogurtproduksie, produkvloei. *Status*: Complete results

Biography of the speaker: Annelie het haar MCom in Kwantitatiewe Bestuur aan die Universiteit van Stellenbosch in 2021 verwerf. Sy werk tans as 'n data-ontleder by Shoprite Holdings.

Data Cleaning using OpenRefine: A Case of Blast Incidents and Explosives Research Data Extraction from Social Media Platforms

Matshidiso Marengwa

Council for Scientific and Industrial Research

The increase in explosive and blast incidents has resulted in the need for a method or tool to help monitor and keep track of said incidents to provide insight into the methodologies and devices used by attackers to develop counter-active measures. The prevalence of social media in society has harnessed the generation of data and information which can be applied by organisations to improve functions and processes which in turn helps aid decision-making. With regards to the field of explosives, more institutions and news outlets have opted for the use of social media and other online platforms to share real-time data pertaining to explosives and blast related incidents and events that occur on a global scale. This study presents a method for extracting and capturing data pertinent to the field of explosives research from social media sites and other online platforms through monitoring and highlighting any blast related incidents, events and trends.

The data used in the paper was collected over a period of 10 months and retrieved and extracted using a predetermined form which specified the type of information that should be mined and processed. The data was then cleaned, visualised and presented using various techniques available on the OpenRefine application. This data then provided insight into, but not limited to questions such as: the most prevalent sources, types of blast incidents or events, the types of devices used; casualties etc.

The results of the study helped improve operations within the unit through enabling the identification and improvement of training efforts by shedding light on the effective methodologies and techniques used by explosives ordnance disposal (EOD) groups. The results of the study also helped compile a list of tope perpetrators and users of explosives; potential suppliers and/or collaborators which can be used if the need prevails and the data regarding the countries with the highest incidents helped to shift the focus on which states to keep track of.

Keywords: data extraction, data incidents, data cleaning, social media, twitter, explosives, OpenRefine. *Status*: Complete results

Biography of the speaker: Matshidiso Marengwa is currently employed at the CSIR as a researcher in the Defence and Security cluster and has been at the CSIR for 8 years. She has a BIS (Hons) in Information Science and a MIT (Masters in Information Technology - Stream A) from the University of Pretoria. Her research interests include Information and Knowledge Management, Ontology Engineering, Model-Based Systems Engineering, Operations Research, Information Architecture and Information Retrieval and Extraction.

Using deep learning and affective computing to acquire sentiment on information security policies

Tiny Du Toit, Hennie Kruger, Lynette Drevin, Nicolaas Maree

North-West University

Information security behaviour has emerged as a prominent topic in several research studies due to its incorporation into business operations. Information security policies (ISPs) are one of the most essential tools for influencing information security behaviour. The protection of information assets is governed by these policies, which are formalised rules and regulations. Although several ISP and related studies exist, many studies identify ISP non-compliance as a significant contributor to undesirable information security behaviour. Notably, these studies do not often focus on users' or employees' perceptions of the content of the ISPs with which they are expected to comply. The standard method for gathering user or employee feedback is to conduct a survey. However, surveys provide unique challenges in the form of false responses and response bias, making results often unreliable and worthless. This research proposes a deep learning approach to affective computing for facial expression sentiment analysis. The study aims to address the problem of response bias that may occur during an opinion survey and provide decision-makers with a tool and methodology for evaluating the quality of their ISPs. The proposed affective computing methodology generated positive results in an experimental case study. The deep learning model accurately classified positive, negative, and neutral opinions based on facial expressions that conveyed sentiment.

Keywords: Affective computing, Deep learning, Information security policies, Non-compliance, Sentiment analysis. *Status*: Complete results

Biography of the speaker: Prof Tiny du Toit obtained his PhD in Computer Science at the North-West University. Currently, he is an associate professor in Computer Science at the university where he lectures and performs research in the field of deep learning.

Machine Learning in online environments.

Robert Bennetto

Icepack Limited

A multi-window LSTM implementation (analogous to a convolutional MLP) is presented as a baseline model. We discuss the non-trivial requirements of production environments and which frameworks meet the requirements of such environments. Key differences between the popular frameworks such as Tensorflow (Keras) and Pytorch are discussed as well as pit-falls, bottlenecks and implementation workarounds. This talk is the product of months of trial and error in the Reinforcement Learning space and should provide new entrants to ML with key considerations they should note when tooling applications for online purposes.

