Operations Research Society of South Africa

At the Forefront of Analytics in Africa

ORSSA Newsletter March 2015

www.orssa.org.za

44th ORSSA Annual Conference

13–16 September 2015

An advanced warm welcome to the 44th Annual Conference of the Operations Research Society of South Africa (ORSSA). The conference will be hosted by the Johannesburg Chapter of ORSSA, and held at Pecan Manor in the Hartbeespoort valley from 13-16 September 2015. The theme of the conference is **Future Analytics**.

The conference will open with an optional tutorial on Sunday afternoon and a welcome reception on Sunday evening, September 13th and will close at lunchtime on Wednesday, September 16th. Participation over the full spectrum of Operations Research is encouraged, including papers of a more fundamental nature, those on the application of Operations Research techniques in business and industry, about topical issues in Operations Research, and about the philosophy, teaching and marketing of Operations Research.

The conference keynote speakers will be Mike Trick and Russ Taylor.

Mike Trick

Russ Taylor

Following the successful introduction of published conference proceedings in 2011, authors will again have the choice of either (a) only presenting papers orally at the conference, or (b) submitting full papers (which will also be presented orally at the conference) for inclusion in the peer-reviewed conference proceedings. Registration, and submissions of abstracts and full papers opened on the **16th of March 2015.**

Delegates are responsible for their own travel and accommodation arrangements. Pecan Manor and her sister lodge Green Leaves are recommended, as the Society has arranged competitive rates for delegate at these venues.

Pecan Manor – http://www.pecanmanor.co.za/
Green Leaves – http://www.greenleaves.co.za/

Peacon Manor

Important Dates

16 March 2015	Early bird registration & abstract/paper submission opens
10 April 2015	Abstract submission closes for reviewed papers
17 April 2015	Notification of acceptance of abstracts of reviewed papers and go-ahead to submit full papers for peer-review
15 May 2015	Submission of full papers for inclusion in the conference proceedings closes
10 July 2015	Abstract submission closes for oral presentation of all papers
17 July 2015	Notification of abstract acceptance for non-reviewed papers
17 July 2015	Notification of acceptance of reviewed papers for proceedings
24 July 2015	Early bird registration closes
14 August 2015	Cut-off for qualification of reduced room rates at the hotel
21 August 2015	Registration closes

Please visit the ORSSA website and click on the link *ORSSA 2015* for more information:

www.orssa.org.za

From The Editor

By Bernie Lindner (berndtlindner@gmail.com)

Bernie Lindner

Welcome to the first edition of the newsletter of 2015. This is also my first contribution as editor, and I am proud to say that the editorial responsibility is still in the hands of expats from Zimbabwe. Yes, the previous editor, Mark Einhorn, and I actually went to the same small primary school in Bulawayo. It seems ORSSA members enjoy foreign investment. I am very honoured, albeit a bit nervous, to be taking the reins from Mark Einhorn, who has been monumental in creating an informative, entertaining and pleasing newsletter. Mark, thank you for all your help and guidance. I wish you all the best in your new role as marketing manager of the Operations Society of South Africa and in your new job at OPSI Systems in Johannesburg.

I hope you enjoy this issue, which focusses on computers and cloud computing. Whether you're a mathematical enigma trying to stop world war II (see pages 10-12) or trying to upload pictures of your grandchildren to Facebook, there is no escaping our vast dependence on computers. And even if you have been looking down at your computer screens for days (or weeks, if solving an MILP), before you can look up the clouds are starting to expand above and around you.

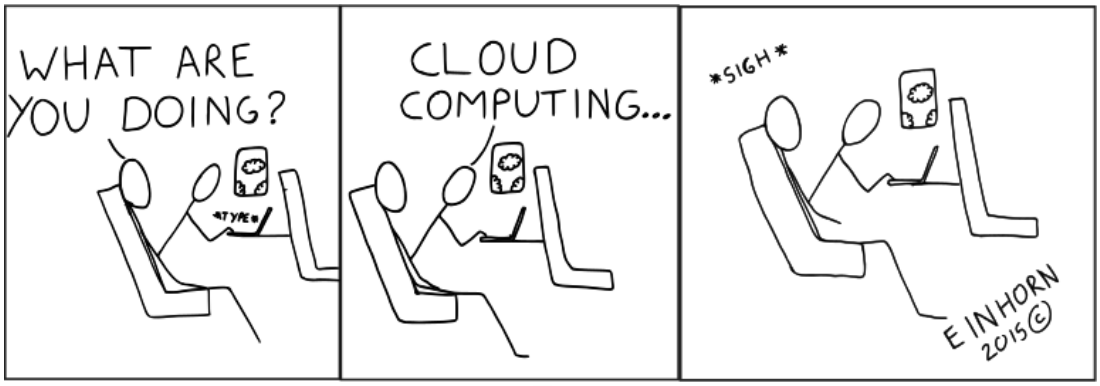
And before you can decide on what the exactly the cloud is, it changes shape to another form called cloud computing, which I never fully comprehended until Dr. JP Barnard (page 5) presented the work he performs with Microsoft Azure's service. As I understand it, their service is similar to renting computing power from any location at any time (usually when you want to run your algorithm), rather than buying a powerful computer for indefinite use.

The new Executive Committee can be seen on page 3, and the Society's 2014 financial statements can be seen on page 8. There is also a new feature to this newsletter which highlights what current members of the OR society are up to (page 4).

I would like to strongly encourage all members to submit anything they feel would be relevant and interesting to the Society to me for inclusion in future editions of this newsletter. Additionally, I would like to encourage all members to visit our social media sites on facebook, linkedin and twitter.

All the best until June.
Bernie

Features



From The President's Desk

By Hennie Kruger
(Hennie.Kruger@nwu.ac.za)
ORSSA President

Hennie Kruger

The year 2015 has already kicked off with immense speed and I trust that each and every one of you enjoyed a pleasant festive season with friends and family. I want to wish you all a prosperous 2015 and I believe that everybody is looking forward to a full programme with very interesting operational research that will be taking place.

