



**50th Annual Conference of the
Operations Research Society of South Africa**

12 - 15 September 2021

Second Virtual Conference

Welcome from the Society President



Honoured guests, speakers, operations researchers and delegates, it is with great pleasure that I welcome you all to our conference. It is special this year from two perspectives: it is being held jointly with AFROS – the African Federation of Operations Research Societies, and it is the 50th Annual Conference of the ORSSA – the Operations Research Society of South Africa.

We would like to extend a special welcome to our keynote speakers, who will be properly introduced when they deliver their talks:

- Prof Hatem Masri, President of AFROS,
- Prof Gerda Claeskens from KU Leuven in Belgium,
- Prof Roelof Coetzer of North-West University,
- Prof Laura Albert from the University of Wisconsin-Madison, and
- Kim Rozwadoski Triegaardt; the niece of Tom Rozwadowski.

The annual conference is a highlight in our Society’s calendar and has been organised this year by the Vaal Triangle Chapter of ORSSA. I would like to thank Marius Smuts, chair of the Local Organising Committee of the conference, and his team for the hard work they have put in over many months, particularly because of the abnormal issues related to the Covid situation.

The LOC secured a number of local sponsorships and I would like to express ORSSA’s gratitude to those companies who generously helped to make the conference a success:

- Blue Stallion Technologies
- Spatial Edge
- The North-West University (NWU)
- The NWU Centre for BMI
- The NWU Department of Statistics
- The NWU Focus Area for Pure and Applied Analytics
- The NWU School for Industrial Engineering
- The Department of Statistical Sciences at the University of Cape Town (UCT)
- The Department of Industrial Engineering at Stellenbosch University (SU)

We would also like to thank Hatem Masri, the AFROS President and Sue Merchant on the AFROS Exco for their efforts in obtaining international speakers and participants, and the additional sponsorship from EURO - the Association of European Operational Research Societies, IFORS and the British OR Society, which has covered the conference registration fees for most of the AFROS delegates.

In addition to interesting and stimulating content on business decision making and analytics, the ORSSA conferences are well known for the thoroughly enjoyable social aspects of the conference

programme. We had hoped that this conference would be face to face, when that tradition could have been continued. Unfortunately, that aspect at the macro level is not to be, but we hope the chapters who have arranged small get togethers enjoy them, observing all the appropriate Covid behaviours. Hopefully we will be back to normal next year in the Cape.

As President of ORSSA, my main report is during our annual general meeting on Wednesday afternoon, but there are two topics I would like to draw to the attention of all attendees:

- The IPCC report on climate change, five weeks ago, highlights the fact that humanity has been causing very significant, undesirable changes to the planet's climate, and these are going to continue to increase significantly, to the major detriment to the humanity, unless we dramatically reduce our climate changing emissions. This needs to be done very urgently. Anything we can do as operations researchers to help to make that happen will be very valuable.
- A closely related topic is the use of OR to support better decision making in political and diplomatic environments, as this is where the major climate change initiatives need to be driven. There is published OR work in this area, and again, anything we can do to accelerate the right kind of actions in those areas will be invaluable.

I trust that all delegates will have a productive few days exchanging new and valuable ideas, renewing old acquaintances, and making new friends and colleagues, to the extent that that is possible.

May you enjoy a memorable and inspiring conference, which I now declare open

Dave Evans, President
Operations Research Society of South Africa

Welcome from the Chair of the Organising Committee



It is my privilege to welcome each and every one to the 50th Annual Conference of the Operations Research Society of South Africa (ORSSA) in collaboration with AFROS (the African Federation of Operations Research Societies). We are thankful that even amidst the global pandemic we have this opportunity to be able to engage our peers in meaningful discussions on practical and theoretical aspects of our discipline, foster new partnerships in research collaboration, and even make a few new friends along the way.

This year the Local Organising Committee (LOC) were not so local, but somewhat international as well. I want to sincerely thank each and every one from ORSSA and AFROS that were involved in organising this truly one of a kind event.

It is a honour to welcome our keynote speakers at this year's conference:

- Prof Gerda Claeskens from the research group OR & Statistics and the Leuven Statistical Research Center at KU Leuven in Belgium.
- Prof Roelof Coetzer from the Department of Statistics at the North-West University.
- Prof Laura Albert who is the David Gustafson Department Chair of Industrial & Systems Engineering at the University of Wisconsin-Madison.
- Prof Hatem Masri, a professor of business analytics and dean of the college of business administration at the university of Bahrain, Kingdom of Bahrain and also the president of AFROS.

We are privileged to also welcome invited speakers from INFORMS:

- Emma Gibson is a PhD candidate at the MIT Operations Research Center
- Prof Elise Miller-Hooks, Professor & Hazel Chair in Infrastructure Engineering at the George Mason University.
- Dr Jorge Samayoa is the CEO of SciLambda.net, a company dedicated to providing Data Science consulting services. He is also the director of the Operations Research Institute at Galileo University.

Furthermore, we are excited to have Kim Rozwadowski Triegaardt speak at the conference this year. Kim is the niece of Tom Rozwadowski and will give personal insight into the man behind the medal at the prize giving ceremony on Tuesday afternoon.

I would also like to extend a special welcome to Prof. Fanie Terblanche from Elytica who will be presenting a tutorial on how to implement an optimisation formulation using one of three algebraic modelling systems.

The conference programme has a diverse set of session talks which promises to stimulate a wide range of interests and allow for fruitful discussions around the virtual tables. The conference would not have been possible without the continuous support from all our sponsors, and I sincerely thank you:

- Blue Stallion Technologies

- Spatial Edge
- The Department of Statistical Sciences at the University of Cape Town (UCT)
- The Department of Industrial Engineering at Stellenbosch University (SU)
- The North-West University (NWU)
- The NWU Centre for BMI
- The NWU Department of Statistics
- The NWU Focus Area for Pure and Applied Analytics
- The NWU School for Industrial Engineering

Lastly, I would also like to thank the team from XL Millennium for all their support and assistance during the conference.

I sincerely hope that you will have a memorable online conference experience!

Marius Smuts, Chair
ORSSA 2021 Local Organising Committee

— *The ORSSA 2021 Local Organising Committee* —

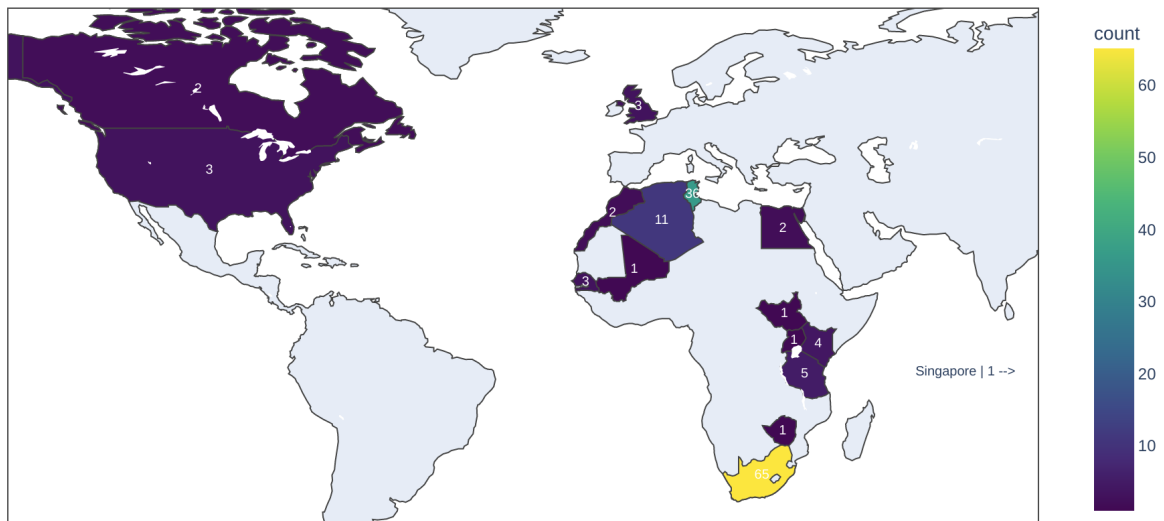
- (1) Marius Smuts, Chair (North-West University)
- (2) James Allison (North-West University)
- (3) Chanel Bisset (North-West University)
- (4) Elzanie Bothma (North-West University)
- (5) Chantelle Du Plessis (North-West University)
- (6) Gerrit Grobler (North-West University)
- (7) Bernie Lindner (Spatialedge)
- (8) Hatem Masri (University of Bahrain)
- (9) Patrick Reynolds (North-West University)
- (10) Leonard Santana (North-West University)
- (11) Neill Smit (North-West University)
- (12) Fanie Terblanche (Elytica)
- (13) Philip Venter (North-West University)
- (14) Jaco Visagie (North-West University)

We would also like to acknowledge the following people for their contribution to the success of the conference:

- Hans Ittmann and Sue Merchant, for their assistance with inviting the INFORMS speakers for their plenary session;
- Lieschen Venter, for her invaluable input;
- all of the ORSSA Executive Committee members for their guidance.

— *Global Map of Conference Attendees* —

This year's conference plays host to attendees from all over the world! The map and table below summarises the information we obtained during registration concerning the countries from which each of the attendees will be participating.



	country	country_code	count
0	South Africa	ZAF	65
1	Tunisia	TUN	36
2	Algeria	DZA	11
3	Tanzania, United Republic of	TZA	5
4	Kenya	KEN	4
5	United States	USA	3
6	Senegal	SEN	3
7	United Kingdom	GBR	3
8	Canada	CAN	2
9	Egypt	EGY	2
10	Morocco	MAR	2
11	Uganda	UGA	1
12	Singapore	SGP	1
13	South Sudan	SSD	1
14	Bahrain	BHR	1
15	Mali	MLI	1
16	Zimbabwe	ZWE	1

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~~~ *Programme at a Glance* ~~~

**Sunday 12 September 2021**

|               |                                                                                        |
|---------------|----------------------------------------------------------------------------------------|
| 14:00 – 17:30 | <b>Integrated Analytics Workshop</b> by Fanie Terblanche<br><i>Venue:</i> Zoom session |
|---------------|----------------------------------------------------------------------------------------|

**Monday 13 September 2021**

|               | ORSSA Auditorium                                                         | Elephant Room                                        | Lion Room                                          |
|---------------|--------------------------------------------------------------------------|------------------------------------------------------|----------------------------------------------------|
| 08:00 – 08:10 | Welcome                                                                  |                                                      |                                                    |
| 08:10 – 08:30 | Presidential address: Dave Evans                                         |                                                      |                                                    |
| 08:30 – 09:20 | <b>Plenary:</b> Gerda Claeskens<br><i>Chair:</i> Marius Smuts            |                                                      |                                                    |
| 09:20 – 10:20 | MSc student competition                                                  |                                                      |                                                    |
| 10:20 – 10:30 | Tea break                                                                |                                                      |                                                    |
| 10:30 – 12:30 | <b>Data Analysis &amp; Pred. modelling</b><br><i>Chair:</i> P.M. Takouda | <b>OR in Healthcare</b><br><i>Chair:</i> Imen Mejri  | <b>Optimisation</b><br><i>Chair:</i> G. Hüsselmann |
| 12:30 – 13:00 | Lunch                                                                    |                                                      |                                                    |
| 13:00 – 15:00 | <b>Machine Learning</b><br><i>Chair:</i> P. Cilliers                     | <b>OR in Healthcare</b><br><i>Chair:</i> Z. Chergui  | <b>Optimisation</b><br><i>Chair:</i> C. Bisset     |
| 15:00 – 15:30 | Tea break                                                                |                                                      |                                                    |
| 15:30 – 17:00 | <b>Neural Networks</b><br><i>Chair:</i> R. Jordaan                       | <b>OR in Healthcare</b><br><i>Chair:</i> R. Borchani | <b>Optimisation</b><br><i>Chair:</i> K. Searle     |
| 17:00 – 17:10 | Tea break                                                                |                                                      |                                                    |
| 17:10 – 18:00 | <b>Plenary:</b> Laura Albert<br><i>Chair:</i> S. Merchant                |                                                      |                                                    |

**Tuesday 14 September 2021**

|               | ORSSA Auditorium                                                    | Elephant Room                                                 | Lion Room                                                            |
|---------------|---------------------------------------------------------------------|---------------------------------------------------------------|----------------------------------------------------------------------|
| 07:50 – 08:00 | Sponsors                                                            |                                                               |                                                                      |
| 08:00 – 08:50 | <b>Plenary:</b> Roelof Coetzer<br><i>Chair:</i> P. Venter           |                                                               |                                                                      |
| 08:50 – 09:50 | Hons student competition                                            |                                                               |                                                                      |
| 09:50 – 10:00 | Tea break                                                           |                                                               |                                                                      |
| 10:00 – 12:00 | <b>Transportation &amp; Routing</b><br><i>Chair:</i> M. Affi        | <b>OR in Healthcare / Education</b><br><i>Chair:</i> D. Clark | <b>Decision Support</b><br><i>Chair:</i> R. Ganzevoort               |
| 12:00 – 12:30 | Lunch                                                               |                                                               |                                                                      |
| 12:30 – 14:30 | <b>Transportation &amp; Routing</b><br><i>Chair:</i> P.J. Steenkamp | <b>Logistics</b><br><i>Chair:</i> J. Elbaz                    | <b>Decision Support</b><br><i>Chair:</i> W. Pelser                   |
| 14:30 – 15:00 | Tea break                                                           |                                                               |                                                                      |
| 15:00 – 17:00 | <b>Transportation &amp; Routing</b><br><i>Chair:</i> R. Bennetto    | <b>Logistics</b><br><i>Chair:</i> C. Gurgur                   | <b>Decision Support / Simulation</b><br><i>Chair:</i> P.H. Potgieter |
| 17:00 – 18:00 | <b>Prize-giving ceremony</b><br><i>Speaker:</i> Kim Triegaardt      |                                                               |                                                                      |

**Wednesday 15 September 2021**

|               | ORSSA Auditorium                                                           | Elephant Room                                       | Lion Room                                                   |
|---------------|----------------------------------------------------------------------------|-----------------------------------------------------|-------------------------------------------------------------|
| 07:50 – 08:00 | Sponsors                                                                   |                                                     |                                                             |
| 08:00 – 09:15 | <b>Plenary:</b> INFORMS speakers<br><i>Chair:</i> H. Ittmann               |                                                     |                                                             |
| 09:15 – 09:30 | Tea break                                                                  |                                                     |                                                             |
| 09:30 – 11:30 | <b>OR in Energy</b><br><i>Chair:</i> C. Searle                             | <b>Logistics / Other</b><br><i>Chair:</i> R. Karimi | <b>OR in Finance / Other</b><br><i>Chair:</i> J. Du Pisanie |
| 11:30 – 11:40 | Tea break                                                                  |                                                     |                                                             |
| 11:40 – 12:50 | <b>Plenary/AFROS session:</b> Hatem Masri<br><i>Chair:</i> B. Lindner      |                                                     |                                                             |
| 12:50 – 13:00 | <b>Closing</b>                                                             |                                                     |                                                             |
| 13:15 – 14:15 | <b>OR Virtual Meetup</b><br><i>Venue:</i> Zoom session                     |                                                     |                                                             |
| 14:30 – 16:30 | <b>Annual General Meeting of ORSSA (AGM)</b><br><i>Venue:</i> Zoom session |                                                     |                                                             |

# Creating business value with AI.

Spatialedge is a data science solutions company that creates sustainable value for large companies.

We **empower data science teams to deliver significantly more value to business faster** and more reliably, by providing a toolkit consisting of engineers, data science specialists, open-source and bespoke software, and training programs.

The benefit of data science is more than just once off insights from models running in notebooks; it is **providing a sustainable solution** that continuously delivers the right information to the right people, at the right time. Sharing insights with other services, embedding insights in applications or creating **enterprise decision support applications**.

We assist clients through the whole data engineering and data science lifecycle. From identifying the **most valuable problems to deploying models** and integrating them with the rest of the organization. While reducing development risk through **agile** and **iterative** processes.

The opportunity cost of not properly operationalizing machine learning models is very high. That is why we specialize in doing it fast, yet properly.

We have extensive experience working with a wide variety of big data vendors, including the Cloudera stack (Hive, Spark, Kafka, etc), Confluent Kafka and the main cloud providers (AWS, Azure and Google Cloud Platform).



With our clients, we delivered **80%** of models into production within 3 months,

created more than **R500 million in savings** and generated more than **R400 million in revenue**

Currently managing data volumes in excess of **80 billion** records per day.

We decided to do it differently. We partner with companies and drive to value using a solutions toolkit consisting of:



**Big data capability and maturity assessment.** independent audit of your big data environment, business environment people and processes.



**+7 PHDs and > 320 years** combined xp. Software, Data and Machine Learning Engineers. Data science specialists.



**Pre-built scripts, models and services** to accelerate development and integration



**Patterns, methodologies and workflows** that ensures robustness at speed.



**Decision framework** to rapidly build decision support applications.



**Training material:** workshops, courses and mentoring to further enable and upskill your people.



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— *Detailed Conference Programme* —

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**Sunday, 12 September 2021**

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**Workshop: 14:00–17:00**

[Venue: Zoom session]

**Integrated Analytics Workshop** by Prof. Fanie Terblanche

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**Monday, 13 September 2021**

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**Welcome: 08:00–08:10**

[Venue: ORSSA Auditorium]

**Presidential address: Dave Evans: 08:10–08:30**

[Venue: ORSSA Auditorium]

**Plenary session I: 08:30–10:20**

Chair: Marius Smuts [Venue: ORSSA Auditorium]

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08:30–09:20 **Prof. Gerda Claeskens**  
*Confidence distributions for most powerful inference after model selection* ..... (p. 11)

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**National Student Competition (Master’s division)**

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09:20–09:50 **Günther Hüselmann**, *Bus route design and frequency setting for public transit systems* ..... (p. 51)

09:50–10:20 **Kit Searle**, *A mathematical model for sustainable harvesting of a theoretical biological species* ..... (p. 92)

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**Tea break: 10:20–10:30**

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**Data Analysis and Predictive modelling: 10:30 – 12:30**

Chair: Pawoumodom Matthias Takouda [Venue: ORSSA Auditorium]

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10:30–11:00 **Willem Moore**, *A framework for modelling customer invoice payment predictions* ..... (p. 74)

11:00–11:30 **Alexander Flemming**, *A framework for modelling spatio-temporal competition and spread of invasive Acacia species in South Africa* (p. 42)

11:30–12:00 **Pawoumodom M. Takouda**, *Assessing the performance of the African entrepreneurial ecosystem: a DEA based approach* ..... (p. 98)

12:00–12:30 **Karamoko Sita Diallo**, *Measure of the efficiency of the Autonomous Port of Dakar: Application of Data Envelopment Analysis (DEA) and bootstrap approaches* ..... (p. 38)

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**OR in Healthcare: 10:30 – 12:30**

Chair: Imen Mejri [Venue: Elephant Room]

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10:30–11:00 **Ines Rekik**, *Solving the patients scheduling problem in the emergency department of the Tunisian Habib Bourguiba Hospital using Genetic Algorithm* ..... (p. 56)

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|             |                                                                                                                                                 |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| 11:00–11:30 | <b>Layeb Sana</b> , <i>A multidisciplinary collaboration for the healthcare of autistic children: a Tunisian field study</i> ..... (p. 90)      |
| 11:30–12:00 | <b>Imen Mejri</b> , <i>Organizational structure improvement of a Tunisian hospital’s emergency department</i> ..... (p. 73)                     |
| 12:00–12:30 | <b>Marwa Hasni</b> , <i>A new DEA-based approach to assessing the performance of learning processes within teaching hospitals</i> ..... (p. 50) |

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**Optimisation: 10:30 – 12:30**

*Chair:* Günther Hüsselmann [*Venue:* Lion Room]

|             |                                                                                                                                                         |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10:30–11:00 | <b>Hamou Satla</b> , <i>An exact method for the multi-objective matching problem</i> ..... (p. 91)                                                      |
| 11:00–11:30 | <b>Günther Hüsselmann</b> , <i>A dynamic mutation strategy for incorporation into a genetic algorithm</i> ..... (p. 52)                                 |
| 11:30–12:00 | <b>Nouara Makhoulouf</b> , <i>On a discrete nonlinear multi-objective optimization problem with bounded variables</i> ..... (p. 69)                     |
| 12:00–12:30 | <b>Allen R. Mushi</b> , <i>An algorithm for determination of university enrolment workload: The case of the University of Dar es Salaam</i> ... (p. 82) |

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**Lunch: 12:30–13:00**

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**Machine Learning: 13:00 – 15:00**

*Chair:* Pierre Cilliers [*Venue:* ORSSA Auditorium]

|             |                                                                                                                                                                    |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13:00–13:30 | <b>Pierre Cilliers</b> , <i>A spatio-temporal framework for machine learning-inspired prediction of informal settlement emergence and growth</i> (p. 34)           |
| 13:30–14:00 | <b>Richard Ball</b> , <i>Deep anomaly detection using network features</i> . (p. 22)                                                                               |
| 14:00–14:30 | <b>Bianca Van Zyl</b> , <i>A generic framework for aspect-based sentiment analysis</i> ..... (p. 99)                                                               |
| 14:30–15:00 | <b>J.S. Du Toit</b> , <i>Improved human pose differentiation in convolutional neural network classification using colour-based data augmentation</i> ..... (p. 40) |

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**OR in Healthcare: 13:00 – 15:00**