Keywords: Machine learning, LSTM, online,. *Status*: Complete results

Biography of the speaker: (don't read this) *Editor's note: overruled* Rob is an ORSSA stalwart and a founding member of the Order-of-the-computational-complexity - a religious belief that each wasted computational cycle needs to be repaid in the afterlife, by hand. As such, he spends most of his days concerned with polynomial time approximations so that he can have a happy afterlife.

Lessons learnt from neurochemistry as a framework for information transfer, be it a switch or the Universe to the mind.

Rupert Spann

SARAO

The talk presents the parallels between how brains grow using chemicals tags to build its structural relationships between different sections and how information can be treated in the same manner. The motivation for a brain based model for information structure was derived from the human requirement for information discovery to improve cohesive, coherent and efficient decision making through human machine interfaces. In parallel the information structure is standardised for integration of data from disparate sources for automated systems.

Keywords: information,data mining, information mapping, information exploration. *Status*: Work in progress

Biography of the speaker: Rupert Spann completed a degree in mathematics and computer science via correspondence, while laying bricks and optimising construction times, dissecting brains, modelling container terminals in Barcelona, writing multi-threaded telephony systems in User interfaces Frankfurt, doing meteorological site analysis for the Thirty Meter Telescope, and spent a year on Gough Island looking at the clouds,

After completing his Hons in Astophysics and Space science - he is currently working on the SARAO / SKA / MeerKAT project as the (Telescope) Operations Development Manager.

Parallel Session 8: Decision Support Systems

Teaching vs learning DSSs

Annette Van Der Merwe

North-West University

The module outcomes of many programs presented at the tertiary level relate to teaching fundamental concepts with little or no case-related implementation. The module, Decision Support Systems (DSS), presented to third-year IT students at the North-West University, introduces mathematical modelling approaches to solve specific, real-world business, statistics, and logistics problems. However, a balanced trade-off between teaching optimisation, simulation, decision analysis, queuing, etc., and the art of reasoning logically with formal models needs to be instilled. The goal should be to teach students to think of novel problem-solving methods rather than expecting them only to relate the steps required in an algorithm and use them as tools. Furthermore, the swift introduction of online learning platforms necessitated novel approaches to developing various assessment tools that can be used in any environment. In addressing these issues, an andragogical teaching approach was followed, rendering students responsible for their own learning. They were required to design and personally manage their own virtual businesses by systematically using and implementing the problem-solving modelling techniques studied in the DSS module. Automated electronic quizzes further supplemented the learning process to ensure personalised formative assessments which can be taken anytime without compromising academic quality. While modelling techniques formed part of the module content, linear programming with scalable weights was also used in the final mark calculation. Despite a short learning curve, students exhibited a general sentiment of ownership in the learning event: they felt they could control how their marks would be calculated and were in part responsible for designing an assessment tool applicable to the specific learning outcomes of the module.

Keywords: automatic assesment, decision support systems, education. *Status*: Complete results

Biography of the speaker: Annette van der Merwe completed her PhD in Computer Science in 2018 at the North-West University in Potchefstroom. She works as Computer Science lecturer in Decision Support Systems and Artificial Intelligence at the University and as part of her research she is developing, implementing and evaluating mathematical models for use in educational applications.

A Decision Support System for Decentralised Waste Utilisation in South Africa

Mareli Botha, Stephanus Esias Terblanche, Ruan Luies

North-West University, Potchefstroom

The concept of waste valorisation is relatively new in South Africa for numerous reasons. Firstly, the South African economy is historically linear concerning waste and resource reuse [1]. Though the principles of the waste hierarchy are noted in various policies, regulations, and strategies [2], effective waste management remains an issue. Secondly, waste management in South Africa is the responsibility of the municipalities [3]. In the context of the Polluter Pays Principle [4], the waste producer is responsible for all costs associated with the waste stream, but the waste management responsibility lies with the local government. Thirdly, though effective waste management is notably ill-implemented [5], centralised services remain the status quo with little focus being placed on decentralisation [6]. In this context, an opportunity exists for sustainable business development around waste utilisation with a focus on decentralisation and public sector participation. This implies the need to identify viable projects for implementation, where project viability is dependent on understanding and optimising parameters that influence waste management projects, such as financial, social, technical, legal, environmental, and risk-based considerations. For this work, a novel Waste Utilisation Decision Support System (WUDSS) for decentralised waste utilisation in South Africa is defined, developed and evaluated. The system focuses on small-scale (10 ton/day), general waste utilisation to develop small, medium and macro enterprises (SMMEs). The WUDSS model is a five-tier process, which includes Inputs, Step 1 Conversion Processes, Intermediate Products, Step 2 Conversion Processes and End-Products. As model inclusions, 7 feedstocks are selected together with 17 Step 1 and 23 Step 2 processes. In total, this allows for more than 600 unique combinations of inputs, processes, and outputs that are modelled as part of this study. Next, the WUDSS is abstracted by defining, quantifying, and modelling each parameter that influences waste utilisation decision-making from first principles. Process design principles are applied to model each included process. Environmental factors such as emissions, liquid and solid waste streams are defined as outputs of the mass and energy balances. Financial modelling is completed for outputs that could prove a potential project's viability. Social factors are also defined, considering both direct and construction-based job creation. Legal and regulatory guidance are also provided based on typical requirements, licenses or permits for potential projects. To simplify decision-making, other guidance functions are added which include, amongst others, quantification of predictable project risks to be capitalised and included in the project contingency as well as an optimisation function. Once the model has been set, a prototype is created for verification and validation. The outputs are compared to values from historical projects, literature, and case studies. During the mass balance verification, the accuracy of the WUDSS technical outputs is tested. It was found that 94% of the 63 results fell within the required accuracy ranges. The financial verification showed that 82% of the benchmark data fell within the ranges predicted by the system. Where the benchmark data fell outside of the ranges, the predicted median cost was found to correlate well with the data points. Lastly, three

