



AT THE FOREFRONT OF ANALYTICS IN AFRICA



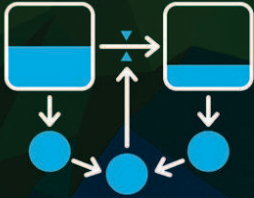
ORSSA Newsletter December 2017

www.orssa.org.za





DEFINITIVE MULTIMETHOD MODELING ENVIRONMENT



SYSTEM DYNAMICS



PROCESS-CENTRIC (DISCRETE EVENT)



AGENT BASED MODELING

Distributed by



+27 (0)11 447 9916
 info@bluestallion.co.za
 www.bluestallion.co.za



Manufacturing and production



Transportation and warehousing



Healthcare



Supply chains and logistics



Markets and competition



Business processes and service systems



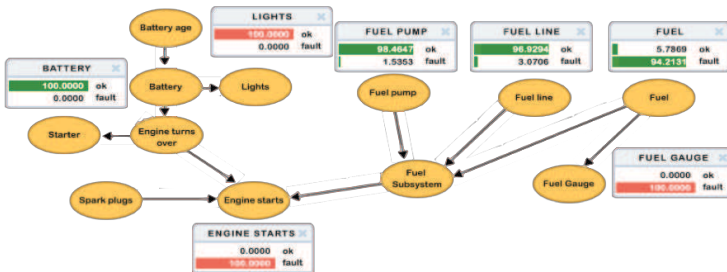
Airports, stations and shopping malls



Social dynamics

Bayesian Networks

Because every bit of information counts



For the best possible predictions – use HUGIN analytics.

Advantages:

- Graphical, easy-to-visualize method of illustrating a decision problem and its model variables
- Can exploit information about past events to predict the likelihood of future events
- Optimal for handling and interpreting large data sets
- Can be used with incomplete data sets
- Can incorporate different types of data within the same model
- Provide valuable analysis even when information is incomplete or uncertain
- Can quickly assess the impact of many different strategies and scenarios
- Can be used to predict or diagnose, depending on your analysis needs
- Provide better, more flexible and robust recommendation strategies



Distributed by:
 Blue Stallion Technologies
 Tel: (011) 447 9916
 Fax: (011) 447 9911
 info@bluestallion.co.za

HUGINEXPERT

www.hugin.com

FROM THE EDITOR

By **BRIAN VAN VUUREN** (brianjohnvanvuuren@gmail.com)



Brian van Vuuren

Dear ORSSA Members,

So another year draws to a close. It's mid-December, by now, shopping malls and retail stores have been playing Christmas music and sporting decorations for almost a full month already!

As we wrap up 2017, i'd like to thank all of you who have contributed to the newsletter over the last year. I know the time and effort that is required to put together an article, review, interview or opinion piece, and I truly appreciate what you all bring to this publication.

In particular, i'd like to thank Shane van Heerden who began a new tradition this year with his 'Quarterly Puzzle'. Apart from the fact that it's probably fast becoming the reason 90% of the reason anyone reads the newsletter (with the remaining 10% going towards the lame cartoon...), it brings a fun, interactive dimension to the newsletter which (I think) is a fantastic addition. Moreover, Shane spends hours finding suitable puzzles or (as is the case in this quarter's puzzle) making up his own puzzles in order to entertain the readers.

Similarly, Hans Ittmann never fails to willingly contribute a book review, whilst Jan van Vuuren always kindly proof reads the newsletter before we send it out. It's this kind of effort that makes ORSSA such a special society - each doing something (be it small or big) to contribute to the bigger picture.

And on that note, 2018 will bring 4 new newsletter editions. So, please, use some of that free time over the festive season to jot down your thoughts or experiences towards a contribution for next year.

This edition is a compilation of material contributed over the course of the year which didn't fit well into previous

The dating mathematician on a festive date...



editions and, as such, makes for a diverse and interesting December newsletter. I trust you will enjoy the articles.

I'll still be serving as newsletter editor (and desperately lame cartoon drawer) in 2018, so I look forward to bringing you interesting, cutting-edge insights and stories from the OR landscape in South Africa.

I trust you will all have a blessed festive season and prosperous new year. Enjoy the time off!

Until next year,
Brian (*Editor*)

Features	Page
FROM THE EDITOR	1
FROM THE PRESIDENT'S DESK	2
QUARTERLY PUZZLE	3
AVANT-GARDE DEEP LEARNING APPLICATIONS	3
GETTING TO KNOW GILL TOPLIS	7
A CASE STUDY ON MILK DELIVERY IN INDIA	7
BOOK REVIEW: THE UNDOING PROJECT	9

SOCIAL MEDIA

- **Facebook:** Please visit (and like!) our page at www.facebook.com/ORSAocietySA
- **Twitter:** @_ORSSA
- **LinkedIn:** Please visit our page at www.linkedin.com/company/the-operations-research-society-of-south-africa

FROM THE PRESIDENT'S DESK

By WINNIE PELSER

(WPELSER@CSIR.CO.ZA)

ORSSA PRESIDENT



Winnie Pelsler

At the end of a year it is normal to look back at what was achieved. This is my last contribution to the Newsletter in my current capacity. Two years have flown past very rapidly. I would like to review some of the activities that took place.

Most of the ORSSA chapters were very active during the year. Frequent Chapter meetings and meetup groups continued to be productive and interesting. The meetup groups seem to be a very effective manner of getting together and to further ideas. It does require a lot of commitment and dedication. I want to thank all involved in Chapter activities. The Zimbabwe OR Society became a Chapter of ORSSA. They will remain a Chapter until they have enough members to be an independent Society in Zimbabwe. The only chapter that is not active is KwaZulu Natal Chapter. Several unsuccessful attempts were made to get the Chapter active.

The annual conference in the Drakensberg at Champagne Sports Resort was once again very successful. Fanie and his team did a sterling job of organising the conference. The large number and variety of papers presented at the conference is proof of the wellbeing of OR in South Africa. It is always a great opportunity to reward recipients for outstanding achievements with the Tom Rozwadowski, Theodor Steward and Gerhard Geldenhuys medals. A number of recognition awards and a fellowship were also awarded to members. Congratulations to these very worthy recipients. The social side of the conference was as usual a wonderful opportunity to rekindle old friendships and to build new relationships!

