

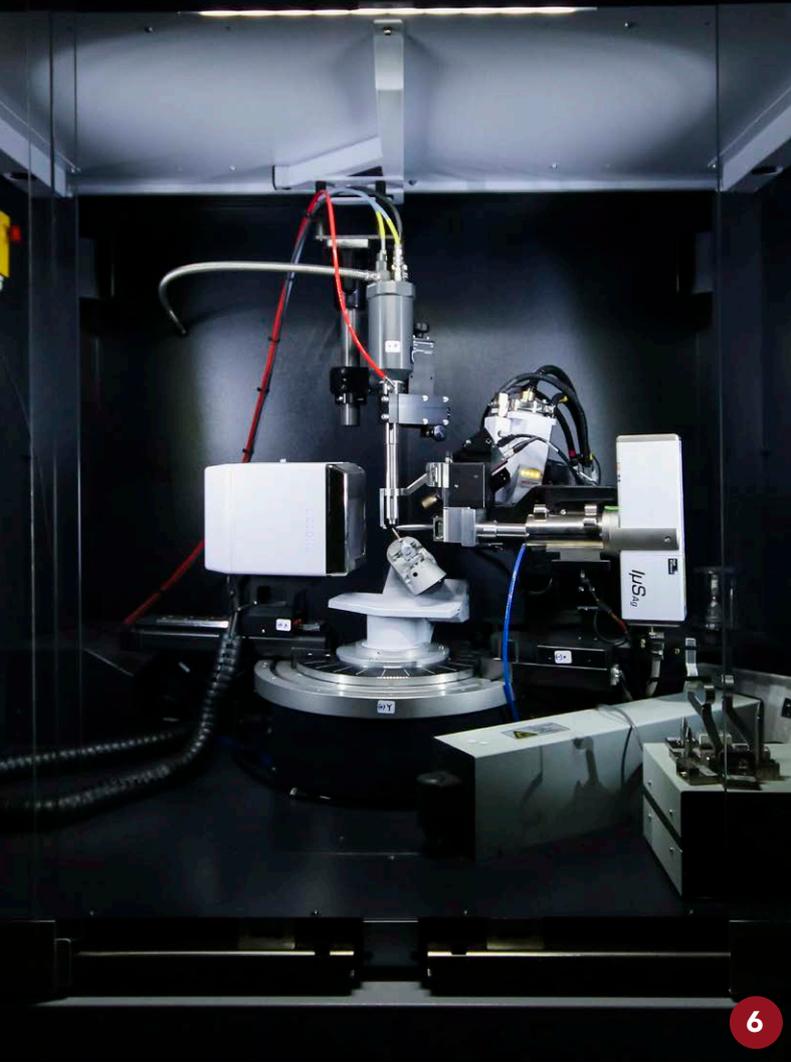
CURIOS.TY

Research . Rethink . Relearn

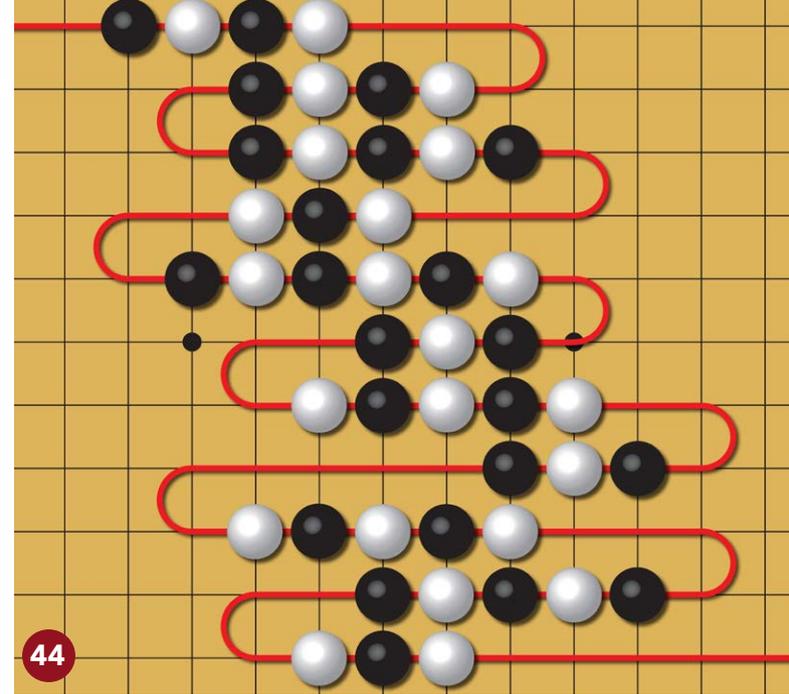


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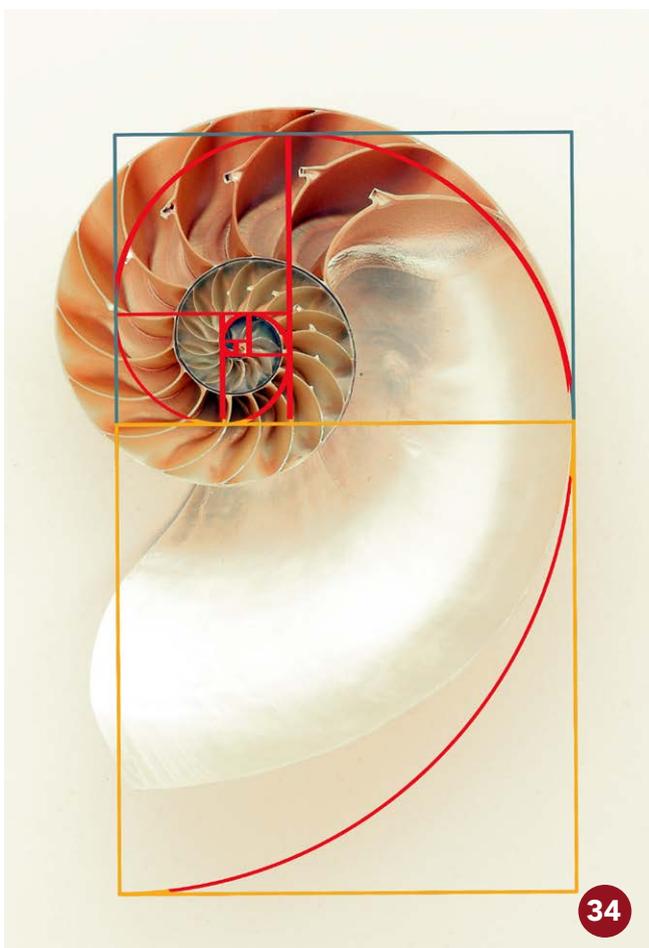
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NEXT ISSUE