case studies were simulated to validate the system. For all three studies, the WUDSS was able to closely match the actual results published in the case studies. As a result, the system was found to be adequate for decision support for decentralised waste management in South Africa.

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Keywords: Waste management; decision support; industrial ecology; circular economy; decentralisation; business development. *Status*: Complete results

Biography of the speaker: Mareli is a Senior Process Engineer and Project Manager, currently employed by Zutari as Team Lead for the Process Mechanical Group. She has worked on a number of projects in Africa, Australia, Europe, America and the Middle East, mostly in the role of technical process lead. She is involved in projects in various fields, including industrial ecology / circular economies, waste to energy, food processing, plasma engineering, emission reduction, petrochemical and gasification. Mareli obtained a Master of Science in Project Management for Energy and Environmental Engineering in 2017 from the École Nationale Supérieure Mines-Télécom Atlantique Bretagne-Pays de la Loire or École des Mines Télécom Atlantique (IMT Atlantique) in France and a Bachelor of Engineering in Chemical Engineering from the North-West University (NWU), South Africa, in 2014. She is a registered professional engineer with the Engineering Council of South Africa (ECSA) and a registered Project Management Professional (PMP) with the international Project Management Institute (PMI). She has also published two articles in the fields of plasma engineering for waste management and pollution abatement.

Self-organising maps for feature interpretation in anomaly detection

Richard Ball, Hennie Kruger, Lynette Drevin

Computer Sciences and Information Systems, North-West University

Anomaly detection is a machine learning approach for identifying observations that differ significantly from the majority of the observations within a data set. An important application of anomaly detection is fraud detection, where various techniques are applied in order to detect financial fraud. One of these approaches, autoencoders, are powerful neural networks that excel in detecting anomalies in unlabelled data. In this paper, an autoencoder was developed to detect anomalies in a transactional system. The model was trained using a real-world transactional data set sourced from an organisation in the financial services industry. The autoencoder was extended by incorporating social network analysis metrics as training features, including metrics such as PageRank and degree centrality. Applying SHAP to the output of the autoencoder showed that both transactional and network metrics features contribute significantly to the detection of anomalies. Self-organising maps are then introduced in order to understand the nature of the anomalies in more detail. Various visual analysis techniques are employed, including node activation frequency, class distribution, and class proportion methods, as well as u-matrix and component plane analysis. Component plane analysis proved to be a valuable technique for determining feature importance as well as for detecting anomalous subgroupings in the data. The findings from the component plane analysis confirmed the results of applying SHAP on the autoencoder output for determining feature importance for the anomalies detected. The self-organising map produced feature contributions that overlapped significantly with those determined by the SHAP approach, for a fraction of the computational effort. Future work will entail combining the autoencoder and self-organising maps into a consolidated decision-support system for detecting anomalies in a transactional setting.

Keywords: Anomaly detection, Autoencoder, Self-organising maps and neural networks. *Status*: Complete results

Biography of the speaker: The speaker, Richard Ball, is currently completing his PhD in Computer Science through North-West University. His research topic is "A machine learning-based decision support system for anomaly detection". Richard also works at Luno as the Lead Data Scientist, where he focuses on applying machine learning and network analysis for fraud detection.