Thank you to all the members of the Executive Committee (EC) of 2014. Each portfolio in the EC was filled by a member who delivered valuable contributions with devotion and care, despite other work pressure, and who helped to manage the society in a professional way. Unfortunately, some members of the EC had to resign at the end of 2014 (mainly because of work pressure). They are Tanya Visser (Secretary), Ian Durbach (Database Administrator), Dave Evans (Marketing Manager), Niel Matthee (Webmaster), Elias Munapoe (Additional Member) and Elias Willemse (Additional Member). I want to thank all these members for their unselfish service to the society over a long period of time. Jan van Vuuren also stepped down as Vice-President at the end of 2014 (but will fortunately still be an Additional Member) and I want to thank him, especially for his great supporting role in 2014.

New members who have joined the EC since January 2015 are Louzanne Oosthuizen (Database Administrator), Jacque du Toit (Webmaster), Bernie Lindner (Newsletter Editor) and Linke Potgieter (Additional Member). There are also two newly elected chapter chairs who are co-opted members of the EC now, namely Fanie Terblanche (Vaal Triangle chapter) and Quinten van Heerden (Pretoria chapter). I want to welcome these new members of the EC – we are looking forward to reach new heights with you in our Committee.

Some reshuffling of portfolios on the EC also took place. Mark Einhorn moved from Newsletter Editor to the Marketing portfolio. Jan van Vuuren, as mentioned before, moved from the Vice-President to the Additional Member portfolio. Lieschen Venter also moved from the Chairperson of the Vaal Triangle chapter to the National Secretary portfolio. Winnie Pelser, previously the Pretoria chapter Chair, has been elected as new Vice-President. Winnie will thus begin with her four-year presidential cycle in 2015, which means that she will be Vice-President in 2015 and 2018, and President during 2016 and 2017. I want to welcome you, Winnie, and I believe that your four-year term will be enriching and special – to yourself as well as to ORSSA. The entire Executive Committee of 2015, with their respective portfolios, can be found on page 3 of the newsletter.

The year 2015 will certainly be full of challenges and interesting features. Some of these include our annual conference during September which will be organised by the Johannesburg chapter (see the conference advertisement elsewhere in the inside front cover). For those of you who are fortunate enough to travel overseas, there is also the international EURO conference which will take place in Glasgow, Scotland during July. The Meetup groups which came into existence last year are promising to reach new heights this year with plans to introduce themselves to as many ORSSA members as possible. There are also plans to advertise ORSSA and its activities to a wider audience with the help of social media like Facebook, Twitter, LinkedIn et cetera. This year, we hope to see members who will tackle the Certified Analytics Professional (CAP) international examinations; congratulations to Angela Rademeyer and Richard Ball, who became only the second and third ORSSA members to acquire this qualification, respectively.

I am looking forward to work closely with the Executive Committee during 2015, ensuring that ORSSA is and remains the professional home of all the operational researchers in South Africa. I am also looking forward to join forces with all the ORSSA members to realise our operational research ideals and I want to invite everyone to contact me or any other member of the Executive Committee with suggestions and ideas to improve ORSSA's services and activities even more.

With best wishes / Alles van die beste
Hennie Kruger

QUERIES & CONTRIBUTIONS

Any queries or contributions to the Newsletter are most welcome, especially article submissions. For any queries or contributions, please contact the Newsletter editor at *berndtlindner@gmail.com*.

The 2015 ORSSA Executive Committee

President:
Hennie Kruger

Vice-President:
Winnie Pelser

Secretary:
Lieschen Venter

Treasurer:
Tiny du Toit

Database Manager:
Louzanne Oosthuizen

Marketing Manager:
Mark Einhorn

ORiON Editor-in-Chief:
Stephan Visagie

ORiON Journal Manager:
Martin Kidd

Newsletter Editor:
Bernie Lindner

Newsletter Business Manager:
Daniel Lötter

Webmaster:
Jacques du Toit

Additional Elected Members

Margarete Bester

Jan van Vuuren

Linke Potgieter

Angela Rademeyer

Chapter Chairs

Johannesburg:
Brahm Bothma

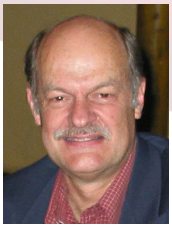
Pretoria:
Quintin van Heerden

Vaal Triangle:
Fanie Terblanche

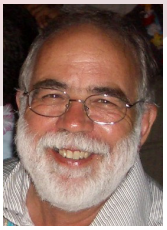
Western Cape:
Daniel Lötter

Kwazulu-Natal:
Aderemi Adewumi

Co-opted External Liaison Representatives



IFORS Representative:
Hans Ittmann

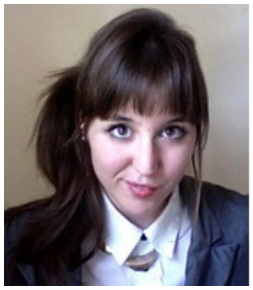


EURO Representative:
Theo Stewart

What o(u)r Members Are Up To

Angela Rademeyer
Member Since: 2009
Chapter: Johannesburg
Age: 31
Angela became the second member to receive the CAP certification. She is currently working at Discovery Health.

Chantel Von St Ange
Member Since: 2014
Chapter: Western Cape
Age: 24
Chantel has just completed her Masters of Engineering (Industrial) *Cum Laude* at Stellenbosch University. She recently started working as a Data Analyst in the Business Intelligence department at Digitial Outsource Services in Cape Town.



Lieschen Venter
Member Since: 2007
Chapter: Western Cape
Age: 30
Lieschen has taken up the posistion as lecturer of Operations Resarch at the Department of Logistics at Sellenbosch Universtiy.

Anton de Villiers
Member Since: 2009
Chapter: Western Cape
Age: 27
Anton graduated in 2010 with a PhD in Operations Research from Stellenbosch University. He has started working at wiGroup in Observatory, Cape Town.

Antoinette Erasmus
Member Since: 2013
Chapter: Western Cape
Age: 24
Antoinette is busy completing her Masters of Commerce in Operations Research in the Department of Logistics at Stellenbosch University. This year, she started working as a Load Plan Expeditor for South African Breweries in Randburg.

Richard Ball
Member Since: 2013
Chapter: Western Cape
Age: 29
Richard became the third member to receive the CAP certification. He currently works as a Business Analyst in Allan Gray's Institutional Operational Analytics department. He is currently in the second year of his Masters of Engineering Management studies at the University of Cape Town.

