

49th Annual Conference of the Operations Research Society of South Africa

19 - 21 October 2020

First Virtual Conference

Welcome from the Society President



Welcome to the 49th Annual (and first digital) Conference of the Operations Research Society of South Africa. ORSSA is proud to present this new endeavour to keep the conference tradition alive in an unprecedented year of tumult.

The Johannesburg Chapter bravely volunteered to create this completely online experience and I thank the Local Organising Committee for its tireless work to create such an interesting programme at short notice. Thank you to every member of the Society for keeping the standard of operations research practiced during this year so high. I

look forward to seeing you all in person again soon and hope for a quick return to our regular meeting format.

May you enjoy every digital minute of the programme, and may you and your loved ones remain safe and healthy in these unsure times. See you in the Zoom rooms!

Gemma Dawson, President Operations Research Society of South Africa

Welcome from the Chair of the Organising Committee



A warm welcome to the 49th Annual Conference of the Operations Research Society of South Africa. It is a privilege to welcome you to our first digital conference!

We are honoured to have professor Tshilidzi Marwala (Vice-chancellor of the University of Johannesburg), professor Hatem Masri (Dean of the College of Business Administration, University of Bahrain and President of the African Federation of Operations Research Societies), and professor Pascal van Hentenryck (Associate Chair for Innovation and Entrepreneurship and A. Russell Chandler III Chair and Profes-

sor) as our conference key note speakers along with Dr Berndt Lindner who presents a special session on the 2019 Tom Rozwadowski Medal winning paper.

Apart from the scientific aspect of the conference programme, the programme includes a special social event for catching up with old Operations Research colleagues and for meeting some new ones.

This year's banquet gala is replaced by a digital award ceremony where top practitioners are honoured during the National Student Competition Medal ceremony, the recognition awards ceremony, and the Tom Rozwadowski Medal ceremony.

A special word of thanks to our sponsors for making this event possible, and to the members of the Local Organising Committee for their hard work in pulling the rabbit out of the hat. Welcome all, and I hope that you will have a memorable conference experience!

David Clark, Chair ORSSA 2020 Local Organising Committee

- The ORSSA 2020 Local Organising Committee -

- (1) David Clark, Chair (Chalcid)
- (2) Gemma Dawson (Data Analytics, PwC South Africa)
- (3) Bernie Lindner (Spatialedge)
- (4) Dave Evans (ORSSA Fellow)
- (5) Liesl Hendry (Code Assayer)
- (6) Robert Bennetto (Icepack)
- (7) Handre Williams (Radixtrie)
- (8) Melusi Magele (University of South Africa)
- (9) Lieschen Venter (Department of Logistics, Stellenbosch University)

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- Conference at a Glance -

	Sunday, 18 October 2020
17:30-19:00	Pre-conference social (Discord)
	Monday, 19 October 2020
08:00-10:00	Morning meetup (Meetups)
15:45-16:00	Onboarding and marketing (Zoom)
16:00-16:15	President's welcome (Zoom)
16:15-17:30	2019 TR Medal winning paper by Dr. Berndt Lindner (Zoom)
17:30-18:30	National Student Competition Honours/fourth year project division (Zoom)
	Tuesday, 20 October 2020
15:45-16:00	Onboarding and marketing (Zoom)
16:00-17:00	National Student Competition Master's thesis division (Zoom)
17:00-18:30	Keynote address by Prof. Hatem Masri (Zoom)
	Wednesday, 21 October 2020
15:45-16:00	Onboarding and marketing (Zoom)
16:00-17:00	Keynote address by Prof. Tshilidzi Marwala (Zoom)
17:00-18:00	President's address (Zoom)
18:00-18:30	ORSSA Awards prizegiving ceremony (Zoom)
18:30-20:00	Keynote address by Prof. Pascal va Hentenryck (Zoom)

Sunday, 18 October 2020

$-Detailed \ Conference \ Programme-$

Sunday, 18 October 2020

Pre-conference social (17:30–19:00) Online pub quiz [Discord]

Monday, 19 October 2020

Morning meetup (08:00–10:00) [Meetups]

Monday, 19 October 2020 (15:45–18:30)

Plenary session I

Opening plenary

Chair: Lieschen Venter [Venue: Zoom]

15:45–16:00 Spatialedge (Sponsor) Onboarding and marketing
16:00–16:15 Gemma Dawson (ORSSA President) President's welcome
16:15–17:30 Berndt Lindner (Keynote speaker)

Tradeoffs between levelling the reserve margin and minimising production cost in generator maintenance scheduling for regulated power systems (p. 16)

Plenary session II National Student Competition (Fourth year / honours division) Chair: Lieschen Venter [Venue: Zoom]