Investigation into a Surrogate Test System for Kinetic Energy Less Lethal Projectile Validation

Winnie Pelser, Philip Roach

CSIR

Problem description : Non-lethal or less-lethal weapons are designed and developed to minimize permanent injury or death, repel, or dissuading belligerents to continue with their selected course of action by inflicting pain and/or temporarily incapacitating the individual or target group. There are weapons, which are 100% lethal, but thus far unfortunately there are no weapons, which are 100% non-lethal. Non (or less)-lethality is dependent on the inherent nature of the weapon, the way a weapon is used and the vulnerability of the opponent or equipment [1]. As different parts of the body differ in vulnerability, and because people vary in physiology, any weapon powerful enough to incapacitate may be capable of killing under certain circumstances. Thus "less-lethal force" does have some risk of causing death: in this context "less-lethal" means only "not intended to kill or permanently injury" [2]. This aim of this presentation is to discuss ways of testing kinetic energy less-than-lethal projectile (KELTLP) weapon ammunition in a reliable and repeatable way using materials that closely replicate human skin and soft tissue. Solution technique description The project started with a literature study to look at international methods to approach the possible test methods. The presentation will define the difference in design (hard, rigid & fast vs slower, flexible and heavier KELTLP weapon ammunition. Describe possible methods to test KELTLP weapon ammunition for "safe" use against civilians during riots or unrests. Indicate the most viable solution. Summary of results At the time of writing this submission all tests were not completed. In the presentation progress and lessons learned so far will be discussed, as well as the road ahead.

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Keywords: Quantifying injury risk of non-lethal projectiles, Surrogate Test System, Skin surrogates, Soft tissue surrogate. *Status*: Work in progress

Biography of the speaker: Winnie Pelser is a Defence Analyst at the CSIR with many years of experience in Defence projects. Currently working at the Landward Defence Impact Area. Specialising in research on a variety of areas as well as systems engineering.

On the conditional distribution of the mean of the two closest among a set of three observations

Jaco Visagie, Fred Lombard

North-West University

Chemical analyses of raw materials are often repeated in duplicate or triplicate. The assay values obtained are then combined using a predetermined formula to obtain an estimate of the true value of the material of interest. When duplicate observations are obtained, their average typically serves as an estimate of the true value. On the other hand, the "best of three" method involves taking three measurements and using the average of the two closest ones as estimate of the true value. In this talk, we consider another method which potentially involves three measurements. Initially two measurements are obtained and if their difference is sufficiently small, their average is taken as estimate of the true value. However, if the difference is too large then a third independent measurement is obtained. The estimator is then defined as the average between the third observation and the one among the first two which is closest to it. Our focus is the conditional distribution of the estimate in cases where the initial difference is deemed too large. We find that the conditional distributions are markedly different under the assumption of a normal distribution and a Laplace distribution.

Keywords: Conditional density, normal distribution, Laplace distribution, closest two out of three.. *Status*: Complete results

Biography of the speaker: Jaco Visagie is from the North-West University's Statistics Department. He obtained his PhD in 2015 under the supervision of Prof Fred Lombard. Jaco's specialisation is goodness-of-fit testing as well as the use of Lévy processes in financial modelling.

Optimal crop grouping using clustering algorithms with/without outliers

Stefany Bam, Olukanmi Peter, Micheal Olusanya

Sol Plaatje University, Kimberley

Crop recommendation is used to determine which crop farmers should plant based on environmental attributes such as the pH of the soil, the relative humidity, and the rainfall. This research seeks to evaluate the performance of six different classification algorithms on datasets with/without outliers where clustering algorithms are used for optimal crop grouping. DBSCAN and k-Means clustering was used to cluster each individual crop into their

optimal grouping. For k-Means clustering, the elbow method was used to determine the optimal number of clusters for each individual crop. In the case of the DBSCAN algorithm the epsilon value was determined using the k-distance graph and then we specified the minimum sample value. These crop groupings are then used to create new target variables which intern is used to create new datasets. The DBSCAN algorithm is used to identify 'Noise' points in the original dataset. These points will be treated as outliers which will be removed from the different datasets. The accuracy of the models was calculated using the average cross-validation and F1 score. The execution time of each model is recorded for all three datasets with and without outliers. Approximately 10,45% of the dataset is outliers. From that 10,45% ,73,04% of the outliers were pigeon peas and papaya. 92% of the pigeon peas are outliers and 76% of papaya are outliers. Gaussian Naïve Bayes had the highest accuracy score and lowest execution regardless of the labels in the dataset. k-NN and decision trees had the second-best accuracy followed by SVM. Using the results from the Cross-validation average score, it is best to use the dataset with the ungrouped original labels and with/without outliers since the difference is 0.09%. It is advised to use the DBSCAN labels without outliers for the second-best results. For the F1 accuracy score, it is best using the dataset with the ungrouped original labels and with outliers. Finally using the DBSCAN labelled dataset gives you the second-best results. Using the average execution time, it is best to use the original dataset without outliers since it has the lowest execution time followed by the DBSCAN labelled dataset without outliers.