Marc Hatton
Member Since: 2013
Chapter: Western Cape
Age: 24
Marc has just completed his Masters of Engineering (Industrial) *Cum Laude* at Stellenbosch University. He started working at AdaptIT, a consulting company which specialises in the information and communications technology industry. (Hopefully he will be able to sniff out candidate TSP problems and apply metaheursitcics appropriately.)

Danie Lötter
Member Since: 2009
Chapter: Western Cape
Age: 28
Danie has taken the position as lecturer of Operations Research at the Department of Industrial Engineering at Sellenbosch Universtiy at the beginning of 2015 and is currently completing his doctorate in Operations Research

Mark Einhorn
Member Since: 2009
Chapter: Johannesburg
Age: 27
Mark has just completed his PhD in Operations Research at Stellenbosch University and has also started working for OPSI Systems in Johannesburg.

SOCIAL MEDIA

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

Practical Computational Capability in the Cloud

by Dr JP Barnard from Process Engineering, Stellenbosch University (jbarnard@sun.ac.za)

Computational capability has become a pivotal piece of infrastructure at academic institutions. It can be as cardinal to academic excellence as funding. And the engineering discipline is a prime example.

Over the past 30 years, engineering achievements have improved hand over fist, primarily due to advances in simulation and design automation. Computational capability has been central to this revolution. The aerospace and automotive industries have made dramatic progress, producing magnificent machines, by utilising simulation software in various application fields, such as structural, thermal and aerodynamic design, and 3-D CAD/CAM.

The design, formulation and development of advanced engineering materials rely on computational capability in addition to lab work.

Process industries increasingly formalise their process performance monitoring, using various forms of computational capability. It only stands to reason that the primary source of formalised knowledge, *i.e.* universities, must invest in up-to-date computational capability, in order to stay abreast with R&D that leverages such computational infrastructure. Against this backdrop, a very relevant question emerges: What can cloud services do for the advancement of practical academic computational capability? At Process Engineering, Stellenbosch University, Dr J P Barnard has set off in pursuit of an answer to this question.

Microsoft Azure Award

During the first quarter of 2014, Dr Barnard, a member of the Process Monitoring & System (PM&S) group, successfully applied for an Azure Research Award to test the impact of cloud services on research projects and activities within that research group.

The Azure Research programme evaluates applications every quarter of each year. Successful applicants receive a quota of resources in the Azure cloud for 12 months from activation of the award. The researcher may apply these resources in any way that suits the research project, within the constraints of the research award and the available Azure facilities.

The Azure Award that Dr Barnard has received provides 32 CPU cores, in any configuration supported by the available virtual machine (VM) templates in the Azure VM menu; no limitation of RAM, within what is available in the VM templates, and sufficient storage space to cover a year's research use.

The PM&S group specialises in data analysis for the purpose of fault detection and identification. Their activities apply MATLAB in various research projects, specifically for numerical optimisation, multivariate analysis (such as PCA), image processing, regression and classification with ensemble methods, and various machine learning techniques.

One particular feature of MATLAB – the Parallel Toolbox – draws attention to the exploitation of multi-core processors and HPC clusters for accelerated computation. Cloud services can play into this feature and handsomely reduce computational time on parallel problems.

The MATLAB Parallel Toolbox allows common MATLAB commands and familiar tools from the MATLAB client session to run as parallel jobs, either on the local client machine (exploiting multiple CPU cores) or on an HPC cluster (via a particular job scheduler).

Dr Barnard has set a number of goals for the project:

1. Investigate a number of specific computational capability questions,
2. Write a technical report on the findings, and
3. Publish a paper in a suitable journal on these findings.

The questions, referred to above, include:

1. What configuration of cloud services best serves to expand the local computational capability available to the research group?
2. How does the local HPC cluster, Rhasatsha, fare in supplementing the computational capability of the research group?
3. Can a MATLAB HPC cluster be configured, especially since the Mathworks-Amazon EC2 project is not generally available in South Africa? Mathworks produces MATLAB and has entered into collaboration with Amazon in the USA, so as to provide MATLAB as a service in the Amazon EC2 cloud to licensed MATLAB users in the USA.

In answering at least some of the above, two computational problems were thrown at this Azure resource, as well as at the local HPC cluster of the University, and the server stack housed at Process Engineering:

- Fault detection, using the proximity matrix of a random forest regressor, trained on Normal Operating Condition (NOC) process data. This problem poses

high memory demand of order *NxN* (where *N* is number of data records). A typical PC or laptop cannot accommodate this problem with sufficient number of data records for representative results. Memory of order 100GB is required. A single HPC node is not sufficient, either. Furthermore, a distributed array solution is not readily available.

- Parallel optimisation of a set of 26 ODEs (a reaction rate equation set for a base metal refinery process), over 4 different reaction conditions, using three different optimisation strategies. This problem ran well on a single Intel i7 (3rd generation) with 8 logical cores and 16 GB RAM. However, additional machines could reduce total workflow time by a factor of 3 or more.

Findings from Azure Research Award

To make short a long story, Dr Barnard and his colleagues in PM&S, have found the following:

1. Single node HPC VMs in Azure best suits scale-out demands of the computational problems typical of the PM&S group. The group used two A9 templates, configured with MATLAB. Each A9 template provided 16 cores at 2.6 GHz, 112 GB RAM. It benchmarked with an Intel i7 3.5GHz (3rd generation).
2. The University's HPC cluster presented some instability in terms of client machine connectivity, which rather annoyingly aborted runs of the optimisation search problem.
3. The effort to construct a MATLAB HPC cluster in Azure proved many times more complicated than configuring single node HPC machines in Azure.
4. Configuring an HPC single node VM in Azure with MATLAB that runs against Process Engineering's MATLAB license server was relatively straight-forward, after setting up the necessary access rules and VPN tunnel from the VM back to the appropriate MATLAB license server on campus.
5. A configured VM can be saved as an image and reused to spin up new VMs from that image, as required, when required.
6. The Azure portal is very intuitive and simple to use. Managing computational capability with Azure as scale-out resource is feasible and relatively easy to accomplish, requiring moderate IT skills from a single support person in the group and a very low learning curve for researchers.
7. Configured VMs can be reached through the University's firewall, by using the University's Inetkey and Windows Remote Desktop Client.
8. Transferring data between local machines and Azure VMs is simple and bandwidth is reasonable.