17:30–18:00 Willem Moore, Shared-resource school timetabling decision support (p. 17)
18:00–18:30 Pieter Steenkamp, A decision support system for assigning buses to pre-determined routes (p. 18)

Tuesday, 20 October 2020

	Tuesday, 20 October 2020 (15:45–18:30)
	Plenary session III National Student Competition (Master's division)
	Chair: Gemma Dawson [Venue: Zoom]
15:45-16:00	Department of Industrial Engineering, Stellenbesch University (Spanser)
	Onboarding and marketing
16:00-16:30	Dirk Human, An agent-based simulation modelling approach to assess-
	ing various refuge strategies in Bt sugarcane (p. 19)
16:30-17:00	Jacqueline Kazmaier, A framework for evaluating unstructured text
	data using sentiment analysis (p. 20)
	Plenary session IV
	ORSSA and AFROS
	Chair: Gemma Dawson [Venue: Zoom]
17:00-18:30	Hatem Masri (Keynote speaker)
	AFROS: Towards a sustainable development of operations research in
	Africa (p. 12)

Wednesday, 21 October 2020

	Wednesday, 21 October 2020 (15:45–20:00)
	Plenary session V The future of OR Chair: Robert Bennetto [Venue: Zoom]
15:45-16:00	ORSSA Marketing Manager
16:00-17:00	Onboarding and marketing Tshilidzi Marwala (Keynote speaker) The future of OR and data science (p. 13)
	Plenary session VI ORSSA Awards Chair: Robert Bennetto [Venue: Zoom]
17:00-18:00	Gemma Dawson (ORSSA President) President's address
18:00-18:30	Gemma Dawson (ORSSA President) ORSSA Awards prizegiving ceremony
Plenary Session VII Closing plenary Chair: Robert Bennetto [Venue: Zoom]	
18:30-20:00	Pascal van Hentenryck (Keynote speaker), <i>Future mobility systems</i> (p. 14)

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ession	Day Time	Slot	Topic	Chairperson	Venue	Page
	Mon 15:45 Mon 17:30	-17:30 -18:30	Opening plenary National Student Competition (Fourth year / honours division)	Lieschen Venter Lieschen Venter	Zoom Zoom	$\frac{16}{17}$
	Tues 15:45 Tues 17:00	-17:00 -18:30	National Student Competition (Master's division) ORSSA and AFROS	Gemma Dawson Gemma Dawson	Zoom Zoom	19
	Wed 15:45 Wed 17:00	-18.30	The future of OR ORSSA Awards	Robert Bennetto Robert Rennetto	Zoom	13
Ξ	Wed 18:30	-20:00	Closing plenary	Robert Bennetto	Zoom	14

—List of Paper Titles ‡ —

[‡]In alphabetical order *Speaker

(1)	A decision support system for assigning buses to pre-determined routes (Pieter Steenkamp [*] , Prof. Jan van Vuuren)
(2)	A framework for evaluating unstructured text data using sentiment analysis (Jacqueline Kazmaier*, Prof. Jan van Vuuren)
(3)	An agent-based simulation modelling approach to assessing various refuge strategies in Bt sugarcane (Dirk Human [*] , Dr. Linke Potgieter)
(4)	AFROS: towards a sustainable development of operations research in Africa (Prof. Hatem Masri)
(5)	Future mobility systems (Prof. Pascal van Hentenryck)14
(6)	Shared-resource school timetabling decision support (Willem Moore [*] , Prof. Jan van Vuuren)
(7)	The future of OR and data science (Prof. Tshilidzi Marwala)
(8)	Tradeoffs between levelling the reserve margin and minimising production cost in generator maintenance scheduling for regulated power systems (Dr. Berndt Lindner [*] , Ruan Brits, Prof. Jan van Vuuren, Dr. James Bekker)

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-List of Authors -

(1)	Bekker, Dr. James
(2)	Brits, Ruan
(3)	Human, Dirk
(4)	Kazmaierr, Jacqueline
(5)	Lindner, Dr. Berndt
(6)	Marwala, Prof. Tshilidzi
(7)	Masri, Prof. Hatem
(8)	Moore, Willem
(9)	Potgieter, Dr. Linke
(10)	Steenkampr, Pieter
(11)	Van Hentenryck, Prof. Pascal
(12)	Van Vuuren, Prof. Jan

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$-Keynote \ Abstracts --$

Keynote speaker: Hatem Masri

AFROS: towards a sustainable development of operations research in Africa

The African Federation of Operations Research Societies (AFROS) was initiated in 2016 with the support of the International Federation of Operational Research Societies (IFORS) to promote operations research in Africa. Its affairs are regulated by an executive committee consisting of representatives from national operations research societies in Africa. In this talk, we will provide an overview of AFROS and affiliated members activities. Then, we will analyze data about intellectual contributions of African researchers during the last two decades to understand the impact of operations research has had on Africa. Finally, we discuss how AFROS could help to advance knowledge, interest and education in Operations Research and announce new initiatives that allow researchers to meet, exchange ideas, experiences, and research results, and support each other in research work.