The next issue of *Curios.ty* is themed GREEN. We invite Wits academics and postgraduates to submit 200 words outlining their research that relates to global change, climate change, Earth, nature, 'going green' (or not), or any interpretation of GREEN in theory or practice that is grounded in research. We will consider these submissions for story publication in *Curios.ty* 9, the GREEN issue. Email curiosity@wits.ac.za. See previous issues at www.wits.ac.za/curiosty.



UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG



ENABLING THE FUTURE THROUGH DECODING THE PAST

Anyone who knows me will know that I am a physicist with a keen interest in history and the history of technological developments in particular. I am a firm believer that we learn from the past to build our collective futures. As Wits approaches its 100th anniversary, the timing is appropriate to decode some of the University's innovations that open up endless possibilities in the 21st Century.

Take our advances in moving from binary to quantum computing as an example. In the 1960s, Wits was the first university to host an IBM mainframe computer in Africa (p. 50). Today, Wits is the first African partner on the IBM Q Network, enabling academics across Africa to enter the quantum computing universe. Quantum computing is exponentially faster than classical computing and promises to solve problems – from chemical simulations to reducing the time for drug discovery.

This issue of *Curios.ty*, themed CODE, explores how we decipher and create meaning out of systems, letters and symbols. For those caught in the hype of the Fourth Industrial Revolution, CODE is associated with computer coding, big data, artificial intelligence, and machine learning – all areas in which Wits leads currently. Read about Wits' 4IR efforts on pages 6, 8 and 12. And yes, it's good for your kids to learn to code (p. 16).

This issue also explores CODE-related climate change modelling (p. 30), decoding knowledge and languages (pages 14 and 42), mathematics as a universal code (p. 34), decoding political texts (p. 43), data dominance (p. 46), and representation in the arts (pages 38 and 40). We delve into issues around data

privacy, ethics, governance and access in a hyper-connected world (pages 8 and 24). Transdisciplinary and multidisciplinary research approaches are evident in many of these stories.

Wits is renowned for its world-firsts such as bouncing the first radar of Northcliff Hill after World War 2 began, but today I found the story on how knitting won the war through Morse code particularly intriguing (p. 18). The first medical school in Johannesburg opened its doors in 1919 (three years before Wits was inaugurated) and amongst its eminent alumni is Nobel Laureate Sydney Brenner, recognised for his work on genetic codes and molecular biology. At Wits today, scientists build on this legacy through advances in precision medicine (p. 24) and revolutionising the treatment of haemophilia, a genetic blood disorder (p. 26).

There are hundreds of such stories to tell but too many to reflect on these pages alone. Let's start the conversation ahead of 2022 as it is only through understanding yesterday that we can shape today and create tomorrow.

Professor Zebulon Vilakazi
Deputy Vice-Chancellor: Research and Postgraduate Affairs

Curios.ty is a print and digital magazine that aims to make the research at Wits University accessible to multiple publics. It tells the stories of pioneering research at Wits through the voices of talented researchers, students and academics. First published in April 2017, *Curios.ty* is published three times per year. Each issue is thematic and explores research across faculties and disciplines at the University that relate to this theme. The theme of issue 9 is CODE. This refers to any systems, letters and symbols that have meaning, are representative, or govern behaviour. In 2019, CODE is also associated with computer coding, big data, artificial intelligence, and machine learning. *Curios.ty* explores not only these Fourth Industrial Revolution manifestations of code, but also our genetic code, cryptic codes in queer conversation, political speak and knitting, and interpreting meaning through words, animation, theatre, and graffiti. We delve into data surveillance, the 21st Century 'Big Brothers' and privacy, and we take a gander at how to win the Lottery by leveraging the universal code of mathematics. Spoiler alert: rather decode casinos.

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FEATURED

RESEARCHERS

A number of Wits experts are featured in this edition of *Curios.ty*. View the profiles of all the researchers and contributors at: www.wits.ac.za/curiosity 

BRIAN ARMSTRONG

Professor Brian Armstrong holds the Wits Business School (WBS)/Telkom Chair in Digital Business, the first of its kind in Africa. A self-professed “business scientist” and “scientific businessman”, Armstrong has a passion for the science behind digitalisation, and how it applies to the business context from a business model/strategy point of view. He describes digitalisation as “a concept that is over-traded but under-researched” and the Chair thus seeks to ensure that the WBS conducts research and teaching that enables business in a digital world. (Story: pages 8 to 11).

AMES DHAI

Professor Ames Dhai is the Director of the Steve Biko Centre for Bioethics at Wits, which she established in 2007. Dhai is an ethicist of international standing with an outstanding record in academic citizenship. Her inaugural lecture in September 2017 unpacked the evolution of protectionism in health research in South Africa from the 1800s. She is a medical doctor who specialised in obstetrics and gynaecology. She also holds a Master's in Medical Law and Ethics and a PhD in Bioethics and Health Law. (Story: pages 24 to 26).

ABDULLAH ELY

Associate Professor Abdullah Ely completed his PhD in the Antiviral Gene Therapy Research Unit at Wits in 2009, focusing on exploiting the RNA interference pathway to silence Hepatitis B Virus (HBV) replication. Since graduating, he has continued to develop novel gene therapy-based approaches to combat chronic HBV infection. In addition to his role as a researcher, he is actively involved in the training of postgraduate students. (Story: pages 24 to 26).