*Chair:* Zhor Chergui [*Venue:* Elephant Room]

|             |                                                                                                                     |
|-------------|---------------------------------------------------------------------------------------------------------------------|
| 13:00–13:30 | <b>Sarah Ben Terzi</b> , <i>Implementation of 5S-Kaizen in Healthcare - Abderahman Mami Hospital</i> ..... (p. 26)  |
| 13:30–14:00 | <b>Sondes Hammami</b> , <i>Development of an ambulance dispatching management tool – SAMU 04 Sfax</i> ..... (p. 48) |
| 14:00–14:30 | <b>Zhor Chergui</b> , <i>Coronavirus hospitalisation : decision making tool in Africa region</i> ..... (p. 32)      |
| 14:30–15:00 | <b>Carike Karsten</b> , <i>Robust container clinic location: A South African application</i> ..... (p. 62)          |

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**Optimisation: 13:00 – 15:00**

*Chair:* Chanel Bisset [*Venue:* Lion Room]

|             |                                                                                                                                                         |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13:00–13:30 | <b>Lamia Zerfa</b> , <i>Solving multiobjective integer convex programs with linear constraints</i> ..... (p. 102)                                       |
| 13:30–14:00 | <b>Wassila Drici</b> , <i>Nonlinear optimization over the integer efficient set of multi-objective integer linear fractional programs</i> ..... (p. 78) |
| 14:00–14:30 | <b>Chanel Bisset</b> , <i>A stochastic programming approach for marketing campaign optimisation</i> ..... (p. 28)                                       |

14:30–15:00 **Theodor Stewart**, *Interactive multiobjective optimization with multiple reference points* ..... (p. 97)

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**Tea break: 15:00–15:30**

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**Neural Networks: 15:30 – 17:00**

*Chair:* Ruan Jordaan [*Venue:* ORSSA Auditorium]

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15:30–16:00 **Ryno Kleinhans**, *A framework for intelligent document processing of image data* ..... (p. 64)

16:00–16:30 **Ruan Jordaan**, *Implementation of reinforcement learning algorithms in the wrapslide environment* ..... (p. 57)

16:30–17:00 **Jacobus Jacobs**, *A generic human activity recognition framework* ..... (p. 54)

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**OR in Healthcare: 15:30 – 17:00**

*Chair:* Rahma Borchani [*Venue:* Elephant Room]

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15:30–16:00 **Sumaya M. Kagoya**, *Review of the current status of Operations Research applications in hospital operations management in East Africa* ..... (p. 58)

16:00–16:30 **Rahma Borchani**, *Hybrid Hungarian method and GVNS metaheuristic for PAS problem* ..... (p. 29)

16:30–17:00 **Fatma Ben Amor**, *Multi-vehicle covering tour problem for healthcare facilities the case of the NSSF* ..... (p. 25)

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**Optimisation: 15:30 – 17:00**

*Chair:* Kit Searle [*Venue:* Lion Room]

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15:30–16:00 **Mouhamadou A. M. T. Baldé**, *A greedy evolutionary hybridization algorithm for the optimal network and quadratic assignment problem* ..... (p. 21)

16:00–16:30 **Mohamed Nedjai**, *The two-stage chain reentrant hybrid flow-shop problem with deteriorating jobs* ..... (p. 85)

16:30–17:00 **Kit Searle**, *A PDE-constrained optimisation approach towards optimal harvesting yield of a biological species* ..... (p. 93)

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**Tea break: 17:00–17:10**

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**Plenary session II: 17:10 – 18:00**

*Chair:* Sue Merchant [*Venue:* ORSSA Auditorium]

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17:10–18:00 **Prof. Laura Albert**  
*Operations research with impact: a journey in public sector operations research* ..... (p. 16)

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## Tuesday, 14 September 2021

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**Sponsors 07:50–08:00**

[Venue: ORSSA Auditorium]

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**Plenary session III: 08:00 – 09:50**

Chair: Philip Venter [Venue: ORSSA Auditorium]

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08:00–08:50 **Prof. Roelof Coetzer**  
*Continuous improvement and optimization of an ore processing value chain through application of Data Science technologies* ..... (p. 12)

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**National Student Competition (Honours division)**

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08:50–09:20 **Stuart McMaster**, *Simulating deforestation and evaluating mitigation methods* ..... (p. 71)

09:20–09:50 **Aaron Shuttleworth**, *Vehicle routing decision support for a local retailer* ..... (p. 95)

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**Tea break: 09:50–10:00**

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**Transportation and Routing: 10:00 – 12:00**

Chair: Mannoubia Affi [Venue: ORSSA Auditorium]

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10:00–10:30 **Ben Mansour Mouin**, *Road transport safety in Vehicle routing problem: An integration approach* ..... (p. 75)

10:30–11:00 **Jacobus King**, *A capacitated vehicle routing and scheduling problem for increased driver-route familiarity* ..... (p. 63)

11:00–11:30 **Mamadou Koné**, *Optimal mass transportation for Land Use Problem* ..... (p. 65)

11:30–12:00 **Mannoubia Affi**, *An integration of split procedure and ILS algorithm: The case of the Battery Swap Station Location-Routing Problem with capacitated electric vehicles* ..... (p. 20)

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**OR in Healthcare / OR in Education: 10:00 – 12:00**

Chair: David Clark [Venue: Elephant Room]

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10:00–10:30 **David Clark**, *Learning from Volunteering - ORSSA, Datakind and Riders for Health* ..... (p. 35)

10:30–11:00 **Chinasa I. Ikelu**, *Optimizing drone operations for healthcare services in Africa* ..... (p. 53)

11:00–11:30 **Yalaoui Nabila**, *Analysis and optimization of the pharmaceutical distribution chain of NIGAPHARM company: A case study in Algeria* ..... (p. 84)

11:30–12:00 **Edwin Reed**, *A framework for quantifying the sensitivity of anticipated employment rates in different sectors of the South African economy with respect to throughput rate changes in the education sector* ..... (p. 89)

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**Decision Support: 10:00 – 12:00**

Chair: Reinard Ganzevoort [Venue: Lion Room]

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10:00–10:30 **Jurie Zietsman**, *A framework for decision support in inventory management pursuant of economies of scale* ..... (p. 103)

10:30–11:00 **Mohamed Ali Elleuch**, *Multi-criteria decision analysis for energy source selections problem* ..... (p. 41)

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|             |                                                                                                                                                                      |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11:00–11:30 | <b>Benitho Gasper Mung’Ong’O</b> , <i>Application of multi-criteria decision making methods on the choice of crops for small scale agro-processing</i> ..... (p. 81) |
| 11:30–12:00 | <b>Reinard Ganzevoort</b> , <i>A decision support framework for the selection of appropriate demand time series forecasting methods</i> ..... (p. 44)                |

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**Lunch: 12:00–12:30**

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**Transportation and Routing: 12:30 – 14:30**

*Chair:* Pieter Jacobus Steenkamp [*Venue:* ORSSA Auditorium]

|             |                                                                                                                                                          |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12:30–13:00 | <b>Mezali Zineb</b> , <i>Optimizing a linear function over the efficient set of a multi-objective transportation problem</i> ..... (p. 104)              |
| 13:00–13:30 | <b>Pieter Jacobus Steenkamp</b> , <i>On solving the vehicle-driver rostering problem in an integrated fashion</i> ..... (p. 96)                          |
| 13:30–14:00 | <b>Phillip Christian Malan</b> , <i>An agent-based approach to customer crowd-shipping</i> ..... (p. 70)                                                 |
| 14:00–14:30 | <b>Ben Mansour Mouin</b> , <i>Road safety in transportation: A journal review and a proposed taxonomy analysis of accidentology-factor</i> ..... (p. 76) |

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**Logistics: 12:30 – 14:30**

*Chair:* Jamal El Baz [*Venue:* Elephant Room]

|             |                                                                                                                                                     |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| 12:30–13:00 | <b>Rokaya Lassoued</b> , <i>A bilevel optimization programming model to solve the berth and quay cranes allocation problems</i> ..... (p. 67)       |
| 13:00–13:30 | <b>Rim Bhiri</b> , <i>The improvement of logistic distribution process in a commercial company</i> ..... (p. 27)                                    |
| 13:30–14:00 | <b>Rachid El Gadroui</b> , <i>Digital supply chain: Particularities, levers and barriers</i> ..... (p. 43)                                          |
| 14:00–14:30 | <b>Jamal El Baz</b> , <i>Correlation between green supply chain management and cultural factors : Empirical evidence from Morocco</i> ..... (p. 55) |

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**Decision Support: 12:30 – 14:30**

*Chair:* Winnie Carla Pelser [*Venue:* Lion Room]

|             |                                                                                                                                          |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------|
| 12:30–13:00 | <b>Van Zyl Venter</b> , <i>A decision support framework for cross-functional team selection</i> ..... (p. 101)                           |
| 13:00–13:30 | <b>Zhor Chergui</b> , <i>Workshop scheduling: New multi-criteria heuristic for machinery breakdown constraint</i> ..... (p. 79)          |
| 13:30–14:00 | <b>Mouna Regaieg Cherif</b> , <i>An interactive disaggregation approach of codas method for urban rainwater management</i> ..... (p. 33) |
| 14:00–14:30 | <b>Winnie Carla Pelser</b> , <i>Sound decision making under stressful situations</i> ..... (p. 86)                                       |

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**Tea break: 14:30–15:00**

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**Transportation and Routing: 15:00 – 17:00**

*Chair:* Robert Bennetto [*Venue:* ORSSA Auditorium]

|             |                                                                                                                                  |
|-------------|----------------------------------------------------------------------------------------------------------------------------------|
| 15:00–15:30 | <b>Zainab Alaa Hameed</b> , <i>The four-dimensional transportation problem</i> ..... (p. 47)                                     |
| 15:30–16:00 | <b>Souhail Dhouib</b> , <i>New heuristic for the Hexagonal Fuzzy Transportation Problem: the Dhouib-Matrix-TP1</i> ..... (p. 36) |

|             |                                                                                                                                                                                                                                                                        |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 16:00–16:30 | <b>Ben Mansour Mouin</b> , <i>A multidimensional Genetic Algorithm applicable for our VRP variant dealing with the problems of infrastructure defaults SVRDP-CMTW: “Safety Vehicle Routing Diagnosis Problem with Control and Modified Time Windows”</i> ..... (p. 77) |
| 16:30–17:00 | <b>Robert Bennetto</b> , <i>A clean result for a dirty problem</i> ..... (p. 24)                                                                                                                                                                                       |

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**Logistics: 15:00 – 17:00**

*Chair:* Cigdem Gurgur [*Venue:* Elephant Room]

|             |                                                                                                                                                             |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:00–15:30 | <b>Jamal Elbaz</b> , <i>Exploring smart logistics’ environmental and economic externalities: Case studies of Moroccan logistics providers</i> ..... (p. 23) |
| 15:30–16:00 | <b>Asmaa Laaziz</b> , <i>Block Chain in a supply chain environment</i> .. (p. 66)                                                                           |
| 16:00–16:30 | <b>Sumaya M Kagoya</b> , <i>E-logistic Practices and Health Care Supply Chain Management for Public Referral Hospitals in Uganda</i> ..... (p. 59)          |
| 16:30–17:00 | <b>Cigdem Gurgur</b> , <i>Blockchain Meta-Analytic Typology for Achievement of Sustainable Development Goals</i> ..... (p. 45)                              |

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**Decision Support / Simulation: 15:00 – 17:00**

*Chair:* Petrus H. Potgieter [*Venue:* Lion Room]

|             |                                                                                                                                                                   |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:00–15:30 | <b>Hichem Brahmi</b> , <i>A new group decision making approach with fuzzy SWARA and ARAS-H for selecting steel products suppliers: A case study</i> ..... (p. 31) |
| 15:30–16:00 | <b>Cigdem Gurgur</b> , <i>Supply side flexibility in revenue management: An application in medical wire and device manufacturing</i> ..... (p. 46)                |
| 16:00–16:30 | <b>Petrus H. Potgieter</b> , <i>Cardinality bundling under oligopoly – A simulation model</i> ..... (p. 88)                                                       |
| 16:30–17:00 | <b>Amadou S. Diallo</b> , <i>Stochastic optimal control and simulations with application to the cashew nut’s sector in Senegal</i> ..... (p. 39)                  |

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**Prize-giving ceremony: 17:00 – 18:00**

[*Venue:* ORSSA Auditorium]

|             |                                |
|-------------|--------------------------------|
| 17:00–18:00 | <i>Speaker:</i> Kim Triegaardt |
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## Wednesday, 15 September 2021

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**Sponsors: 07:50–08:00**  
[Venue: ORSSA Auditorium]

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**Plenary session IV: INFORMS speakers: 08:00 – 09:15**  
Chair: Hans Ittmann [Venue: ORSSA Auditorium]

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- 08:00–08:25 **Elise Miller-Hooks**  
*Investing for sustainable and resilient roadway infrastructure ...* (p. 13)
- 08:25–08:50 **Emma Gibson**  
*Redesigning sample transportation in Malawi through improved data sharing and daily route optimization ...* (p. 14)
- 08:50–09:15 **Jorge Samayoa**  
*Data Science at work: an overview around PerMed ...* (p. 15)
- 

**Tea break: 09:15–09:30**

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**OR in Energy: 09:30 – 11:30**  
Chair: Christa Searle [Venue: ORSSA Auditorium]

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- 09:30–10:00 **Desiree Taliane Mpassi Mahinga**, *A model for the design and operation management of a wind /photo-voltaic solar hybrid power generation system ...* (p. 68)
- 10:00–10:30 **Christa Searle**, *Hydrogen freight solutions towards net zero ...* (p. 94)
- 10:30–11:00 **Mohamed Dia**, *An assessment of the efficiency of Canadian power generation companies with bootstrap DEA ...* (p. 37)
- 11:00–11:30 **Jackline Mutunga**, *Design and optimization of energy production from a biogas plant ...* (p. 83)
- 

**Logistics / Other: 09:30 – 11:30**  
Chair: Rose Karimi [Venue: Elephant Room]

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- 09:30–10:00 **Rose Karimi**, *Redesigning the coffee supply chain with Blockchain technology ...* (p. 61)
- 10:00–10:30 **Slaheddine Baklouti**, *The Goleman model as predominant style of leadership in Tunisia – An exploratory study ...* (p. 60)
- 10:30–11:00 **Marthi Harmse**, *A history of operations management ...* (p. 49)
- 11:00–11:30 **Kendi Muchungi**, *Transitioning from traditional agriculture to automated agriculture using IoT to manage resources ...* (p. 80)
- 

**OR in Finance / Other: 09:30 – 11:30**  
Chair: Johan Du Pisanie [Venue: Lion Room]

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- 09:30–10:00 **Imen Zghidi**, *A New Derivation for an Optimal Portfolio ...* (p. 30)
- 10:00–10:30 **Johan Du Pisanie**, *On testing the hypothesis of population stability for credit risk scorecards ...* (p. 87)
- 10:30–11:00 **Sara Megaiz**, *Facility layout design in an Algerian case study: PP woven bag manufacturing industry ...* (p. 72)
- 11:00–11:30 **Jaco Visagie**, *On numerical considerations associated with the Kolmogorov-Smirnov test for exponentiality in the presence of censoring ...* (p. 100)
- 

**Tea Break: 11:30–11:40**

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**Plenary session V: 11:40 – 13:00**

*Chair:* Berndt Lindner [*Venue:* ORSSA Auditorium]

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11:40–12:50 **Prof Hatem Masri**

*The Operational Research revolution in Africa: Paving the way for future generations* ..... (p. 17)

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**Closing: 12:50 – 13:00**

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**OR Virtual Meetup: 13:15–14:15**

[*Venue:* Zoom session]

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**Annual General Meetng (AGM) of ORSSA: 14:30–16:30**

[*Venue:* Zoom session]

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— *Keynote Abstracts* —

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Keynote speaker: *Gerda Claeskens*

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***Confidence distributions for most powerful inference after model selection.***

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When a model is not given, but is the result of a model search endeavor, the uncertainty about the model that is used for inference has consequences for hypothesis testing and for the construction of confidence intervals for the model parameters of interest. Ignoring this uncertainty leads to overoptimistic results, implying  $p$ -values that are too small and confidence intervals that are too narrow for the intended coverage.

In this talk I will explain how to use confidence distributions to obtain valid inference after model selection for the parameters of interest. Under some assumptions, uniformly most powerful post-selection confidence curves are obtained.

This is joint work with Andrea Garcia-Angulo.

**Biography of the speaker:**

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Gerda Claeskens is professor of *Statistics* at the research group OR and Statistics and the Leuven Statistical Research Center at KU Leuven in Belgium. Her research topics include model selection methods, inference post-selection and nonparametric estimation methods.

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Keynote speaker: *Roelof Coetzer*

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## *Continuous improvement and optimization of an ore processing value chain through application of Data Science technologies*

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Ore processing facilities are hugely complex, which entails blending, stacking and reclaiming of different sources of raw materials with varying ore qualities. In addition, the performance of the downstream units depends crucially on the quality and stability of the raw materials fed to the process. Therefore, it is critical for the business to not only know the quality of the raw material being stacked and reclaimed in real time, but also to optimize the stacking-reclaiming process in order to reduce the variability in the feed quality over time. Furthermore, prediction of plant performance and diagnostic analysis on performance deviations as functions of the feed quality are critical for the continuous improvement of the operations downstream.

Therefore, in order to better understand, control and manage these complex systems in pursuit of continuous improvements and optimization, a holistic Data Science strategy and implementation roadmap are required. This paper will discuss how different Data Science technologies, including data engineering, statistical, machine learning and operations research methods, are used for continuous improvement and optimization of a commercial ore processing value chain. A Coal Value Chain in South Africa will be used as case study to demonstrate the development and implementation of the different technologies with direct business benefits.

### **Biography of the speaker:**

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Roelof Coetzer has been at Sasol from 1998 and for the last few years he acted as Senior Manager of Machine Learning and Statistics within the Data Science Team, Sasol Operations Improvement. He was responsible for line management, project leader of multidisciplinary projects and teams, and the development and implementation of Data Science, Data Analytics and Digital solutions. In total, he has about 30 years' experience in Industry. However, he is also an academic and researcher, and obtained his PhD in Mathematical Statistics from the University of the Witwatersrand in 2004. He co-authored of 47 peer-reviewed articles in national and international scientific journals and conference proceedings, and have one patent in coal preparation related to coal particle size distribution.

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Keynote speaker: *Dr. Elise Miller-Hooks*

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## *Investing for sustainable and resilient roadway infrastructure*

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Increased storm frequency and intensity, increased total precipitation, sea level rise and very high tides are among some of the concerns associated with climate change. Thus, with climate change, more frequent temporary or permanent inundation of transportation system elements can be expected. This has important consequences for economies and the safety of motorists. This talk describes an optimization-based solution technique for long-term transportation investment planning in protective measures for safeguarding the performance of our roadway networks. The importance of explicitly considering the stochastic nature of future climate impact predictions and predictive accuracy to investment planning and enhanced system resilience is also investigated.

### **Biography of the speaker:**

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Dr. Elise Miller-Hooks holds the Bill and Eleanor Hazel Endowed Chair in Infrastructure Engineering at George Mason University, is an advisor to the World Bank Group, and the founding Editor-in-Chief of Elsevier's Sustainability Analytics and Modeling journal. Prior to this, Dr. Miller-Hooks served as a program director at the U.S. National Science Foundation and on the faculties of the University of Maryland, Pennsylvania State University and Duke University. Dr. Miller-Hooks received her Ph.D. (1997) and M.S. (1994) degrees in Civil Engineering from the University of Texas – Austin and B.S. in Civil Engineering from Lafayette College (1992). She has expertise in: disruption planning and response; multi-hazard civil infrastructure resilience quantification and protection; stochastic and dynamic network algorithms; transportation systems engineering; intermodal passenger and freight transport; real-time routing and fleet management, including paratransit, delivery, ridesharing and bikeways; and collaborative and multi-objective decision-making

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Keynote speaker: *Emma Gibson*

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***Redesigning sample transportation in Malawi through improved data sharing and daily route optimization***

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Centralized diagnostic networks play a critical role in the delivery of essential healthcare services in resource-limited settings. These large-scale diagnostic networks depend on sample transportation (ST) systems to move medical samples (e.g. blood, sputum) between healthcare facilities and laboratories. Operational inefficiencies in these transportation systems contribute to unnecessary delays in the communication of diagnostic results to patients, leading to worse health outcomes.

Our work is focussed on improving the efficiency of a national transportation system operated by Riders For Health in Malawi. We propose a two-part system that uses a low-cost, feature phone data sharing platform to monitor sample volumes at healthcare facilities, and an optimized sample transportation model to generate efficient routes for ST couriers on a daily basis.

This system has been operating continuously in three districts in Malawi since August 2019. Since implementation, the proportion of unnecessary courier trips has been reduced by 55% and average ST delays have been shortened by an estimated 25

Link to paper: <https://ssrn.com/abstract=3712556>

**Biography of the speaker:**

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Emma Gibson is a PhD candidate at the MIT Operations Research Center. Her research interests include optimization, logistics, and machine learning, and she is particularly interested in real-world applications of mathematical models to improve healthcare delivery programs in resource-limited settings. Prior to joining the ORC PhD program, Emma obtained a BSc (Hons) in Mathematical Sciences from the University of the Witwatersrand and an MSc in Logistics from Stellenbosch University.

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Keynote speaker: *Jorge Samayoa*

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## *Data Science at work: an overview around PerMed*

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In this talk, we introduce the audience to the different application of data science to personalized medicine. There are hundreds of algorithms being developed in order to extract information from data. This information is used to predict the best treatment for a patient. For example, we can use customer stratification techniques to classify severity of a disease depending on patients' blood pressure. We will give a brief explanation of how this type of algorithms work and provide some of the most relevant applications in PerMed. Also, we will discuss why data science has become relevant nowadays, and how "modern" statistics is helping us to solve problems that were impossible to describe in the past.