Biography of the speaker:



Hatem Masri is Professor and Dean of the College of Business Administration at the University of Bahrain, Kingdom of Bahrain. He received his PhD in Management in 2004 and Master in Operations Research in 1999 from the University of Tunis, Tunisia. His research interests include multiple objective stochastic programming, supply chain management, financial engineering, and vehicle routing problems. His research has been published in more than 15 international journals (including EJOR, ANOR, FSS, IJAR) and funded by the University of Tunis, the University of Nizwa and the University of Bahrain. He is a member of the International Society

on Multiple Criteria Decision Making, INFORMS, IEEE and the Tunisian Decision Aid Society. He is the President of the African Federation of Operations Research Societies (AFROS).

Keynote Speaker: Tshilidzi Marwala

The future of OR and data science

An showcase of the many examples of decision support through computational intelligence techniques.

Biography of the speaker:



Tshilidzi Marwala is the Vice-Chancellor and Principal of the University of Johannesburg, beginning January 2018. Previously he was the Deputy Vice-Chancellor for Research and Internationalisation and the Executive Dean of the Faculty of Engineering and the Built Environment, both at the University of Johannesburg. He holds a Bachelor of Science in Mechanical Engineering (magna cum laude) from Case Western Reserve University (USA) in 1995, a Master of Mechanical Engineering from the University of Pretoria in 1997 and a PhD specialising in Artificial Intelligence and Engineering from the University of Cambridge in 2000. He has received more than 45 awards, including the Order of Mapungubwe, and was a delegate to the 1989 London International Youth Science Fortnight (LIYSF) when he was in high school. His writings and opinions have appeared in the magazines New Scientist, The Economist and Time. He has also been appointed as Deputy

Chair of the Presidential Commission on the Fourth Industrial Revolution.

Keynote speaker: Pascal van Hentenryk

Future mobility systems

The sharing economy has radically transformed taxi services in the last decade, through the combination of new business models and advanced technology. However, most of the mobility needs are not addressed by these innovations. This talk will review how ICT technology and Operations Research have the potential to revolutionize public transit and commuting in general. The presentation will introduce the new mobility services addressing these needs, the OR techniques that powers them, real case studies, and the barriers that remain for large-scale adoption.

Biography of the speaker:



Pascal Van Hentenryck is the A. Russell Chandler III Chair and Professor in the H. Milton Steward School of Industrial and Systems Engineering at Georgia Tech and the associate chair for innovation and entrepreneurship. Prior to this appointment, he was a professor of Computer Science at Brown University for about 20 years, he led the optimization research group (about 70 people) at National ICT Australia (NICTA) (until its merger with CSIRO), and was the Seth Bonder Collegiate Professor of Engineering at the University of Michigan. Van Hentenryck received his undergraduate and PhD degrees from the University of Namur in Bel-

gium, while doing research at the European Computer-Industry Research Centre in Munich, Germany. Van Hentenryck is also an Honorary Professor at the Australian National University.

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Operations Research 314, 326, 344 & 354

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Researcher / lecturer: Universities (local / abroad), CSIR

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Talk to us

EMAIL: Prof. Stephan Visagie svisagie@sun.ac.za WEB: Department of Logistics www.sun.ac.za/english/faculty/economy/logistics/

$-Contributed \ Paper \ Abstracts -$

Plenary session I: Opening plenary

Tradeoffs between levelling the reserve margin and minimising production cost in generator maintenance scheduling for regulated power systems

Dr. Berndt Lindner^{*}, Ruan Brits, Prof. Jan van Vuuren, Dr. James Bekker Department of Industrial Engineering, Stellenbosch University

Abstract

One of the key focus areas for a power utility is the planned preventative maintenance of the power generating units in its power system. The well-known generator maintenance scheduling (GMS) problem involves finding a schedule for the planned maintenance outages of generating units in a power system. A novel bi-objective model is proposed for the GMS problem in which demand reliability is maximised, by minimising the sum of squared reserves (SSR), and electricity production cost (predominantly fuel cost) is minimised. A novel production planning module is proposed to estimate the production cost associated with an energy generation plan, using a linear programming (LP) model to solve the economic dispatch (ED) problem, which precedes application of a simple unit commitment (UC) algorithm. A dominance-based multi-objective simulated annealing approach is then adopted to determine trade-off solutions to the model. Parallel computing is also utilised to increase the efficiency of approximating the Pareto front. The modelling approach is demonstrated in the context of a case study involving the 32-unit IEEE Reliability Test System. The results are compared to the best known single-objective solution in the literature, which only minimises the SSR, and the conflicting relationship between the two model objectives is investigated. It is found that more non-dominated trade-off solutions result if the load demand increases (*i.e.* the gap between installed capacity and load demand decreases). Therefore, if the installed capacity is sufficiently high, the reliability objective of minimising the SSR produces sufficiently small production cost solutions. Fuel cost savings of 0.41% are achieved in respect of a most "reliable" solution in the literature, but considerable cost savings are possible (up to 7.11%) if the maintenance duration and crew constraints are relaxed.