RAIMI GBADAMOSI

Professor Raimi Gbadamosi is an artist, writer and curator. He is a Research Associate at the Wits Institute for Social and Economic Research (WiSER). He holds a doctorate in Fine Art from the Slade School of Fine Art, London and is a member of the interdisciplinary research group *AfroEuropeans*, University of Leon, Spain.

His media include multiples, music, websites, writing and audience participation. His works create debate rather than representing preconceived concerns defined by specific social, cultural, and political cant. (Story: pages 44 and 45).

SAMKELISWE KHANYILE

Samkelisiwe ‘Sam’ Khanyile is a junior researcher at the Gauteng City-Region Observatory (GCRO). She holds an MSc in Geographic Information Systems and Remote Sensing from Wits. Her research interests converge at the impact of mining on surrounding communities, and access to information. She is part of the GCRO's Graffiti in the City project, the goal of which is to understand the role of graffiti in urban spaces and involves the development of an app to document graffiti sites in Gauteng and Durban. (Story: pages 20 and 21).

DINEO MPANYA

Dr Dineo Mpanya is a specialist in nuclear medicine and molecular imaging. She lectures in Nuclear Medicine in the Division of Cardiology at Wits, where she is also a PhD candidate. She integrates medicine and computer science to develop supervised machine learning algorithms that predict the risk of in-hospital mortality and hospitalisation in heart failure patients. In 2019, Mpanya received the Discovery Foundation Award for academic fellowship, which recognises innovators and inventors in health care. (Story: pages 28 and 29).

SHIVAN PARUSNATH

Shivan Parusnath is a PhD candidate in the School of Animal, Plant and Environmental Sciences at Wits. He researches the population genetics of the sungazer (*Smaug giganteus*), a threatened lizard species. His Master's research findings on the sungazer's conservation status influenced the national legislature on their trading. Parusnath now researches the use of genetic barcoding and social media to track illegally traded reptiles. He was a participant in the 2017 National Geographic Young Explorer Leadership and Development Programme and is an award-winning photographer. (Story: pages 32 and 33).



BRIAN ARMSTRONG



AMES DHAI



ABDULLAH ELY



RAIMI GBADAMOSI



SAMKELISWE KHANYILE



DINEO MPANYA



SHIVAN PARUSNATH

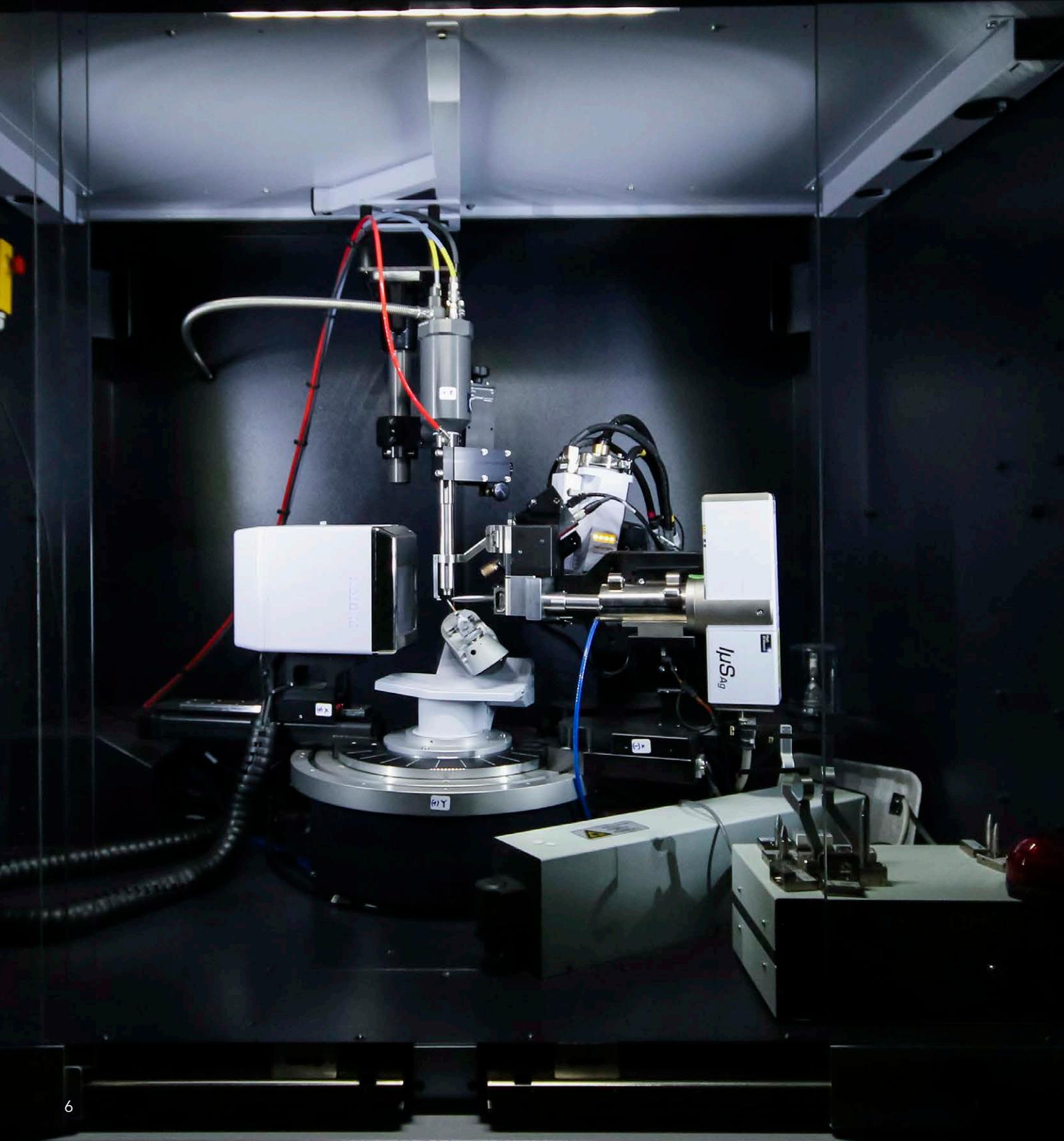


HELEN ROBERTSON

HELEN ROBERTSON

Dr Helen Robertson is a Lecturer in the School of Computer Science and Applied Mathematics at Wits. She trained in analytic philosophy and now works on projects at the intersection of philosophy and computer science. Her primary research is in theory of knowledge, with long-standing interests in Kantian epistemology and a more recent interest in debates within the philosophy of machine learning. In her teaching, she introduces data science students to normative and applied ethics. (Story: pages 8 to 11).