Azure Portal and VMs

The Azure portal (Figure 1) is accessed via a web browser. And it is not IE centric at all. In fact, Azure is not particularly Microsoft centric either. One can find templates for various flavours of Linux, for example, amongst the gaggle of Windows 2012 server templates.

A particular VM, configured in the Azure portal, can be connected by running the Windows Remote Desktop Client from the researcher's local PC or laptop (Figure 2).

Windows HPC Pack

The Windows HPC Pack has been updated and is available

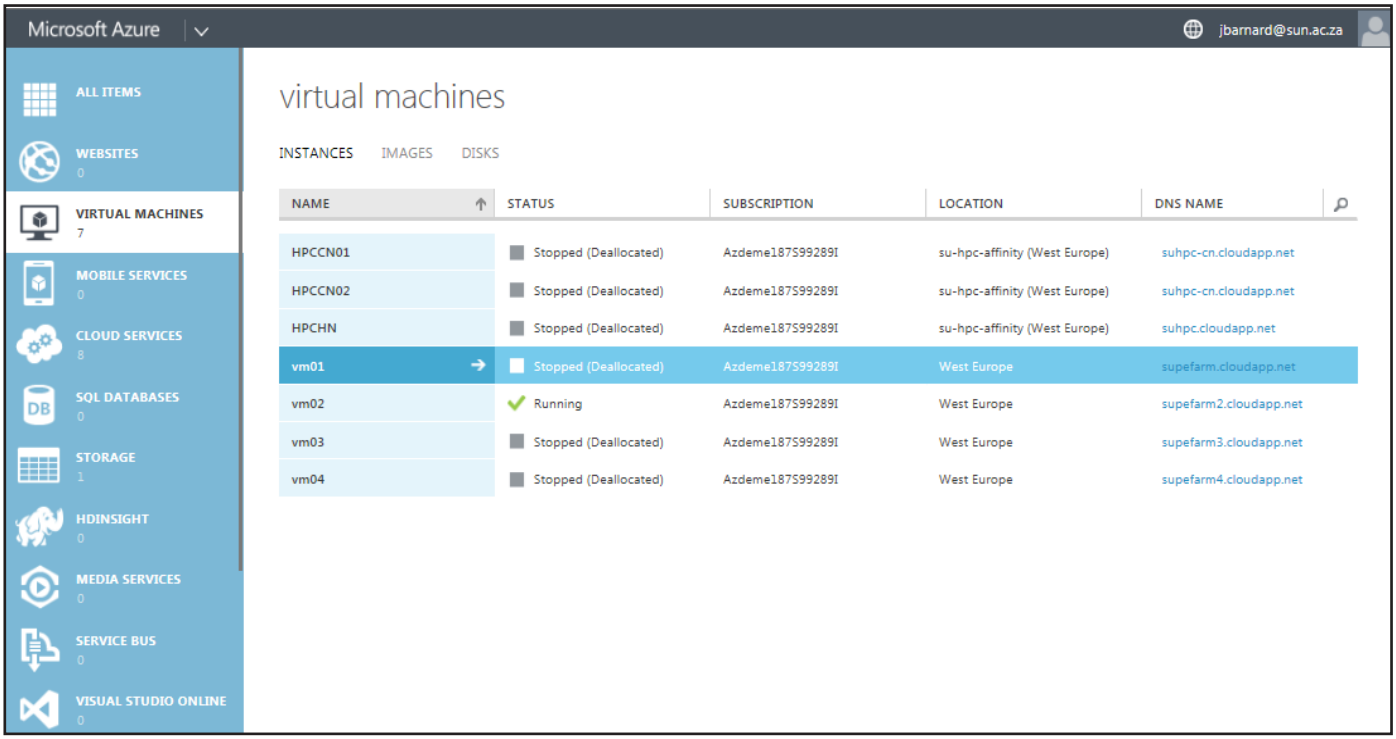


Figure1: Example of Windows Azure Portal.