Shared-resource school timetabling decision support

Willem Moore^{*}, Prof. Jan van Vuuren Department of Industrial Engineering, Stellenbosch University

Abstract

Education is arguably one of the most important aspects in the development of the cognitive and social abilities of children throughout their growth towards adolescence. A further invaluable aspect of education, especially in the context of South Africa, is that it provides a platform for individual empowerment to transcend poverty and to reap the benefits of the skilled working class. Unfortunately, the concept of universal education is still a distant dream in various parts of South Africa due to a widespread lack of educational resources, and teachers in particular. These shortcomings have made it increasingly important for organisations in the private sector to contribute towards high-quality education through the medium of private schools.

In the management of such a private school, the optimal utilisation of time and resources is imperative to the success of the initiative. A useful tool by which teacher utilisation may be improved is highquality decision support in respect of school timetabling. School timetabling focuses on the assignment of teaching tasks, or the teaching of subjects, to the smallest number of teachers in such a manner that all subjects are represented the required number of times during a timetable scheduling cycle, without conflicting with physical constraints.

The notion of shared resource school timetabling, however, differs from ordinary school timetabling in that schools adopt a shared resource policy whereby teachers may be shared between schools in close proximity, with the goal of minimising the global number of teachers required by the combined schools under consideration. A decision support system is proposed in this project for facilitating the development of effective shared resource school timetabling. The efficacy of the decision support system is evaluated by means of a practical case study consisting of a comparison of the results proposed by the system with those implemented in practice.

A decision support system for assigning buses to pre-determined routes

Pieter Steenkamp^{*}, Prof. Jan van Vuuren Department of Industrial Engineering, Stellenbosch University

Abstract

In an ever-expanding urban environment, much emphasis has been placed on the use of public transport as a solution to the problem of traffic congestion in urban areas. During the latter part of the twentieth century, timeliness of public transport services became an increasingly important factor for people in the working class. Possible improvements in the effective use of bus services in urban areas has therefore been investigated extensively in a bid to alleviate commuter stress associated with being on time. If managed effectively, bus service companies can utilise their resources in more effective ways to provide cheaper, more frequent and more reliable transport to commuters who have traditionally been averse to the use of bus transport as a result of its relative unreliability or unavailability.

The goal in this project is to contribute towards the effective use of the resources of a public transport bus company by providing decision support with respect to the use of its buses to service its bus routes. In particular, a computerised decision support system (DSS) is designed in this project for aiding a shift manager of a bus company in his or her decisions related to the assignment of available buses to predetermined routes. The DSS takes as input a daily list of the buses available as well as a daily list of bus routes that have to be serviced (together with their respective schedules), and produces as output a list of routes for each bus. The bus-to-route objectives pursued in the DSS is either, (1) to minimise the total distance travelled by all buses while deadheading (i.e. travelling without passengers between routes), or (2) to minimise the time spent in total by all bus drivers deadheading, taking into account average traffic conditions as a function of the time of the day, or (3) to minimise the number of buses utilised in the bus-to-route assignment, or (4) to minimise the time spent on the road (i.e. away from the depot) by the busiest bus in the bus-to-route assignment.

The DSS is implemented on a personal computer and validated by applying it to a special case study based on real data obtained from a bus company in Cape Town.

Plenary session III: National Student Competition (Master's division)

An agent-based simulation modelling approach to assessing various refuge strategies in Bt sugarcane

Dirk Human^{*}, Dr. Linke Potgieter Department of Logistics, Stellenbosch University

Abstract

Crops expressing genes from the bacterium Bacillus Thuringiensis (Bt) produce a protein toxic to members of the order Lepidoptera and are a popular alternative to sprayed insecticides. Although these Bt crops are considered to be an effective pest control method, careless usage may add selective pressure on the pest population to develop resistance to the protein over time. One method of limiting the rate of resistance development is to keep small portions of the cultivated land planted with the non-GMO crop which then acts as a refuge area for susceptible pests, limiting its exposure to the protein. Varieties of Bt sugarcane for the South African market that should limit the damage caused by the stalk borer moth, Eldana Saccharina Walker, are being developed, and a prerequisite to releasing such a product is to manage resistance development. Refuge areas are the primary way of managing resistance, but a recommendation is required on the size and layout of the refuge areas to be planted, as an area too small may not curb the rate of resistance development enough, but an area too large may not be economically viable for the industry.