SURFING THE DATA TSUNAMI TOMORROW



Humankind is facing an ever-growing data tsunami that could swamp us as a species – or provide us with unheard of opportunities.

SHAUN SMILLIE

We have entered an age where information is being released at increasing rates. Ninety percent of all data generated in the history of humankind were produced in just the last two years. Mining and analysing this data will require new technologies and skill sets, and this is where universities like Wits hope to play a role. With new technologies come the promise of jobs, medical breakthroughs, and scientific discoveries. And it is all so new.

"Data analysis and data science were not fields of study 15 years ago, so some of the jobs to be created by this technology do not exist," explains Professor Zebulon Vilakazi, Deputy Vice-Chancellor for Research and Postgraduate Affairs at Wits. "So the future of data is about the future of jobs."

MANAGING MASS INFO IN AFRICA

Vilakazi's mandate is to both position Wits for this future and help South Africa and Africa leverage it. There have already been projects where South African scientists have had to tackle big data. The Square Kilometre Array (SKA) in the Karoo is now generating more data than the Large Hadron Collider in Geneva. And the SKA is still in its infancy and promises to spew out even more data in the decades to come. "So there has to be a future where we need to be thinking how we manage this data," says Vilakazi.

As a species, humans are not neurologically wired to process all this information. Adam Pantanowitz, a biomedical engineer in the Wits School of Electrical and Information Engineering, says, "Dealing with data in the future is going to be a challenge and an opportunity, and one of the main ways we are going to tackle this is through machine learning and artificial intelligence [AI]."

Both these technologies will enable us to process and make sense of vast amounts of data. Wits has joined several projects across the continent to deal with the data management challenge. In 2019, Wits became the first African partner on the IBM Quantum Computing (IBM Q) Network, which will include 15 African Research Universities Alliance (ARUA) partners. This network will enable researchers to use quantum computing and machine learning in fields such as cosmology, molecular biology and HIV drug research.

Wits University is also a founding member of the 4IRSA, which aims to help South Africa respond to the challenges of the Fourth Industrial Revolution, through research. By harnessing data and utilising it to its full potential, Pantanowitz believes the spin-offs will be immense.

"A huge belief I have is that the most successful cities, nations and continents of the future will be those that will be able to sense their environment and create feedback loops that act rapidly on that environment," he says. "We would be able to make better decisions from a resourcing and governance perspective."

THE AFRICAN ADVANTAGE

Although it may appear that Africa – with its lack of infrastructure and digital divide – is ill prepared for such a future, this might be to the advantage of the continent, believes Vilakazi.

"Being behind means you can leapfrog, so we must take

advantage of our disadvantage," he says. "There has been a lot of work over the last decade. Cables are being laid across the entire African continent, and we are experimenting with new protocols of wireless transmission, like 5G tech."

Networks have also been established across the continent to share knowledge and help Africans develop their own technologies. Dr Benjamin Rosman, a Senior Lecturer in the Wits School of Computer Science and Applied Mathematics, is a founder of the Indaba programme. "The programme aims to increase African participation and contribution to the advances in artificial intelligence and machine learning," he says.

"The future of data is about the future of jobs."

Participation has grown remarkably over the last couple of years, but being able to leapfrog existing technology means having something with which to replace it. In the Wits School of Physics, scientists are working on something that could one day transport huge packets of data.

Professor Andrew Forbes and his team are working on using light patterns to increase the bandwidth of communications systems one hundred-fold. These patterns, because they are unique, can be used to encode information. This communication system will work over "free space" – meaning through the air – so no infrastructure, such as cabling, is needed.

"We have trialled it in the laboratory and it all works. Now we have a local company that has ceded their IP [intellectual property] to us and we plan to use this IP as a platform to build a practical device," says Forbes. "We are hoping in the next few years that we would have taken the lab demonstration through to a device that can then be commercialised."

With the ever-increasing utilisation of data come issues of ethical use. Already there are allegations of elections being swung through the information gleaned from millions of social media accounts.

Rosman is working on the ethics around AI in collaboration with the Wits Philosophy department.