Keywords: Crop grouping, Clustering Algorithms, Outliers. *Status*: Work in progress

Biography of the speaker: Stefany Bam received her B.Sc (Data Science) degree at Sol Plaatje University, Kimberley. She is currently doing her hons degree in Data Science at the same university. And a student member of ORSSA.

Parallel Session 10: Health Management

The design and implementation of an affinity matching model at Discovery Health

Marno Du Plessis

Discovery Health

Discovery Health is the largest medical scheme administrator in South Africa, providing administration and managed care services to more than 3.3 million beneficiaries across various medical schemes. Every day, Discovery Health's call centre plays a critical role in the servicing of its medical scheme members and considerable effort is made to maximise the quality of each service experience. Some years ago, the business introduced the concept of so-called 'affinity matching' in its call centre environment. The premise of affinity matching is to match call centre agents with members – based on a particular set of features – so as to maximise the quality of the particular member-agent interaction. Recently, a need arose to design and implement an improved affinity matching model and this problem is considered in this paper.

In this presentation, a brief account is given of the original affinity matching methodology employed in the inbound call centre, before describing the need for, and the design objectives of, the new affinity matching approach. The implementation of the machine learning model that lies at the heart of this new affinity matching methodology, including descriptions of the model training and prediction steps, are also discussed. Finally, valuable lessons learnt during the model building step as well as the automation of this model at scale are shared.

Keywords: call centre, affinity matching, machine learning. *Status*: Complete results

Biography of the speaker: Marno du Plessis started working as a data scientist in Discovery Health's Data Science Lab in 2020, focussing on operational and servicing-related challenges. He obtained his master's degree in operations research in the Department of Industrial Engineering at Stellenbosch University in March 2020. He was awarded the prestigious Gerhard Geldenhuys Medal for the best fourth-year project in operations research in South Africa by the Operations Research Society of South Africa in 2018.

'n Stelselsperspektief van die impak van COVID-19 op 'n reeds wankelrige onderwysstelsel

Theresa Viljoen, Lieschen Venter

Department of Logistics, Stellenbosch University

Die WKOD se prioriteitsbeleid fokus op die versterking en verbetering van kreatiwiteit en paraatheid vir 'n veranderende wêreld. Dit vereis vroeë bekendstelling aan tegnologie in skole om die gaping tussen die huidige toestand en die plek waar toekomstige gegradueerdes moet wees, te verklein. Die COVID-19 pandemie het Suid-Afrika se basiese onderwysstelsel genoodsaak om baie vinnig besluite te neem met die gevolg dat leerders en onderwysers amper oornag in 'n onderwysmodel forseer is waar geen stelsel nog ontwikkel of geïmplementeer is om hulle te ondersteun nie. Hierdie gebeurtenis kan gebruik word in 'n ondersoek om te probeer vasstel of, indien 'n skoolmodel ontwikkel word wat voorsiening maak vir tegnologie en e-leer, dit nie die ongelykheid in ons huidige skoolstelsel kan verminder nie. 'n Ondersoek van die skoolmodel vóór die pandemie en 'n vernuwe skoolmodel wat

deur die pandemie aangemoedig is kan moontlik die vraag beantwoord oor wat die impak van die pandemie op die vooruitgang in skole in die Wes-Kaap is. Daar bestaan reeds 'n Hoërskoolsimulasiemodel (HSM) wat Graad 3, Graad 6 en Graad 12 leerders se vordering sowel as hulle kognitiewe ontwikkeling stelseldinamies simuleer. In hierdie lesing word die HSM bekendgestel en pogings om die model uit te brei met agentgebasseerde modellering (ABM) en verbeterde data-insameling word bespreek. Moontlike aanpassings aan die HSM word genoem sodat die model die post-pandemie navorsingsvrae sal kan beantwoord.

Keywords: tegnologie en e-leer in skole, impak van pandemie, post-pandemie Hoërskoolsimulasiemodel, Agentgebasseerde modellering. *Status*: Work in progress

Biography of the speaker: Theresa studied a B.Sc. (Mathematical Science) degree at Stellenbosch University after which she joined the teaching profession as a Mathematics teacher. After ten years of teaching she returned to Stellenbosch to further her studies. She is currently busy with her master's degree in Operations Research where she forms part of the STEP (System Thinking for Education Policy) group which consist of a team of system dynamics simulation modelers that tries to uncover the hidden dynamics behind poor academic performance. Her teaching philosophy is that mentorship and education can lead to a positive change in society.