The establishment of an African Federation of Operations research Societies (AFROS) is a highlight. AFROS is still in the infant stage, but a conference in Tunisia is planned for July 2018. I want to thank Bernie Linder for his assistance with the AFROS activities. Dave Evans also gave valuable assistance to Bernie and me with a number of AFROS issues.

A few members are leaving the national Executive Committee at the end of the year. They are Dave Evans (Treasurer), Stephan Visagie (Orion Editor), Martin Kidd (Orion Manager), Linke Potgieter (Additional Member), Ian Campbell (Additional Member) and Hennie Kruger

(Additional Member). We thank them for their contributions over the years. Thanks also to the outgoing chapter executive members; your hard work during 2017 is greatly appreciated.

To all serving members, I want to convey a big thank you to each of you. Newly elected members of the Executive Committee are Christa de Kock (Treasurer), Fanie Terblanche (Orion Editor), Susan Campher (Orion Manager), Patrick Reynolds (Additional Member), Stephan Visagie (Additional Member), Joke Bührman (Additional Member) and Sumarie Koetsier (Additional Member). Welcome to you all.

Danie Lötter has served as vice-president during 2017 and will become the 31st president of ORSSA on 1 January 2018. He will then lead the Executive Committee in serving ORSSA until the end of 2019 after which he will become the vice-president again for a further year. I would like to thank Danie for his support during 2017 and wish him all the best for his term as president.

Any member should please feel free to contact Danie or me if you have any suggestions on how ORSSA may improve the service that it delivers to its members, or if you would like to become involved in any of the activities or initiatives of the Society.

On this last occasion, I want to thank each and every member of the Society and particularly the Executive Committees of 2016 and 2017 for their kindness and friendly support during the time I served as president. It was an honour and privilege to serve ORSSA in this manner and an experience that I will never forget.

Last but not least, I want to wish each and every member a peaceful and joyful festive season.

Best wishes for 2018,
Winnie

A VOTE OF THANKS

As we reflect on another successful year as a society, it seems only fitting that we acknowledge Winnie for the fantastic role she has played as ORSSA president over the last two years. We, as a society, are particularly blessed to have such talented, capable people who give so freely of their time to serve our OR community.

Thank you, Winnie - for all that you've done and for all that you'll continue to do as you finish your term with a year as vice-president. We are so grateful for your service and value your expertise and experience that you bring to our society's executive committee.

QUARTERLY PUZZLE: AN OR CROSSWORD

Provided by Shane van Heerden (17683068@sun.ac.za)



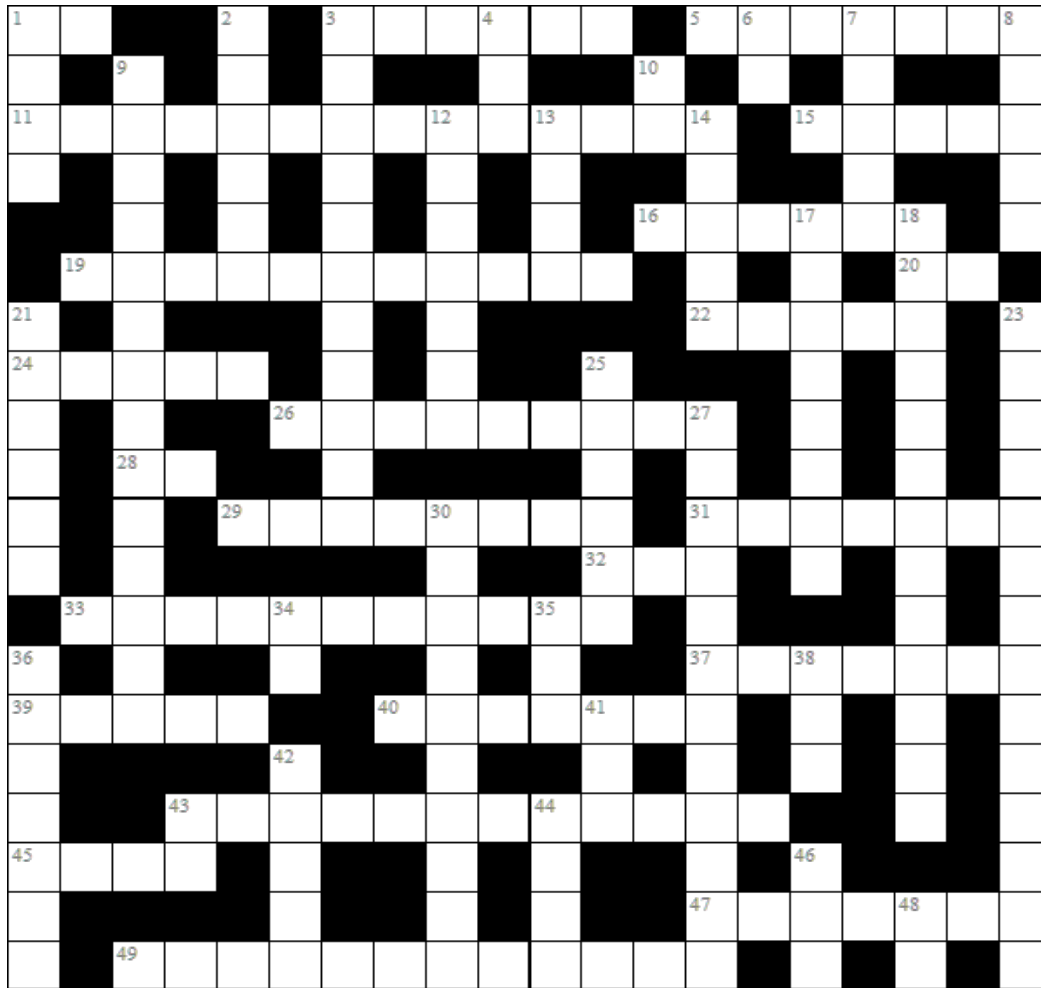
Shane v Heerden

Hey puzzle enthusiasts!

This is your chance to prove that you are both a knowledgeable member of ORSSA, as well as a wise operations researcher.

I've started you off easily with the first clue, but things get much tougher – I promise.

You can find the solution to the puzzle on page 13 of the newsletter. Good luck!