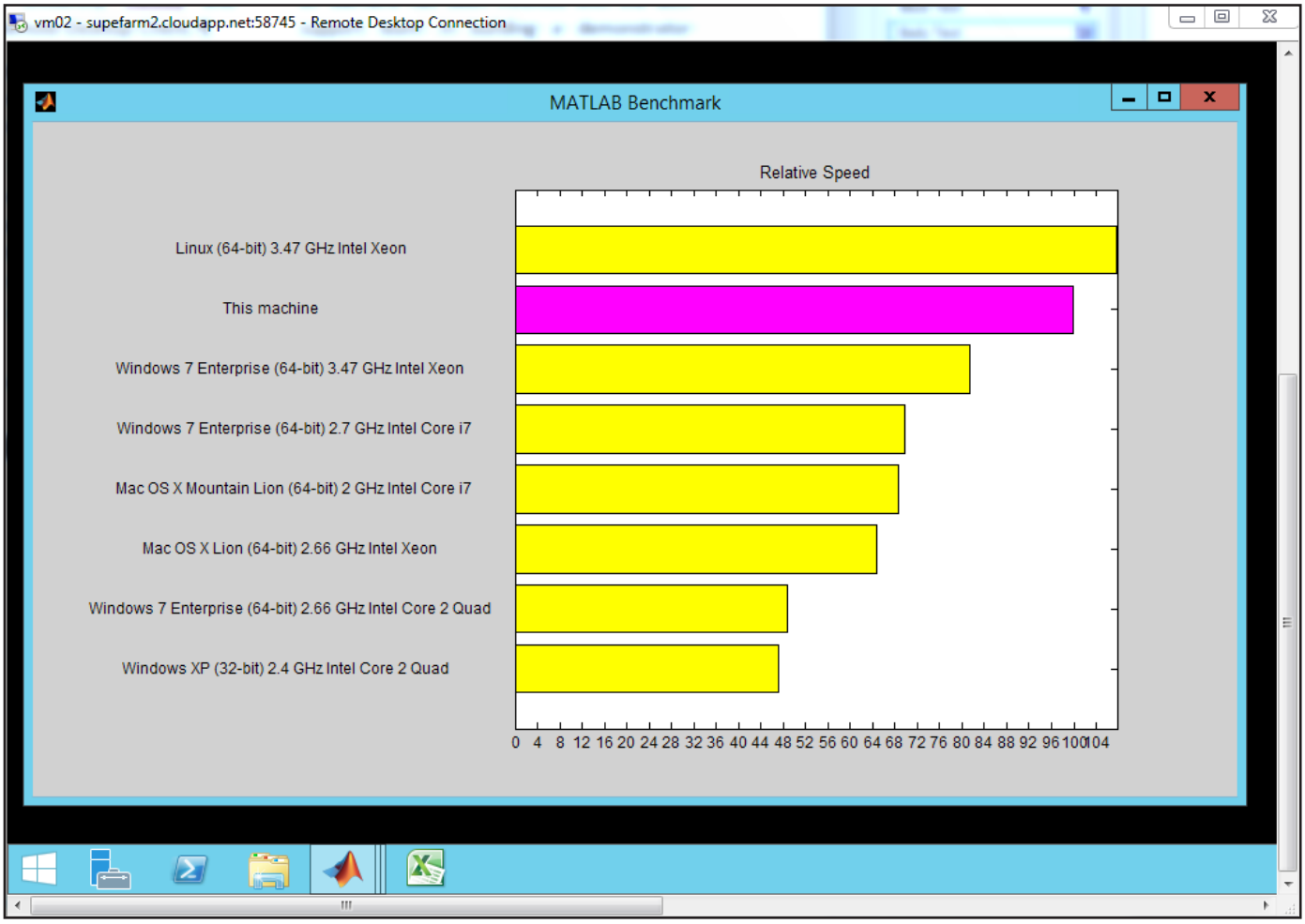


Figure 2: Example of Remote Desktop Client window, showing MATLAB bench mark result for A9-based VM in Azure.

as a Windows HPC Server template. Microsoft's Azure team is busy developing auto-scale-out features to Azure compute nodes for their Windows HPC Pack. Dr Barnard has been involved with the tech support team in building a demonstrator MATLAB HPC cluster, using Windows HPC pack on Server 2012 R2.

Quo Vadis?

This Azure Research project has been particularly exciting and rewarding (excuse the pun). The Microsoft Azure support for the investigation has been superb.

Where to next? At the end of the Azure Award (in May 2015), Dr Barnard intends to write a technical report on his findings, as well as a paper for publication in a suitable journal. The experience should provide useful feedback to decision makers at Stellenbosch University for future provisioning of computational capability scale-out.

It remains to be seen whether a competitive price structure will be offered to the University for accessing such cloud services for research and development on a regular basis.

Acknowledgements

- Microsoft Azure Research
- Mr Kenji Takeda (Azure Research)
- Mr Danny Fu (Azure Tech Support)
- Mr Riedwan Bassadien (Azure Tech Support)
- Mr Charl Moller (SU IT, HPC Cluster)
- SU IT Unit (for tech support)
- Engineering Faculty (Stellenbosch University) for sponsoring MATLAB MDCS license for HPC cluster.
- My colleagues for putting up with my head in the cloud.

Some contact details

Microsoft Azure Award:
http://research.microsoft.com/en-us/projects/azure/
Mr Kenji Takeda: Kenji.Takeda@microsoft.com

SUBMIT A FEATURE ARTICLE

The ORSSA Newsletter is an excellent medium for showcasing one's work or interests to the Operations Research community, not only in South Africa, but around the world. There are zero costs associated with submitting an article to the Newsletter and if selected for publication, the article sets the theme for the entire edition. If you would like to submit an article to the Newsletter, please send your article and all associated media (e.g. images, charts, etc.) to the editor at *berndtlindner@gmail.com*.

The 2014 ORSSA Preliminary Financial statements

by Tiny du Toit, North West University (tiny.dutoit@nwu.ac.za)

The preliminary statements for 2014. The final statements for 2014 will be published later this year when the Society's independent accountant has approved and signed off the statements.

ORSSA PRELIMINARY INCOME STATEMENT: 01/01/2014 TO 31/12/2014

ACCOUNT	ACTUAL YTD Conference Incl. Dec-14	ACTUAL YTD Conference Excl. Dec-14	ACTUAL YTD Conference Dec-14	BUDGET FOR 2014	PREVIOUS YTD Dec-13
Conference Income	280 533,35		280 533,35		275 300,00
Interest Received	1 299,94	1 299,94		10 080,00	8 585,07
Membership Fees	173 280,00	173 280,00		127 000,00	133 500,00
Newsletter Income	16 100,00	16 100,00		21 512,20	21 910,00
ORiON Journal Income	600,00	600,00		27 600,00	27 572,40
Provision for Bad Debts Reversal					109 442,22
Total Income	**471 813,29**	**191 279,94**	**280 533,35**	**186 192,20**	**576 309,69**
Accounting Expenses	1 750,00	1 750,00			
Arhive Projects	1 181,75	1 181,75			
Bad Debts		-		33 423,50	148 296,24
Bank Charges	3 685,15	3 685,15		2 404,39	2 425,12
Chapters fees	43 320,00	43 320,00			33 375,00
Computer		-			5 125,00
Conference Expenses	256 558,93		256 558,93		270 255,74
Honorariums	10 000,00	10 000,00		10 000,00	5 500,00
Meals/Entertainment		-		1 514,63	2 224,00
Membership - EURO	3 175,05	3 175,05		1 991,57	
Membership - IFORS	3 316,69	3 316,69		3 749,45	3 923,03
Newsletter Expenses	32 890,33	32 890,33		34 404,48	29 923,32
ORiON Journal Expenses	10 195,13	10 195,13		15 758,72	32 285,26
Prizes/Awards	6 241,56	6 241,56		19 000,00	37 041,39
Rent Postbox		-		340,00	
Resignations		-		2 634,15	
Stationary	1 425,00	1 425,00		143,36	
Web Hosting	1 594,00	1 594,00		2 865,37	3 680,00
Total Expenses	**375 333,59**	**118 774,66**	**256 558,93**	**128 229,62**	**574 054,10**
Net Profit	**96 479,70**	**72 505,28**	**23 974,42**	**57 962,58**	**2 255,59**

ORSSA PRELIMINARY BALANCE SHEET: 01/01/2014 TO 31/12/2014

ASSETS	2014	2013
Accounts Receivable	**110 090,00**	**86 000,00**
Accounts Receivable	110 090,00	-
Prepaid Expenses - Conference		86 000,00
Bank Accounts	**455 736,60**	**307 577,34**
Nedbank Current	449,50	130 986,95
Nedbank Long term	176 590,39	176 590,39
Standard Bank Current	237 396,77	
Standard Bank Investment	41 299,94	
Total Assets	**565 826,60**	**393 577,34**