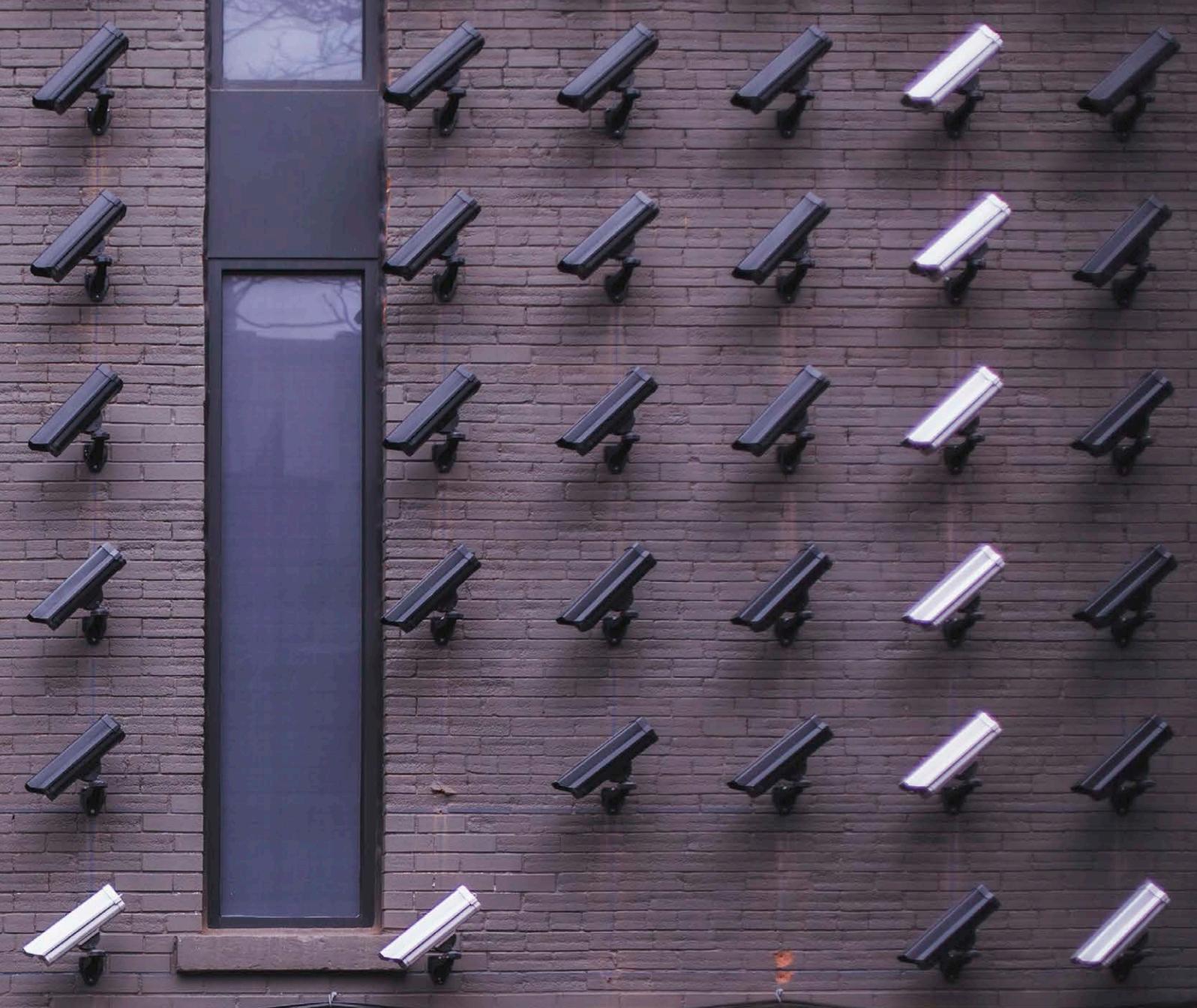
"We have been looking at what should be happening with AI in Africa. There are a lot of questions on what kind of expectations people should have, what should be taken into consideration when these systems are built," he says.

Another issue is that of culture. "It is important to get more involvement from society, and for people who think about societal norms and values and ethics to get involved in these conversations, otherwise they are just kind of implicitly dealt with by whoever designed the system," he says.

Ultimately, it is going to come down to just how we are going to deal with that data tsunami and if we learn to surf that wave to a brighter future. 



FAIR TRADE: YOUR SOUL FOR DATA?



In an increasingly data-driven world, are we just walking data sources for the benefit of giant multinational corporations? Retha Langa explores the depth of where our virtual identities lie in the future.

Every single minute, there are 3.8 million search queries on Google; 4.5 million videos watched on YouTube; almost \$1 million spent online; 41.6 million messages sent via WhatsApp and Facebook Messenger – and these are a fraction of the interactions that currently happen online.

As we go about our daily lives – sharing our personal experiences on social media, asking Siri to set our alarms, and counting how many steps we walk on our wearables – we are essentially becoming walking data points, where our information is collected and analysed to predict behaviour. Where will it end?

Professor Turgay Celik, Director of the National e-Science Postgraduate Teaching and Training Platform (NEPTTP) and the Wits Institute of Data Science (WIDS), predicts that in the next 10 to 15 years, humans will be “directly connected to cyber space

without using devices” – “Your brain will be directly connected to the internet,” he says.

Wits Biomedical engineers have already connected a human brain to the internet in real time. This Brainternet project essentially turned the brain into an Internet of Things node on the World Wide Web. In 2019, the same team connected two computers through the human brain and transmitted words like ‘hello’ and ‘apple’, passively, without the user being aware that a message was present.

“Do we really need to have our physical bodies to experience life, or do we only need to have our own brain?” asks Celik. “We will be seeing the systems creating those virtual environments to give humans an experience of nature. You want to go and see the sea, but do you really need to physically go there? Can I stimulate a part of my brain to give me that experience?” Not long ago, these ideas were part of an extravagant plot for Arnold Schwarzenegger sci-fi movies.

ANDROID RIGHTS AND THE BIG OTHER

Dr Christopher Wareham, Senior Lecturer in the Wits Steve Biko Centre for Bioethics argues that we need to think about the implications of such technological developments from the perspective of artificial agents. These “digital beings” will potentially have lives – and rights – of their own.

“Traditionally the focus on this question is very much on the other side of the issue: How are we going to stop them from harming us? There is very little work that looks at it from the other side. How are we going to prevent humans from harming this being, experimenting on it? Should there be laws that protect this type of being?”

The developments in machine learning and artificial intelligence (AI) already significantly affect how we live our lives today. American academic Shoshana Zuboff coined the term ‘surveillance capitalism’ in 2014. Surveillance capitalism depends on “the global architecture of computer mediation... [which] produces a distributed and largely uncontested new expression of power”. Zuboff christens this the “Big Other”. Currently, the “Big Other” includes Facebook, Google, Microsoft and Amazon.