ACROSS:

- 1. Operations research (abbr.) (2)
- 3. Greece's OR national society (abbr.) (6)
- 5. USA's OR national society (abbr.) (7)
- 11. Newest ORSSA fellow as of 2017 (7,7)
- 15. Intermediate theorem in a proof (5)
- 16. Not a vector (6)
- 19. The study of graphs (5,6)
- 20. Optimisation where all variables are integers (abbr.) (2)
- 22. Reasoning conducted or assessed according to strict principles of validity (5)
- 24. Chile's OR national society (abbr.) (5)
- 26. ORSSA's treasurer for 2017 (4,5)
- 28. Optimisation where relations between variables are stated by constraints (abbr.) (2)
- 29. 46th ORSSA conference room venue (8)

- 31. If a Markov chain is aperiodic and positive recurrent, it is said to be _____ (7)
- 32. 3rd step in the Fridrich Method for solving the Rubik's cube (abbr.) (3)
- 33. A graph with tour visiting each vertex (11)
- 37. 5th letter of the Greek alphabet (7)
- 39. Portugal's OR national society (abbr.) (5)
- 40. Selecting the alternative that maximises the minimum pay-off achievable (7)
- 43. ORSSA's marketing manager for 2017 (6,6)
- 45. Linear programming where some variables may be constrained to integers (abbr.) (4)
- 47. If a straight line segment, subtended between any two points on a function, is never above the curve, then the function is said to be _____ (7)
- 49. 46th ORSSA conference closing plenary speaker (5,2,5)

DOWN:

1. 46th ORSSA conference sponsor (4)
2. Programming language developed by Microsoft (1,5)
3. Honorary life member and fellow of ORSSA (4,7)
4. United Kingdom's OR national society (abbr.) (3)
6. A set of decision problems solvable in polynomial time by a theoretical non-deterministic Turing machine (abbr.) (2)
7. Last letter of the Greek alphabet (5)
8. A _____ variable is added to an inequality constraint to transform it into an equality (5)
9. He developed the theory of soft systems methodology (5,9)
10. 14th letter of the Greek alphabet (2)
12. A mathematical operation that undoes what was done by the previous operation (7)
13. Australia's OR national society (abbr.) (4)
14. Replaced Lotus 1-2-3 (5)
17. _____ multipliers are used to find the local maxima and minima of a function subject to equality constraints (8)
18. President of EURO for 2017 (7,6)
21. Relationship where directly proportional change between two variables occurs (6)
23. ORSSA Secretary for 2017 (8,6)
25. IBM's natural language question answering computer system (6)
27. First South African university to offer OR courses (12)
30. Notation used to classify queue systems (7,3)
34. Mathematical model whose requirements are represented by linear relationships (abbr.) (2)
36. Selecting the alternative that maximises the maximum payoff available (7)
38. 46th ORSSA conference sponsor (3)
41. Smallest objective function value (abbr.) (3)
42. First South African university to offer a full undergraduate programme in OR (5)
43. Method for solving a complex problem by breaking it down into simpler sub-problems (abbr.) (2)
44. Europe's OR regional grouping (abbr.) (4)
46. Computing systems inspired by the biological processes that occurs in the brain (abbr.) (3)
48. Intelligent behaviour by machines (abbr.) (2)

AVANT-GARDE DEEP LEARNING APPLICATIONS

Written by Stephan Nel (17064554@sun.ac.za)



Stephan Nel

Somewhat regrettably, I have resorted to the tactics employed in the un-savoury field of 'clickbait'. OMG, right?! I explicitly say *somewhat* because, deep (no pun intended) down, I really want to attract as much attention as I possibly can and, if this means getting my hands dirty – so be it! *Deep learning* –

the article's main subject matter – is a topic that is close to my heart (and my brain). Not only does it involve concepts that are key to my steadily progressing thesis, but it is also changing the world as we know it. In this article, I will shed some much-deserved light on various uncommon applications of deep learning that, I feel, are truly fascinating and innovative, yet are less publicised by the "mainstream" media. Most of you have heard of DeepMind's *AlphaGo* or IBM's *Watson* and, as impressive as they are, I would rather like to turn your attention to what lies beneath the visage. Let's jump in at the deep end!

The aforementioned statement that deep learning is changing the world is definitely not a hyperbole and I am sure that most of you have realised the significance of both *Artificial Intelligence* and *Machine Learning* (the field and sub-field in which deep learning resides, illustrated in Figure 1). As a side note, I would have preferred to refrain from using the buzzword that is Artificial Intelligence, as it has inherited a slightly negative connotation owing to its



Figure 1: The bigger picture (adapted from NVIDIA)

hackneyed use by the ignorant as well as those that seek to exploit the ignorant (an article for another newsletter, perhaps). Alas, I have, once again, compromised on my principles. There is nothing I won't do for my reader (I sure hope my supervisor is reading this). But context is key, so consider my means justified. Back to the topic at hand!

What is deep learning? Well, deep learning is, arguably, humanity's current best Machine Learning tool/method/technique utilised in the pursuit of Artificial Intelligence. It employs *artificial neural networks* (i.e. computational models that emulate the brain's neurological design and information processing capability) to learn from and make sense of data. Complicated relationships and intricacies within data – which are inconceivable by mere mortals – are inferred and captured by these *brainy* networks. Neural networks (NNs) consist of many neurons, with synaptic links connecting neurons in successive layers, as seen in Figure 2. The term "deep" refers to these networks com-

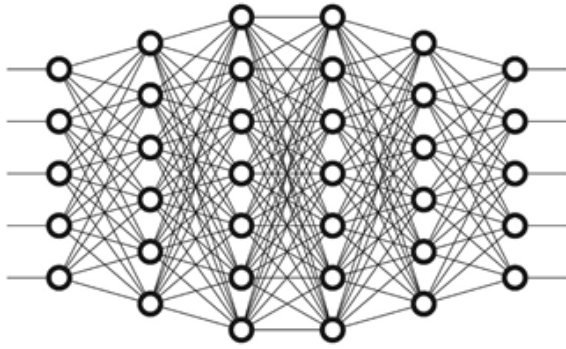


Figure 2: A typical deep neural network

prising many of these layers. A synaptic connection has an associated *weight*, which is calculated in a so-called *training* stage. The process of ascertaining the values of these weights (*i.e.* parameters) is called “learning”. Andrew Ng, the most prominent pioneer of deep learning, argues that it is the scalability that renders deep learning an immensely powerful tool – basically, performance improves as more data is fed to the network. With today’s data deluge, it ought to be trivial why deep learning is dominating the scene. Deep learning has allowed machines/computers to surpass humans in tasks involving the processing of images, video, speech and audio. The avant-garde applications highlighted in this article stem mostly from Károly Zsolnai-Fehér’s popular YouTube channel *Two Minute Papers*. Károly aims to find novel academic literature related, primarily, to deep learning and, subsequently, makes a video summarising his findings in roughly (*very roughly*) two minutes. These applications are:

1. **Paper: *Unsupervised Image-to-Image Translation Networks* [2]:** The first enthralling application is the use of Generative Adversarial Networks (GAN) to perform interesting image translation tasks. In a GAN, two NNs contest with each other within a *zero-sum game* context. In typical image translation tasks, an image is provided as input and the output is the same image with different semantics. When employing deep GANs, exciting applications are viable, one example is the accurate conversion of a satellite image of a city to the corresponding map of the city. Another example is the translation of day-time video footage to night-time footage (changing seasons is also possible), as seen in Figure 3. Another amazing possibility is the conversion of real-life video footage to video-game footage, or, even more remarkable, vice versa – converting video-game footage to real-life footage. Have you ever wanted to see what your dog/cat would look like as a different breed? Well, it’s now possible. You can even change a person’s facial attributes in a photo, for example changing hair colour, putting sunglasses on, or turning someone’s frown upside down. All of these translations are done with exceptional results to boot.



Figure 3: Image translation of daytime to nighttime, as well as summer to winter

2. **Paper: *Synthesizing Obama: Learning Lip Sync from Audio* [7]:** The next notable feat in the field of deep learning has to do with lip syncing (eat your heart out, Justin Bieber). Recurrent neural networks (RNNs) are excellent at extracting insights from sequential data. Given raw speech-audio as input, a well-trained deep RNN is able to output the movement of a person’s lips (as well as its evolution over time), to closely match the given audio, with frightening accuracy. When combined with DeepMind’s *WaveNet*, a generative model capable of generating natural sounding speech from text by employing both RNNs and another type of deep neural network called *convolutional neural networks* (CNNs), it would be possible to convert any video footage of a human being speaking, to footage of the exact same person saying precisely what you want him/her to say. This is made possible by another breakthrough in enabling computers to learn (and, consequently, mimic) the sound/tone of a person’s voice. Promising, yet a little scary considering, what nefarious individuals would do with this tool. Perhaps we can make Donald Trump deliver a decent speech, for once.



Figure 4: The Obama case study

3. **Paper: *Parallel Multiscale Autoregressive Density Estimation* [4]:** Another incredible deep learning application (employing CNNs specifically) is the conversion of text – in the form of a sentence – to a brand-new image that almost achieves photo-realism. The produced images are said to be “significantly different” than the images used to train the CNNs. Thus, deep learning is enabling machines to exhibit traits that mimic one of human beings’ most significant and defining characteristics – *imagination*. An example of this tool in action is

indicated in Figure 5 and the results are truly astonishing. A personal request would be: “Stephan showing off his Tom Rozwadowski Medal”. A man can dream, right?

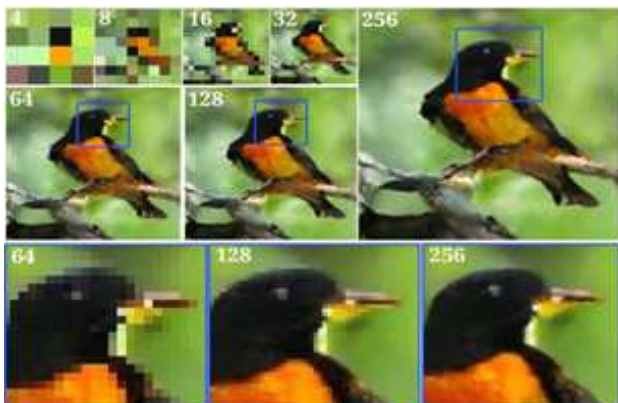


Figure 5: A new image generated from the phrase “A yellow bird with a black head, orange eyes and an orange bill.”

4. **Paper: A Neural Algorithm of Artistic Style** [1]: CNNs are once again responsible for a very intriguing application of deep learning. Imagine taking one of your favourite photographs and then applying one of your favourite paintings’ art style to it. Figure 6 provides a very convincing proof-of-concept when using deep CNNs to convert a Gandalf selfie to a soon-to-be famous Picasso portrait. CNNs have been proven to be especially useful in analysing visual imagery.



Figure 6: Gandalf-Picasso combination [6]

5. **Miscellaneous applications:** A few honourable mentions include colourising black-and-white images using CNNs [8], using RNNs to convert songs from one genre to another (e.g. classical to rock), writing new literature in the same style as a certain author, with appropriate context, using RNNs [3] and employing RNNs to identify forgeries of famous painting, with 100% accuracy [5].

It is difficult to not be impressed (and inspired) by these awe-inspiring capabilities of deep learning. Deep learning is, relatively speaking, still in its infancy and with ever-improving computer hardware as well as the growing popularity surrounding the field – the future looks nothing but stupendous. One ought to embrace this revolutionary field, one ought to embrace a field that will, undoubtedly, change our lives.