An agent-based simulation model is presented where individual moths are modelled as agents on an underlying sugarcane field that can either be Bt or refuge. The spatial aspect of the simulation model allows for testing the effectiveness of different shapes of refuge and not just the size. To reduce the complexity of the model, the field is divided into a series of smaller cells that can interact with each other, which allows us to model the impact of a severe infestation on an area the size of an average sugarcane farm. The simulation divides the simulated space into two grids representing the layers of the sugarcane that the different life stages of the insect move in. The first layer is the ground layer, representing the lower portions of the sugarcane where the eggs, larvae, pupae and egg-laying female moths are found. These cells are smaller as the immature life stages are nearly stationary and the female moth is assumed to have a much lower dispersal rate when searching for sights to lay eggs. The second layer is the sky layer with larger cells, where adult males and unmated females are able to move over larger distances to find mates. To further reduce complexity, every cluster of eggs laid by a female moth is modelled as a single agent that progresses as a unit through the immature life stages before being converted to many individual moth agents when they mature.

The model is then applied to three hypothetical case studies, each focusing on a specific aspect of refuge planning. The first case study focuses on the size and distribution of refuge, the second on the shape of the refuge, and the third assumes that the Bt sugarcane is introduced gradually and how this may affect the refuge strategy. The results from these case studies as well as those obtained from the sensitivity analysis are then summarised in the form of a decision support tool (DST), which provides some recommendations for refugia planning and highlights the risk factors for resistance development identified during the course of this study. Combining the recommendations with the risk factors that may be associated with a given scenario should provide the growers with a starting point of how to plan their refugia.

A framework for evaluating unstructured text data using sentiment analysis

Jacqueline Kazmaier^{*}, Prof. Jan van Vuuren Department of Industrial Engineering, Stellenbosch University

Abstract

Public opinion has long been an area of research interest. With the exponential growth of the Internet and social media, and the resulting increase in the volume of user-generated content publicly available online, this interest has become even more pronounced. The process of manually studying such content has simultaneously become increasingly cumbersome. This situation gave rise to the research field of sentiment analysis or opinion mining — the computational study of people's opinions, attitudes and emotions.

Whereas the task of sentiment parsing is relatively easy for humans, the subtle nuances of natural languages render this task inherently difficult for computers. This is especially true in the South African context, where opinion-bearing expressions may be composed in up to eleven different languages. Furthermore, while there is an abundance of research dedicated to developing algorithms for the purpose of classifying sentiment, little guidance exists on how to incorporate this information into the decisionmaking processes of affected entities.

In this thesis, a generic framework is proposed for employing sentiment analysis to extract insight from unstructured text data which may then be used to guide decision making. This framework facilitates the process of preparing the data for the purpose of analysis, as well as extracting and selecting features from the unstructured text in order to transform the data into a structured format and to develop suitable models for classifying sentiment. Furthermore, the analysis and synthesis of the results of selected models are accommodated, during which patterns and information may be extracted from the data and presented to the user in a meaningful way. An instantiation of this framework is implemented on a computer as a concept demonstration. This implementation is applied to a real-world case study in the South African banking sector to illustrate the practical applicability of the framework.

— List of $Delegates^*$ —

*Delegates who registered by October19th, 2020.

- (1) Aberdein, AJ (BBD) ashley@aberdein.co.za
- (2) **Badmus**, Aliu (INFRON) badmusaliu@yahoo.co.uk
- (3) **Bashe**, Mantombi (Eskom) mbashe@mweb.co.za
- (4) Belkhamsa, Manel (Quassim University) manelbelkhamsa@gmail.com
- (5) **Ben Amor**, Fatma (University of Sfax) fatma.benamor.chr@gmail.com
- (6) **Benade**, Gerdus (Boston University) benade@bu.edu
- (7) Benbouziane, Mohamed (University of Tlemcen Algeria) mbenbouziane@yahoo.fr
- (8) Bennetto, Robert (Icepack Limited) robert.bennetto.za@gmail.com
- (9) **Berkow**, Eli (Discovery) eliberkow@gmail.com
- (10) Bernhardt, Matthew (University of Pretoria) hazmatt226@gmail.com
- (11) Bester, Margarete (ORSSA)
 mbester@live.com
- (12) BHAR LAYEB, Safa (National Engineering School of Tunis) safa.layeb@enit.utm.tn
- (13) Bosman, Ray (UNISA) bosmanray@googlemail.com
- (14) Bothma, Hennie (ORSSA) hbot120gmail.com
- (15) **Bouzaouache**, Hajer (Institut Superieur des Etudes Technologiques enCommunications) hajer.bouzaouache@ept.rnu.tn
- (16) **Brauer**, Benjamin (Private) bzbrauer@gmail.com
- (17) Campher, Susan (North-West University) susan.campher@nwu.ac.za
- (18) **Caston**, Sigauke (University of Venda) caston.sigauke@univen.ac.za
- (19) Chakroun, Raida (IHEC Carthage) raida.c@yahoo.fr
- (20) Cilliers, Pierre (Stellenbosch University) 18969771@sun.ac.za
- (21) Clark, David (Chalcid) davidclark.orssa0gmail.com
- (22) Cochran, James (University of Alabama) jcochran@cba.ua.edu
- (23) **Dawson**, Gemma (ORSSA) gemmadawson@gmail.com