### **Biography of the speaker:**

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Jorge A. Samayoa holds a B.S. in electronics and computer science, a M.S. in operations research, a M.S. in applied mathematics, and a Ph.D. in Industrial Engineering. He has taught in several universities in Guatemala and USA. In 2007 he was awarded the prestigious Fulbright-LASPAU scholarship to pursue his master's degree at Texas A&M University and later his Ph.D. at Purdue University, where he developed the Calculus for Decision Systems (a generalized systems theory). Currently he is the CEO of SciLambda.net, a company dedicated to providing Data Science consulting services. Also, he is the director of the Operations Research Institute at Galileo University, where he and his team promote research and applications of Data Science to a wide variety of areas.

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Keynote speaker: *Laura Albert*

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## *Operations research with impact: A journey in public sector operations research*

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Government programs spanning public safety, transportation security, and critical infrastructure protection must deliver essential services by managing risks such as health emergencies, crime, acts of terrorism, and natural disasters. Doing so requires allocating resources in complex systems that span people, processes, vehicles, and critical infrastructure, where many decisions are interrelated.

Government leaders and researchers have been studying how to design and operate public sector systems to manage risk for the last half a century. Although researchers have created a body of knowledge for supporting prescriptive and predictive decisions in the public sector, public safety leaders must continually adapt to address new risks in budget-constrained environments. As a result, many research challenges remain.

In this talk, Dr. Laura Albert will discuss her research that studies how to design and operate public sector systems using optimization methodologies. She will discuss how she has connected theory and modeling to application in applications in the United States ranging from emergency medical services, aviation security, and critical infrastructure protection. She will also discuss how to engage policymakers and the public with research. At the end of the talk, Dr. Albert will discuss challenges introduced by the COVID-19 global health crisis to applications in the United States ranging from public safety to voting systems, and she will outline how operations research can help.

### **Biography of the speaker:**

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Laura Albert, Ph.D., is the David Gustafson Department Chair of Industrial and Systems Engineering at the University of Wisconsin-Madison. Her research interests are in the field of operations research, with a particular focus on discrete optimization with application to homeland security and emergency response problems. Dr. Albert's research has been supported by the National Science Foundation, the Department of Homeland Security, the Department of the Army, and Sandia National Laboratory. She has authored or co-authored more than 70 publications in archival journals and refereed proceedings. She has been awarded many honors for

her research, including the American Association for the Advancement of Science (AAAS) Fellow Award, Institute of Industrial and Systems Engineers (IISE) Fellow Award, the INFORMS Impact Prize, four publication awards, a National Science Foundation CAREER award, a Fulbright Award, and a Department of the Army Young Investigator Award. She is a Department Editor for IISE Transactions and is on or has been on six other journal Editorial Boards. Dr. Albert has served on the INFORMS Board as the Vice President for Marketing, Communication, and Outreach and served as the Assistant Dean for Graduate Affairs in the College of Engineering at UW-Madison. She is the author of the blog "Punk Rock Operations Research." You can find her on twitter at @lauraalbertphd.



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Keynote speaker: *Hatem Masri*

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## *The Operational Research revolution in Africa: Paving the way for future generations*

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This presentation aims to highlight the impact of recent development to promote Operations Research in Africa. We will start with a historical review of the major changes that happened during the last years and the major transformations inside AFROS with a focus on promoting networking. We will report on nowadays structure of AFROS and the ambitious strategic plan of the society. Finally, we will provide an answer to the question: How Operations Research will contribute to Africa in 2030 and beyond.

### Biography of the speaker:

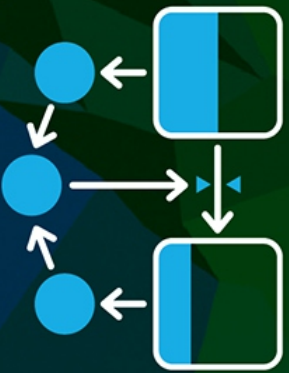
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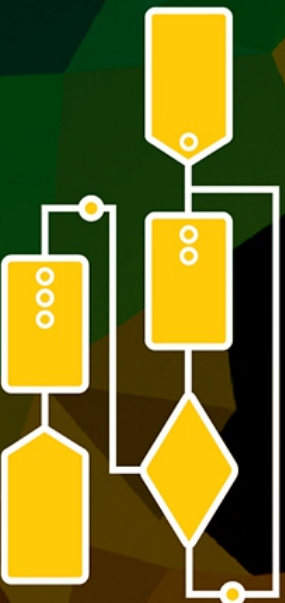
Hatem Masri is professor of *Business Analytics* and dean of the college of business administration at the university of Bahrain, Kingdom of Bahrain. He received a PhD in management science in 2004 and Master in operations research in 1999 from the university of Tunis, Tunisia. His research interests include business analytics, supply chain management, financial engineering, and Islamic finance. He published more than 30 articles and 6 books among them a textbook in Islamic business administration. Hatem is president of the African Federation of Operational Research Societies, founder of the INFORMS Bahrain International Group, general secretary of the Tunisian Decision Aid Society, member of INFORMS and IEEE and volunteer/mentor with the AACSB.



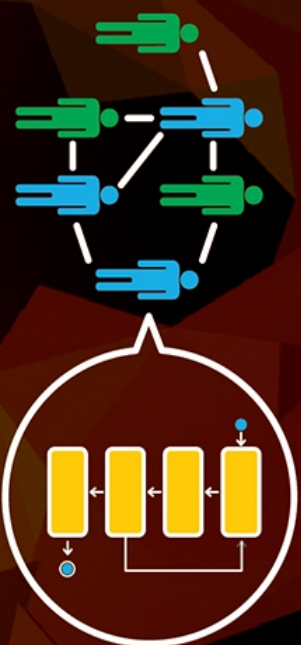
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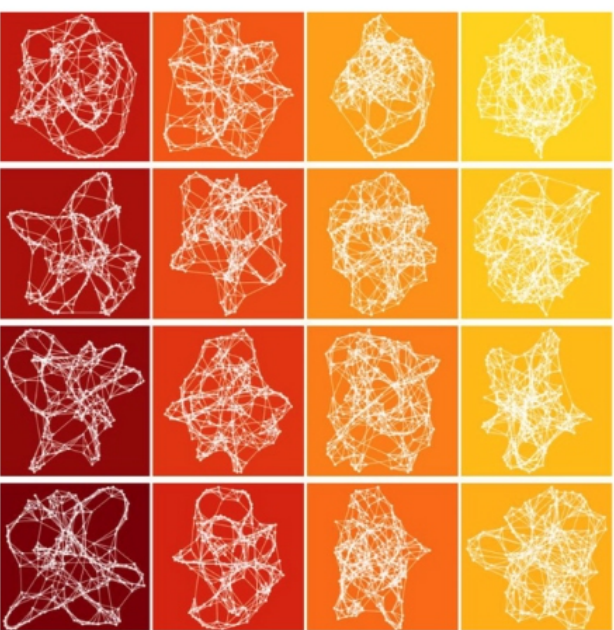
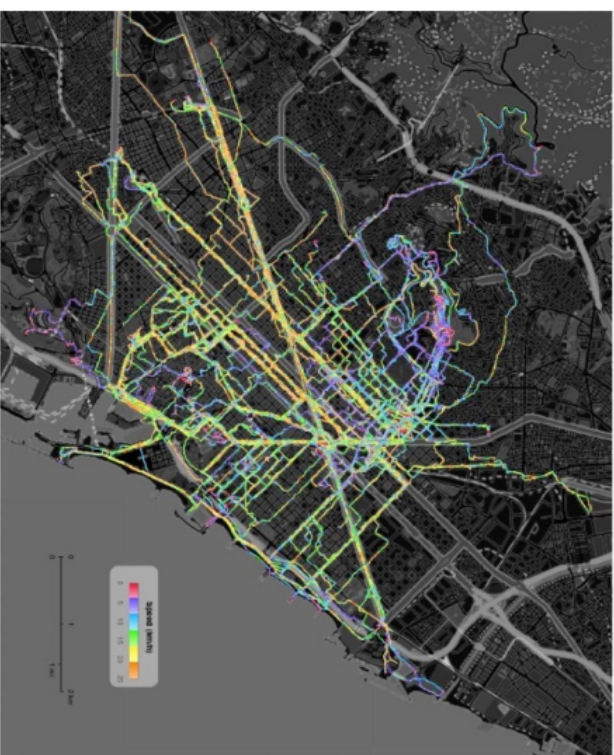
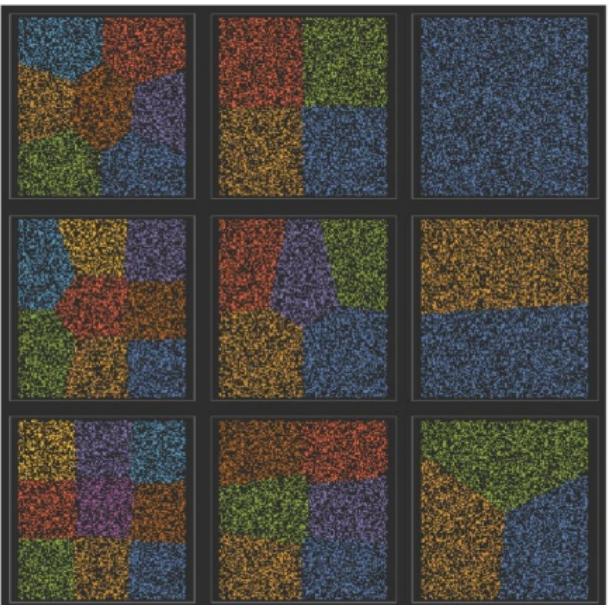


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***An integration of split procedure and ILS algorithm:  
the case of the battery swap station location-routing  
problem with capacitated electric vehicles***

*Mannoubia Affi\**  
*FSEG Sfax*

**Abstract**

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The location of the recharging station decision can be considered as primary role for reducing the amount of energy consumption in several logistics companies. In this work, we consider a new variant of location-routing problem for an electric vehicle with a single depot, which integrates the location decision of the Battery Swap Stations (BSS) with the elaboration of vehicle routing. An integration of split procedure into an iterated local search (ILS) is presented to solve the problem. Experimental results show the effectiveness of our proposed approach in comparison with the existing methods.

**Keywords:** routing, location, electric vehicle, battery swap station, split procedure, iterated local search.

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# *A greedy evolutionary hybridization algorithm for the optimal network and quadratic assignment problem*

*Mouhamadou A.M.T. Baldé\*, Serigne Gueye, Babacar M. Ndiaye*

*Laboratoire de Mathématique de la Décision et d'Analyse Numérique Université Cheikh Anta Diop, BP 45087, 10700, Dakar-Fann, Sénégal.*

## **Abstract**

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Our paper deals with a combinatorial optimization problem called the optimal network and quadratic assignment problem. The problem has been introduced by Los (Region Sci Urban Econ 8:21–42, 1978) as a model of an urban planning problem that consists in optimizing simultaneously the best location of the activities of an urban area (land-use), as well as the road network design (transportation network) in such a way to minimize as much as possible the routing and network costs. We propose a mixed-integer programming formulation of the problem, and a hybrid algorithm based on greedy and evolutionary heuristic methods. Some numerical experiments on randomly generated instances, and on real-life big data from Dakar city, show the efficiency of the method.

**Keywords:** Transportation network; Land-use plan; Quadratic assignment problem; Heuristic; Meta-heuristics; Big data

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# *Deep anomaly detection using network features*

*Richard Ball\*, Hennie Kruger, Lynette Drevin*

## **Abstract**

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Features for detecting anomalies in transactional systems are typically related to Recency Frequency Monetary (RFM) attributes that are used to understand transactional behaviour from a user perspective. While these features have proven to be useful in detecting anomalies in transactional data, they fail to effectively capture the interactions and relationships between the users themselves.

In this paper, a unified approach to detect anomalies is proposed. The approach includes using a neural architecture search technique to simulate a number of candidate autoencoder architectures for the purposes of designing an optimal architecture that can be used to classify anomalies. A threshold optimisation algorithm is then applied in order to determine the optimal threshold on validation and test sets, while Gaussian scaling is used to represent the anomaly scores in an interpretable form. The data used in the unified approach is a real-world data set sourced from an organisation in the financial services industry.

To provide for the problem of interactions and relationships between users, an extension to the unified approach is proposed. Additional network metric features are used to augment the standard transactional features, in order to determine whether these network metric features contribute significantly to model performance.

From an organisational perspective, interactions between users can be represented as a network. The individual users in the network act as nodes, whereas the interactions between nodes are represented as edges. Once defined as a network, the influence of any node within the broader network can be established by calculating various network metrics.

Using network metric features in the unified approach yielded a performant anomaly detection model with an acceptable false positive rate. Applying SHAP to the model predictions indicated that a number of the network metric features contributed significantly to the detection of anomalies in a holdout test set.

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# *Exploring smart logistics' environmental and economic externalities: Case studies of Moroccan logistics providers*

*Jamal El Baz\**

*Logipole Souss Massa Cluster*

## **Abstract**

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This research examines how the adoption of Industry 4.0 technologies by logistics services providers (LSP) might generate positive externalities at the environmental and economic levels. A case study approach was adopted. Seven Moroccan companies' representatives were interviewed to examine their awareness of potential economic and environmental externalities of smart logistics.

Case studies of Moroccan companies were taken from February to July 2021. The Internet of Things, the Cloud, sensor-powered big data analytics, RFID, and telematics deployment were topics mentioned by interviewees and information about real-time transfer of vehicle consumption, route, and shipping activity data constitute the major externalities of smart logistics.

Practitioners and researchers will gain a greater understanding of how implementing smart logistics can generate positive environmental and economic externalities. Moreover, the findings will shed light on the impacts of smart logistics. This research is one of the first studies to investigate smart logistics' environmental and economic externalities.

**Keywords:** Industry 4.0, smart logistics, environmental externalities, economic externalities, Moroccan logistics provider.

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# *A clean result for a dirty problem*

*Robert Bennetto\**  
*Icepack*

## **Abstract**

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Waste management is a well studied problem in the literature whereby the problem of visiting multiple households to collect refuse is modelled as an arc routing problem. In some instances, this is then extended to a capacitated arc-routing problem where the offloading activity of the vehicle at a dump site is modelled. In this talk we'll showcase some of the details required to create robust plans for real-world instances, highlighting required simplifications, transformations and additional constraints to ultimately present the problem as an equivalent asymmetric capacitated vehicle routing problem. The final solution procedure will remove all doubt as to the optimality of the solutions obtained. This talk will focus on the computational procedure and implementation of heuristics and separation routines employed on a real-world problem instance.

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# *Multi-vehicle covering tour problem for healthcare facilities the case of the NSSF*

*Fatma Ben Amor\*, Manel Kammoun, Taicir Loukil  
Faculty of Economics and Management Sciences. Sfax, Tunisia*

## **Abstract**

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Health-care facilities are important to all communities, and their location has long been an attractive subject for many researchers. In general, decision makers need a strategic planning to select the location of these facilities. If they are not well located, this could increase the morbidity and the mortality. In many researches this problem is treated to improve the equity of accessibility, raises the total accessibility for the entire population, maximizes the covered population, and minimizes the cost of building new facilities. In this context, we hope to focus on the problem of the specific pharmacy of the National Social Security Fund policlinic (NSSF). This pharmacy is responsible for distributing the treatment to the 24 Tunisian cities. A large number of patients use to come to this pharmacy to take their treatment which causes congestion in the polyclinics. In this study, we propose to solve this problem by involving a set of pharmacies of the 24 Tunisian cities to distribute the treatment. More precisely, the demand of each city could be satisfied directly by visiting the city along the tour or indirectly by covering it. This constraint is one of the characteristics of the multi-vehicle covering tour problem (m-CTP). In our case, we deal with a routing problem where the constraint of visiting all customers is not considered.

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# *Implementation of 5S-Kaizen in healthcare – Abderrahman Mami hospital*

*Sarah Ben Terzi\*, Rania Taga, Oussama Ben Ali*

*University of Carthage, National Engineering School of Carthage, 2035, Tunis, Tunisia*

## **Abstract**

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Global pandemic COVID-19 context emphasizes the critical importance to improve operational efficiency of healthcare services. As, implementation of 5S-Kaizen in industries has proven its effectiveness, in this study we present the 5S-Kaizen approach applied in three pilot units of the Abderrahman Mami hospital. Firstly, with hospital staff, we started applying 5S to organize and improve the workplace environment. It is necessary to obtain a tangible progress to communicate the expected results at an early stage to get the team's engagement since it is indeed a critical success factor of 5S-Kaizen approach. Then, two types of continuous improvement projects were defined, small and large Kaizen. With small Kaizen themes, we need neither time nor resources, these are some examples that we can mention: improvement of the intrapersonal communication plan, improvement of samples transportation to the laboratory, display documents required to register for the scanner, etc. Among Large Kaizen themes considered we can refer to the reduction of some activities' durations by reorganizing the process and eliminating certain sources of waste. We apply the large Kaizen method to solve "big" problems. The implementation of 5S-Kaizen approach has led to:

- Reducing documents' search time in the radiology archive by 88% (from 25 min to 3 min), for equipment in the warehouse by 35% (from 7 min to 4min30).
- Increasing space released by 49% in the archive.
- Reducing samples transportation time by 80% (from 39 min to 8 min per day).
- Reducing recovery time of unused medication by 83% (from 30 min to 5 min).
- Reducing the waiting time of scanner exam validation by 40% (from 85 min to 50min30)

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# *The improvement of logistic distribution process in a commercial company*

*Rim Bhiri\**

*Faculté des Sciences Économiques et de Gestion de Sfax*

## **Abstract**

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Companies all around the world are frantically trying to attain the greatest levels as a result of quick and constant improvement. Improving supply chain procedures is an essential technique for achieving this aim. The Supply Chain Operation Reference Model (SCOR) is a guide of managing supply chain. Our research activity is launched in a distribution company called “CEG Gros” to incorporate a commercial company’s delivery method using the SCOR Model, version 12. First, the workflow is observed thoroughly. Next, since the process is the base of all tasks, the process to be focused on is selected. After that, the procedures of SCOR Model version 12 were extracted. The steps of these procedures were compared. Moreover, a detailed study is conducted in this very step to decide whether to add, subtract or reorder these procedures. The pre-steps were definitely taken into account before introducing these changes. The implementation of these adjustments had a clear beneficial impact on the business. These adjustments were found to be effective since they resulted in shorter delivery times.

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# *A stochastic programming approach for marketing campaign optimisation*

*Chanel Bisset\*, SE Terblanche  
North West University*

## **Abstract**

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Stochastic programming was first employed in the marketing industry during the 1970s. Stochastic programming models are formulated to deal with decision-making under uncertainty. This study focuses explicitly on stochastic problems with resources, where random parameters or probability distributions represent the uncertainty in the model.

A two-stage stochastic programming model is formulated where the most valuable customers are selected for a marketing campaign to maximise profitability. The first-stage decision variable decides which customer and product to target and through which marketing channel. The second stage decision variable determines which retail store the products should be allocated to for the customers identified in the first stage.

The first-stage model constraints enable the decision-maker to choose a particular group of customers, products and marketing channels. The second-stage model constraints allow a campaign to be launched in a specific retail store or period.

A stochastic model's counterpart, a deterministic model, consisting of only one decision variable, is formulated. The purpose of this study is to determine that decision-making under uncertainty is a more efficient approach than decision-making under determinism. Before this can be confirmed, it is imperative to show that both models yield the same results using the same scenario data.

Individual scenario analysis demonstrates that the stochastic model produces different results as to the deterministic model when incorporating different scenario outcomes. It is concluded that considering multiple scenario outcomes when making decisions at this very instance will ensure that the decision-maker is more equipped and prepared to face uncertainty.

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# *Hybrid Hungarian method and GVNS metaheuristic for PAS problem*

*Rahma Borchani\*, Bassem Jarboui, Malek Masmoudi*  
*TORS*

## **Abstract**

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In this work, we study a healthcare problem, the patient admission scheduling (PAS) problem. This is a combinatorial optimization problem that involves assigning patients to beds in specialized rooms and departments depending on their medical requirements as well as their wishes. To solve this problem, we hybridized the hungarian method and the general variable neighborhood search (GVNS) metaheuristic. The proposed method is tested on the standard benchmark datasets and produces competitive results when compared with other state-of-the-art approaches.

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# *A new derivation for an optimal portfolio*

*Abdelfettah Bouri, Imen Zghidi\**  
*Sfax University*

## **Abstract**

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The objective of this paper is to propose a novel formula that computes an optimal portfolio that maximizes the expected utility of an agent as a function of her degree of risk aversion. More precisely, we express the optimal portfolio of the agent as a function of two common efficient portfolios: (1) the efficient portfolio with minimum variance (EPMV); and (2) the zero-beta portfolio admitting an expected return equal to zero.

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# *A new group decision making approach with fuzzy SWARA and ARAS-H for selecting steel products suppliers: A case study*

*Hichem Brahmī\*, Maroua Ghram, Taicir Moalla Loukil  
Phd Student*

## **Abstract**

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Due to the increasingly competitive and globalized markets, companies seek to optimize their supply chains and their relationships with their stakeholders. Providing the customer with the desired product or service, with a better cost, quality and lead times than those offered by competitors on the market is nowadays the major concern of every company (Zouggari, 2011). The Third Party Logistic 3PL is charged of part or all of the logistics of the company. The terminology 3PL is due to the fact that is not the logistics provider who owns the products but participates in the supply chain at the points between the manufacturer and the user. Currently, choosing the most suitable 3PL supplier is a major challenge. In this case study, we have coupled the FSWARA (Fuzzy Step-wise Weight Assessment Ratio Analysis) method with ARAS-H (Hierarchical Additive Ratio ASsessment) for selecting steel products suppliers. The FSWARA method (Kersulienė et al, 2010) is used to evaluate the criteria weights. Its main feature is its ability to estimate the decision makers (DMs) preferences with respect to the attributes in the weight determination process. The ARAS-H (Hierarchical Additive Ratio ASsessment) method (Ghram et al, 2021) aims to select the best alternative among others. A major advantage of this method is that it enables the DM to analyze the partial pre-orders (the rankings of the alternatives) at each node of the criteria tree i.e. according to each sub-criterion.