SURVEILLANCE CAPITALISM

Writing in *The Guardian*, Zuboff explains, “The logic of surveillance capitalism begins with unilaterally claiming the private human experience as free raw material for production and sales. These experiences are translated into behavioural data. Some of this data may be applied to product or service improvements, and the rest is valued for its predictive power. These flows of predictive data are fed into computational products that predict human behaviour.”

Surveillance capitalism is a “real issue”, says Professor Brian Armstrong, Chair in Digital Business at the Wits Business School. “In my view, a very big concern is around the whole idea of social scoring.” This refers to the practice of developing a social rating system to establish if a person is a fit and proper member of society, in terms of their “social score”.

In China, private companies are already operating social credit systems, as is local government in pilot projects. The plan is to develop a nationwide system that scores the individual’s behaviour, including giving citizens a score and adding rewards and penalties for specific actions. For example, if you donate to charity, you score points but you lose points for traffic violations.

But one need not look as far as China for Big Brother-style surveillance. In Johannesburg, thousands of surveillance cameras already monitor motorists and pedestrians 24/7. In June, the *Financial Mail* reported that Vumacam – a subsidiary of internet fibre company, Vumatel – had installed more than 1 200 surveillance cameras to combat crime. By 2020, the number of cameras will increase to over 10 000.

Local security companies can access the Vumacam live feed and, as the artificial intelligence system learns what a typical day in a neighbourhood looks like, it will flag behaviour that is out of the ordinary for that area. Dr Helen Robertson, who lectures Data Privacy and Ethics in the School of Computer Science and Applied Mathematics, refers to the battle between our right to safety and our right to privacy that such forms of surveillance bring to the fore.

“It strikes me as plausible that we think our claims to safety have increased weight in contrast with our claims to privacy. If the relevant algorithms are going to identify abnormalities in the footage, we need to keep in mind how good these algorithms are or aren’t.”

SAFETY VS. PRIVACY

Our views on privacy have not only been impacted by safety concerns. The pervasiveness of social media has also played a role. Robertson says that the average person is willing to share a lot more about their private lives today compared to a few decades ago. These evolving views are not necessarily problematic. “It might simply be a matter of one society’s convention in contrast with another society’s convention, and how they tend to feel with regard to how much they are willing to share.” Celik believes that privacy will become personalised, with individuals being able to define how much privacy they want for themselves.

Our autonomy is another area influenced by the online world. Wareham argues that a lot of micro-targeted advertising and political messaging is designed specifically to degrade our autonomy. “If you do a Google search now, you’re not going to get an unbiased sample of information ... you’re going to get information that Google has catered for you to get ... these sorts of micro-targeting ... want to trigger you through nudges to behave in certain non-rational ways.”

The question then becomes about who decides what you read, listen to, or watch, and who makes the decisions on what content is “appropriate” for a specific digital platform, and what is not.

TOWARDS TECH THAT TEACHES

Data-driven advancements are, however, not all doom and gloom. “Data in itself is not agnostically good or bad, but it is what we do with it. It can be abused, or it can be used for very positive purposes,” argues Armstrong, adding that education is one area in which South Africa could benefit immensely.

“If we were able to use learning management systems more efficiently to see how students are learning, to see what material they are struggling with ... to learn what teaching styles work best, we can individualise the learning experience.”

In China, AI-enabled education has already blossomed with tens of millions of students using some form of AI to learn. This includes tutoring platforms where algorithms curate lessons and adapt the curriculum based on an individual’s understanding of specific concepts, reports *MIT Technology Review*.

PROTECTING PERSONAL DATA

Staggering amounts of data are generated daily, but who owns all this data? Robertson points out that there is currently no consensus among ethicists about this thorny issue. Some argue that the data subject owns the data. Others say that the data processor who uses his/her resources to create and analyse a dataset has ownership rights, while some argue that in certain cases, such as medical research that benefits society, the public’s need for medical treatment and breakthroughs mean that data belong to the public.

These different claims to ownership “add a lot of ethical greyness”, says Robertson. “The ownership of data is particularly difficult. It is an object that can be traded, but at the same time, it has a reference to an individual, something like other artefacts do, such as photographs. The rights certainly seem to pull in different directions.”

“It strikes me as plausible that we think our claims to safety have increased weight in contrast with our claims to privacy.”

In the near future, South Africans will have considerable legal power regarding the protection of their data. The Protection of Personal Information Act (POPIA) aims to protect the right to privacy, while enabling the social and economic benefits that result from the free flow of information. POPIA stipulates conditions under which personal information must be processed lawfully, although there are exceptions.

These conditions include that personal information “must be collected for a specific, explicitly defined and lawful purpose”. Further processing of personal information can only take place if it is in line with the purpose for which it was originally collected. Most sections of the Act have not yet commenced. The announcement of a commencement date is expected before the end of 2019, after which companies will have one year to comply.

Ms Verine Etsebeth, a Senior Lecturer in the Wits School of Law who specialises in data protection and information security law, says the POPI Act is long overdue. “The sooner it is in practice, the sooner it can come before our courts and we can have precedents set,” says Etsebeth. “It is going to be survival of the fittest. If your competitor complies and you don’t, you won’t be able to retain your customers. Companies will realise just how much their reputations are worth.”

DIGITAL DISEMPOWERMENT

Despite the excitement over technology’s potential to solve some of our most complex problems, many South Africans are still excluded from these advances. Only 40% of Africa’s population has access to the internet compared to 61% for the rest of the world. In South Africa, internet penetration currently sits at 56%.

“In today’s world, digital disempowerment is one of the most profound forms of disempowerment,” says Armstrong. “Digital disempowerment comes in three levels. The first is do you have access, secondly do you use it, and thirdly are you engaged, transacting and impacted? In South Africa, you don’t have access if the networks don’t cover where you are, or if you can’t afford the mobile device ... or if you can’t afford the price of data. In all of those areas we have a challenge.” 



PLUGGING DIGITAL LEAKS

Big data is a big conversation. It's also leaving behind a big mess. Data are gathering in pools and lakes and as we dip our toes into these murky waters, we see a sign that says, 'Here be dragons...'