(24)	De Kock , Christa (Stellenbosch University) christadk@sun.ac.za
(25)	De Sousa , Luis (Sveop)
(20)	luisd@sveop.co.za
(26)	De Villiers Dan (Spatialedge)
(20)	danûsnatialedre co za
(97)	Dilegala Dhil (University of Limpone)
(21)	nhillemen dikusle@ul.ee.
(\mathbf{a}_{0})	philiemon.dikgaleeul.ac.za
(28)	Du Toit, 1iny (North-West University)
$(\mathbf{a}\mathbf{a})$	liny.Duloit@nwu.ac.za
(29)	Emslie, Rowan (Genop Healthcare)
	emslie.rowan@gmail.com
(30)	Euchi , Jalele (University of Sfax)
	jalel.euchi@fsegs.rnu.tn
(31)	Evans, David (ORSSA)
	davevans@gmail.com
(32)	Fabris-Rotelli, Inger (University of Pretoria)
	inger.fabris-rotelli@up.ac.za
(33)	Fatti, Paul (Wits University)
	paulfatti@gmail.com
(34)	February, Taariq (Spatialedge)
	taariq@spatialedge.co.za
(35)	Gace. Wesley (Lovemore Bros)
()	wesgace@gmail.com
(36)	Gebbie. Stewart (Wits)
(00)	sgebbie@gethos.net
(37)	Gevers Wim (University of Stellenbosch Business School)
(01)	wolush.ac.za
(38)	Guennichi Nevla (TBS)
(00)	gnichinewla@gmail.com
(20)	Homes Linda (University of Cape Town)
(39)	linda haines@uct_ac_za
(40)	IIIda.Haineseuct.ac.za
(40)	Hendry, Liesi (Chaicid)
(41)	liesimarynendry@gmail.com
(41)	Hendry, Gill (Private)
(gillmhendry@gmail.com
(42)	Heyns, Andries (Hanken School of Economics)
()	andriesheyns@gmail.com
(43)	Hofmann, Flora (Stellenbosch University)
	20304269@sun.ac.za
(44)	Human, DJ (DataRobot Inc.)
	dirk.human@gmail.com
(45)	Ikelu, Chinasa (Institute de Mathematiques et de Sciences Physiques)
	chinasa.ikelu@daad-alumni.de
(46)	Ingabire, Grace (Laterite)
	grace.ingabire@gmail.com
(47)	Ittmann, Hans (University of Johannesburg)
	hittmann010gmail.com
(48)	Jaffe, Mark (Sunstone Logistic Systems)
(-)	mark@sunstonels.com
(49)	Janse van Rensburg, Dawid (Cargo Solutions)
(-0)	dawid@cargocarriers.co.za
(50)	Jooste Wayne (Jooste Quants Research)
(00)	