**Keywords:** Group decision support, 3PLs suppliers, Fuzzy SWARA, ARAS-H

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# *Coronavirus hospitalisation : Decision making tool in Africa region*

Zhor Chergui\*

AFROS working group (AWG)

## **Abstract**

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The Africa Centres for Disease Control (CDC) has warned about rising fatality rates across the continent, saying that of the 55 countries they monitor, 21 are reporting death rates above the global average of 2.2%. A study published suggests hospital patients who are critically ill with Covid-19 in Africa are far more likely to die than in other parts of the world because of limited healthcare resources. Researchers, who looked at patients in hospitals across 10 African countries, found that nearly half of those who needed intensive care died, whereas the global average was less than a third. The global fatality rate has fallen since the start of the pandemic, which in itself would put more African countries above the global average [1]. In several countries the fatality rates are mainly affected by the lack of health materials such as breathing machine or beds. In this abstract we aim to provide an urgent solution to this painful situation by defining a multicriteria decision making tool setting priorities when the number of patients is greater than the number of breathing machines available for use. The sorting of patients should take into account several factors called criteria (s.a, age, Chronic diseases, historical data of same situations, immune system, etc.). All of these criteria are chosen, weighted and aggregated in order to sort patients eligibility to be related to one of these machines. The decision tool should cover all the hospitals in a given area this is why an affectation outside a fixed hospital is possible according to the disponibility of health machines and transportation, it is very important to note that the areas are not necessarily disjonctifs. Since the policy of ‘first come first served’ can not be adopted in Africa region, the tool constitutes an alternative solution to decrease the number of deaths indicating non-access to intensive care at the right time.

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- [1] <https://www.bbc.com/news/world-africa-53181555>;
- [2] <https://pubs.rsc.org/ft/content/articlehtml/2020/1c/d01c00373e>;
- [3] Debnath, S., Barnaby, D.P., Coppa, K. et al. Machine learning to assist clinical decision-making during the COVID-19 pandemic. *Bioelectron Med* 6, 14 (2020). <https://doi.org/10.1186/s42234-020-00050-8>.



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# *An interactive disaggregation approach of codas method for urban rainwater management*

*Mouna Regaieg Cherif\*, Hela Moalla Frikha*

*Faculty of Economics Sciences and Management of Sfax, University of Sfax, Sfax, Tunisia*

## **Abstract**

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The aggregation method CODAS (COmbinative Distance-based Assessment) is a new Multi-Criteria Decision Making (MCDM) method that consists in ranking each alternative from the best to the worst. Indeed, it requires fixing parameter values a priori by the Decision Maker (DM) in a subjective manner. The objective of this paper is to develop a preference disaggregation approach in order to determine objectively the CODAS threshold value from binary preference relations provided by the DM. The proposed approach is based on Mixed Integer Linear Programming. Like any preference disaggregation method, the problem consists in minimizing the inconsistency between the model obtained with this parameter and DM's preferences. Furthermore, an illustrative example of urban rainwater management is performed to check the performance of this disaggregation approach.

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# *A spatio-temporal framework for machine learning-inspired prediction of informal settlement emergence and growth*

*Pierre Cilliers\*, Jan van Vuuren, Quintin van Heerden*

*Stellenbosch Unit for Operations Research in Engineering, Department of Industrial Engineering, Stellenbosch University*

## **Abstract**

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Many developing countries grapple with the problem of rapid informal settlement emergence and expansion. This exacts considerable costs from neighbouring urban areas, largely as a result of environmental, sustainability and health-related problems associated with such settlements, which can threaten the local economy. Hence, there is a need to understand the nature of, and to be able to predict future informal settlement emergence locations as well as the rate and extent of such settlement expansion in developing countries.

In this presentation, a novel generic framework is proposed for machine learning-inspired prediction of future spatio-temporal informal settlement population growth. This data-driven framework comprises three functional components which facilitate informal settlement emergence and growth modelling within an area under investigation. The framework outputs are based on a computed set of influential spatial feature predictors pertaining to the area in question. The objective of the framework is ultimately to identify those spatial and other factors that influence the location, formation and growth rate of informal settlements most significantly, by applying a machine learning modelling approach to multiple data sets related to the households and spatial attributes associated with informal settlements. Based on the aforementioned influential spatial features, a cellular automaton transition rule is developed, facilitating the spatio-temporal modelling of the rate and extent of future formations and expansions of informal settlements.

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# *Learning from volunteering – ORSSA, datakind and riders for health*

*David Clark\**  
*ORSSA*

## **Abstract**

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Over the course of the last 7 months, a team of ORSSA volunteers together with Datakind have been working on a project for Riders for Health in Lesotho to help assist with understanding the routing of sample deliveries from clinics to labs across the Mountain Kingdom. There are many interesting lessons to learn when working with multi-disciplinary volunteer engagements and NPOs. Understanding requirements, managing work, team dynamics, and how the problem itself was approached will be covered for those curious about sharing their skills and learning as a volunteer.

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# *New heuristic for the hexagonal fuzzy transportation problem: the Dhouib-matrix-TP1*

*Souhail Dhouib\*, Aida Kharret, Taicir Loukil*  
*University of Sfax*

## **Abstract**

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The Transportation Problems (TP) play an important role in many industrial real-life applications with the aims of minimizing the transportation costs of distribution items from a source to a destination. The ordinary form of the TP present crisp parameters: transportation costs, demand and supply quantities. Nevertheless, in real-world the values of these parameters are uncertain and the fuzzy theory is widely used in this field.

Very recently, Dhouib in designed a new column-row method namely Dhouib-Matrix-TP1 (DM-TP1) to solve the TP with crisps numbers. In this paper, we adapt the DM-TP1 heuristic with the centroid ranking function to solve the hexagonal fuzzy TP. The effectiveness of the proposed method is illustrated by means of a numerical example.

**Keywords:** Hexagonal Fuzzy Numbers, Transportation Problems, Centroid Ranking Function.

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# *An assessment of the efficiency of Canadian power generation companies with bootstrap DEA*

*Mohamed Dia\*, Shashi K Shahi, Luckny Zéphyr*

*Research Group in Operations, Analytics and Decision Sciences (RGinOADS) School of Business Administration, Faculty of Management, Laurentian University Sudbury, ON, Canada P3E 2C6*

## **Abstract**

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Power generation companies play an important role in the Canadian economy, as most of the economic activities in the manufacturing and service sectors are powered by electricity. The significance of the Canadian power generation industry shows that efficiency analysis is essential for efficiently managing power generation and distribution in Canada. However, there have been very few attempts to study the relative efficiencies of the Canadian power generation companies. This study fills in this gap by assessing the overall technical, managerial and scale efficiencies of a sample of Canadian power generation companies via the non-parametric bootstrapping DEA methodology, with firm-level annual inputs and outputs data over a 18-year horizon. The results of our investigation indicate low levels of overall technical and managerial efficiencies, but relatively high levels of scale efficiencies of the Canadian power generation companies over the entire study period. We also found that the 2007-2009 financial crisis impacted the relative performance of the Canadian power generation companies. Our results also allowed to identify the benchmark power generation companies for each type of efficiency that the inefficient companies should target toward improving their efficiency.

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# *Measure of the efficiency of the Autonomous Port of Dakar: Application of data envelopment analysis (DEA) and bootstrap approaches*

*Karamoko Sita Diallo\*, Babacar M. Ndiaye, Guy Degla*

*Laboratory of Research Unit of mathematics of decision (URMAD-RO) Institute of Mathematics and Physical Sciences, University of Abomey Calavi, Porto-Novo, Benin (IMSP), BP 42, Dangbo, Benin*

## **Abstract**

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Port efficiency measurement is an important factor in boosting port competitiveness and stimulating national development. Port efficiency is analyzed by two types of method namely parametric and nonparametric. The Data Envelopment Analysis (DEA) method is one of the most widely used methods for evaluating the efficiency of a unit of multiple-inputs and multiple-outputs simultaneously. The aim of this article is to evaluate the efficiency of the Autonomous Port of Dakar applied the two models of the DEA (i.e. Charnes et al. (1978) model and Banker et al. (1984) model) and bootstrapping approach to obtain an estimate of the efficiency of the Port and to identify the causes of inefficiency for the year 2019. We apply the bootstrap approach for bias correction and for confidence intervals creation of our estimates. The Autonomous Port of Dakar has land infrastructures in two distinct zones separated by a Fishing Port (PP), Naval Repair Workshops (ATN) and the Military Zone (ZM). In this article, we have considered these, zones and others as Decision-Making Units (DMUs). Both models led to the following results: the Autonomous port of Dakar has obtained six (6) efficient Decision-Making Units (DMUs) by the CCR model and ten (10) efficient Decision-Making Units (DMUs) by the BCC model.

**Keywords:** Data Envelopment Analysis (DEA), Optimization, Port, Efficiency, Container terminal, Bootstrapping.

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# *Stochastic optimal control and simulations with application to the cashew nut's sector in Senegal*

*Amadou S. Diallo\*, Steeven B. Affognon, Babacar M. Ndiaye*  
*Laboratory of Mathematics of Decision and Numerical Analysis Cheikh Anta Diop University, P.O. Box 45087, 10700, Dakar-Fann, Senegal.*

## **Abstract**

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In this article, we propose a new methodology based on stochastic optimal control problems, to solve the revenue, investment and exploitation issues of the cashew nut sector in Senegal. First we will review some underlying tools from stochastic calculus such as stochastic processes, stochastic integration, Brownian movement, martingales, stochastic differential equations. Based on these concepts we will then formulate a stochastic optimal control problem which we will solve using the dynamic programming approach. Numerical simulations on real data in Casamance show the performance of the approach.

**Keywords:** Stochastic; revenue; optimal control; cashew nut; stock; investment

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# *Improved human pose differentiation in convolutional neural network classification using colour-based data augmentation*

*J.S. Du Toit\*, J.V. du Toit, H.A. Kruger  
North-West University*

## **Abstract**

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Human pose estimation is an important research field in computer vision because of its applicability in numerous human-centred industries. Significant progress has been achieved using deep learning methods, subsequently helping support tasks that require an estimated pose as input to a pose-dependent system. Pose recognition is one such task that is challenged by the high degree of freedom inherent in the configuration of the human body. The Performance of pose recognition using 2D pose estimated mappings is only surpassed by 3D approaches, which are weighed down by their higher computational cost and complex processing. This study examines the use of novel data augmentation techniques to enhance a 2D keypoint-based, pose-estimated representation with spatial information through the use of colour. The keypoint colours are derived from either a radial or ringed colour wheel and superimposed as a skeletal mapping over a silhouette of a person in a video frame sequence. Using a convolutional neural network, the supplemented pose allows a machine-learned classifier more freedom to selectively map the most distinctive features from the input space to its feature space. This improves pose recognition by encouraging the classifier to identify common cues based on orientation and silhouette deformation as denoted by colour. The augmentation techniques provide an improvement of up to 11 percentage points over a baseline model when applied to a pose dataset. In addition, due to the simplicity of the techniques, the approach can be readily employed in an incoming video feed to support real-time, pose-dependent applications and improve other forms of human behaviour analysis.

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# *Multi-criteria decision analysis for energy source selections problem*

*Mohamed Ali Elleuch\*, Ahmed Frikha*  
*operational research*

## **Abstract**

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The energies are important resources for all user sectors in the world. The energies extraction process is characterized by several different practices, techniques and impacts. Really, every energy user plays an important role in shaping energy policy. For sustainable energy, it is important to include the main energy users at the same time in energy decision-making. In this context, the presented paper develops a Fuzzy MCGDM approach to evaluate and prioritize energy sources for various sectors based on economical, social, and environmental criteria.

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# *A framework for modelling spatio-temporal competition and spread of invasive acacia species in South Africa*

*Alexander Flemming\*, Jan van Vuuren*

*Stellenbosch Unit for Operations Research in Engineering, Department of Industrial Engineering, Stellenbosch University*

## **Abstract**

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The study of artificially introduced plant and animal species is important in South Africa, a country rich in indigenous biodiversity and home to three biodiversity hotspots recognised by Conservation International. An introduced species is one living outside of its native distribution range, but which has been introduced to a new environment either by accidental or deliberate human activity. Not all introduced species are harmful to the native ecology or to humans. It is, therefore, important to distinguish between introduced species that are either benign or useful, and those that become harmful and invasive. These classifications may indicate whether a species should be removed from its new environment and whether there are any environmental or ethical complications to be considered. Invasive alien species are a sub-category of introduced species that negatively impact the natural species of a particular area. These invasions 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.

In this presentation, we consider the application of automated processes aimed at conducting spatial analyses of ecosystems in South Africa that contain invasive species. In particular, our study is aimed at adopting a machine learning algorithmic approach towards determining which environmental, spatial and climactic factors are to be attributed to the occurrence and density of invasive species in an ecosystem. This approach allows for predicting areas requiring investigation due to likely unmapped occurrences or predicted future spread, based on the area's suitability to sustain these species. Finally, a spatio-temporal modelling approach is applied to simulate the spread and interspecific competition of invasive species in order to provide analysts with insight into the severity of an area's invasion potential so that appropriate measures may be taken timeously with a view to preserve the natural ecology.

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# *Digital supply chain: Particularities, levers and barriers*

*Rachid El Gadroui\**  
*IBNO ZOHR UNIVERSITY*

## **Abstract**

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The Digital Supply Chain (DSC), a term whose emergence does not date back many years. The reasons for this emergence are cumulative thanks to the implementation and acceleration of the 4.0 industry, the development of technological tools and also to the current characteristics of the competitive environment, particularly in terms of uncertainty, complexity and strong dynamics.

The DSC is becoming a requirement for companies to be able to hold their ground in this context because it allows them to create a competitive advantage illustrated in the availability of the product offer, the reduction of costs and also in the increase of market shares [1]. It also offers a range of practices to improve access to information, increase responsiveness and collaboration capabilities and even agility. At the same time, this phenomenon is not only manifesting itself at important levers but also at major obstacles. Therefore, this article examines the main technologies and characteristics of DSC, as well as its levers and barriers.

**Keywords:** Digital Supply Chain, Levers, Barriers.

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# *A decision support framework for the selection of appropriate demand time series forecasting methods*

*Reinard Ganzevoort\*, Jan van Vuuren, Berndt Lindner, Jacques du Toit  
Stellenbosch Unit for Operations Research in Engineering, Department of Industrial Engineering, Stellenbosch University*

## **Abstract**

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In the modern, high-turnover retail environment, there is a significant trade-off between limiting in-store inventory levels and mitigating the risk of stock-outs. In particular, retail organisations aim to minimise the capital tied up in inventory subject to a pre-specified service level target. Therefore, in order to better manage inventory, retailers often aim to predict customer demand behaviour as accurately as possible. In practice, however, forecasting processes are usually automated and practitioners consequently have limited knowledge pertaining to the selection of appropriate forecasting methods. A generic framework is proposed in this presentation for assisting a retail forecasting practitioner during the selection of an appropriate forecasting method for a given time series data set generated within a retail environment.

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# *Blockchain meta-analytic typology for achievement of sustainable development goals*

*Cigdem Gurgur\**  
*Purdue University*

## **Abstract**

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World Economic Forum predicts that by 2027 10% of global GDP will be stored on blockchain technology. Research in operations and supply chain management literature has illustrated that the transformative technology Blockchain is a critical component of business ecosystems, identity systems, interorganizational systems related to finance and supply transactions. Any centralized system is always at risk of getting compromised. Blockchain reduces this centralization to a great extent. Blockchain technology is at the center of the decentralized model of self-sovereign identity where the digital identity is owned and controlled by the user. We show how Blockchains can empower developing countries by advancing a reputation-based ownership of shared resources. In order to provide a systematic understanding of these phenomena, we develop meta-analytic classification of indicators and sources of information in various blockchain systems used to promote sustainable supply chains.

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# *Supply side flexibility in revenue management: An application in medical wire and device manufacturing*

*Cigdem Gurgur\**  
*Purdue University*

## **Abstract**

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Revenue management is a concept aimed to maximize capacity utilization and through that maximize revenues. While the main developments in revenue management have taken place in the fields of service industries, relatively little research has been done for the manufacturing sector. We consider revenue management for a medical wire and device manufacturing company with make-to-order mode of operation, complex alloy market, broad-product mix and limited inventory capacity. Orders with different profit margins arrive stochastically and the company has to decide which orders to accept and which orders to reject. In the “Make-to-Order,” the allocation of the finite capacity to certain orders is complicated because the processes that are used to make a product are consistent, but vary in the manner in which product goes through the process. Furthermore, the number of iterative loops in which a particular order may go through the same process varies. We model the problem with a Markov decision process and propose a value iteration heuristic. In numerical tests we show the potential benefit of using revenue management instead of a first-come-first-serve policy and assess the performance of the heuristic procedure.

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# *The four-dimensional transportation problem*

Zainab Alaa Hameed\*, Prof Taicir Loukil Moalla

## **Abstract**

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The transportation problem is one of the most important problems that studies all matters related to transporting goods, raw materials, people, etc. from their locations to the parties requesting them. This process requires a transportation cost, so it requires building a mathematical model that reduces transportation costs using special optimal solutions methods. The process of transportation and this is called the classic (homogeneous) model, in which the commodity is homogeneous of one type, the mode of transportation is also of one type, and the quantities required and offered. [Hamada, 2020]

Either at the present time, the transportation process requires a planning study to transfer a group of non-homogeneous products from supply sources to demand stations at variable costs, or the means of transportation are heterogeneous, which may be land, sea or air, and this has increased the complexity of the mathematical model of the transportation problem. In this context, the three-dimensional model indicates that the mode of transportation is different or the type of goods transported is different. [Bakhayt, et al. 2018]

Usually, road distances between sources and requesting parties are not taken into account in transportation problems, but in fact, routes vary between sources and requesting parties, transportation costs per unit and fixed fees. Some paths may be smooth and in good condition while others may be uneven, not all types of vehicles may travel along each path. Therefore, the choice of roads plays a major role in the transportation problem, and therefore if the different paths are considered along with the different means of transportation, the three-dimensional transportation problem is transformed into a four-dimensional transportation problem. [Bakhayt, 2016]

There are several criteria for making the best decision to adopt an efficient transportation model that involves finding realistic solutions to a transportation problem that contains various different resources or requirements to multiple places requesting these requirements by different means of transportation to achieve a number of goals, for example, cost and time, etc. [Ahmed et al. 2016]

In this work we propose a literature review of the three and four-dimensional transportation problems.

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# *Development of an ambulance dispatching management tool – SAMU 04 Sfax*

*Sondes Hammami\*, Hédi Ltaief, Zidani Housseem*

*University of Carthage, National Engineering School of Carthage, 2035, Tunis, Tunisia*

## **Abstract**

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With the global spread of coronavirus disease 2019 (COVID-19), research try to improve the capacity of medical systems to cover increasing demand. Dispatching the ambulances, the earlier as soon as possible is considered as crucial issue. The objective of this article is to propose a tool for the optimal dispatching of ambulances in Sfax. When SAMU receives a distress call from covid patient, this tool enables to record the name, first name, address, and reason for the call. If necessary to dispatch an ambulance, the tool verifies the availability of ambulances SMUR Covering patient territory. If it is busy, the tool can estimate when it will be available, it checks the availability of other SMUR ambulances and assign to patient the ambulance that will be free earlier. SAMU Sfax includes two SMUR. Each SMUR is assigned to a territory and has its own ambulances dedicated to cover COVID patients. Two applications have been proposed in this regard. A first solution developed using visual basic and a second developed using python. This for support doctors in their task of dispatching ambulances to covid patients.

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# *A history of operations management*

*Marthi Harmse\**  
*Independent*

## **Abstract**

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Operations research and operations management share a history which is often described in terms of different periods and subperiods. Such a history of operations management includes a high-volume industrial production or cost reduction period from the first to the third industrial revolution ending with an operations research subperiod. During the operations research subperiod, which involved mathematical and statistical approaches, operations management emerged as a field. In 1957 Elwood Buffa introduced the term to refer to production activities in manufacturing and nonmanufacturing undertakings and subsequently integrated and consolidated production management, operations research and industrial engineering into a coherent framework for operations management. The paper traces this history to recent events and reflects on implications for current operations management activities

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# *A new DEA-based approach to assessing the performance of learning processes within teaching hospitals*

*Marwa Hasni\*, Safa Bhar Layeb, Najla Omrane Aissaoui*

*LR-OASIS, National Engineering School of Tunis, University of Tunis El Manar, Tunis, Tunisia*

## **Abstract**

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The Data Envelopment Analysis (DEA) is a commonly used approach to assess healthcare systems efficiency. In the existing literature, the DEA usually considers health organizations as a black box by calculating their efficiency based on a set of inputs and outputs without really differentiating the efficiency of its different components or processes. Therefore, this work is devoted to the analysis of the efficiency of the learning processes within 25 departments of a Tunisian multi-specialty Teaching Hospital. To the best of our knowledge, no previous related work has investigated evaluating such process in teaching hospitals, despite their key impact in maintaining sustainable expertise of health services. For that purpose, an improved version of the basic DEA approach is developed. A key aspect of our proposed method is that it uses the production function theory for the DEA clustering task instead of the typically applied distance-based criterion. By means of the conducted empirical study, we demonstrate that our proposed approach allows undertaking significant shortages underpinning the basic DEA in rolling out the relationship between input and output resources. Besides, it yields more robust clusters that help decision-makers to determine appropriate amendments that should be applied toward accurate input resources allocation to reach efficiency.