Colourising black-and-white images (left: original, middle: converted, right: original in colour) [8]

References:

- [1] Gatys, L.A., Ecker, A.S. and Bethge, M., 2015. A neural algorithm of artistic style. arXiv preprint arXiv:1508.06576.
- [2] Liu, M.Y., Breuel, T. and Kautz, J., 2017. Unsupervised Image-to-Image Translation Networks. arXiv preprint arXiv:1703.00848.
- [3] PJREDDIE. 2017. RNNs in Darknet. [ONLINE] Available at: <https://pjreddie.com/darknet/rnns-in-darknet/>. [Accessed 27 November 2017].
- [4] Reed, S., Oord, A.V.D., Kalchbrenner, N., Colmenarejo, S.G., Wang, Z., Belov, D. and de Freitas, N., 2017. Parallel Multiscale Autoregressive Density Estimation. arXiv preprint arXiv:1703.03664.
- [5] Snow, Jackie. 2017. This AI Can Spot Art Forgeries by Looking at One Brushstroke. [ONLINE] Available at: https://www.technologyreview.com/s/609524/this-ai-can-spot-art-forgeries-by-looking-at-one-brushstroke/?utm_source=twitter.com&utm_medium=social&utm_content=2017-11-21&utm_campaign=Technology+Review. [Accessed 27 November 2017].
- [6] Strange, Adario. 2015. New algorithm gives photos Picasso-style makeovers. [ONLINE] Available at: <http://mashable.com/2015/08/29/computer-photos/#feEP17ty-IOq8>. [Accessed 27 November 2017].
- [7] Suwajanakorn, S., Seitz, S.M. and Kemelmacher-Shlizerman, I., 2017. Synthesizing Obama: learning lip sync from audio. ACM Transactions on Graphics (TOG), 36(4), p.95.
- [8] Tinyclouds. 2017. Automatic Colorization. [ONLINE] Available at: <http://tinyclouds.org/colorize/>. [Accessed 27 November 2017].

Optimise your career through research collaboration or by obtaining a degree through the Industrial Engineering Department at Stellenbosch University.

LOGISTICS

Supply chain
Push & Pull systems
Packing
Facility planning
Inventory management
Doing it better

MANUFACTURING

Bio-mechanical body parts
Machining
Rapid prototyping
Robotics
Micro injection moulding
Micro milling

ANALYTICS
SYNTHESIS

Systems dynamics
Statistical analysis
Business analysis
Simulation
Optimisation
Planning
Decision support

MANAGEMENT

Economic modelling
Project management
Business analysis
Operations management
Knowledge management
Change management

BEng (Industrial), MEng (Research) or MEng (Structured) (Engineering Management), MEng (Research) or MEng (Structured) (Industrial Engineering), PhD, Postgraduate Diploma in Engineering Management or Industrial Engineering

**Industrial Engineering
@ Stellenbosch University**

www.ie.sun.ac.za



**World-class logistics
optimisation in a
single package**

The leading supply chain optimisation and consulting company

Whether it's improving your vehicle fleet's efficiency, arranging your sales teams' service areas, reducing distance travelled or creating visibility into your operations, OPSI Systems provides solutions. Through our software offerings and expert consultants, OPSI can create a solution that's best suited to solving your unique logistic optimisation problems. Contact us to find out how we can help you.



www.opsisystems.com | Tel: 011 880 7951 | email: info@opsi.co.za

GETTING TO KNOW GILL TOPLIS

by Kit Searle (18268420@sun.ac.za)



Gill Toplis

Gillian Toplis attended this year's ORSSA conference as a representative of Cape-based Advanced Analytics and Operations Research company, Xtranda.

I sat down with her to hear more about her background, her job and her experience of the conference:

When and where were you first exposed to the field of Operations Research, and what has been your favourite project since working in this field?

I was only exposed to the field of Operations Research during my honours year when I studied Quantitative Management. I was very disappointed that I only discovered Operations Research this late in life because, had I been aware of it sooner, I would have studied it from the start. With regards to my favourite project, there is not one specific project that comes to mind, but because I have a financial background I really enjoy being able to apply different Operations Research models to the finance industry.

A big topic at this year's ORSSA conference has been on how to expose and market Operations Research to high school or undergraduate students. How would you explain what Operations Research is in a few sentences to such a student?

For me Operations Research is all about problem solving and improving processes. So I would pose the question, "Do you enjoy trying to solve problems and do you enjoy helping people to do things better than what they are currently doing? Then Operations Research is definitely the field for you."

With that being said, another hot topic has been the

lack of awareness as to what Operations Research can offer to the different industries. Do you believe that it would be beneficial for ORSSA to offer short courses to people working in industry in order to expose them to the benefits and applications of Operations Research?

I think that is a very interesting idea, but I'm not sure that would work as those who work in industry are very pressed for time. I know as a consultant in the field that you can create awareness by showing industry partners what you can help them do better. Many companies are already implementing Operations Research techniques and have analytics teams in place, they just don't necessarily call it Operations Research. There is definitely an openness to the topic as these companies have tons of data and they are aware of the benefits that working through this data has, and using this data in a way which can help the company progress forward.

Could you describe the company for which you work, and how attending the ORSSA conference could benefit your company?

I work for XTranda which is an analytical solution providing company who helps improve a company's performance by providing optimisation and modelling techniques, as well as empowering our clients through training, which can be used to drive performance. A big part of what we do is teach the principles behind these processes so that we can help these companies to help themselves. The opportunity that ORSSA provides is that we are able to see what others in industry are working on, but most importantly it allows us to see what the students are working on. It is important for us to see the kind of research and the passion with which these students present their research topics because this is what we, at XTranda, want to invest in.

A CASE STUDY ON MILK DELIVERY IN INDIA

by Gemma Dawson (Gemma.Dawson@pivotsciences.com)



Gemma Dawson

Being a member of the millennial generation, I never suffered the displeasure of waking up to the sound of truck clambering up the driveway to deliver the morning's order of milk.

I assumed that door-to-door milk deliveries had gone the way of pet rocks and the ozone. So, when Pivot

Sciences was approached by a dairy farm in India to help optimise their morning milk deliveries, it was with a sense of inquisitiveness that I volunteered for the project.

We were provided with an Excel file containing all the deliveries that had occurred on one day in March this year. The focus was around two of the busier cities, Mumbai and Nashik, indicated on the map in Figure 1.

The depot in Mumbai supplied milk to around 300 households using 12 moped drivers, while Nashik's depot was double the size with about 600 customers and 24 drivers. Routes for each driver were being scheduled by hand each day and, as such, multiple drivers were visiting the same neighbourhood during the two-hour delivery period of 5AM to 7AM.

My task was to demonstrate how ORBIT, an OPSI Systems product, could help them develop master routes that could be followed on a day-to-day basis. Master routes would allow them to set up a standard route that would be followed by a single driver every day, with any required minor changes being handled on the fly. In the process of creating the master routes, driver territories for each depot were also determined. Having clearly defined territories allows planners to establish which driver is responsible for the deliveries of new customers based on their location.