TAMSIN OXFORD @ LAUREN MULLIGAN

The student standing in the corner tapping updates onto her Instagram profile. The tutor sending a quick WhatsApp to his wife, 'Sorry, I'm going to be late'. The accountant uploading documents to the company intranet. Marketing releasing the monthly newsletters. Each individual adding another byte to the data lakes pooling in virtual space, filled with structured and semi-structured data that teases insight and value but never quite seems to deliver.

OCEANS OF INFO

This data is supposedly capable of helping decision makers gain granular insight into their business yet the nature of data is constantly changing in both how it is captured, why it is analysed, and what value it can deliver. It's an evolution from hastily scribbled notes about the good, the bad and the organisational ugly into digital archives that have swollen with information that has no context or relevance and yet whisper about possibility.

"The computer revolution made it economical for data to be stored in increasingly complex and ever expanding data storage solutions," says Phumlani Khoza, Associate Lecturer, School of Computer Science and Applied Mathematics and leader of Scilinx Research, a business solutions design and research laboratory.

"The problem is that data hasn't been strategically recorded in such a way as to deliver a specific economic value, or considered in light of 'If we do X with the data, then we will achieve Y'. Instead we now have tons of data and no clear vision or idea on what to do with it or how to get it to share its most valuable secrets."

POTENTIAL IN THE POOL

Khoza teamed up with 10 other researchers to develop Scilinx Research with the goal of advancing the operational capabilities of organisations through a hybrid structure that targets the generation and application of value-creating research insights. In short, brilliant minds applying themselves to the data conundrum, working to pull out its potential from the mess that relentless data collection has left behind. The goal is to create

intelligent networks that define the next generation of analytics and how data relationships are interpreted across multiple data platforms and sources.

At the peak of the big data hype, people were trotting in with fancy algorithms and mathematical constructs supposedly designed to whisk out insights from within these lakes of data. Yet what they saw, what they found, didn't make much sense. The problem wasn't the data but the questions that people were asking. Pipelines built to carry data insights into stressed executive offices literally leaked insights from every conduit but they lacked relevance. Where was the insight that would help the business make a decision that would positively impact bottom line or customer engagement?

DATA CONUNDRUM

"Businesses were told that if they built these data centres and gained access to all this computational capacity that they could extract economic value from this data," says Khoza. "But when it came time to do this extraction, it couldn't be done. The off-the-shelf solutions were incapable of dealing with the heterogeneity [differences] of the data. These collections of data across email, social media, and operations, that were different dependent on the organisation, were impossible to unify into single solutions. You cannot interpret the data-powered insights from a supply chain company against one that operates in financial services."

What happened next? Companies started to invest into the potential abilities of emergent technologies such as machine learning (ML) and artificial intelligence (AI) – technologies capable of deep diving into the data and scouring the murky depths for even the tiniest grain of relevant insight. These technologies are essentially the pen needed to connect digital dots. Yet they too slip at one hurdle – context. Is the data generated for the marketing department being interpreted by a data scientist who understands what marketing needs?

SCIENCE-LINK SOLUTIONS

"Scilinx combines machine learning and science to find out what is happening," says Tresia Holtzhausen, a member of the Scilinx Research team and a lecturer at Nelson Mandela University. "Everything around you is a system and these

systems can be represented by networks and managed by ML and AI. We examine where we can improve and optimise data interpretation, using techniques that are not embedded in traditional mathematics but that emphasise the connection to maths and network science, to find out where to make the most improvement and to see what's happening underneath the waters of big data."

There is so much information. Vast quantities of data with no context, no point of reference, all gathered relentlessly from the moment that someone said, 'Gosh, maybe this could be useful one day.' Through the Scilnix Research work, the team has developed a prototype that can pull data from multiple sources such as twitter, PDF documents, and emails, and build a picture of what is going on.

"We are taking particular datasets and applying a range of ML techniques, some we have developed from scratch, and seeing the results we get, then working out a systematic approach to integrate them," says Khoza. "We draw a narrative across varied datasets and unlock the relationships hidden within."

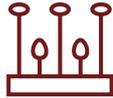
This research combines the information to create analysis that allows the business to make systematic and relevant decisions. It helps the organisation to pull together data from multiple sources and spaces to create a coherent picture. From the broken cash machine (backend alerts) to the outraged consumer (tweets of fury) the data is collated with context and relevance to present an outline of the real business situation.

"We now have tons of data and no clear vision or idea on what to do with it or how to get it to share its most valuable secrets."

"Nobody has the right answer – we are all partially right and partially wrong," concludes Khoza. "If, together, we can erase our biases and create a more accurate representation, then the data have inordinate value. Data allow us to understand why things happen, what people do, and why things have gone wrong. It allows for the business to change and improve, to adapt to what the market wants. As we become increasingly adept at adding context to the data and asking it the right questions, the more we will see how everything is connected."

The data mess is tidied up not with a plug in a panic, but by dropping a stone into a lake and watching the ripples as they expand outwards and influence markets, businesses, individuals and insights. There, within those myriad mixes of sentiment and data lay the answers the business seeks, not trapped in numbers but revealed in relationships. 





WHY WORDS MAKE LANGUAGE

From hieroglyphics to emojis, and grunts to gestures, humans have always used multiple modes to communicate. Language is one such mode and we who use it will define its evolution and future.

SHANTHINI NAIDOO

If you've ever sent a text using emojis, which the recipient received and understood, then you've communicated in a new language code. Communication codes have been with us since the grunts of our ancestors developed into the first languages – Aramaic, Sanskrit, Tamil – the latter having made an appearance in 300 BC and considered the world's oldest language.

Dr Gilles Baro, a sociolinguist at Wits, says that what we consider languages today are "organised, systematised guides to communication". "People have always communicated using multiple modes, such as gestures, sounds, words, scripts and images. Languages are one of those modes and they are not 'invented'. Rather, people – usually the elite – decide on a norm for communication, and that is what we consider 'language' today."