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# *Bus route design and frequency setting for public transit systems*

*Günther Hüsselmann\*, Jan van Vuuren, Simen Johann Andersen  
Stellenbosch Unit for Operations Research in Engineering, Department of Industrial Engineering, Stellenbosch University*

## **Abstract**

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The availability of effective public transport systems is increasingly becoming an urgent problem in urban areas worldwide due to the traffic congestion caused by private vehicles. The careful design of such a transport system is important, because, if well designed, such a system can increase the comfort of commuters and ensure that they arrive at their destinations timeously. A well-designed public transport system can also result in considerable cost savings for the operator of the system.

The problem considered in this presentation is that of designing two computerised models for aiding a bus company in deciding upon efficient bus routes and setting appropriate bus frequencies for these routes, respectively. The design criteria pursued in the first model (for designing bus routes) are simultaneously minimising the expected average passenger travel time and minimising the system operator's cost (measuring the latter as the sum total of all route lengths in the system). Two metaheuristics are adopted for the solution implementation, namely a dominance-based multi-objective simulated annealing algorithm and a non-dominated sorting genetic algorithm.

In the second model, high-quality bus frequencies are sought for each bus route during a simultaneous pursuit of minimising the expected average transit time for passengers (including waiting, transfer and travel time) and minimising the total number of buses required by an operator to maintain the specified frequencies.

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# *A dynamic mutation strategy for incorporation into a genetic algorithm*

*Günther Hüsselmann\*, Jan van Vuuren, Simen Johann Andersen  
Stellenbosch Unit for Operations Research in Engineering, Department of Industrial Engineering, Stellenbosch University*

## **Abstract**

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Metaheuristics are often used to search for high-quality solutions to combinatorial optimisation problems. Sometimes the search mechanisms of such metaheuristics, however, lack the necessary exploration and exploitation capabilities and, as a result, cause the metaheuristic to overlook certain features in the fitness landscape. A dynamic mutation strategy is proposed in this presentation for inclusion in the well-known non-dominated sorting genetic algorithm II. This strategy is capable of judiciously updating the probabilities with which various mutations are carried out as the search unfolds. The strategy equips the genetic algorithm with multiple mechanisms for exploration and exploitation while being guided by each mutation's relative performance. The strategy is applied to the well-known urban transit network design problem, which is a notoriously difficult problem requiring sophisticated techniques capable of traversing its search space effectively.

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# *Optimizing drone operations for healthcare services in Africa*

*Chinasa I. Ikelu\*, Eugene C. Ezin*  
*Institut de Mathematiques et de Sciences Physiques (IMSP)*

## **Abstract**

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Transporting health care products from one point to another using innovative technology like drones can be difficult to achieve especially in hard-to-reach areas in rural Rwanda. This study focuses from the start of drone operation in Rwanda until 2018. We observed that data is critical to the success of any facility location analysis. Using the classical transportation model, we therefore concentrate on solving the problem of costs and the timelines associated with the delivery of blood through this technology - by determining how much blood is shipped from two distribution plants to twelve destination centers thereby minimizing total shipping costs and time of delivery - and finding an optimal solution to the optimization problem using numerical analysis. We envisage that drone-aided health care services can reduce the shipping costs associated with transporting blood from the plants to the centers and that the time it will take to delivery such health care product to their various destinations can be minimized as well. Further, sensitivity tests also known as post-optimality tests were conducted to study the effect of changes in parameters on the optimal solution to convert the static linear programming solution to a dynamic solution. Drone-aided networks using simulation, and numerical analysis helps in obtaining the cost-effective point associated with transporting blood in these areas and finding an optimal solution to the agent and input-output based models.

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# *A generic human activity recognition framework*

*Jacobus Jacobs\*, Stephan Nel*

*Stellenbosch Unit for Operations Research in Engineering, Department of Industrial Engineering, Stellenbosch University*

## **Abstract**

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Computers are perennially being empowered with capabilities that exceed those of human beings — tasks range from devising strategies for complex board games to the detection of cancerous cells from medical imaging data. The machine learning (more specifically, deep learning) research community is devising and exploiting powerful algorithmic, data-driven approaches towards learning increasingly complex patterns and rules through experience. Advances in the domain of deep learning have led to the noteworthy utility of computer vision, the field of study which enables computers to learn to “see”. A recent trend within the domain of computer vision is called human activity recognition and aims to automate the task of discerning human activities, e.g. recognising when a person takes a product off a shelf and adds it to their basket, or recognising whether a person is opening or closing a safe. In this presentation, a work-in-process framework for performing human activity recognition algorithmically is described. The agenda includes a description of the project and proposed solutions to the problem as well as the planned course of action for the remainder of the project.

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# *Correlation between green supply chain management and cultural factors: Empirical evidence from Morocco*

*Jamal El Baz\*, Saadia Iddik  
Ibn Zohr University*

## **Abstract**

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This project addresses a significant gap in the operations management literature related to the role of the soft dimensions in adopting sustainable decisions. Drawing upon behavioral factors, we develop a conceptual model of how the national culture and the organizational culture influence green supply chain practices implementation. Do these factors influence the management decision to support sustainability within different manufacturing industries? Using self-report data from managers via a survey conducted in the Moroccan context, our study contributes by illustrating how the organizational culture can affect the decision makers in the field of green supply chain management. Many existing studies had investigated the association of a broad set of factors and variables with the GSCP implementation e.g., institutional pressures. However, the relationship between GSCP and culture has not been extensively researched. Despite, the efforts made by (e.g., Miska et al., 2018) to link a multidimensional and highly-complex concept of culture with environmental sustainability. Therefore, there were mixed and inconsistent results. The deficiency includes the extent to which both national and organizational at the organizational level explain the GSCP implementation cross countries. A cross-cultural investigation of companies' differences towards green supply chain initiatives implementation still needs to be addressed, not only to know if there are differences but rather to identify these differences and how they do impact the decision-making processes.

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# *Solving the patients scheduling problem in the emergency department of the Tunisian Habib Bourguiba hospital using genetic algorithm*

*Jihène Jlassi, Ines Rekik\*, Sonda Elloumi*  
*OLID*

## **Abstract**

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With the complexity of healthcare and health services related to patients flow, various problems such as patient safety, cost containment crowding and delays appeared in various departments. Emergency Departments (EDs) are the focus of many actual researchers to deal with patient's intentions. Scheduling patients in EDs is a very difficult task, which requires the respect of different constraints such as the availability of staff and material resources, the triage process etc. In this paper, we propose a mathematical model for small sized instances to minimize the patients waiting time in EDs. The suggested model takes into account the need of physician resources for each patient and in each service. A Genetic Algorithm (GA) is then developed for large sized instances. For the assessment of the proposed approach, real-sized instances are taken from the Tunisian Habib Bourguiba Sfax Hospital. Computational results have demonstrated the efficiency of the proposed method.

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# *Implementation of reinforcement learning algorithms in the WrapSlide environment*

*Ruan Jordaan\*, Thorsten Schmidt Dumont  
Stellenbosch University, Department of Industrial Engineering*

## **Abstract**

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Machine learning has seen unprecedented popularity in recent years with new techniques and algorithms being developed by institutions worldwide. As such, one may find oneself overwhelmed with choices when trying to implement a machine learning solution. The aim of this project is to elucidate the process of solving problems using machine learning.

In this project, a literature review is conducted pertaining to a spectrum of facets of machine learning. This review includes both broad topics such as general reinforcement and supervised machine learning algorithms, as well as more nuanced aspects such as activation functions in neural networks and optimization methods.

The the scope is then narrowed to the implementation of reinforcement learning algorithms, specifically Q-learning. Various Q-learning implementations from basic tabular to complex deep Q-learning with convolutional and recurrent layers are evaluated and compared in the WrapSlide environment.

The WrapSlide environment simulates the toroidal puzzle game, WrapSlide, in Python. This game functions much like a Rubik's cube in the sense that it comprises a grid of coloured squares which must be sorted to reach a solved state. WrapSlide differs from a Rubik's cube in that it is represented as a two-dimensional grid where the coloured blocks of the grid must be sorted into quadrants.

The puzzle grid can vary in both size and number of different colours. In this project, grid sizes of  $4 \times 4$ , and  $6 \times 6$  with two, three and four colours are used to test the different implementations' ability to deal with problems of varying complexity.

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# *Review of the current status of operations research applications in hospital operations management in East Africa*

*Sumaya M Kagoya\*, Allen Mushi  
Makerere University Business School, Kampala, Uganda*

## **Abstract**

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This paper reviews applications of Operations Research tools in hospital operations to find the status of these applications in East African Region. Hospital services in developing world are always overwhelmed due to scarce resources compared to the demand from public. Operations Research provides a set of tools that are very useful in optimization of resources and therefore can provide a highly needed service in assuring that the resources are optimally utilized to save lives and provide better healthcare service. It has been found that there is a lot of Operations Research work about hospital operations in the developing world. However, little has been reported from East Africa. A proposal is presented about research opportunities on hospital operations in East Africa by grouping applications into four areas namely; planning, management, medical practice and prevention. The paper concludes by inviting all stakeholders to cooperate and provide necessary support to Operations Research practitioners.

**Keywords:** Hospital Operations, Operations Management, Hospital Planning, Healthcare Management

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# *E-logistic practices and health care supply chain management for public referral hospitals in Uganda*

*Sumaya M. Kagoya\**

*Makerere University Business School, Kampala, Uganda*

## **Abstract**

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This paper examined e-logistic practices and health care supply chain management in the context of Ugandan public referral hospitals. The objective was to examine the relationship between e-logistics operations and performance of health care supply chain management. Quantitative approach was utilized to gather data from public referral hospitals respondents using semi-structured survey questionnaires. For data analysis, descriptive statistics and PLS-SEM were utilised, aided by SmartPLS 3. Findings show a positive significant relationship between e-logistics operations and performance of health care supply chain management. This study implies that central management of drugs, the order picking of drugs is given to the right patients for quality control, and there is a person to update stock daily are key in e-logistics operations in relation to performance of health care supply chain management. E-logistics operations is related to performance of health care supply chain management in terms of ICTs tracking systems and data transparency. There is a positive significant relationship between e-logistics operations and performance of health care supply chain management in the context of Ugandan public referral hospitals.

**Keywords:** e-logistic, health care supply chain management, public referral hospitals, Uganda

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# *The Goleman model as predominant style of leadership in Tunisia – An exploratory study*

*Raoudha Kammoun, Slaheddine Baklouti\**

*Faculty of Economics and Management of Sfax (FSEGS). MODILS Research Unit, University of Sfax, Tunisia.*

## **Abstract**

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Today, face to the global economic challenges and aggressive competition, more and more organizations are striving to maintain their effectiveness. They rely on their human resources, especially leaders and employees, to improve their performance. Leaders play a major role in improving processes and refocusing on the customer to ensure sustainability and ensure a goal of survival in a changing environment, aggressive competition and scarce resources. However, the effectiveness of the results strongly depends on the style of leadership adopted.

The literature review reveals many models related to leadership styles in various contexts. The most common model that focuses on emotional intelligence is developed by Daniel Goleman, Richard Boyatzis and Annie McKee (2001). It defines six styles of emotional leadership: the commanding, the visionary, the affiliative, the democratic, the pacesetting and the coaching. The article aims to demonstrate if Tunisian companies adopt this style of leadership emphasizing the emotional dimension. An exploratory survey is carried out among 82 Tunisian leaders to testify the degree of adoption of this style of leadership in the context of Tunisian companies.

The survey reveals that the commanding and visionary styles are predominant. They are followed respectively by visionary, pacesetting, democratic, affiliative and coaching leadership styles.

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# *Redesigning the coffee supply chain with Blockchain technology*

*Rose Karimi\*, Jim Shi*  
*International Cooperative Alliance-Africa*

## **Abstract**

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Coffee is produced in more than 50 developing economies mainly by small scale farmers making it a major cash crop and a significant source of livelihood, employment and foreign exchange to an estimated 125 million people around the world. However, economic issues, such as limited market access for producers and information asymmetry, coupled with depreciating market prices, all contribute to the challenges small scale farmers face. Although the cost of a cup of latte is around 4or5, merely 1% of this price goes to the coffee growers. Typically, it has been a chronic challenge to improve the small-scale farmers' economy to achieve agricultural sustainability and long-term prosperity in many developing countries where coffee is grown. More often than not, the income the small-scale farmer receives from the sale of coffee does not always reflect the quality of their individual coffee beans.

Blockchain Technology (BCT) has been widely embraced as a disruptive technology, though it is still in a nascent stage, in both academic research or industrial implementations. Blockchain technology refers to a distributed ledger (i.e., database) that maintains a continuously-growing list of data records that are secured from tampering and revision. It consists of blocks holding batches of individual transactions. Each block contains a timestamp and a link to a previous block.

Redesigning the coffee supply chain with blockchain technology to increase transparency, efficiency, and win-win economic transactions can help to rectify the situation of small-scale coffee farmers and other participants in the supply chain. Considering BCT's characteristics of transparency, security, efficiency and immutability, BCT remarkably strengthens trust among participants from small scale coffee farmers to roasters, processors, traders through the end consumers along the coffee value chain. If applied effectively and properly, it is capable of guaranteeing that all the information accessible by participants is reliable and has not been subject to tampering in any way, which greatly resolves the problem of information asymmetry. Adoption of blockchain technology in the coffee supply chain can help small scale coffee farmers see where their beans end up, and enables consumers to see where their coffee comes from.

This study aims to examine how BCT helps coffee farmers streamline operations and increase revenues. We also demonstrate the challenges for such implementations.

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# *Robust container clinic location: A South African application*

*Carike Karsten\*, Wilna Bean, Quintin van Heerden  
UP, CSIR*

## **Abstract**

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Accessible health care is defined as primary health care no more than 5km from a place of residence. There is a significant gap between the actual and desired accessibility to health care for the lower-income communities in South Africa. Container clinics is a cost-effective solution to this problem. An opportunity was identified to investigate the location of low-cost container clinics in lower-income communities as a proposed remedy for this deficiency. With the increase in urban growth of the metropolitans of Gauteng, the robustness of the locations should also be considered. A goal programming approach was used to find robust locations for container clinic deployment over 12 years in an uncertain environment using multiple future city development scenarios. A synthetic population and an urban growth simulation model was used to generate the population distribution from 2018 to 2030 for three scenarios. A genetic algorithm was used to solve the robust p-median facility location problem. Total cost, total household travel distance and total distribution distance were minimised in the model. The difference between the optimal and the robust values for the scenarios was capped at 25% for these variables. The majority of clinics were opened in the first year since no operating costs were included in the initial model. Later on, a budget constraint was added to limit the number of clinics to be opened in a year. This case study investigated the link between facility location planning and urban planning to assist government planners with the locations of clinics.

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# *A capacitated vehicle routing and scheduling problem for increased driver-route familiarity*

*Jacobus King\*, Jan van Vuuren, Stephan Nel, P. Toth  
Stellenbosch Unit for Operations Research in Engineering, Department of Industrial Engineering, Stellenbosch University*

## **Abstract**

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Although the Vehicle Routing Problem (VRP) is one of the most studied and important combinatorial optimisation problems in the literature, practical challenges often arise when implementing the solutions that stem from solving VRP instances. Externalities (typically unplanned), such as unanticipated traffic conditions, can result in increased vehicle travel times and subsequent degradations in supply chain operational efficiency if drivers are not sufficiently familiar with their assigned delivery routes. Moreover, drivers tend to get lost and/or often travel on roads that are not suitable for the delivery vehicles utilised when they are unfamiliar with delivery routes, which typically occurs when these routes differ significantly from one day to the next. A possible solution aimed at streamlining the practical implementation of planned delivery schedules and increasing the overall efficiency of the supply chain is to generate a set of standard delivery routes visiting each customer along different approaches, called master routes. These master routes may then be used as blueprints for daily planning purposes when actual delivery routes are computed. Delivery vehicle drivers are thus afforded the opportunity to become familiar with the master routes, which is anticipated to increase the efficiency with which they can perform deliveries if the actual delivery routes consist of combinations of route portions taken from these master routes. We derive a mathematical model for the creation of such master routes, analyse empirically the time complexity of solving the model, and explore a time-efficient metaheuristic solution approach for the model.

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# *A framework for intelligent document processing of image data*

*Ryno Kleinhans\*, Stephan Nel*

*Stellenbosch Unit for Operations Research in Engineering, Department of Industrial Engineering, Stellenbosch University*

## **Abstract**

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A characteristic trait of the age of digitalisation is the ubiquitous transition from paper-reliant and manual-based business processes to fully digital, computer-assisted and automated versions thereof. Any such attempt towards automating the process of information extraction from semi-structured and/or structured documents involves a large degree of dependency on human vision and cognition so as to interpret both the layout of such documents and the contents therein. The application of data-driven approaches from the realm of machine learning — more specifically, deep learning — certainly warrants consideration within the presented context. Appropriately, in this presentation, a high-level overview is provided of a framework that comprises two main facets, the first of which focuses on the transformation of paper-based financial documents into machine-encoded data whereas the second facet aims to extract and parse insight from the transformed data. Powerful approaches from the domains of optical character recognition together with natural language processing and computer vision are considered.

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# *Optimal mass transportation for land use problem*

*Mamadou Koné\*, Babacar M. Ndiaye, Diaraf Seck*

*Laboratory of Mathematics of Decision and Numerical Analysis University of Cheikh Anta Diop, BP 45087, 10700, Dakar-Fann, Senegal.*

## **Abstract**

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In this article, the major issue is the usefulness of models to design land use problem through the concepts of the Monge-Kantorovich, also known in the literature as the ‘Mass Optimal Transportation’. We present two main contributions for this land use problem. First, we propose a new continuous formulation of the activities location problems. Second, in order to solve the continuous problems, we discretize and compute numerically the optimal transportation by considering finite sums of weighted Diracs. In this specific case, the optimal transportation is a multi-valued map between the Dirac locations. In contrast to linear assignment problem, the Quadratic Assignment Problem (QAP) can handle the case where two or more land use decisions are interdependent, i.e., if there is a so called flow interaction between activities. The technic is globalized by the computation of Gromov- Wasserstein distance to solve the quadratic optimization problem with continuous variables.

**Keywords:** activities location, optimal transportation, land use, quadratic assignment, Gromov-Wasserstein distance.

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# *Block chain in a supply chain environment*

*Asmaa Laaziz\**

## **Abstract**

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The main challenge of new supply chains is the complexity generated by the big amount of data involved in the different processes. The need to set up an integrated system ensuring a seamless mobility of goods and data is actually paramount recognizing that supply chains which share information through a collaborative approach across functions and between organizations achieve maximum efficiency for all members.

Block Chain is a decentralized, transparent and trusted database, defined as part of the distributed ledger technology framework (Institute of Electrical and Electronics Engineers definition). Unlike other storage and sharing records, distributed ledgers have no central data store: transactions are logged and added in a chronological order creating permanent and tamper proof records. Block Chain is also known a revolution of trusted third party. Since the invention of paper in 105, then that of the printing in 1454 to the invention of computer in 1936 states, financial institutions and companies accomplished the role of transactions approvals. Because of its trustless paradigm, Block Chain scatters that role, which makes trust irrelevant.

Many use cases of Block Chain have been reported so far, my work aims to explore the different features impacting the relevancy of the Block Chain implementation in supply chain especially with its potential and promises regarding mitigation of cyber supply chain risk considering the role of Information and Communication Technologies innovation in the supply chain is seen as the key for keeping competitive advantage.

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# *A bilevel optimization programming model to solve the berth and quay cranes allocation problems*

*Rokaya Lassoued\* , Abdelkarim Elloumi*  
*FSEGS*

## **Abstract**

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Ports are the gateways of international trade. They constitute an important economic activity in coastal countries. The higher the throughput of goods year-on-year, the more infrastructure, provisions, and associated services are required. Wherefore researchers give great importance to resources in the port terminal, especially the berth and quay cranes. This paper investigates the berth allocation and quay crane assignment problems in the port terminal. A bilevel programming model is presented. The upper level whose objective is to minimize the total service time of berthed vessels is solved using Cplex software. While the lower-level model whose objective is to minimize the cost of cranes allocated for each vessel. Computational experiments, based on real case study, are presented to show the efficiency of the model against other models and results presented in the literature.

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# *A model for the design and operation management of a wind/photo-voltaic solar hybrid power generation system*

*Desiree Taliane Mpassi Mahinga\*, Jan van Vuuren*

*Stellenbosch Unit for Operations Research in Engineering, Department of Industrial Engineering, Stellenbosch University.*

## **Abstract**

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Renewable energy has been proposed as a potential alternative to traditional energy systems with a view to reducing greenhouse gas emissions that contribute to global warming. The development of renewable energy technologies and the increased scarceness of non-renewable fuel products have led to increasing use of Hybrid Renewable Energy Systems (HRESs) for power generation purposes. In this presentation, a model is proposed for generating quantitative decision support in respect of both the strategic design and operational management of HRESs. The strategic design aspect of the model pertains to the number of power generating components of each technology to include in the hybrid system, as well as the required sizing of these components with a view to meet the load demand of a customer base. The operational aspect of the model, on the other hand, pertains to the scheduling of preventative maintenance of the various system components while still meeting the customer load demand. The components considered for inclusion in the system are Photo-Voltaic (PV) panels, wind turbines and a battery bank as an energy storage system. The objective is to minimise the total establishment and operational cost of the hybrid power generation facility over a period of twenty years.

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# *On a discrete nonlinear multi-objective optimization problem with bounded variables*

*Nouara Makhlouf\*, and M. Moulaï*  
*ESI*

## **Abstract**

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In this work we presents an algorithm specifically designed for the determination of the set of efficient solutions of discrete multi-objective nonlinear programming problem with bounded variables. The algorithm uses the Dantzig cuts modified for the problems with bounded variables and an esclave algorithm for the efficiency test to the obtained solution . We get the set of efficient solutions after a finite number of iterations. Furthermore, all of the problems obtained after the adding of the Dantzig cut that the algorithm must solve can be easily solved, since they are all convex programming problems after the relaxation of the discrete set.