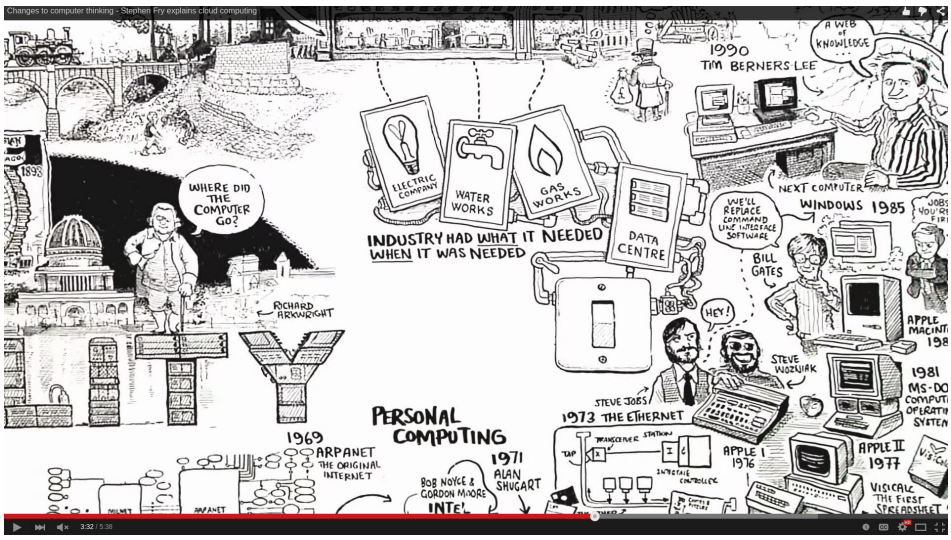
LIABILITIES & EQUITIES	2014	2013
LIABILITIES		
Membership fees due to chapters	241 114,12	185 172,50
KZN Chapter fees in trust	3 128,00	3 128,00
Unallocated Payments	19 827,94	
Total Liabilities	**264 070,06**	**188 300,50**
EQUITIES		
Retained Income	205 276,84	203 021,25
Net Profit Current year	96 479,70	2 255,59
Total Equity	**301 756,54**	**205 276,84**
Total Liabilities & Equity	**565 826,60**	**393 577,34**

Stephen Fry Explains 4 700 Years Leading Up to Cloud Computing

by Berndt Lindner, Industrial Engineering, Stellenbosch University (berndtlindner@gmail.com)

I recently read an article in the Cape Times (18 Feb. 2015) entitled *I spy Stephen Fry.... almost everywhere.* From educating viewers on general knowledge and eradicating general ignorance in the popular show QI, to being defended by the Archbishop of Canterbury on his views on God, to being the Master of Laketown in Peter Jackson's *The Hobbit.*

And there is now a Youtube video of him explaining cloud computing interestingly and informatively in just under 6 minutes! Although the video is an advert for the company Databarracks,



Fry immediately has you captivated with the introduction, "Today we are in the middle of a revolution". This is followed by an explanation of how the Sumerians invented the abacus around 2 700 BC to help make arithmetic faster and less prone to errors. He then goes on to describe the technological advancements that have changed our lives. He mentions Leonardo da Vinci's first drawings of a mechanical calculator (1502 AD), to Charles Babbage's difference Engine during the 19th Century, the Turing Machine and finally Sir Berners Lee's work leading to the invention of the *world wide web* (www).

But interestingly, Stephen Fry focusses the talk on another life-changing event in history, the invention of the lightbulb by Thomas Edison in 1879. As he states, although everyone would want this new invention (just like large computing power), the lack of publically available electricity hindered the utilisation of this wondrous new invention. Therefore, Edison set out to build power stations in London and New York. Having a utility producer provide the light to the masses was what changed the way we lived. In a strikingly similar vein, utility thinking is causing major advancements in our current world of computing. Fry mentions that through the introduction of cloud computing, just like electricity, water and gas, computing has become a utility, where users can pay according to exact usage. Thus, users do not have to purchase large computers for the few days in the year during which they will need all that power. This effectively means that someone sitting at home can have the same access to computing power as massive corporations do.

So if you are part of a small business or a research lab, or merely a single user requiring more than usual computing power, you have the option of buying (in effect renting) the power from a cloud computing service provider. This also would hopefully mean you outsource computing related problems and rather focus on your model or problem.

I know the video is more focussed to general business applications, but I think Fry is right in that cloud computing, like power utilities, is a resource that is here to stay, and should be embraced for all its advantages. I think for Operations Researchers it represents the ancient trade-off between renting or buying a resource (house, car, *etc.*), where renting the computing power from the "cloud" might be more economically feasible if you don't continuously require a lot of computing power. Rather, you can buy the computing power yourself exclusively for a time period during which you will require significant computing resources.

Further resources

1. www.youtube.com/watch?v=J9LK6EtxzgM
2. www.openculture.com/2013/11/stephen-fry-explains-cloud-computing-in-a-short-animated-video.html
3. www.thewhir.com/blog/stephen-fry-explains-4700-year-lead-cloud-computing

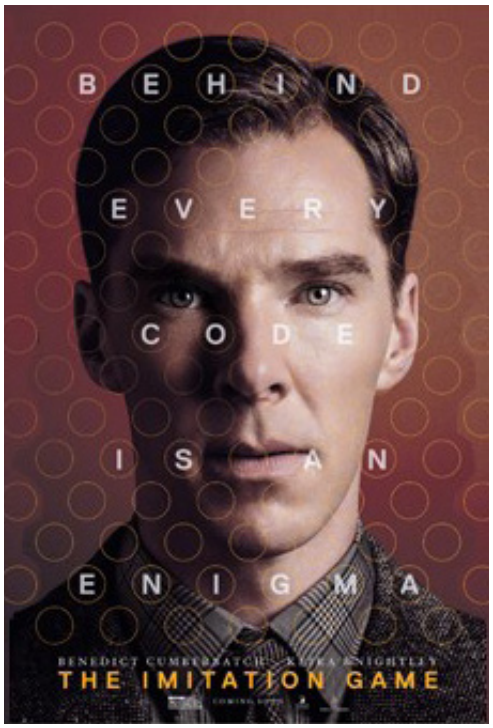
Movie Review: The Imitation Game

by Brian van Vuuren at Stellenbosch University, Industrial Engineering (16057651@sun.ac.za)

'The Imitation Game' follows the events which transpired during World War II where a group of Britain's best minds were brought together and tasked with cracking Nazi Germany's Enigma code.