As with any study, the majority of my time on this project was cleaning the data and organising into the format that is needed by ORBIT. There were some customer geocodes that were missing but addresses in India usually include some major landmark, making them surprisingly easier to track down on Google Maps. Once this chore was completed, the real fun could begin. Two different scenarios were given to ORBIT to solve, the Base Case and the Demo. In the Base Case, ORBIT was restricted to recreating the

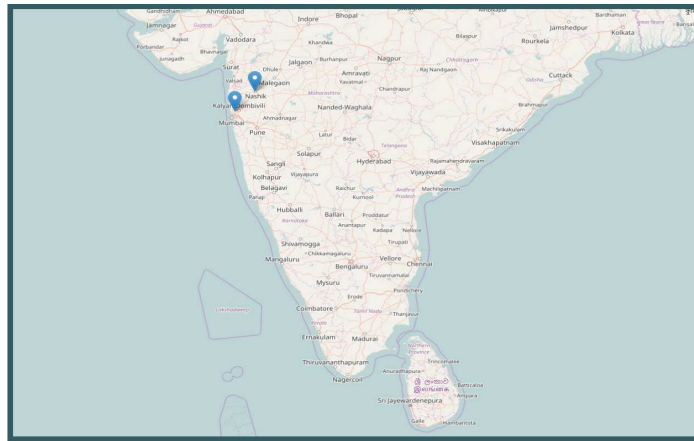


Figure 1: Locations of Mumbai and Nashik in India

day in March as it occurred. The driver who originally completed the delivery was preassigned to that delivery in ORBIT. ORBIT then optimised the sequence of deliveries within each route. In the Demo scenario, ORBIT was given the freedom to select which driver should visit each customer as well as the sequence of deliveries within each route.

The improvements that ORBIT was able to make were remarkable. In both cities, the number of required drivers decreased. The drivers covered significantly less distance, spending less time on the road and, as a consequence, making more deliveries in the day. The improvements realised are shown in Figures 2 and 3.

Milk production in India ranks first in the world, making up 18.5% of world production according to India's Economic Survey 2015/16. Making sure that it reaches its consumers in a cost effective and efficient manner is thus an important consideration. Clearly, as discussed above, there is room for improvement.