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# *An agent-based approach to customer crowd-shipping*

*Phillip Christian Malan\*, Christa Searle, Jan van Vuuren  
Stellenbosch Unit for Operations Research in Engineering, Department of Industrial Engineering, Stellenbosch University*

## **Abstract**

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Customer crowd-shipping (CCS) is a theoretical solution to the growing challenge of last-mile deliveries for retailers. The approach involves, in addition to regular deliveries, in-store customers performing deliveries to online customers after visiting the retailer. These occasional drivers (ODs) are offered an incentive as compensation for performing deliveries. In this study, an agent-based model simulating the mechanisms of CCS is proposed. The model is developed to dynamically identify which online customers are viable candidates for OD deliveries utilising a proposed cost-to-serve algorithm, while further emulating the decision making of ODs. By exploiting microeconomic theory, the value that an individual OD places on the time spent delivering is compared to the monetary incentive offered by the company. Traditional vehicle routing techniques are employed to simulate efficient delivery routes for regular deliveries in an effort to estimate the cost of deliveries in addition to the cost of incentives. Through model analysis, the study aims to evaluate theoretical configurations of CSS that improves the last-mile delivery system of the retailer with respect to its total cost and customer waiting time.

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# *Simulating deforestation and evaluating mitigation methods*

*Stuart McMaster\*, Christa Searle*

*Stellenbosch Unit for Operations Research in Engineering, Department of Industrial Engineering, Stellenbosch University*

## **Abstract**

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Deforestation is a pertinent global challenge and a major environmental concern as a result of the destruction of natural ecosystems and soil cover. Forests exhibit a strong potential to combat global warming and climate change, while also contributing significantly to biodiversity, food provisions and soil protection. The aim of this project is to dynamically model the spatio-temporal features of deforestation in order to assist in predicting, as output, the magnitude and spatial patterns thereof. Within this project, a model is developed to simulate spatio-temporal deforestation and to evaluate mitigation methods, specific to the province of Tshopo in the Democratic Republic of the Congo during the 21st century. Data analysis is conducted based on current forest cover maps and associated spatial variables. These features are utilised as input to the simulation model. A future predicted forest cover map with expected areas of new deforestation is output by the model, using various functions and the incorporation of a cellular automata approach.

The validated model is further used to evaluate the implementation of current protected areas as well as determining which areas are best suited for the implementation of new protected areas to aid in the further reduction of deforestation. The model may serve as a useful tool for socio-economic disciplines in combating the furthering of deforestation and preserving natural biodiversity.

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# *Facility layout design in an Algerian case study: PP woven bag manufacturing industry*

*Sara Megaiz\*, Amina Ouhohd, Zaki Sari, Mehdi Souier, Fouad Maliki  
Manufacturing Engineering Laboratory of Tlemcen (MELT), University of Tlemcen, PB 230, 13000,  
Tlemcen, Algeria.*

## **Abstract**

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**Keywords:** Facility layout design, performance improvement, systematic layout planning, Flow optimization, Productivity.

**1. Introduction:** Industry is today, as it has always been, a cornerstone of the economy for every developed country. At the dawn of the 21st century, industrial companies are facing an increasingly changing market and more variable customer demand. In such an environment, reducing costs, respecting deadlines and maintaining quality are imperative for the company. Therefore, Manufacturing industries must focus on improving productivity and should invest in a plant that is able to adapt to the changing environment and respond effectively to different changes with good productivity and low cost. The study of facility layout design, involves a systematic physical arrangement of the various departments, workstations, machines, equipment, storage areas and common spaces in a manufacturing industry, providing an optimal relationship between them to facilitate the production process, optimize flow, minimize material handling, time and cost, and allow flexibility of operations.

**2. Problem description:** The work presented in this article is based on the need of a company to develop a production unit to produce woven bags for packaging. Our scope of study is focused on the design of the production system layout in order to guarantee maximum productivity, while respecting numerous constraints. These constraints are related to both the types of products, types of manufacturing equipment and the environment. Indeed, during this study, several alternatives will be proposed and will be well treated, while taking into account the sizing of machines, the allocation of intermediate stocks and storage areas, the balancing of the load of the various workstations, the choice of means of handling and the layout of equipment which is to determine the workstations that must be adjacent to each other and how they must be connected to ensure satisfactory and sustainable results.

**3. Methodology:** The company has a production workshop of 2550m<sup>2</sup>. All the operations to manufacture the woven bags extrusion, weaving, lamination, printing and sewing will be carried out in this workshop in which storage areas will be dedicated to store the different materials. In order to establish an effective and efficient design of the facilities. We developed a model based on the SLP 'Systematic Layout Planning' by defining the relationships between the different departments in order to generate alternatives that take into account the different constraints.

**4. Conclusion:** The study of plant design is very important for the company as it gives an effective planning of the plant which can significantly reduce costs, time, travel, and improve the performance of the production line. The proposed model based on SLP proves to be effective in solving the mentioned problems. It is expected that the model will contribute to the overall improvement of the production as the flows are optimized and the distances are minimized. The workstations that must be adjacent to each other and how they must be connected to ensure satisfactory and sustainable results.

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# *Organizational structure improvement of a Tunisian hospital's emergency department*

*Imen Mejri\*, Safa Bhar Layeb, Najla Omrane Aissaoui  
LR-OASIS, National Engineering School of Tunis, University of Tunis El Manar, Tunis, Tunisia*

## **Abstract**

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Health care organizational design is a crucial topic that is still an interesting avenue of care quality improvement. To provide high-quality services, significant efforts are required at all levels to make fundamental reforms of care systems. Because of the increased complexity and size of various organizations, professionals face difficult challenges to design adequate structural models for their entities in a more relevant and effective form. Thus, the key question is how healthcare structures can create fundamental transformational changes to reach this goal. In such context, the scope of this study is to identify best practices for a successful organizational redesign. Precisely, the conduct of research investigation focuses on a specific context of an emergency department within a Tunisian hospital. Toward this aim, the initial step was based on observing in-depth the actual internal environment to capture problems inside the considered department. To conduct an effective site diagnostic, we present a structured approach based on the framework of lean healthcare management. Next, based on the collected data analysis, we properly define strategic qualifications, positions, and authorities of all emergency department members through a well-structured job design. Thus, effective job descriptions have made the impetus to explore health management hierarchy and define structure relationships. They contributed to detect vertical and horizontal flows to design an appropriate hierarchical configuration for the considered emergency department. The proposed well-engineered organization chart was structured on a functional model that would help health care professionals to improve their department's performance.

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# *A framework for modelling customer invoice payment predictions*

*Willem Moore\*, Jan van Vuuren*

*Stellenbosch Unit for Operations Research in Engineering, Department of Industrial Engineering, Stellenbosch University*

## **Abstract**

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One of the fundamental objectives of a company is to maximise profit, typically by the increase of its sales revenue. Such sales revenue may be generated by two methods, namely cash received and credit granted. The former is usually preferred, because it increases cash on hand immediately. The latter is, however, at times required by customers and is then managed by the company as accounts receivables. By offering clients attractive credit terms on sales, a company may increase sales turnover, but granting credit also incurs the cost of money tied up in accounts receivables, increased administration and a heightened probability of bad debt occurring.

Careful management of a company's collection activities may significantly improve accounts receivables collection. For instance, pre-emptive actions may be applied to invoices that are likely to become delinquent in order to drive down collection time. The use of collection resources may be optimised by prioritising delinquent invoices based on their expected payment time. Such an optimisation approach stands in stark contrast with methods currently adopted by the majority of collection departments which usually only take action once an invoice becomes delinquent.

The problem of improving accounts receivable collections may be addressed by attempting to provide insight as to how to prioritise contacting customers based on the probability of late payments. A framework for modelling customer invoice payment predictions is put forward in this presentation, which allows the user of the framework not only to determine when an invoice payment is likely to occur, but also whether or not the invoice is likely to be paid at all. A user of the framework is presented with meaningful insight into the underlying patterns identified among the data utilised during model development so as to facilitate an analysis and synthesis of the results. The framework is verified and validated by applying it to a special case study involving real data pertaining to a collection of schools of Curro Holdings Ltd.

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# *Road transport safety in vehicle routing problem: An integration approach*

*Ben Mansour Mouin\*, Elloumi Abdelkarim*

## **Abstract**

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Road transport safety is vital for prosperity, economic growth and very essential to the well-being of people and logistics companies. Despite this, the typical objective of Vehicle Routing Problems (VRP) is to minimize total travel costs, total travel times, and distances to minimize pollution, fuel consumption, and incorporation of driver behavior. Different variations of VRP have been introduced since the creation of the basic model until now. During this period, researchers in this field incorporated a variety of changes in the mathematical formulation of the basic routing problem. However, in VRP models, road transport safety as an objective to be achieved continues to be neglected when planning vehicle itineraries. Whereas the road safety problem in some countries could lead to huge losses in extreme cases. Our approach consists of integrating the problem of road safety in the routing problems in order to have a secure optimization modeling of VRP. Based on this approach, the new objective of the logistics company for example is to minimize the costs between two nodes  $i$  and  $j$  by integrating road safety (number of typical scenarios of accidents between  $i$  and  $j$ ) which will have a certain autonomy in taking decision making. the potential benefits of the integration of road safety in these models are to have simultaneously the optimal route-choice decision and the safe-route choice decision.

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# *Road safety in transportation: A journal review and a proposed taxonomy analysis of accidentology-factor*

*Ben Mansour Mouin\**, *Elloumi Abdelkarim*  
*PHD-STUDENT*

## **Abstract**

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The road network is of great importance for each country. It constitutes one of the indicators of the degree of its development. Indeed, the calculation of the density of the road network reflects the distribution of infrastructure. To properly study the problems to be solved for such a network, as well as the methods to be used, we need good modeling of the transport network. we present the interest of road safety transportation. For this reason, in the first part, we detailed the 188 scientific journals dealing with the research focus on road safety transportation. This journal review resumes the different subject areas and categories about this problematic. These journals do not treat the problematics of infrastructure defaults for road safety transportation in the subject area: decision science and its category: Management Science and Operations Research.

In the second part, we present our proposed taxonomy that regroupes all accidentology factors related to the road system treated by researchers. Based on this taxonomy, we present a risk analysis of 66 works of road safety transportation in many countries such as Malaysia, Europe, Wisconsin: United States, Tunisia, Asia, China, Thailand, Nigeria, Jordan, United Kingdom, Finland, India, Kenya, South-Africa, Indonesia and, Ghana.

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# *A multidimensional genetic algorithm applicable for our VRP variant dealing with the problems of infrastructure defaults SVRDP-CMTW: “Safety vehicle routing diagnosis problem with control and modified time windows”*

*Ben Mansour Mouin\*, Elloumi Abdelkarim*  
*PHD-STUDENT*

## **Abstract**

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We will discuss the problem of routing a fleet of different vehicles from a central depot to different types of infrastructure-defaults with dynamic maintenance requests, modified time windows and control of default maintained. For this reason, we propose a multidimensional genetic algorithm to solve our mathematical model. SVRDP-CMTW is a variant of an optimal vehicle plan that facilitates the maintenance task of different types of infrastructure-defaults. This task will be monitored after the maintenance, based on its priorities, the degree of danger associated with each default and the neighborhood at the black-spots We will present, in this paper, a multidimensional genetic algorithm “MGA” by detailing its characteristics, proposed mechanisms and roles in our work. The coding of this algorithm represents the necessary parameters that characterize each infrastructure-default with the objective of minimizing a combination of cost, distance and maintenance times while satisfying the priority levels of the most urgent defaults. The developed algorithm will allow the dynamic integration of newly detected defaults at the execution time. This result will be displayed in our programmed interactive system at the routing time. This multidimensional genetic algorithm replaces N genetic algorithm to solve P different type problems of infrastructure defaults (instead of N algorithm for P problem we can solve in one multidimensional algorithm simultaneously who can solve all these problems at once)

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# *Nonlinear optimization over the integer efficient set of multi-objective integer linear fractional programs*

*Mustapha Moulai, Wassila Drici\**  
*USTHB, LaROMaD Laboratory*

## **Abstract**

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We are concerned by the problem of optimizing a linear fractional utility function over the efficient solution set of a multi-objective integer linear fractional program. The proposed algorithm for this class of non linear optimization problems obtains an optimal solution by a Branch-and-Bound technique, efficiency test and cuts. At every node of the search tree, a relaxed problem, where both integrality and efficiency constraints are dropped, is solved by the simplex method. By tests and fathoming rules the algorithm decides, whether the node is fathomed or the relaxed problem is branched into one or two subproblems, hence the computation of the whole set of efficient solutions is not necessary.

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# *Workshop scheduling: New multicriteria heuristic for machinery breakdown constraint*

*Kheira Moussaoui, Zhor Chergui\**  
*ENST*

## **Abstract**

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In mechanical engineering field, it is highly recommended to optimize the time function of the production flow inside the manufacturing workshop. In other words, carrying out an optimal scheduling tasks constitutes one of the most sought-after solutions which can improve significantly the service quality and consequently attract new clients. In this presentation, we propose a new multicriteria scheduling plan allowing to optimize the daily Makespan in which the constraints of Machinery Breakdown is taken into account. Indeed, a compromise solution between several criteria is elaborated, it aims to minimizing technical unemployment of machines while avoiding the creation of choke machines and delivering at time (respecting order deadline). A new heuristic is proposed in order to better meet the requirements of the model developed.

**Keywords:** Scheduling, Mechanical workshop, Heuristics, Makespan,

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# *Transitioning from traditional agriculture to automated agriculture using IoT to manage resources*

*Kendi Muchungi\**

## **Abstract**

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Since Feed the Future's profile of Kenya in 2013, Kenya's population has grown by 21% and the implications on the strain on resources notwithstanding, the livelihood of 75% of 55 million Kenyans is still from some part of agriculture. With a population growth of 21% in 10 years the strain on resources is quite significant. How we handle water and nutrients as a resource within the agricultural sector is very important. With emergent technologies like the Internet of Things (IoT) we can reduce the strain on water and nutrients as resources. With IoT coupled with hydroponics and soilless agriculture we can ensure 85% less waste of water and 100% utilization of organic nutrients farmers, especially the small holder farmer will be able to produce three (3) times their normal yield. Using action research, we were able to setup two pilots; one in Kenya's largest slum, Kibera for a children's home and the second for a widows' group in Meru, in a small village called Kianjai. We used these two (2) different distinct areas as our sample to determine how easily a vertical hydroponics setup that leveraged IoT would be adapted by these groups of people that have limited access to water and limited skilling with regards to the use of technology. Our pilots determined that although the initial cost of setting up the vertical hydroponics systems for leafy vegetables was high at the onset, the return on investment was almost immediate as the two groups were able to harvest three leaves from each of the 95 plants for the entire setup every day for 5 months. For this setup, one gets 31 bunches each of which are sold at KeS 30/= per bunch, each making KeS 142,500, a 9% RoI each month for the five (5) month first growing period. The findings were the fact that there was need for either an electrical source from the grid or solar, for the IoT components to work autonomously a smart phone was a requirement, an ability to test their water PH and acidity levels. As pilot implementors, we learnt the importance of having a manual that was audiovisual and in multiple languages to support the management of the systems for persons with different educational levels to avoid misunderstanding and miscommunication beyond the first user training.

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# *Application of multi-criteria decision making methods on the choice of crops for small scale agro-processing*

*Benitho Gasper Mung'Ong'O\**  
*UNIVERSITY OF DAR ES SALAAM*

## **Abstract**

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The purpose of this study was to find out and prioritize on the kind of crops small scale farmers should grow most for processing in each ward of Njombe region. Decision was made to select crops that could be grown most for agro-processing. The multi-criteria decision making methods were applied in prioritizing the crops. Fuzzy TOPSIS method was used to assess the criteria for the study and ranked the alternatives for each of ten administrative wards of Njombe DC. The fuzzy AHP results were compared with results by fuzzy TOPSIS method. Each ward's crops were assessed on each criterion by fuzzy AHP. Crops were ranked in each ward. It was found that maize ranked highest in five of the ten wards. Other wards had different crops that ranked highest. The study is limited to the wards that were studied but similar study and methodology can be applied in other geographic location

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# *An algorithm for determination of university enrolment workload: The case of the University of Dar es Salaam*

*Allen R. Mushi\**  
*Lecturer*

## **Abstract**

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Public Universities in Tanzania are the most popular among student applicants because of affordable fees which are highly subsidized by the Government. Most of the applicants who miss admissions into public Universities end up missing the University education which is highly important for the country's development. University of Dar es Salaam embarked on a programme called Institutional Transformation to expand student enrolment to give more opportunities to applicants without jeopardizing the quality of education offered. The programme introduced a central timetabling office to allocate teaching space. However, the expansion process, despite many success stories; brought about a problem of overcrowding, both in the teaching resources and available utilities in the campus and therefore the expansion had to stop for a while. No study has ever been conducted at the University to find the optimal enrolment load that can guarantee effective use of resources without jeopardizing the quality of educational output. This study proposes a model which can be used to determine the optimal enrolment numbers given the available teaching space, programmes, and curricular structures, human and other resources. The results indicate an improvement in the enrolment when considering the requirements of specific large crosscutting courses that are shared among programmes.

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# *Design and optimization of energy production from a biogas plant*

*Jackline Mutunga\*, Mark Rodgers*

## **Abstract**

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Growing energy needs for economic development is the leading cause of energy crisis. This has led to increased dependence on fossil fuels for combustion, transport, industry and electrical power generation sectors. Associated with this is the negative impact fossil fuel combustion is causing on the environment and health. Renewable energy sources offer considerable solutions owing to their reduced impact on the environment and vast quantities that are yet to be exploited. Non-renewable energy sources such as coal and petroleum face the challenge of being exhausted in the near future reducing their reliability, in addition to emission of greenhouse gases that are causing climate change. Compared to other renewable energy sources such as solar, wind and hydro, biogas energy can be described as the least intermittent source. It however faces the challenge of having minimal energy content as 20-40% of biogas constituent are impurities. The objective of this research is to optimize the design and operating conditions of a biogas plant, in addition to purifying the biogas before use. This will contribute positively to its reliability, in addition to strengthening uptake of low carbon technologies in the energy sector and improve agricultural productivity through the use of digestate as organic fertilizer. It is expected that an optimized biogas plant which is suitable for energy supply to a Kenyan community living far away from the main grid will be developed and verified.

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# *Analysis and optimization of the pharmaceutical distribution chain of NIGAPHARM company: A case study in Algeria*

*Yalaoui Nabila\*, Ferhat Imen, Maliki Fouad, Souier Mehdi, Sahnoun M'hammed  
Manufacturing Engineering Laboratory of Tlemcen (MELT), University of Tlemcen, PB 230, 13000,  
Tlemcen, Algeria.*

## **Abstract**

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Pharmaceutical distribution chain represents one of the most difficult distribution chains to manage. It is made up of several intermediate links that must interact in order to satisfy customer demands. The system under study represents a real world case in Algeria; we noticed that the circuits used by delivery's vehicles are not optimal after analyzing the distribution chain of the company. This paper deals with NIGAPHARM's distribution network and propose to minimize the total distance driven by the vehicles for short and long distances by selecting the optimal routes planning respecting realistic constraints of this VRP problem.

**Keywords:** Pharmaceutical products, distribution chain, optimization, VRP, minimization of distance, client's demand satisfaction, optimal circuit.

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# *The two-stage chain reentrant hybrid flow-shop problem with deteriorating jobs*

*Mohamed Nedjai\*, Karim Amrouche, Mourad Boudhar  
RECITS laboratory, Faculty of Mathematics, USTHB University, BP 32 Bab-Ezzouar, El-Alia 16111,  
Algiers, Algeria.*

## **Abstract**

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The concept of deteriorating jobs has been considered in many mono-objective scheduling problems. In such problems, the processing time of each job is a linear function of its starting time. Not much is known about the bi-objective case. To the best of our knowledge, the bi-objective problem of minimizing both of the makespan and the total energy consumption has recently been investigated. In our paper, we are concerned with the minimization of the same criteria in a two-stage chain reentrant hybrid flow-shop with deteriorating jobs. In this framework, each job must initially be scheduled on a primary machine M1 (first stage) which is then scheduled on one of the  $m$  unrelated parallel machines of the second stage and returns back to M1 for its last operation. For the resolution of this problem, we implement and compare two meta-heuristics: a nondominated sorting-based multi-objective genetic algorithm NSGA2 and an archived multi-objective simulated annealing method "AMOSA". We then give a multi-objective decision-making using the TOPSIS method (technique for order of preference by similarity to ideal solution) to determine the best solution from the Pareto front according to the decision-makers preferences.

**Keywords:** Scheduling, deteriorating jobs, bi-objective, NSGA2, AMOSA, TOPSIS

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# *Sound decision making under stressful situations*

*Winnie Carla Pelsler\**  
*CSIR*

## **Abstract**

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Decision makers are confronted with uncertainty and abstraction on many levels. Decision making in complex situations are not trivial. Defense Forces and other security officials face an operating environment characterized by volatility, uncertainty, complexity, and ambiguity. Decision makers must make sense of this paradoxical and chaotic setting. Succeeding in such environments requires decision makers that are willing to embrace improvisation and reflection. Effective decisions must be based on a rational analysis of a situation. Regardless of good intentions, things often go very wrong. Many military operations in the past failed due to poor decisions. The bad part is that if a military or security operation fail, lives are often lost. This place a high premium on sound decision making. The underlying cause of failed military or security operations have been attributed to a variety of explanations, but a failure in human thinking or human cognitive processes may be the underlying cause. The effect of stress add to the difficulty of making good and ethical decisions. What can be done to make sound and ethical decisions under uncertain and stressful circumstances as well as to avoid decision failures that stem from stressful situations.