LongCovid: A Data Science Perspective

Sunday Oladayo Oladejo, Kanshukan Rajaratnam,

School for Data Science and Computational Thinking, Stellenbosch University

The prolonged effects and the reoccurrence of the symptoms and health problems associated with COVID-19 are known as Post-Acute Sequelae of SARS-COV-2 infection (PASC), is widely regarded as LongCovid. These symptoms and health problems include shortness of breath, recurring chest pain, low oxygen levels, heart rate dysfunction, constant fatigue, joint and muscle pains, brain fog, loss of sense of smell and taste, sleep disturbances, depression, digestive problems, and kidney related problems, respectively. However, these symptoms and diseases may not be uniquely attributed to LongCovid. This may not be unconnected to LongCovid data on symptoms captured before and post COVID-19 for the respective patients, thereby creating ambiguity. Moreover, there have been very few open-source LongCovid datasets for the effective prediction and treatment of LongCovid. Additionally, data-driven systems will play a critical role in the management of LongCovid. In this work, we embarked on the creation of a South African LongCovid Repository in collaboration with medical and biologist professionals in South Africa. We explore the South African LongCovid Repository datasets in our analysis of LongCovid management. Moreover, the dataset has 845 data points representing patients and attributes such as comorbidities, symptoms, vaccination status, gender, age, cancer status, and chemotherapy status. The statistical analysis of the South African Long COVID registry data was carried out in a Jupyter notebook environment and the Pandas library was employed for data manipulation and statistical analysis. With the aid of an interactive Python data library, Plotly the visualization of the statistical analysis is illustrated using Sankey plots.

Keywords: LongCovid, Symptoms. Comorbidities, Data Science,. *Status*: Complete results

Biography of the speaker: Sunday O. Oladejo received PhD in Electrical and Electronic Engineering from the University of Cape Town, South Africa, in 2021. He is currently a postdoctoral research fellow at the School for Data Science and Computational Thinking, Stellenbosch University, Stellenbosch, South Africa. From 2007 to 2017, he was a Senior Core Network Engineer with Glo-Mobile, Nigeria. His research interests include radio resource management in wireless networks, artificial intelligence, swarm intelligence, optimization, computational thinking, data science and analytics.

Parallel Session 11: Applications: Miscellaneous

Towards optimal route planning for solar-powered battery electric vehicles

Ruan Luies, Fanie Terblanche

Elytica

There is expected to be increased worldwide BEV adoption since they require less expensive and less frequent maintenance than Internal Combustion Engine Vehicles (ICEVs). A significant problem with BEVs is range anxiety; route planning may help mitigate this. BEVs need frequent recharging during trips, which renders existing route planning methods used for ICEVs infeasible. Limited driving range, lack of charging stations and possible long charging times of BEVs affect the route choices significantly. BEV route planning may also lower BEVs' energy consumption and, consequently, the travel cost.

Current Mixed Integer Linear Programming (MILP) models consider multiple factors such as wind speed and -direction, solar irradiation in the case of a solar panel mounted on the vehicle, vehicle acceleration, and drive-train efficiency incorporated to determine optimal routes. We extend one of these models to account for charging time at a charging station, given the current state of charge of the battery.

Keywords: mixed integer linear programming, battery electric vehicle. *Status*: Complete results

Biography of the speaker: Ruan holds a master's in Computer Engineering and a PhD in Industrial Engineering. He is the author of a mathematical modelling language and an active contributor to open-source Operations Research projects.

Examination timetabling at the University of Cape Town: a tabu search approach to automation

Ebrahim Steenkamp

University of Cape Town

With the rise of schedules and scheduling problems, solutions proposed in literature have expanded yet the disconnect between research and reality remains. The University of Cape Town's (UCT) Examinations Office currently produces their schedules manually with software relegated to error-checking status. While they have requested automation, this study is the first attempt to integrate optimisation techniques into their examination timetabling process. Tabu search and Nelder-Mead methodologies were tested on the UCT November 2014 examination timetabling data with tabu search proving to be more effective, and capable of producing feasible solutions from randomised initial solutions. To make this research more accessible, a user-friendly app was developed which showcased the optimisation techniques in a more digestible format. The app includes data cleaning specific to UCT's data management system and was presented to the UCT Examinations Office where they expressed support for further development: in its current form, the app would be used as a secondary tool after an initial solution has been manually obtained.