Enigma was an electro-mechanical rotor machine used during the war to decipher and encipher messages. The machine worked by forming a varying electrical circuit. When a key was pressed, a certain circuit path was completed; causing a corresponding lamp to light up the equivalent ciphertext letter.

The machine consisted of three rotors and a reflector which rerouted the signal back through the rotors a second time, along a different circuit path, to the output. This resulted in the current from the pressed plaintext letter moving through one of 26 different electrical connections, hard-wired into the rotors, a total of six times to complete the circuit and light up a corresponding ciphertext letter. This type of scrambler was called a polyalphabetic substitution cipher and was the heart of Enigma's security. Each time a key was pressed, at least the one rotor would rotate, causing the next depressed key to follow a completely different route and, as such, light up a different ciphertext letter.



Over and above the rotors, Enigma also had a plugboard which permitted variable wiring, reconfigured by the operator. This provided more security than an additional hard wired rotor would have, after it was found that Enigma without a plugboard could be broken relatively easily using hand-based methods. The effect of the plugboard was that two letters could be connected in a steckered pair and were then swapped before and after the main motor scrambling unit. This random arrangement, determined by the operator, increased the complexity of the cipher and meant that, with each change in the plugboard configuration, the system had no similarity to the previous configuration. The plugboard had capacity for 13 steckered pairs to be used, but usually only 10 were required.

The enigma transformation process for each letter can be specified mathematically as a product of permutations. In the typical German Army Enigma, if 'P' denotes the plugboard transformation, 'U' is the reflector and 'L, M, R' as the left, middle and right rotors respectively; then the encryption 'E' is expressed as

$$E = P{\cdot}R{\cdot}M{\cdot}L{\cdot}U{\cdot}L^{-1}{\cdot}M^{-1}{\cdot}R^{-1}{\cdot}P^{-1}.$$

After each key press, the rotors of the machine would turn, changing the transformation. For example, if the right-hand motor 'R' has rotated i positions, the transformation becomes $\rho^{i}R\rho^{-i}$ where ρ is the cyclic permutation which maps A to B, B to C and so forth. Similarly, the middle and left-hand rotors can be represented as j and k rotations of M and L and the encryption transformation is specified as

$$E = P{\cdot}(\rho^{i}R\rho^{-i}){\cdot}(\rho^{j}M\rho^{-j}){\cdot}(\rho^{k}L\rho^{-k}){\cdot}U{\cdot}(\rho^{k}L\rho^{-k}){\cdot}(\rho^{j}M\rho^{-j}){\cdot}(\rho^{i}R\rho^{-i})(P^{-1}).$$

In total, using 3 rotors, each with 26 positions and the plugboard with 10 connections employed, the military Enigma was capable of 158 962 555 217 826 360 000 (nearly 159 quintillion) different arrangements.

'The Imitation Game' is a nailbiting thriller which follows the life of Alan Turing, a genius and contentious member of the British group tasked with cracking Enigma, and who is today widely considered the father of theoretical computer science and artificial intelligence. His design, named 'The Turing Machine', was the formalisation of the first concepts of 'algorithm' and 'computing'.

Although an outspoken and, for the most part, unpleasant team member, Turing's insight and design played a pivital role in Britain's cracking of Enigma and, in turn, intercepting coded messages which allowed the Allies to defeat the Nazis in many crucial engagements. His work saved countless lives and is estimated to have shortened the war in Europe by two to four years.

Without giving too much else away about the storyline, the film also deals with Turing's personal struggles, his internal development and, of course, his 'lightbulb' moment which lead to his team's eventual success in their quest. Benedict Cumberbatch and Kiera Knightley are fantastic in their

roles, leading to an Oscar nomination for Best Male Lead and Best Supporting Female, respectively. Those were two of the eight Oscar nominations received by the film, of which the only success came for Best Writing, Adapted Screenplay by Graham Moore.

None-the-Less, 'The Imitation Game' is a wonderful account of a passionate, pioneering computer scientist, mathematician, cryptanalyst and philosopher in Alan Turing and, although not terribly technical and mathematically detailed (for obvious reasons) it is definitely worth a watch by an audience with an appreciation for not only the brilliance that was the Enigma machine, but the genius behind cracking the 'unbreakable' code.

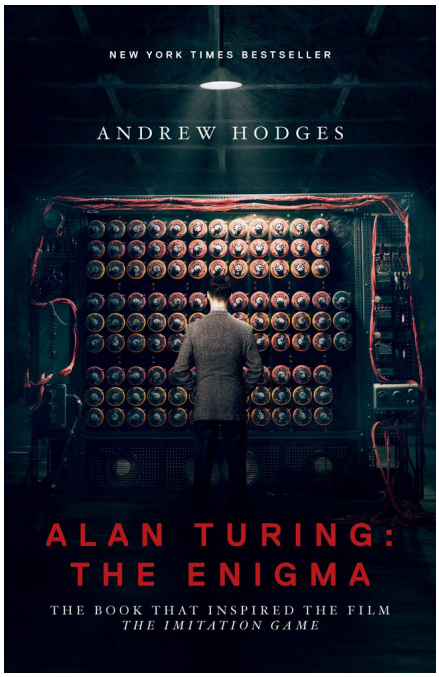
Book Review: Deciphering an Enigma

by Hans Ittmann, University of Johannesburg (hittmann01@gmail.com)

(This book review also appeared in the March 2105 edition of the IFORS newsletter)

It is not often that a mathematician is featured in the editorial (Gibbs, December 2014) of a magazine such as Time. Referring to *The Imitation Game,* the film based on this book, Gibbs calls Turing "the brilliant, tortured father of modern computing". These days, people, most especially the young, cannot imagine a life without computers- they are simply everywhere and indispensable!