wayne@jqr.co.za

- (51) **Kammoun**, Manel (University of Sfax) kamounemanel@gamil.com
- (52) Karsten, Carike (CSIR) ckarsten@csir.co.za
- (53) **Kazmaier**, Jacqueline (Stellenbosch University) jqkazmaier@gmail.com
- (54) **Keebine**, Tshepiso (Private) keebinetshepiso@gmail.com
- (55) Kellermann, Johan (Spatialedge) johan@spatialedge.co.za
- (56) **Ketcha**, Orline Sorel (Explore Data Science Academy) sorelleketcha@gmail.com
- (57) **Khoza**, Yolanda (Statistics South Africa) yolandanqweniso@gmail.com
- (58) **Khumalo**, Vusi (University of South Africa) v.khumalo@worldonline.co.za
- (59) Koen, Renee (CSIR) rkoen@csir.co.za
- (60) Kouaib, Amel (University of sfax) amelkouaib@hotmail.fr
- (61) **Kruger**, Hennie (North-West University) Hennie.Kruger@nwu.ac.za
- (62) Lamola, Lebo (Explore Data Science Academy) leboganglamola7@gmail.com
- (63) Lanz, Ernest John (Anheuser-Busch InBev Africa) ejlanz@hotmail.com
- (64) Laurens, Nico (King Price) laurens.nico@gmail.com
- (65) Layton, Casey lee (Stellenbosch University) casey.layton@icloud.com
- (66) Le Roux, Jeanne (Decision Sciences, Unisa) lrouxj@unisa.ac.za
- (67) Lekalakala, Shella (Explore data science academy) leksshe@gmail.com
- (68) Lindner, Berndt (Spatialedge) berndtlindner@gmail.com
- (69) Lobati, Jongumuzi (DeSignage Fox) thesignagefox@gmail.com
- (70) Lötter, Daniel (Spatialedge)
 Daniel.lotter@spatialedge.co.za
- (71) Lotz, Lizette (RCI) lizette@rcinv.co.za
- (72) Loukil, Taicir (Faculty of economics and management of Sfax Tunisia) loukilt@gmail.com
- (73) Mabaso, Thanduxolo (PEC Utility Management (Pty) Ltd) tsmabaso@gmail.com
- (74) Magele, Melusi (Transnet) melusi.magele@transtnet.net
- (75) **Maimane**, Pride (UNISA) pride.maimane880gmail.com
- (76) Makhubela, Moses (unisa) 36204609@mylife.unisa.ac.za

- (77) **Malan**, Christian (Stellenbosch University) koenamalan@gmail.com
- (78) **Marais**, Len (South African Reserve Bank) len.marais@resbank.co.za
- (79) **MaseTshaba**, MT (University of South Africa) emasetmt@unisa.ac.za
- (80) Mathema, Theophilous (University of Cape Town) mathematheo2009@gmail.com
- (81) Merchant, Sue (VP INFORMS International Activities) suemerchant@hotmail.com
- (82) **meyer**, Isabel (csir) iameyer@me.com
- (83) Meylahn, Benedikt (Stellenbosch University) benedikt.meylahn@gmail.com
- (84) **Mfundisi**, Thami (Individual) thamimfundisi@gmail.com
- (85) Mgaga, Sikelela (Comair Ltd) 45747946@mylife.unisa.ac.za
- (86) Mnisi, Sabelo (Private) sabelomasina1@gmail.com
- (87) Mokoena, Oratilwe (Sefako Makgatho Health Sciences University) Oratilwe8250@gmail.com
- (88) **Moore**, Willem (Curro Holdings Ltd) willem.m@curro.co.za
- (89) Moremoholo, Kgotso Rudolf (Wits) 2399825@students.wits.ac.za
- (90) **Mosoeu**, Selebogo (Explore Data Science Academy) scmosoeu@gmail.com
- (91) Motsi, Gab (Touchsides SA) gabrielmotsi@gmail.com
- (92) Mtiyane, Sibusiso (University of South Africa) slmtiyane@gmail.com
- (93) munyanyi, fadzai (University of Cape Town) fadzai.munyanyiQuct.ac.za
- (94) **Muparuri**, Louisa (University of Botswana) lmuparuri@gmail.com
- (95) **Muparuri**, Louisa (Zimbabwe School Examinations Council) lmuparuri@gmail.com
- (96) Nel, Stephan (Stellenbosch University) gsnel@sun.ac.za
- (97) Netshivhangoni, Vhangani (Anglo American) Vhangfani.Netshivhangoni@angloamerican.com
- (98) **Nkomo**, Sanelisiwe Amanda (Private) sanienk@gmail.com
- (99) **Ntene**, Nthabiseng (Standard Bank of South Africa) nthabiseng.ntene@standardbank.co.za
- (100) Obasohan, Phillips (University of Sheffield) peobasohan1@sheffield.ac.uk
- (101) **Ojo**, Mayowa (Thermo Fisher Scientific) mmojomth@gmail.com
- (102) **Pelser**, Winnie (CSIR) wpelser@csir.co.za
- (103) **Perrie**, Cailin (Private)