Keywords: Exam timetabling, tabu search. *Status*: Complete results

Biography of the speaker: Ebrahim Steenkamp is a consultant for the Statistical Consulting Unit at the University of Cape Town. While work may span different fields, his current interests lie in operations research, with a focus on automation.

A hypothesised Solution to UCT's Timetabling problem

Wasim Ghoor, Alex Thompson

University of Cape Town

The timetabling problem is a large subset of Operations Research and uses a mathematical approach such as integer linear programming to solve scheduling problems that have been around since the 1960's. The timetabling problem can be found in a variety of areas including education, industrial sector and even healthcare. The main focus of this thesis will be the educational area of the timetabling problem and from the literature it is further broken down into three categories: school, course and exam timetabling. This paper provides an overview on the current literature regarding such issues and proposes a variety of solutions to the timetabling problem faced by the University of Cape Town's statistics honours department. The problem that the department faces can be described as an inefficient allocation of time with regards to module and venue scheduling for lecturers and students. The approach that the Statistics department takes is a manual one with regards to the modules and venues. With regards to venues there are internal venues within the statistics department, with a small number of seating, that will be the preference to host lectures and when these internal venues do not accommodate students due to a large class then external venues, which are applied for externally through a specialised Venues department at UCT, will be used.Our aim for this thesis is to provide a clear structure and create an automated system that can be used each year in order to allow the department to save time which will allow the department to devote more time towards events that, for now, require a manual approach to the problem such as such as registration and exams. In this paper we have divided our model into 3 different phases: Lecturer preferences to the modules they will teach (Phase 1), Student preferences to when the lectures take place (Phase 2) and Venue preference to internal venues (Phase 3). The data for each phase is collected through surveys that were sent out to lecturers and students in the statistics honours department and class of 2022. Phase 1 aims to provide a solution to an optimal module allocation to allow lecturers to teach their first or at least their second preference. This is hypothesised to result in a higher, more efficient quality of teaching (Munaindy et al., 2022;50). The solution to phase 1 will be found by creating a function, through integer linear programming, that maximizes the weighting of modules associated with the lecturer's highest preferences. Phase 2 takes a look at module selection in terms of student preferences and lecture times where students will state their preferences for lecture times and high costs will be assigned to the most preferred time slot. Students within the class have been surveyed to obtain their preferences regarding lecture times. Phase 2 aims to maximize the weighting of having a lesson in a preferred time slot, once again through integer linear programming. Phase 3 will focus on venue allocations with preference to venues being allocated within the statistics department, in order to minimise the high cost associated with external venue allocations. The main method used in this paper is an integer linear programming approach using

R as the programming tool for the underlying algorithms. The models built in this thesis are validated using the current year's (2022) timetable for the statistics honours department.

Keywords: timetabling problem, integer linear programming, r studio, optimisation, university timetabling problem. *Status*: Work in progress

Biography of the speaker: Wasim and Alex are both final year students of the University of Cape Town currently studying a bachelor of business science specialising in analytics and are currently working together to present a solution to the timetabling problem that the University of Cape Town is currently faced with. Both students have a passion for data science and statistics and are excited about the field of operations research look forward to emphasising how much of an underrated field of research it is especially amongst universities in South Africa and both students look forward to presenting the work that they are in the progress of completing.

Parallel Session 12: Social and Behavioural Modelling 2

Towards an infodemiological analysis of social media & mental health

Kurt Marais

Department of Logistics, Stellenbosch University

The emerging field of infodemiology was introduced in 2002 by Gunther Eysenbach who defines the field to be "the science of distribution and determinants of information in an electronic medium, specifically through the Internet, or in a population, with the ultimate aim to inform public health and public policy". The Internet has undoubtedly become an integral part of how we communicate and connect with other human-beings. Through social media it is easier to connect with others and to access resources that improve quality of life. With that it has also posed new challenges, such as the effect it has on users' mental health.

There are various factors that may contribute to mental health problems. One such factor that has been debated since its advent is the adverse effects of social media in the growing age of the Internet, and specifically Web 2.0. The topic of social media and its effect on the wellness of its users is relevant and new within the context of infodemiological studies. This presentation introduces findings on the problem to date and opportunities for future research in this field in an effort to answer the question as to how the diffusion of affective behaviours on the mental health of social media users can be measured and tracked in online social networks.

Keywords: infodemiology, social network analysis, social media. *Status*: Work in progress

Biography of the speaker: Kurt Marais is currently enrolled for his PhD in operations research with a focus on social network analysis as it relates to the impact of social media on mental health disorders. He is a lecturer of Operations Research and Business Analytics as he supervises students on topics relating to social media and the spread of information online.