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# *On testing the hypothesis of population stability for credit risk scorecards*

*Johan Du Pisanie\*, James Allison, Jaco Visagie  
North-West University*

## **Abstract**

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Scorecards are models used in credit risk modelling. These models segments a population into various so-called “risk buckets” based on the risk characteristics of the individual clients. Once a scorecard has been developed, the credit provider typically prefers to keep this model in use for an extended period. As a result, it is important to test whether or not the model still fits the population. To this end, the hypothesis of population stability is tested; this hypothesis specifies that the current proportions of the population in the various risk buckets are the same as was the case at the point in time at which the scorecard was developed. In practice, this assumption is often tested using a measure known as the population stability index together with a well-known rule of thumb.

This talk considers the statistical motivation for the use of the population stability index. Numerical examples are provided in order to demonstrate the effect of the rule of thumb as well as other critical values. Although previous numerical studies relating to this statistic are available, the sample sizes are not realistic for the South African credit market. We demonstrate that the population stability index has little statistical merit as either a goodness-of-fit statistic to test the hypothesis of population stability or as an intuitive discrepancy measure. As a result, a novel methodology for testing the mentioned hypothesis is proposed. This methodology includes a restatement of the hypothesis to specify a range of “acceptable” deviations from the specified model. An alternative test statistic is also employed as discrepancy measure; this measure has the advantage of having a simple heuristic interpretation in the context of credit risk modelling.

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# *Cardinality bundling under oligopoly – A simulation model*

*Petrus H. Potgieter\*, Bronwyn E. Howell  
Unisa*

## **Abstract**

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The analysis of the putative effect of proposed mergers of mobile telecommunications operators has reached unprecedented levels of complexity. This paper takes a new approach in which we explicitly focus on the fact that for mobile operators today, the main product is data bundles. In the presence of heterogeneous consumer valuations, firms choose bundle sizes and prices.

We construct a discrete model in which optimal pricing strategies for firms are determined in a Stackelberg-type competition model. There are finitely many consumers and finitely many firms. Firms determine their quasi-optimal pricing strategy in sequence by using simulation to each select a fixed number of bundles of a single product to offer. There is assumed to be no product differentiation among the firms and consumers have randomized willingness to pay and select their optimal purchase(s) by maximizing their individual consumer surplus.

First, we select distributions for the firms' choices and for the consumer valuations that allow for outcomes that are typically observed in an oligopoly market like mobile network data. The finite number of consumers can be thought of discrete groups of types of consumers. This is not entirely dissimilar to the user baskets often used (low, moderate and high volume users) in merger analysis.

Second, we investigate the effect on consumer and total welfare of a change in the number of firms using our Monte Carlo simulation. Prices and quantities as well as customer valuations are discrete variables and we purposely eschew an attempt to find an analytical solution.

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# *A framework for quantifying the sensitivity of anticipated employment rates in different sectors of the South African economy with respect to throughput rate changes in the education sector*

*Edwin Reed\*, Jan van Vuuren*

*Stellenbosch Unit for Operations Research in Engineering, Department of Industrial Engineering, Stellenbosch University.*

## **Abstract**

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Since the demise of the Apartheid era, South Africa has been grappling to restore the equality imbalance left in its wake. Education has been at the forefront of this rebuilding process, due to its proven direct relation to labour-market improvement prospects. Although formalised racial segregation has been abolished for 20 years, no significant improvements in the national school system have been observed since. This is concerning, as studies suggest that inadequate education drives an intergenerational cycle of poverty where children inherit the social standing of their parents or caregivers, irrespective of their own abilities or effort. The ineffectiveness of former attempts to improve educational outcomes begs the question: Where would interventions in this expansive system yield the most significant impact?

In this presentation, a framework is proposed for modelling both the progression of learners and students through the South African education system, as well as the absorption of these individuals into the workforce of the country. The applicability of the framework is explored in terms of aiding policy and decision makers by projecting the long-term effects that changes in throughput rates within the education system are anticipated to have on the workforce distribution of the country. Finally, the framework is applied to a case study which focusses on the impacts of school dropouts as a result of teenage pregnancies.

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# *A multidisciplinary collaboration for the healthcare of autistic children: A Tunisian field study*

*Layeb Sana\**

*University of Carthage, Research Team on Ambiances (ERA), Graduate School of Architecture and Urbanism (ENAU), Tunisia*

## **Abstract**

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In this research, we aim by a multidisciplinary protocol combining architecture, psychology and technology to better understand the hypersensitivity of children with autism and to adapt their care environments. The approaches followed will allow the therapists, the educators and even the families of autistic children to face, anticipate, experiment and protect these persons in relation to unsuitable and stressful situations of daily life. Our experimental protocol is based first on a spatial and architectural characterization of the places, based on numerical simulations and also on metrology. Then, on psychophysiological measurements based on the capture of emotions via a biosensor of electrodermal activity which evaluates the level of arousal of the user via the conductance of the skin. These measurements were combined with the sensory profile which is based on the theory of sensory integration which explains the behaviours of the children by the interpretation of their capacity of integration of the sensory stimuli. We try to improve the spatial conditions of the child's evolution in his care space. The results showed that the spatial arrangements and devices should inflect a controlled qualitative dimension for the child, according to his sensory profile. In order to support designers and decision makers, this field study provides accurate spatial design characteristics for the special needs of the autistic children.

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# *An exact method for the multi-objective matching problem*

*Hamou Satla\*, Mohamed El-Amine Chergui  
USTHB, RECITS Laboratory, Algeria*

## **Abstract**

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A branch and bound based method is implemented to generate the efficient set of the multi-objective matching problem (MOMP) in a given graph. The method exploits the structure of the incidence matrix of the graph and makes it possible to break down the initial problem in a search tree structure into independent sub-problems of small sizes, each one is solved by a general method reported in the literature and dedicated to the multi-objective integer linear programming problem (MOILP). To do this, the process will continue with the branching and vector bounding steps at each node of the search tree following the principle depth-first strategy, with the assumption that the number of variables of the created sub problems is set beforehand to avoid the combinatorial explosion. At each node of the search tree, two bounds are calculated. The upper bound vector corresponds to the ideal point in the sub domain corresponding to the current node and the corresponding coordinates are easy to calculate. The lower bound consists of the set of all the non-dominated vectors matching previously generated up to the current node. The results of the experiment show that the method is advantageous compared to a general method dedicated to the MOILP problem when applied directly to solve the MOMP problem.

**Keywords:** maximum matching; multi-objective linear integer programming; branch and bound; non dominated vector; efficient solution.

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# *A mathematical model for sustainable harvesting of a theoretical biological species*

*Kit Searle\*, Jan van Vuuren*

*Stellenbosch Unit for Operations Research in Engineering, Department of Industrial Engineering, Stellenbosch University*

## **Abstract**

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In this presentation, a maximally sustainable pro-rata density-dependent harvest rate is determined analytically for a hypothetical biological species subjected to harvesting on the spatial boundary of its habitat, which is otherwise a protected zone (i.e. no harvesting of the species is allowed in the interior of its habitat). This is achieved by analysing an abstract mathematical model for the spatio-temporal evolution of the species density over its habitat if it were to be subjected to a continuum of potential pro-rata density-dependent harvest rates on the spatial boundary. The model takes the form of an initial-boundary value problem involving a reaction-diffusion equation in which the reaction term is a concave function of the population density and in which Robin boundary conditions are pre-scribed. A long-time asymptotic analysis of the population density is undertaken by invoking classical results from the theory of eigenproblems. In this way, necessary and sufficient conditions on the pro-rata density-dependent harvest rate are established for the existence of a strictly positive equilibrium attractor of model solutions. Moreover, important necessary properties of this equilibrium attractor are established which guarantee the existence of a density pro-rata harvest rate which maximises the total harvest per unit time at equilibrium.

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# *A PDE-constrained optimisation approach towards optimal harvesting yield of a biological species*

*Kit Searle\*, Jan van Vuuren*

*University of Stellenbosch, Department of Industrial Engineering*

## **Abstract**

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In this presentation, the maximally sustainable pro-rata density-dependent harvest rate of a hypothetical biological species on the spatial boundary of its habitat, which is otherwise a protected zone (i.e. no harvesting of the species is allowed in the interior of its habitat), is determined analytically. This is achieved by analysing an abstract mathematical model for the spatio-temporal evolution of the species density over its habitat if it is subjected to a continuum of potential pro-rata density-dependent harvest rates on the spatial boundary. The model takes the form of an initial-boundary value problem involving a reaction-diffusion equation, equipped with a Robin boundary condition, in which the reaction term is a concave function of the population density and time periodic. A long-time asymptotic analysis of the population density is undertaken in order to establish necessary and sufficient conditions on the pro-rata density-dependent harvest rate for the existence of a strictly positive time-periodic attractor of model solutions. Thereafter, the problem of finding a pro-rata harvest rate which maximises the total harvest over a single interval of seasonality is considered. This is achieved by formulating the problem as a Partial Differential Equation (PDE)-constrained optimisation problem. The solution to this problem is a pro-rata harvest rate that results in a population distribution which maximises the total harvest over a single interval of seasonality. The existence of a solution to the PDE-constrained optimisation problem is established by exploiting a monotonicity property of the underlying PDE model. Finally, the optimal pro-rata harvest rate and corresponding optimal population distribution are approximated numerically for a special case.

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# *Hydrogen freight solutions towards net zero*

*C. Searle\*, P. Greening, N.S. Taou*

*Edinburgh Business School, Heriot-Watt University, Edinburgh, UK*

## **Abstract**

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In realising the global initiative towards a future with net zero emissions, the implementation of cleaner energy sources is critical. The transport sector is a large contributor to the total greenhouse gas emissions and although various innovative solutions, such as hydrogen, biofuels and electricity, are currently being advanced, the adoption towards such a strategy is often challenging. When considering freight transport, hydrogen fuel cell technologies have the advantage of a larger driving range and shorter refuelling time when compared to other green technologies. Prior to the implementation of hydrogen freight solutions, however, it is imperative to gain an understanding of the investment required for hydrogen refuelling and distribution networks. This study considers the methodology towards the analysis of a strategic hydrogen refuelling infrastructure. Data analysis and simulation modelling techniques may be utilised to map the current road freight movement on selected corridors in an attempt to determine the optimal location and capacity of hydrogen infrastructures required to serve the hydrogen needs of the given corridors. From the initial analysis of demand to the development of agent-based models with optimisation capabilities, this methodology aims to provide an economic analysis for deploying hydrogen refuelling infrastructure.

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# *Vehicle routing decision support for a local retailer*

*Aaron Shuttleworth\*, Jan van Vuuren  
Stellenbosch University*

## **Abstract**

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In the retail sector, the problem of transporting products from distribution centres (DCs) to stores is a crucial one. Large quantities of goods are typically dispatched daily from a DC to a set of customers served by the DC, and so complex delivery vehicle routing decisions have to be made quickly by human schedulers at the DC so as to meet customer demand both timeously and cost-effectively, with only a small information horizon available.

The goal in this presentation is to contribute to the effective routing of vehicles between the Western Cape DC of Spar and its customers by implementing a mathematical model capable of supplementing the expertise of the human schedulers employed by the DC. This model takes as input demand, customer, and vehicle information, and provides as output a set of recommended routes to which vehicles may be assigned. The objective of the model is to minimise the cost of meeting all customer demand, while satisfying a variety of routing constraints.

In pursuit of this goal, an appropriately extended mathematical model is formulated, inspired by a standard mixed-integer programming model formulation in the literature for the capacitated vehicle routing problem with time windows. This model is implemented and verified by solving it exactly for small problem instances. Thereafter a state-of-the-art metaheuristic, called the hybrid genetic search with advanced/adaptive diversity control (HGSADC) algorithm, is implemented and verified by comparing the solutions it returns against the aforementioned exact solutions. The model and approximate solution methodology are finally validated in the context of a case study involving real historical routing data obtained from the SPAR Western Cape DC. The purpose of this case study is to explore the extent of potential cost savings achievable by the DC when implementing vehicle routing recommendations returned by metaheuristic instead of relying on manual vehicle routing.

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# *On solving the vehicle-driver rostering problem in an integrated fashion*

*Pieter Jacobus Steenkamp\*, Jan van Vuuren*

*Stellenbosch Unit for Operations Research in Engineering, Department of Industrial Engineering, Stellenbosch University*

## **Abstract**

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A prominent public transport company in the Cape Metropole, which provides a passenger transport service in and around Cape Town in the form of daily timetabled trips, currently performs the assignment of buses and drivers to these trips manually. This assignment process is characterised by the solution of three different combinatorial optimisation problems, namely the vehicle scheduling problem (VSP), which entails the assignment of buses to trips over a scheduling period, the driver scheduling problem (DSP), which entails the assignment of drivers to trips over a scheduling period, and the driver rostering problem (DRP), which entails the assignment of drivers to trips over a rostering period (whereas a scheduling period typically spans one day, a rostering period typically spans several days). Traditionally, the aforementioned sub-problems are solved sequentially due to their considerable individual computational complexities. The public transport company in question has, however, launched a research project in which three objectives are pursued: (1) To develop metaheuristics for solving the three sub-problems above in a sequential manner, (2) to develop a metaheuristic that simultaneously solves all of these sub-problems together (known in literature as the integrated vehicle-driver rostering problem), and (3) to compare the two approaches of solving the sub-problems sequentially as opposed to following an integrated solution approach, when attempting to minimise a cost function in both cases. Results obtained when following these two solution approaches are presented in the context of real timetabled trips data obtained from the transport company.

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# *Interactive multiobjective optimization with multiple reference points*

*Theodor Stewart\**  
*University of Cape Town*

## **Abstract**

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We propose an interactive for multiobjective optimization with many (typically  $>3$ ) objectives, that can be viewed in some ways as intermediate between conventional interactive methods (which examine one solution at a time), and EMO methods which seek to provide representations of the Pareto frontier. We demonstrate that the use of multiple widely dispersed reference points can be implemented in a single algorithm, to generate a dispersed set of Pareto optimal solutions. The decision maker can compare these to provide a simple partial ordering, which we recognize as a simple and unambiguous form of preference statement. On this basis, the range of reference points considered is reduced, before the process is repeated to obtain a new set of Pareto optimal solutions for evaluation by the decision maker. The interaction is achieved by generating reference points as linear combinations of the vectors approximating the payoff matrix, where the coefficients are generated from a Dirichlet distribution. Initially this distribution is uniform on the simplex. A pseudo-Bayesian process, analogous to multinomial sampling, is introduced, whereby the distribution is updated on the basis of the classification of the resultant Pareto optimal solutions into preference classes, so that at each new iteration the reference points become more clustered. Numerical experiments on a test problem showed robust performance, with rapid convergence towards an assumed desired goal-point in a matter of 3 or 4 iterations. In confirmation, the approach was also applied to a problem in project portfolio optimization, generating very similar results.

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# *Assessing the performance of the African entrepreneurial ecosystem: A DEA based approach*

*Pawoumodom M. Takouda\*, Mohamed Dia, Alassane Ouattara, Konan Vincent De Paul Kouadio  
Research Group in Operations, Analytics and Decision Sciences (RGinOADS) School of Business Administration, Faculty of Management Laurentian University, Sudbury, Ontario, Canada*

## **Abstract**

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In this study, the performance of the entrepreneurial ecosystem of a sample of African economies is evaluated using Data Envelopment Analysis (DEA) models. Using data from Doing Business reports, published yearly by the World Bank, we compute various composite indicators of the dimension “creating a business” using DEA models, as well as Principal Components Analysis. We show that they are robust and consistent with the one published by the Doing Business reports. DEA-based approaches allow in addition a further analysis of the relative importance of the sub-indicators for each economy, as well as a benchmarking. Hence, our analysis based on DEA provides guidelines to analysts and policymakers who aim to adjust and improve their entrepreneurial regulatory environments

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# *A generic framework for aspect-based sentiment analysis*

*Bianca Van Zyl\*, Jan van Vuuren, Stephan Nel*

*Stellenbosch Unit for Operations Research in Engineering, Department of Industrial Engineering, Stellenbosch University*

## **Abstract**

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With the increasing volume and complexity of user-generated content shared via the Internet, the need has arisen for automated methods capable of extracting meaningful insights from unstructured text data. Sentiment analysis is a form of text analysis involving the process of computationally identifying the polarity of an opinion expressed by an author of a given piece of text. While the majority of existing work in this field focusses on document-level or sentence-level analysis, aspect-based sentiment analysis involves a more fine-grained approach, facilitating the discovery of both the topics, and sentiment polarities towards these topics, present in the text data. A generic framework for aspect-based sentiment analysis is proposed in this presentation. Further follow-up work is anticipated to include a computerised instantiation of the framework in the form of a practical decision support system.

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# *On numerical considerations associated with the Kolmogorov-Smirnov test for exponentiality in the presence of censoring*

*Jaco Visagie\*, Elzanie Bothma, James Allison  
North-West University*

## **Abstract**

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It is often of interest to test the hypothesis that lifetime data are realised from the exponential distribution. This distribution is popular in various fields, including medical studies, reliability theory and financial modelling. In these fields, random right censoring is often present. As a result, it is of interest to be able to test the hypothesis that observed censored data are exponentially distributed. Classical goodness-of-fit tests are frequently based on the distribution function, which can be estimated using the Kaplan-Meier estimator in the presence of censoring. However, this estimator is undefined for values greater than the sample maximum in cases where the this observation is censored; two different assumptions are regularly made in this case. In this talk, we consider the effect of these assumptions on the Kolmogorov-Smirnov test for exponentiality. The methods used are general and can be applied to other tests as well as other distributions.

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# *A decision support framework for cross-functional team selection*

*Van Zyl Venter\*, Jan van Vuuren*

*Stellenbosch Unit for Operations Research in Engineering, Department of Industrial Engineering, Stellenbosch University.*

## **Abstract**

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Team formation has become an integral part of modern-day organisations and the procedure for selecting appropriate candidates to fulfil specific roles in a team can become complex. This process of cross-functional team selection (CFTS), where members from different departments in an organisation are to be selected to form a team whose members are required to work together to complete a project, is further complicated if team compositional decisions have to be made at multiple points in time over the lifetime of a project. Predicting the timing of performance peaks anticipated for available team candidates over the entire lifetime of the project may therefore prove valuable when composing the initial project team. In this presentation, a multi-period cross-functional team selection framework is described for the development of a decision support system tailored for CFTS problems in a specific context. The prediction of candidate performances is illustrated through a case study involving team selection in the context of Fantasy Premier League Soccer, and the applicability of the framework in terms of aiding a decision maker by recommending a CFTS for each game week of the season is demonstrated.

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# *Solving multiobjective integer convex programs with linear constraints*

*Lamia Zerfa\*, Mohamed El-Amine Chergui*

*University Alger 1, Faculty of Sciences, 02 Rue Didouche Mourad, Algiers, Algeria. RECITS laboratory, USTHB, Faculty of Mathematics, P.O.32 El Alia 16111 Algiers, Algeria.*

## **Abstract**

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We describe a branch and bound based algorithm for generating all the non dominated points for a multiobjective integer programming problem considering convex objective functions and linear constraints (MOICP). The principle consists of solving a single-objective program (P) from the initial MOICP program with relaxed integrality constraints. Then every time an integer solution is found using a branching process, a node is created in the search tree for each criterion by adding a cutting plane that approximates locally the criterion. Nodes are treated according to the depth-first strategy and each obtained program will be solved in the same manner as (P). The added cuts have the effect of removing a set of dominated solutions. We provide numerical results based on randomly generated quadratic multiobjective integer problems that illustrate the efficacy of our algorithm.

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

*Jurie Zietsman\*, Jan van Vuuren*

*Stellenbosch Unit for Operations Research in Engineering, Department of Industrial Engineering, Stellenbosch University*

## **Abstract**

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Globalisation and the growth of e-commerce has led to retail companies having to manage and control larger and larger numbers stock keeping units (SKUs). The success of any retail company depends on how well it can satisfy customer demand while remaining financially viable. Inventory management systems are aimed at balancing the conflicting objectives of providing high-quality customer service and minimising inventory and operating costs. As the number of SKUs a company holds increases, so does the complexity of this balancing problem. The main decisions in respect of SKU inventory management in a retail warehouse, which affect this balance, are (1) which SKU inventories to replenished, (2) when to place replenishment orders for these SKUs, and (3) the appropriate volumes of SKUs to request in these orders.

In this presentation, a generic framework is proposed for the development of decision support systems in the context of SKU inventory replenishment in a retail warehouse. The framework facilitates the processing of historical demand data, the forecasting of future demand by applying appropriate forecasting models to the historical data, recommending and applying inventory model parameters per SKU by means of a combinatorial optimisation approach, and synthesising the recommended replenishment orders in a user-friendly fashion based on pre-specified objectives. An instantiation of this framework is presented in the context of a case study involving real demand data in the South Africa retail sector.

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# *Optimizing a linear function over the efficient set of a multi-objective transportation problem*

*Mezali Zineb\*, Chergui Mohamed El-Amine  
USTHB, RECITS Laboratory, Algeria*

## **Abstract**

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In this study, an exact method is proposed to optimize a linear function over the efficient set of a multi-objective transportation problem (MOTP). This kind of problems emerges when a decision maker must optimize a preference function over a large number of efficient solutions. We develop a branch-and-bound based algorithm coupled with a classical transportation method to find an optimal solution in a finite number of steps. This is made possible by using reduced costs of all the cost matrices in order to define the promising regions which may contain an efficient optimal solution for the problem to be solved. This algorithm is strengthened by efficient bounds allowing us to prune a large number of nodes in the search tree and hence eliminate many non efficient solutions.

**Keywords:** Transportation problem, multi-objective optimization, Efficient solution, Branch-and-bound.

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## Pure and Applied Analytics (PAA)-NWU

Our overarching aim is to conduct fundamental research regarding the foundational principles and paradigms of the Mathematical and Statistical sciences and their applications at an internationally competitive level to the advancement of scientific knowledge. To achieve this aim we strive to create a space conducive to research where the different branches of the mathematical sciences can exchange ideas in a holistic inclusive way. Such holism should include the integration of different subdisciplines to achieve a fuller understanding of research problems, and be inclusive in the sense of extending to the broader South African mathematical sciences community and providing an accessible forum for the development of graduate students and emerging researchers. We also strive to be aware of and responsive to new developments in the mathematical sciences and concomitantly strategically expand our skill set so as to stay abreast of such trends.