For the not-so-young, computer programs were written on sheets of paper handed over to staff whose job it was to carefully "type" them into punch cards. After instruction cards were added to the stack, a card reader enabled submission and execution of the program by the mainframe. Hard as it may be to comprehend this for those who never experienced this era, imagine going back to the very beginning of the era. It is where this comprehensive biography by Hodges contributes to the understanding of the role that Turing played in what is now considered the Digital Revolution. Those of us in the field of OR will be delighted at the insights into the early developments and origins of the devices we use in our profession.



The first part of the book is devoted to the origins of the Turing family and Turing's childhood. A year after his birth on 23 June 1912, Turing was left with a retired couple as his parents went back to India where his dad worked. His mother returned a couple of years later. An eccentric child, Turing was described by his mother as "being abstracted and dreamy, sometimes lost in his own thoughts". He wasn't the neatest child and when asked by his father if he would be good he answered, ''Yes, but sometimes I shall forget!" At the age of 13, he went to Sherborne boarding school, where he realized he was homosexual. Turing became friends with a schoolmate, Christopher Morcom, who sadly died of tuberculosis. Throughout the rest of his life, he felt this loss and kept in regular contact with Morcom's mother.

After school, Turing won a scholarship to read mathematics at King's College, Cambridge in the UK and, using his prize money, bought the book Mathematical Foundations of Quantum Physics by John von Neumann (see Gass and Assad, 2011). This stimulated his interest in the mathematics of what happens at subatomic level. Von Neumann, one of the pioneers of computer design, had a lasting effect on Turing.

At King's College, Turing was recognized for his abilities with his election as a Fellow at the age of 22. It was here that he was introduced to the three, now famous, questions the renowned mathematician Hilbert raised about any formal system of mathematics. Hilbert's third question, the Entscheidungsproblem or decision problem, was expressed as follows to Turing: "Is there a "mechanical process" that can be used to determine whether a particular logical statement is provable?" Turing loved solving "unsolvable" puzzles and this specific question led him, by refining the concept of "computable numbers", to the "Logical Computing Machine". This was an imaginary machine that could handle any mathematical computation. In 1936 he completed the paper "On Computable Numbers, with an Application to the Entscheidungsproblem" in which he had conceived as a mathematical abstraction this "computing machine". The "Logical Computing Machine" later became known as the "Turing Machine" which "offered a bridge, a connection between abstract symbols, and the physical world". The book covers a lot of material on this topic.

During the mid-thirties when the expectation of a World War was imminent, Turing refused an invitation to work in the USA in favour of joining the British government's crypt-

analysis group as their first mathematician. From 1939 he was stationed at Bletchy Park where he played a major role in building machines to break the codes of the Enigma, the German encryption machine used for all German communication. At some point, Turing was heading the Naval Enigma group. His work at Bletchy had a direct impact on the success of the Allied forces in combatting the onslaught of the U-boats. Turing and his colleagues achieved this by building a machine, called the "bombes," that was able to exploit weaknesses in the German encrypted code. With an enhancement suggested by mathematician Gordon Welchman, the bombe became one of the primary tools, and the major automated one, used to attack Enigma-enciphered messages. It was also during this period that Turing became engaged with a fellow cryptanalyst but broke the engagement because of his homosexuality.

Turing moved onto other interesting topics. He spent a year at Cambridge, then returned to Bletchy and initiated work on the Automatic Computing Engine (ACE). He was not happy with how this project was managed and did not receive the deserved recognition for his work on the project. From around 1945 to 1950, he was mostly involved in work related to a theory of structural evolution, or morphogenesis. He was elected a Fellow of the Royal Society in 1951, before reaching his 40th birthday.

During the early fifties, a series of investigations of a reported robbery at his home led to his arrest, trial and conviction in February 1952 for ''Gross Indecency contrary to Section 11 of the Criminal Law Amendment Act 1885" or the practice of male homosexuality. It is interesting that he had always been frank about his sexual orientation at a time when homosexual relations were still a felony in Britain. He was spared a prison sentence but subjected to hormonal injections. On June 7, 1954, he was found dead in his home near Manchester with a half-bitten, presumably cyanide-laced apple in his hand.

The last part of the book is devoted to (i) an in depth description of debates about artificial intelligence and (ii) the issue of gay rights and how wrong things were during those days. What OR people would appreciate about the book though is how the author, Hodges, himself a mathematician at Oxford University, gives an in depth and clear exposition, in mathematical "speak" and terms, throughout the book. This was made possible by his access to many different books, papers, documents, letters, as well as to Turing's family and friends. An in depth understanding of Turing's work made it possible for Hodges to explain complex ideas, particularly the functioning of the Enigma machine and the work that went into the Turing machine. This greatly helps in bringing to the reader how Turing thought, his originality, passion for truth (even to his own detriment), and relentless pursuit of the bridge that would connect the worlds of the theoretical and the practical.

Turing received many awards and recognitions. The editorial to the Centenary Edition of the book mentions President Obama singling out Newton, Darwin and Alan Turing as British contributors to science. In addition, British Prime Minister Gordon Brown in 2009 apologised officially in public for Turing's trial and punishment while Queen Elizabeth II granted him posthumous pardon in 2013. Finally, Isaacson (2014) who poses the question, "who invented the computer?" points out that it had been a collaborative effort of many individuals but adds, "a lot of the credit, too, should go to Turing for developing the concept of a universal computer."
As the book title suggests, Turing was the enigma — which perhaps no Turing machine, or for that matter, nor even Watson can fathom.

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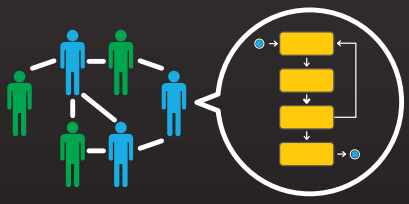

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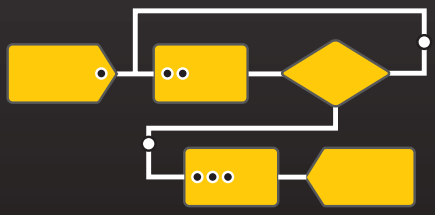

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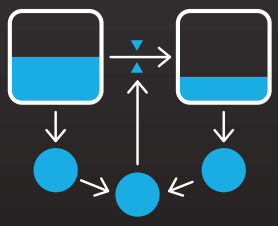

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