Towards a graduate success analysis model

Sha-Abaan Slamang, Lieschen Venter

Department of Logistics, Stellenbosch University

Stellenbosch University (SU) aims to be one of the leading research institutions on the African continent. High school graduates (both locally and internationally) can apply to SU with the hope of graduating through one of SU's ten faculties. The selection of students for enrolment into a degree programme in the Economic Management Sciences (EMS) Faculty is based on academic merit.

For a student to progress to the each academic year, they must obtain the minimum academic credits required to continue. This presentation introduces various modelling attempts to simulate the progression of students and ultimately their graduate success. Such a simulation model can assist university management in setting policies and intervention strategies to better understand the challenges students face and how stakeholders can assist students so that the maximum number of them graduate in minimum time. A new approach is introduced and the progress towards a completed solution is presented.

Keywords: simulation modelling, education, systems thinking, higher learning. *Status*: Work in progress

Biography of the speaker: Sha-abaan Slamang is currently enrolled for an MCom degree in Quantitative Management and is a supply chain analyst at the Department of Analytics and Insights at Shoprite Holdings Ltd. His research interests include data analytics, data visualization and simulation models for analysis of education systems. He is a member of the Systems Thinking for Education Policy research group at Stellenbosch University.

The development of an Eldana Risk Index

Philip Prinsloo, Linke Potgieter

Stellenbosch University

The South African sugarcane industry is not immune to the global decline in sugar demand brought on by consumption regulation and taxation. These macroeconomic pressures exacerbate an already complex set of problems that affect profitability and yield. Loss of yield and damage to crops caused by the African stem borer Eldana saccharina Walker is one of the major concerns for the local industry. Diverse decision support models were required for area-wide integrated pest management (AW-IPM) strategies to safeguard profits and maximize yield. In contrast to previous research aimed at discrete modelling and simulation of either sugarcane yield or E. Saccharina population dynamics, this project creates an integration framework for the strategic calculation of the relative risk and predicted extent of sucrose yield loss due to E. Saccharina for a particular crop season. The risk is based on past infestation trends, the effect of temperature variation, crop water stress, and precipitation on both the sugarcane crop and E. Saccharina's life cycle and population dynamics to identify the high-risk stages of each phenological cycle, and the probability of infestation in neighbouring regions. These effects are then quantified as an Eldana Risk Index (ERI) by modelling and integrating key components of previous research on sugarcane crop yield and E. Saccharina population growth models into the proposed ERI by developing a series of seasonally integrated E. Saccharina risk kites. The risk kites model the cumulative and seasonal effect of the underlying risk by defining an ideal or potential cumulative curve and calculating the cumulative difference curve by comparing the actual or observed value to the ideal or potential value. The magnitude and severity of the risk is determined by the area between the two curves, which is then weighted according to phenological stages to create a risk index. The ERI model is then initiated multiple times for each crop season, over a number of years, and utilizing numerous regional data sets. The data from six in-field weather stations in KwaZulu-Natal were used to develop the model and generate relative risk across multiple years and crop seasons. In order to predict sugarcane areas with a high risk of infestation, the model should ideally be integrated into an existing decision support platform and initiated across multiple regions and climate zones with similar conditions.

Keywords: integrated pest management, Eldana, risk index model. *Status*: Work in progress

Biography of the speaker: Philip Prinsloo is currently enrolled for a Masters in Operations Research at Stellenbosch University. He is working full time as a data scientist at Capitec in the integrated business planning team.

Determining the size of refuge areas required in Bt sugarcane when combined with sterile insect releases

Samantha Downing, Linke Potgieter

Stellenbosch University

An agent-based simulation of a genetically diverse Eldana saccharina Walker population was developed in order to simulate the progression of resistance development in Eldana against Bt-sugarcane. This research aimed to investigate the need for the inclusion of a refuge area, in the case that sterile insect releases are implemented. Three experiments were conducted using the simulation model, each focusing on different aspects of the implementation of sterile insect releases. First, the impact of sterile insect releases on resistance development and corresponding infestation dynamics in Bt sugarcane without refugia is investigated using various release ratios. The second experiment considers the inclusion of refugia in the Bt environment in addition to sterile insect releases. The third experiment uses the results from the first two experiments to then investigate the effect of various methods of sterile insect releases. The results from these experiments indicate a trade-off between sterile insect releases and the size of the refuge area, as well as that sterile insect releases should be located at areas of highest population density.

Keywords: agent based simulation, sterile insect releases, Bt sugarcane, Eldana saccharina Walker. *Status*: Complete results

Biography of the speaker: Samantha Downing completed her BCom Honours in Operations Research at Stellenbosch University in 2021.

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