cailin.perrie@gmail.com

- (104) **Phaswana**, Awelani (Eskom) apawe8320gmail.com
- (105) **Pieterse**, Lohan (Stellenbosch University) lohan912@gmail.com
- (106) **Potgieter**, Linke (Stellenbosch University) lpotgieter@sun.ac.za
- (107) **Potgieter**, Eugene (Consultant) potgie@yahoo.com
- (108) **Pretorius**, Philip (North-West University) Philip.Pretorius@nwu.ac.za
- (109) **Putu**, Moshabi (ORSSA) dputu@mweb.co.za
- (110) Rabbouch, Hana (University of Sousse) hana.rabbouch@gmail.com
- (111) **Rademeyer**, Angela (Discovery) angelara@discovery.co.za
- (112) **Rahmoune**, Fazia (University of Bejaia) rahmouneaoudia@gmail.com
- (113) **Rakotonirainy**, Rosephine Georgina (University of Cape Town) rosephine.rakotonirainy@uct.ac.za
- (114) Rammutla, Kwena (FSCA) KwenaLR@gmail.com
- (115) **Ramokgopa**, Dakalo (Private) dmramokgopa@gmail.com
- (116) Ratau, Tumelo (UNISA) 44561334@mylife.unisa.ac.za
- (117) **Reed**, Edwin (Stellenbosch University) eddiereed0@gmail.com
- (118) Rees, Jess (Discovery)
 jess.sian.rees@gmail.com
- (119) **Saadaoui**, Foued (King Abdulaziz University) foued.saadaoui@gmail.com
- (120) Saasa, Chupisha (TFR) chupisha.saasa@transnet.net
- (121) sait, Razika (Bejaia University) razika.sait@gmail.com
- (123) **Sbaa**, Anwar (Hôpital Tahar sfar mahdia) anwar.sbaa@yahoo.fr
- (124) Schiendorfer, Alexander (University of Augsburg) alexander.schiendorfer@gmail.com
- (125) Schlunz, Bernard (Shoprite Group) schlunzeb@gmail.com
- (126) Schmidt, Guenter (MaxiMax) gj.schmidt@yahoo.de
- (127) Scholtz, Esmarie (Private) esmarie.s@gmail.com
- (128) Schutte, WD (North-West University) wd.schutte@nwu.ac.za
- (129) **Searle**, Kit (Stellenbosch University) 182684200sun.ac.za

- (130) **Seatlhodi**, Thapelo (Department of Health) tseatlhod@gmail.com
- (131) **Shaikh**, Dr Zakir (Bahrain Training Institute) skzakir1230gmail.com
- (132) **Sigauke**, Caston Sigauke (University of Venda) caston.sigauke@univen.ac.za
- (133) **Sigauke**, Caston (University of Venda) caston.sigauke@univen.ac.za
- (134) **Sigauke**, Caston (University of Venda) caston.sigauke@univen.ac.za
- (135) Silal, Sheetal (University of Cape Town) Sheetal.Silal@uct.ac.za
- (136) Snydert, John (ORSSA)
 john.snydert@gmail.com
- (137) Sondes, Hammami (Enicarthage) sondeshammami@yahoo.fr
- (138) **Steenkamp**, Pieter (Stellenbosch University) pieterjst@gmail.com
- (139) **Stewart**, Theodor (University of Cape Town) theodor.stewartQuct.ac.za
- (140) **Strasheim**, Emile (Curro) emile.s@curro.co.za
- (141) **Tarchi**, Mubarak (Ministery of Education Oman) moubarak.tarchi@hotmail.com
- (142) Thiart, Jeanette (Stellenbosch University) jthiart@sun.ac.za
- (143) Van der Merwe, Annette (North-West University) annette.vandermerwe@nwu.ac.za
- (144) Van der Merwe, Anette (Sasol) anette.vandermerwe@sasol.com
- (145) Van Dyk, Esbeth (iKhanyisa) esbethvandyk@gmail.com
- (146) Van Heerden, Johan (Altron SI) Johan.vanHeerden@altron.com
- (147) Van Hoepen, Willemien (UNISA) vhoepwa@unisa.ac.za
- (148) Van Staden, Heletje (KU Leuven) heletje.vanstaden@kuleuven.be
- (149) Van Vuuren, Jan (Stellenbosch University) vuuren@sun.ac.za
- (150) Van Vuuren, Brian (Allan Gray) brian.vanvuuren@allangray.co.za
- (151) **Van Vuuren**, Rikus (Private) rikusv@gmail.com
- (152) **Vendle**, Nomfezeko (Private) nomfezekov@gmail.com
- (153) Venter, Lieschen (Stellenbosch University) lventer@sun.ac.za
- (154) **Visagie**, Jaco (North-West University) visagiejaco30gmail.com
- (155) Weenink, Pieter (BeGrowth) pieter@begrowth.com
- (156) Wessels, Annelie (Stellenbosch University)

annelie99@hotmail.com

- (157) Wessels, Gysbert (Baird's CMC) wessels.gys@gmail.com
- (158) Williams, Handre (RadixTrie) handre.williams@gmail.com
- (159) Yadavalli, Venkata (University of Pretoria) sarma.yadavalli@up.ac.za

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