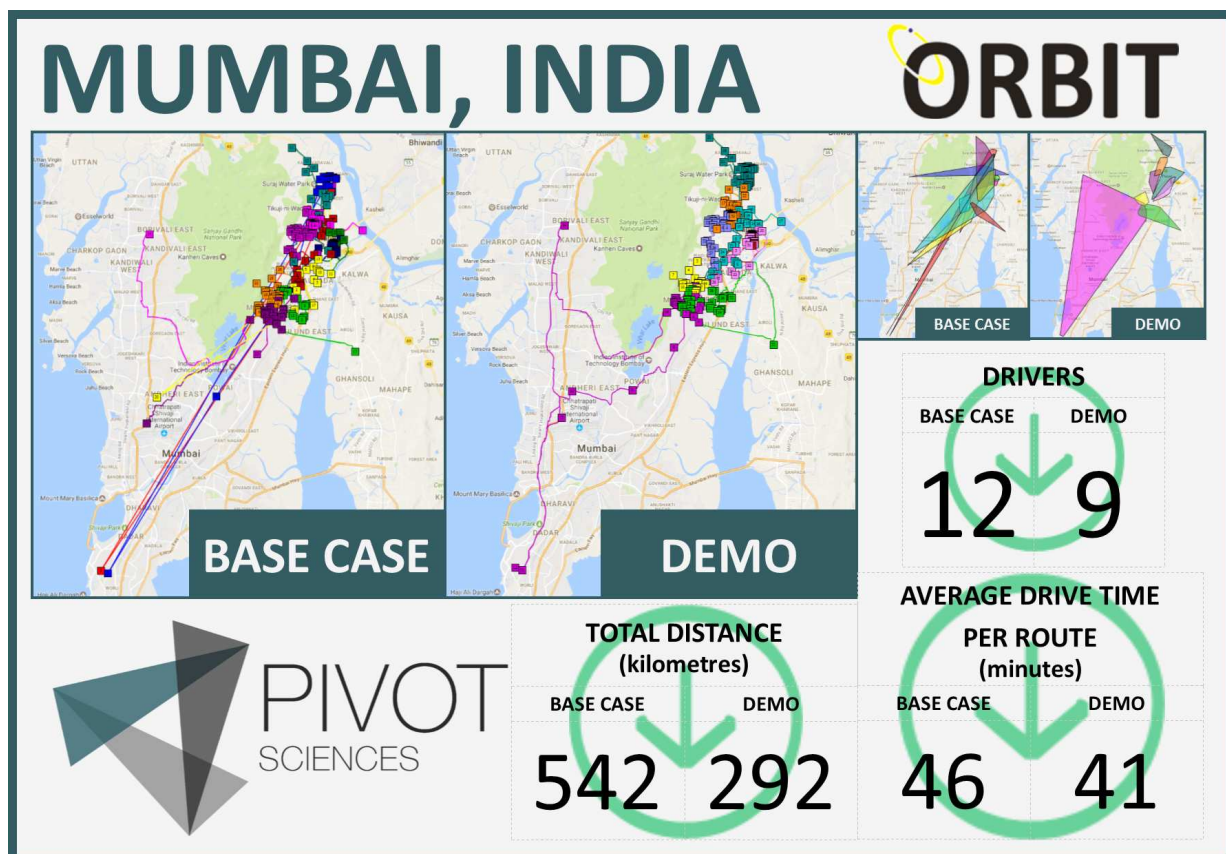


Figure 2: Potential improvements realised in Mumbai

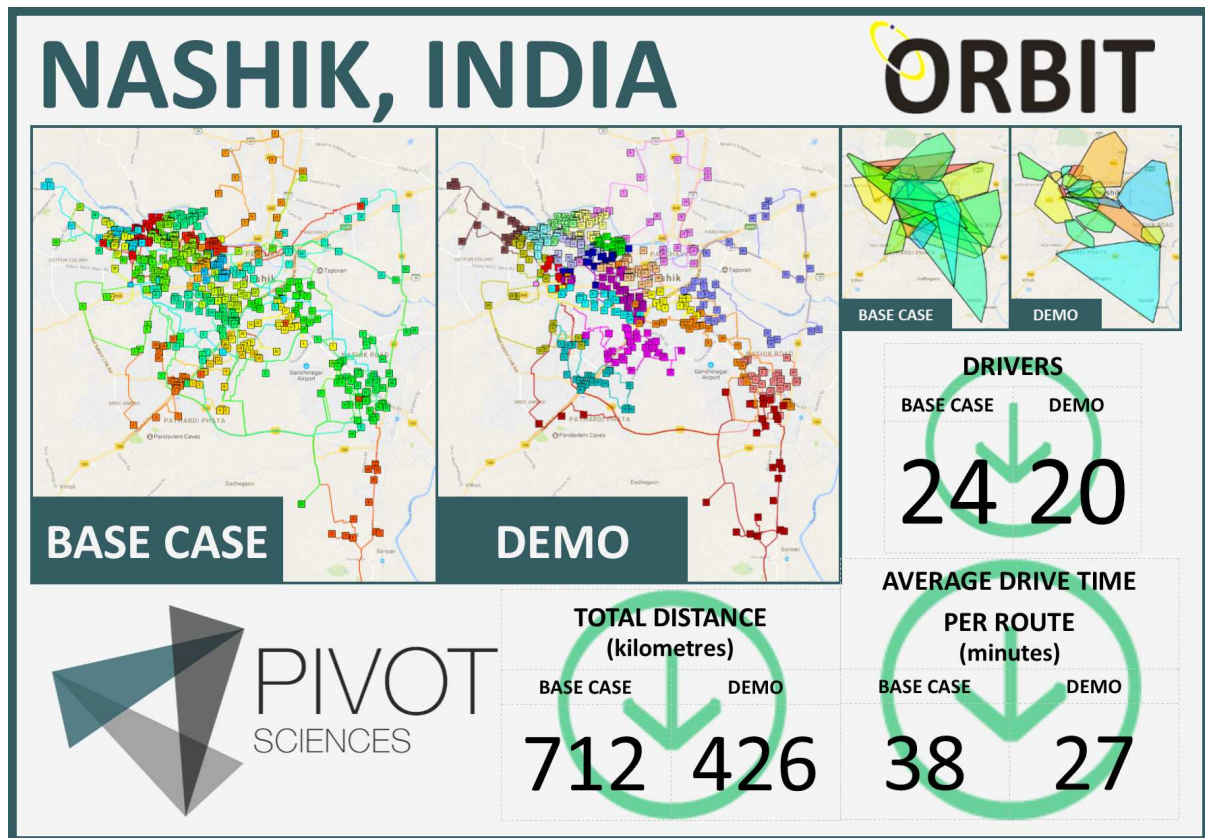
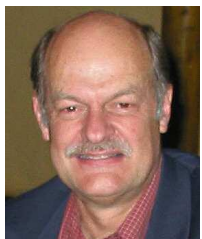


Figure 3: Potential improvements realised in Nashik

BOOK REVIEW: THE UNDOING PROJECT

Written by Hans W. Ittmann (hittmann01@gmail.com)



A joint biography of Israeli psychologists Kahneman and Tversky, **The Undoing Project**, gives a comprehensive and in depth look at the ideas, research and complex relationship of these two fascinating, brilliant individuals.

Hans Ittmann How this book came about is already interesting for Operations Researchers! Michael Lewis is the author of *Moneyball*, a book published in 2003. It describes how one of the poorer US baseball teams, *Oaklands Athletics*, started to win in its league by analysing data and using this to improve the way baseball players are valued and baseball strategies are evaluated. They in essence introduced and used analytics to exploit inefficiencies and improve decision making. Many teams and organizations in other industries, copied this approach. However over time, it became clear that there was an overreliance on numbers.

What did not come out in *Moneyball* were the deeper reasons for these inefficiencies, the inner workings of the human mind, how experts may misjudge players and how the human mind works, or fails to work, when forming judgements and making decisions. These aspects had in fact already been described by Kahneman and Tversky!

Even with Kahneman’s autobiography published in 2011[1], Lewis’s interest in and treatment of the work and life of both Kahneman and Tversky resulted in something that is still not that well known while it gives a much more intimate view of their relationship. This is a story of how gifted researchers, through their work, were able to show how human beings and decision makers can easily diverge from rationality. In addition, they show how, despite being made aware of the issues again and again, humans with ingrained biases make wrong choices and wrong decisions. These are all critical aspects which operations researchers involved in problem solving should be aware of and continuously consider.

Lewis draws a parallel when reflecting on the background of the two scientists. Both were grandsons of rabbis from Eastern Europe; both did military service in the Israeli military which affected them deeply and both were involved in the 1973 Yom Kippur War. This was after they had already established themselves as academics at the Hebrew University. It is there that they met in 1969. Tversky was invited by Kahneman to give a talk and by the end Kahneman responded: “*Brilliant talk, but I don’t believe a word of it!*” That was the start of a collaboration that would upend or ‘undo’ the understanding of human behaviour.

The author also points out their differences. Tversky was an optimist, for as he put it: “*when you are a pessimist and the bad thing happens, you live it twice. Once when you worry about it, and the second time when it happens.*”. He was also a night owl. Initially in his career he was a “*mathematical psychologist*”, so he used formal models to characterize human behaviour. He was highly organized and disciplined with a spotless office. On the other hand, Kahneman was disorganized and always struggling to find things. He was a constant worrier, a morning person and prone to pessimism. They were different individuals but something special happens when they apply their minds to a problem; their collaboration is impossible to fathom yet perfectly complementary!

A period of extraordinary creativity followed after they met. From 1971 to 1979, they published the work that would lead to Kahneman winning the Nobel Prize in Economics. (If Tversky was still alive there is no doubt he would have won it as well.) Their work was characterised by two distinct themes - judgment and decision making. Judgment is the way we estimate or guess magnitudes and probabilities. Decision-making is about how one chooses, especially when there is uncertainty, which implies almost all the time.