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Find out more about us at the site below:

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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.

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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.

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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 leadership 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

PHYSICAL ADDRESS: PD Hahn Building (South Entrance)  
Level 5 below the Science Faculty Office, Upper Campus, UCT

CONTACT DETAILS: Tel: +27 (0)21 650 3219 Fax: +27 (0)21 650 4773  
[www.facebook.com/statistics.uct](http://www.facebook.com/statistics.uct) <https://twitter.com/StatsUct>  
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A recent survey on members of the Southern African Institute for Industrial Engineers showed that a third of all Industrial Engineers have a postgraduate qualification. Thus, to be competitive in the job-market, postgraduate studies is one way to gain an advantage. The Department of Industrial Engineering at the Stellenbosch University hosts three postgraduate study domains: Industrial Engineering, Engineering Management and Data Science. Definitions for the different study domains are adopted from various sources and institutions involved in the field and are presented in this section as a basis to distinguish the domains.

## Masters in Industrial Engineering

**Industrial Engineering** is a discipline of engineering dealing with the optimization of complex processes or systems.

It is concerned with the development, improvement, implementation and evaluation of integrated systems of people, money, knowledge, information, equipment, energy, materials, analysis and synthesis, as well as the mathematical, physical and social sciences together with the principles and methods of engineering design to specify, predict, and evaluate the results to be obtained from such systems or processes.

Its underlying concepts overlap considerably with certain business-oriented disciplines such as operations management and financial management, but the engineering side tends to emphasize extensive mathematical proficiency and usage of quantitative methods.



## Masters in Engineering (and Technology) Management

**Engineering (and Technology) Management** is a specialized form of management that is concerned with the application of engineering principles to business practice. Engineering management often leads to a career that brings together the technological problem-solving abilities of engineering and the organisational, administrative, and planning abilities of management in order to oversee complex systems from conception to completion. To illustrate this, technology management, as a sub-set of engineering management, is a specialised professional practice that captures technology-based innovation opportunities. It guides technological progress, assesses the potential of individual technologies and uses this potential to the benefit of business, society and the environment. It distinguishes five generic processes:

- (i) identification of technologies, which are (or may be) of importance to the business;
- (ii) selection of technologies that should be supported by the organization;
- (iii) acquisition and assimilation of selected technologies;
- (iv) exploitation of technologies to generate profit, or other benefits; and
- (v) protection of knowledge and expertise embedded in systems.

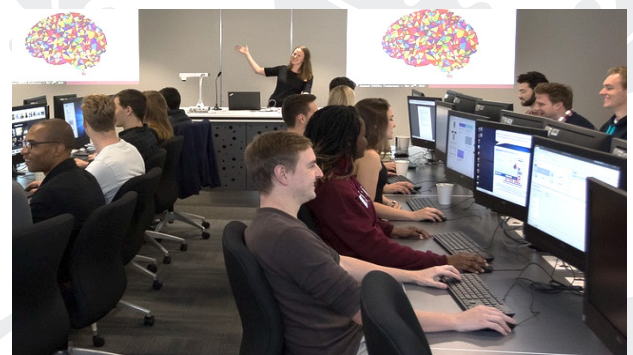


## Masters in Data Science

**Data Science** focuses on the development of innovative machine learning and optimisation techniques to produce novel, efficient and robust data science technologies, for use in Industrial Engineering and Engineering Management applications. Data science techniques can be used on extremely large data sets to computationally reveal patterns, trends and associations, especially relating to human behaviour and interactions.

Examples include:

- Forecasting customer demand from millions of retail transactions to understand demand patterns.
- Determining the optimal segmentation of customers to customize service delivery and develop targeted marketing strategies.
- Using machine learning to predict order delivery times in a distribution scenario.
- Analyzing imaging data for real time inventory decision making.



### Contacts

**Postgraduate Manager:**  
Melinda Rust: [mrust@sun.ac.za](mailto:mrust@sun.ac.za)

**Departmental Chair:**  
Prof Corne Schutte: [corne@sun.ac.za](mailto:corne@sun.ac.za)

Tel: (021) 808 4234  
[www.ie.sun.ac.za](http://www.ie.sun.ac.za)



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— *List of Authors* —

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|                                     |              |
|-------------------------------------|--------------|
| (1) Elloumi Abdelkarim .....        | 75, 76, 77   |
| (2) Mannoubia Affi .....            | 20           |
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| (26) Pierre Cilliers .....          | 34           |
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| (29) Souhail Dhouib .....           | 36           |
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| (33) Lynette Drevin .....           | 22           |
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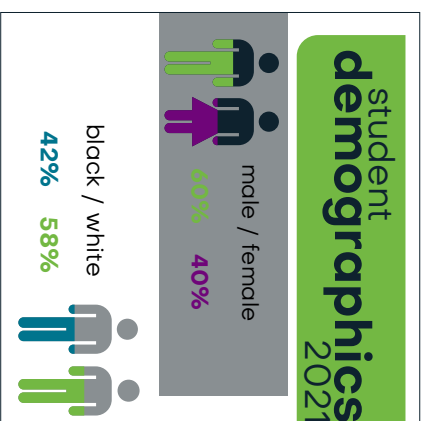
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| (104) | <b>Babacar M. Ndiaye</b> .....              | 38, 65, 21, 39 |
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— *List of Delegates\** —

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\*Delegates who registered by the 6<sup>th</sup> of September 2021.

- (1) **Affi**, Mannoubia (FSEG Sfax)  
mannoubia.affi@gmail.com
- (2) **Albert**, Laura (University of Wisconsin-Madison)  
laura@engr.wisc.edu
- (3) **Allison**, James (North-West University)  
james.allison@nwu.ac.za
- (4) **Alwaeli**, Zainab  
zain90ab@yahoo.com
- (5) **Baklouti**, Slaheddine (TORS)  
slaheddine.baklouti67@gmail.com
- (6) **Balde**, Mouhamadou (University Of Cheikh Anta Diop Of Dakar (UCAD))  
mouhamadouamt.balde@ucad.edu.sn
- (7) **Ball**, Richard (North-West University)  
rballe33@hotmail.com
- (8) **Ben Amor**, Fatma (Faculty Of Economics And Management Sciences. Sfax, Tunisia)  
fatma.benamor.chr@gmail.com
- (9) **Ben Terzi**, Sarah  
sarahbenterzi@gmail.com
- (10) **Bennetto**, Robert (Icepack)  
robert.bennetto.za@gmail.com
- (11) **Bhiri**, Rim  
rimbhiris@gmail.com
- (12) **Bisset**, Chanel (North-West University)  
26026856@nwu.ac.za
- (13) **Borchani**, Rahma (TORS)  
borchani.rahma@gmail.com
- (14) **Bothma**, Hennie (ORSSA)  
hbot@kriboa.co.za
- (15) **Bothma**, Elzanie (North-West University)  
elzanieb@yahoo.com
- (16) **Brahmi**, Hichem  
hichembrahmi@yahoo.fr
- (17) **Buluba**, Nelson (University Of Dar Es Salaam)  
nelsonbuluba@gmail.com
- (18) **Campher**, Susan (North-West University)  
susan.campher@nwu.ac.za
- (19) **Claeskens**, Gerda (KU Leuven, Belgium)  
gerda.claeskens@kuleuven.be
- (20) **Coetzer**, Roelof (North-West University)  
roelof.coetzer@nwu.ac.za
- (21) **Chergui**, Zhor (AFROS working group (AWG))  
chergui\_zhor@hotmail.fr
- (22) **Cilliers**, Pierre (University Of Stellenbosch)  
18969771@sun.ac.za
- (23) **Clark**, David (Chalcid)  
davidclark.orssa@gmail.com

- (24) **Dempers**, Clemens (Blue Stallion)  
dempers@bluestallion.co.za
- (25) **Dhouib**, Souhail (University Of Sfax)  
souhail.dhouib@gmail.com
- (26) **Dia**, Mohamd (Laurentian University)  
mdia@laurentian.ca
- (27) **Diallo**, Amadou Saikou (Assane Seck University)  
saikoudiallo1@gmail.com
- (28) **Drici**, Wassila (USTHB, LaROMaD Laboratory)  
w.drici@univ-boumerdes.dz
- (29) **Du Pisanie**, Johan (North-West University)  
dupisanie@gmail.com
- (30) **Du Plessis**, Chantelle (North-West University – Industrial Engineering)  
chantelle.coetzee@nwu.ac.za
- (31) **Du Plessis**, Marno  
marnod@discovery.co.za
- (32) **Du Plessis**, Regardt (University of Stellenbosch, Department of Industrial Engineering)  
regardtqp98@gmail.com
- (33) **Du Toit**, Jaco (North-West University)  
dujtoit@gmail.com
- (34) **Du Toit**, Tiny (North-West University)  
Tiny.DuToit@nwu.ac.za
- (35) **El Baz**, Jamal (Ibn Zohr University)  
j.elbaz@uiz.ac.ma
- (36) **Elgadrouri**, Rachid (Ibno Zohr University, Morocco)  
rachid.elgadrouri@edu.uiz.ac.ma
- (37) **Elleuch**, Mohamed Ali (Multiple-Criteria Decision Analysis)  
mohamedali.elleuch@isgis.usf.tn
- (38) **Evans**, David (President, ORSSA)  
davevans@gmail.com
- (39) **Fatti**, Paul (Wits University)  
paulfatti@gmail.com
- (40) **Flemming**, Alexander (University Of Stellenbosch, Department Of Industrial Engineering)  
alex.el.arquero@gmail.com
- (41) **Ganzevoort**, Reinard (University Of Stellenbosch, Department Of Industrial Engineering)  
reinardganzevoort@gmail.com
- (42) **Gibson**, Emma (Massachusetts Institute of Technology)  
emgibson@mit.edu
- (43) **Gevers**, Wim  
wg@sun.ac.za
- (44) **Grobler**, Gerrit (North-West University)  
gerrit.grobler@nwu.ac.za
- (45) **Grobler**, Jacomine (University of Stellenbosch, Department of Industrial Engineering)  
jacominegrobler@sun.ac.za
- (46) **Gueye**, Serigne (Avignon Université)  
serigne.gueye@univ-avignon.fr
- (47) **Gurgur**, Cigdem (Purdue University)  
gurgurc@pfw.edu
- (48) **Gwasha**, Norest (Black)  
gwasha727@gmail.com
- (49) **Harmse**, Marthi (Independent)  
kmharmse@mweb.co.za
- (50) **Hasni**, Marwa (UR-OASIS-ENIT)

- marwa.gharbi@enit.rnu.tn
- (51) **Heyns**, Andries (Doctors Without Borders UK/Ireland)  
andriesheyns@gmail.com
- (52) **Hüsselmann**, Günther (University Of Stellenbosch, Department Of Industrial Engineering)  
17832020@sun.ac.za
- (53) **Ikelu**, Chinasa (Institut De Mathematiques Et De Sciences Physiques)  
ignatius.chinasa@gmail.com
- (54) **Ittmann**, Hans (University Of Johannesburg)  
hittmann01@gmail.com
- (55) **Jacobs**, Jacobus (University Of Stellenbosch, Department Of Industrial Engineering)  
20706677@sun.ac.za
- (56) **Jihene**, Jlassi  
jihene.jlassi@isgis.usf.tn
- (57) **Jordaan**, Ruan (University Of Stellenbosch, Department Of Industrial Engineering)  
19810628@sun.ac.za
- (58) **Kagoya**, Sumaya (Makerere University Business School)  
thumakago@gmail.com
- (59) **Kakeneno**, Joseph (Decision Analytics And Management Services Ltd)  
joekakeneno@yahoo.co.uk
- (60) **Kammoun**, Raoudha (TORS)  
raouda.kammoun@fsegs.usf.tn
- (61) **Karamoko Sita**, Diallo (Institut De Mathématiques Et De Sciences Physiques De L'Université D'Abomey-Calavi (Ims-Uac))  
diallokkaramokosita@gmail.com
- (62) **Karimi**, Rose (International Cooperative Alliance-Africa)  
karimikiwanuka@gmail.com
- (63) **Karsten**, Carike (CSIR and UP)  
ckarsten@csir.co.za
- (64) **Kellermann**, TJ  
johan@spatialledge.co.za
- (65) **Khireldin**, Awad  
awad.khireldin@Singaporetech.edu.sg
- (66) **King**, Jacobus (University Of Stellenbosch, Department Of Industrial Engineering)  
20771401@sun.ac.za
- (67) **Kleinhans**, Ryno (University Of Stellenbosch, Department Of Industrial Engineering)  
kleinhansryno@gmail.com
- (68) **Koen**, Renee  
rkoen@csir.co.za
- (69) **Kone**, Mamadou (Ph.D)  
madouxkone@gmail.com
- (70) **Kruger**, Hennie (North-West University)  
Hennie.Kruger@nwu.ac.za
- (71) **Laaziz**, Asmaa  
asmaa.laaziz@edu.uiz.ac.ma
- (72) **Lassoued**, Rokaya  
rokalasswed92@gmail.com
- (73) **Layeb**, Safa Bhar (LR-OASIS, National Engineering School of Tunis, University of Tunis El Manar, Tunis, Tunisia)  
safa.layeb@enit.utm.tn
- (74) **Layeb**, Sana (ERA/ENAU/University of Carthage)  
sana.layeb@yahoo.fr
- (75) **Layton**, Casey Lee  
22206981@sun.ac.za



- (76) **Lindner**, Berndt  
berndtlindner@gmail.com
- (77) **Loukil**, Taicir (TORS)  
loukilt@gmail.com
- (78) **Maimane**, Pride  
pride.maimane88@gmail.com
- (79) **Malan**, Phillip Christian (University Of Stellenbosch, Department Of Industrial Engineering)  
koenamalan@gmail.com
- (80) **Mapfumo**, Eldridge (North-West University - Industrial Engineering)  
42570530@nwu.ac.za
- (81) **Masmoudi**, Mariem (Sfax University)  
masmoudi\_mariem@yahoo.fr
- (82) **Masri**, Hatem (University Of Bahrain)  
hmasri@uob.edu.bh
- (83) **McMaster**, Stuart (Stellenbosch University)  
mcmasterstu@gmail.com
- (84) **Megaiz**, Sara Fatima Zohra (Manufacturing Engineering Laboratory Of Tlemcen (MELT), University Of Tlemcen, Pb 230, 13000, Tlem)  
sara.megaiz29@gmail.com
- (85) **Mejri**, Imen (UR-OASIS, National Engineering School of Tunis, University of Tunis El Manar)  
imen.mejri@enit.utm.tn
- (86) **Merchant**, Sue (VP (International Activities)INFORMS)  
suemerchant@hotmail.com
- (87) **Mezali**, Zineb (USTHB, RECITS Laboratory, Algeria)  
mezalizineb@gmail.com
- (88) **Miller-Hooks**, Elise (George Mason University)  
miller@gmu.edu
- (89) **Mjamba**, Khanyo  
khanyo@gabamedia.co.za
- (90) **Mng'Ong'O**, Benito (University Of Dar Es Salaam)  
bengaspar2008@gmail.com
- (91) **Mohamed**, Ali (Cairo University)  
aliiwagdy@gmail.com
- (92) **Moore**, Willem (University Of Stellenbosch, Department Of Industrial Engineering)  
willemrm@gmail.com
- (93) **Mouin**, Ben Mansour (Phd-Student)  
benmansour.mouin@yahoo.fr
- (94) **Moussaoui**, Kheira (National Higher School of Technology ENST)  
chergui\_zhor@hotmail.fr
- (95) **Mpassi Mahinga**, Désirée Taliane (University Of Stellenbosch, Department Of Industrial Engineering.)  
taliane@aims.ac.za
- (96) **Muchungi**, Kendi  
mwaremwega@gmail.com
- (97) **Mujuni**, Egbert (University Of Dar Es Salaam)  
egbertmujuni2016@gmail.com
- (98) **Mushi**, Allen (Lecturer)  
allenmushi66@gmail.com
- (99) **Mutunga**, Jackline (Jomo Kenyatta University Of Agriculture And Technology)  
jacquiemwende@gmail.com
- (100) **Ndiaye**, Babacar Mbaye (Cheikh Anta Diop University)  
babacarm.ndiaye@ucad.edu.sn
- (101) **Nedjai**, Mohamed (Recit Laboratory, Houari Boumediene University(Algiers))

mohamed161994@yahoo.fr

- (102) **Nel**, Stephan (University Of Stellenbosch, Department Of Industrial Engineering)  
gsnel@sun.ac.za
- (103) **Nouara**, Makhlof  
n\_makhlof@esi.dz
- (104) **Pedraza Guevara**, Santos (Innova Scientific)  
serviciosmarisan@gmail.com
- (105) **Pelser**, Winnie (CSIR)  
wpelser@csir.co.za
- (106) **Phillips**, Colin (Discovery Health)  
colinp@discovery.co.za
- (107) **Potgieter**, Petrus (Unisa)  
php@grensnet.com
- (108) **Probst**, Zaine  
zaine.probst2@gmail.com
- (109) **Raubenheimer**, Helgard (NWU)  
Helgard.Raubenheimer@nwu.ac.za
- (110) **Reed**, Edwin (University Of Stellenbosch, Department Of Industrial Engineering)  
17707277@sun.ac.za
- (111) **Rees**, Jess (Discovery)  
jess.sian.rees@gmail.com
- (112) **Regaieg Cherif**, Mouna (Faculty Of Economics Sciences And Management Of Sfax, University Of Sfax, Sfax, Tunisia)  
regaieg.mouna@gmail.com
- (113) **Rekik**, Ines (OLID laboratory)  
ines.rekik@isgis.usf.tn
- (114) **Reynolds**, Patrick (NWU)  
patrick.reynolds.za@gmail.com
- (115) **Samayoa**, Jorge (Universidad Galileo, Guatemala)  
jorge.samayoa@galileo.edu
- (116) **Santana**, Leonard (NWU)  
leonard.santana@nwu.ac.za
- (117) **Sanaa**, Aidi (Genie Mecanique)  
sanaa.aidi@gmail.com
- (118) **Satla**, Hamou (USTHB, RECITS Laboratory, Algeria)  
hsatla@usthb.dz
- (119) **Schlunz**, Bernard (The Shoprite Group Of Companies)  
schlunzeb@gmail.com
- (120) **Schmidt-Dumont**, Thorsten (Stellenbosch University)  
tschmidt757@gmail.com
- (121) **Schoeman**, Ilse (NWU)  
Ilse.Schoeman@nwu.ac.za
- (122) **Schutte**, Willem (WD) (Centre For Business Mathematics And Informatics, North-West University)  
wd.schutte@nwu.ac.za
- (123) **Searle**, Christa  
searle.christa@gmail.com
- (124) **Sekhasimbe**, Malesela  
sekhasja@gmail.com
- (125) **Shuttleworth**, Aaron (Student Competition Finalist)  
aaronshuttleworth@gmail.com
- (126) **Silal**, Sheetal (University Of Cape Town)  
sheetal.silal@uct.ac.za

- (127) **Smit**, Neill (North-West University)  
neillsmit1@gmail.com
- (128) **Smuts**, Marius (North-West University)  
smuts.marius@nwu.ac.za
- (129) **Sondes**, Hammami (ENICarthage)  
sondeshammami@yahoo.fr
- (130) **Souier**, Mehdi (High School of Management of Tlemcen, PB 1085, 13000, Tlemcen, Algeria)  
souier.mehdi@gmail.com
- (131) **Steenkamp**, Pieter (University Of Stellenbosch, Department Of Industrial Engineering)  
pieterjst@gmail.com
- (132) **Stewart**, Theodor (University Of Cape Town)  
theodor.stewart@uct.ac.za
- (133) **Takouda**, Pawoumodom (Laurentian University)  
mtakouda@laurentian.ca
- (134) **Terblanche**, Fanie  
fanie.terblanche@nwu.ac.za
- (135) **Van Der Merwe**, Annette (Northwest University)  
annette.vandermerwe@nwu.ac.za
- (136) **Van Vuuren**, Jan (Department Of Industrial Engineering, Stellenbosch University)  
vuuren@sun.ac.za
- (137) **Van Zyl**, Bianca (University Of Stellenbosch, Department Of Industrial Engineering)  
biancajvz@gmail.com
- (138) **Venter**, Lieschen (Department of Logistics, Stellenbosch University)  
lventer@sun.ac.za
- (139) **Venter**, Philip (NWU)  
philip.venter@nwu.ac.za
- (140) **Venter**, Van Zyl (University Of Stellenbosch, Department Of Industrial Engineering)  
vanzylventer@gmail.com
- (141) **Visagie**, Jaco (North-West University)  
jaco.visagie@nwu.ac.za
- (142) **Wilfried Yves Hamilton**, Adoni (International University Of Casablanca)  
adoniwilfried@gmail.com
- (143) **Yalaoui**, Nabila (Manufacturing Engineering Laboratory Of Tlemcen (Melt), University Of Tlemcen, Pb 230, 13000, Tlemce)  
yalaouinabila07@gmail.com
- (144) **Yohana**, Endrick (University Of Dodoma)  
silelenddy@gmail.com
- (145) **Zerfa**, Lamia (University Alger 1, Faculty Of Sciences, Algiers,Algeria- Recits Laboratory,Usthb.)  
zerfa-lamia@hotmail.fr
- (146) **Zghidi**, Imen (FSEGS, Tunisia)  
zghidi.imen@gmail.com
- (147) **Zietsman**, Jurie (University Of Stellenbosch, Department Of Industrial Engineering)  
uberziets@gmail.com

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