Their first paper looked at how people routinely extrapolate conclusions from statistically insignificant samples: “*Belief in the Law of Small Numbers*” – the faith that if a coin is tossed and came down heads twice in a row, the next toss was more likely to be tails. Their response to this was: “*Even the fairest coin, given the limitations of its memory and moral sense, cannot be as fair as the gambler expects it to be.*”

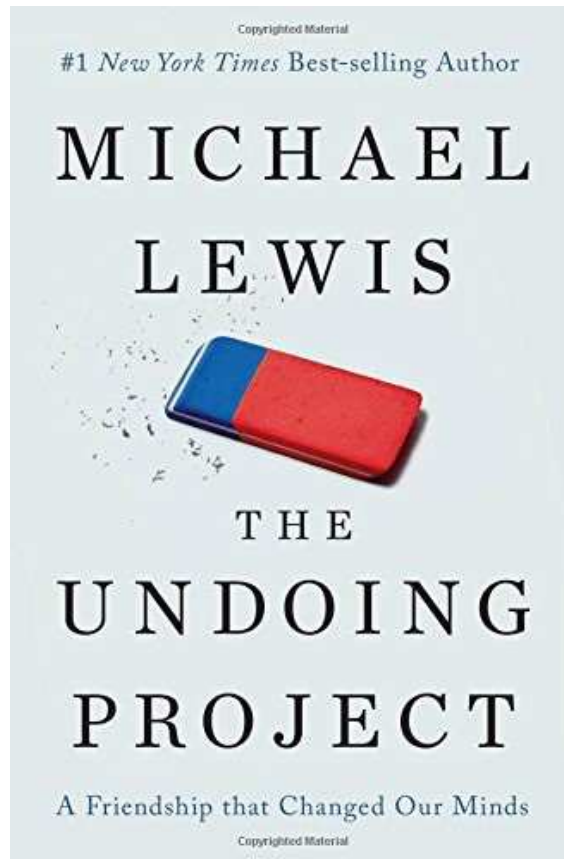
In their work, they revealed patterns of human irrationality that were not known before: the ways that our minds consistently fool us and the steps we can take, at least some of the time, to avoid being fooled. They used the word heuristics to describe the rules of thumb that often lead people astray. They point out rules such as the: *halo effect*, where thinking about one positive attribute of a person, or thing, causes observers to perceive other strengths that aren't really there; *representativeness*, leading to cause and effect perceptions instead of uncertainty or randomness, and; *availability heuristic*, causing both excessive fear and unjustified com-

placency, even leading governments astray. Other rules and heuristics are described in a fair bit of detail with examples. Kahneman and Tversky brought conversations on cognitive biases and heuristics in decision making to the centre.

Both Tversky and Kahneman ended up at universities in the Americas. Tversky was given tenure at Stanford while Kahneman ended up initially at British Columbia in Vancouver, later going to Berkeley and then to Princeton. Tversky got more of the attention and accolade, of which Kahneman was, to put it mildly, not happy. Since they were at different locations, both started to work with other people, leading to a strain in the relationship. This was unfortunate because Tversky was the brilliant shaper of ideas, not an instigator, and recognised in Kahneman's mind the raw material he needed. On his own, Tversky almost got depressed because he had no source of ideas. Even though they still interacted Kahneman basically ended the relationship saying, “*I sort of divorced him*”. Three days later, Kahneman received a call from Tversky who informed him that a type of eye cancer was diagnosis giving him, Tversky, 6 months to live. Tversky died at the young age of 59. In 2002 the Nobel Prize in Economics was awarded to Kahneman for their joint work. The impact of their work has been immense, not only in psychology and economics, but in

every other field of social science, as well as medicine, law, business including the airline industry and public policy.

This review will not be complete without mentioning the one effect this book had on the teaching of Analytics. ‘*Undoing the teaching of analytics*[2]’ is an article written by well-known Canadian educator Peter Bell, a past-president of IFORS. With over 40 years of experience, Peter felt confident that he was teaching analytics in a way that would influence his MBA students to become more analytic. However having read and being exposed to **The Undoing Project** his “*teaching has been disrupted*”. To quote Bell: “*Reading The Undoing Project provides the strongest case I have seen of the importance of analytical data-driven decision-making, but the book also leads me to believe that we can improve our students' decision-making skills if we can sensitize them to the kinds of basic errors that people make when confronted with the two main factors that make decision-making difficult: uncertainty and complexity.*”



This book, which appears on the New York Times 100 notable books of 2017, is essential reading for all teachers and practitioners of analytics and operations research. (Based largely on the book review published in the IFORS newsletter of September 2017)

ton & Company, New York, pp.368, ISBN-10: 0393254593, ISBN-13: 978-0393254594, \$20.26.

[1] Kahneman, D., 2011, *Thinking, Fast and Slow*, Penguin Group, London

The Undoing Project - A Friendship That Changed Our Minds by Michael Lewis, 2016, W.W. Nor-

[2] Bell, P., 2017, 'Undoing' the teaching of analytics, OR/MS Today, August 2017, p. 22-25.

CROSSWORD PUZZLE SOLUTION

O	R		C		H	E	L	O	R	S		I	N	F	O	R	M	S		
P		P	S		A			R			X		P		M			L		
S	T	E	P	H	A	N	V	I	S	A	G	I	E		L	E	M	M	A	
I		T		A		S		N		S			X		G			C		
		E		R		I		V		O		S	C	A	L	A	R		K	
	G	R	A	P	H	T	H	E	O	R	Y		E		A		I	P		
L		C				T		R					L	O	G	I	C		L	
I	C	H	I	O		M		S			W				R		H		I	
N		E			D	A	V	E	E	V	A	N	S		A		A		E	
E		C	P			N					T			T	N		R		S	
A		K		Z	U	N	C	K	L	E	S			E	R	G	O	D	I	C
R		L						E			O	L	L		E		E			H
	H	A	M	I	L	T	O	N	I	A	N		L				G			E
M		N		P				D		G				E	P	S	I	L	O	N
A	P	D	I	O				M	A	X	I	M	I	N		A		E		V
X					U			L			I			B		S		S		E
I			D	E	N	Z	I	L	K	E	N	N	O	N			E			N
M	I	L	P		I			L		U				S		A				T
A					S			E		R				C	O	N	C	A	V	E
X		R	I	A	A	N	D	E	J	O	N	G	H		N			I		R

CONTRIBUTE TO THE NEWSLETTER

If you've conducted some interesting research, worked on an interesting project, attended and workshop or conference, or been exposed to something interesting within the OR community recently - please consider submitting a written piece to the newsletter! We'd love to hear all about it.

Submissions can be made to the editor at brianjohnvanvuuren@gmail.com