LINGUISTIC MIGRATION

Over time, this code evolves, says Maxwell Kadenge, Associate Professor and Head of the Department of Linguistics in the School of Literature, Language and Media at Wits. And where this code will be in future is anyone's guess.

"Languages evolve naturally as a result of the migration of people, which in turn results in languages getting into contact with each other. Think of Afrikaans, which was originally spoken by the Dutch, but began to develop distinct characteristics as a result of its contact and borrowing from South African languages, especially Khoe and San languages."

Similarly, says Kadenge, South African spoken languages that evolved because of contact between existing languages include

Fanagalo and *Tsotsitaal*. “Both of them have borrowings from Bantu languages like Zulu, Xhosa, English and Afrikaans. *Chilapalapa* developed in Zimbabwe [then Rhodesia] from the contact between English, Shona varieties and Zambia languages,” he says.

BRAVE NEW WORD

Baro says that along with migration, new environments and technology also influence how language evolves. Emojis and text language are an example of how spoken language has merged with digital communication.

“Today, considering the internet, language is more open and in a way more vulnerable to be changed or influenced. We are exposed to a lot more variations than in the past. For example, a study done at the University of Cape Town showed the increasing use of the word ‘like’ as a quotative, hedge, or discourse particle by young South Africans was influenced by their exposure to North American popular culture, via movies and songs. Often the accent and vocabulary of a nearby community will influence a language too, through the borrowing of words.”

A quotative is a grammatical device to mark quoted speech – essentially “spoken quotation marks” – while hedge and discourse particles make speech less direct and manage the flow of dialogue.

DEGREES OF UNDERSTANDING

“The word ‘language’ is broad and fluid, as it has both linguistic and political connotations. In simple terms, a language is a communally owned means of communication, which is passed on from one generation to the other through the process of socialisation,” says Kadenge.

The reason we have differences in languages and dialects is essentially to understand each other in a particular space and time. “One of the criterion that are used to consider varieties such as dialects of the same language, or as distinct languages, is mutual intelligibility. This simply refers to the degree to which speakers of different languages understand each other in the same conversation,” he says.

Kadenge explains: “Normally, varieties that are mutually intelligible are considered dialects of the same language. For example, the Zimbabwean language – Shona – is made up of four main dialects, namely Karanga, Zezuru, Korekore and Manyika, whose degree of mutual intelligibility varies. These varieties are considered dialects of the Shona language. However, Scandinavian languages – Danish, Norwegian and Swedish – are mutually intelligible, just like the Shona dialects, but are considered different languages, probably because they are spoken in different countries. Against this background, the question on what makes a language a language is not easy to define.”

EmpoWORDment

Some would argue that language is steeped in our identity, and can separate communities. Baro says variations in language are also clues to particular traits of identity. “So when hearing someone use language, we can guess their gender or sex, race, class, etc.”

Language, being a social aspect of life, has the power to divide as much as it brings people together. In South Africa particularly, it is contentious when public discussions are held in a language that only some can understand. People who cannot speak the language would undoubtedly feel excluded from the group.

“Languages signify identity and belonging. This is primarily because people who speak the same language understand each other, the languages contain words that all the members of a community understand,” Kadenge says.

“In South Africa, due to internal colonialism, some big and politically powerful groups tend to suppress smaller groups. This is evident in language policies and practices. Why is it that the national anthem has English, Afrikaans, Nguni and Sotho languages but does not include Venda and Tsonga languages? The national anthem is one of the main national symbols; sacrosanct heritage and rallying point of the country. This tells you who is in power and who is not. Language symbolises power, and when you exclude some languages in the linguistic landscape, such as a national anthem, you are disempowering the speakers.”

“A language is a communally owned means of communication.”

CULTURE CARRIER

But language also allows us to pass our cultural values and sensibilities from one generation to another, says Kadenge. “Hence, we usually say language is a carrier of culture. It is the means through which we share our values and socialise our children.”

Simultaneously, language also allows us access into other cultures. “Many people around the world now have access to the Chinese culture because the Chinese language is spreading around the world through the establishment of Confucius Institutes and the teaching of the language all over the world. This is how English culture has spread around the world. English is now considered a global language. Right now, South Africa is strengthening its links with East Africa by introducing the teaching of Swahili in its education system. It is why Swahili has been taught at the University of Zimbabwe for a while.”

THINKING ALOUD

While the number of spoken languages is said to be reducing globally, language code is developing in other ways. English is being manipulated, moulded and restructured using psycholinguistics, or psychology of language, which considers the way that it is shared and understood.

Baro adds, “Agency is important, meaning that people purposefully make use of different variations of language in order to *perform* aspects of identity. Formality versus informality, humour, or wanting to sound serious, for example.”

“Because of our agency to use language as one form of communication, we get to express ourselves using language based on how the language and its different forms or variations are perceived in society. One will use different forms of language if they want to appear friendly or unfriendly, for example. This is why language is considered a system, because each word, sound, accent, variant, indexes a particular meaning,” says Baro. 🗨️

DO KIDS NEED TO CODE?



Faster than you can say “Fourth Industrial Revolution” is how quickly technology becomes obsolete. Preparing for a digital revolution is as much about getting the basics right as it is looking to the future.

UFRIEDA HO

Artificial intelligence (AI), robotics and greater automation is on the horizon. But, says Mitchell Cox, a Lecturer in the School of Electrical and Information Engineering at Wits, the dreams of AI and the 4IR are not the things to worry about, if we lay the foundation of teaching and learning that builds the critical skills of problem solving, reasoning and logic.

READING, WRITING, REASONING?

Back to basics, he says, can start with setting the foundation of maths skills at a primary school level. It's the first building block of computer programming or "coding", Cox says. Maths presents a way to break down complex problems into components, allowing us to organise our thoughts and processes to allow solutions to be constructed – it's a thought process at the heart of coding, which in turn is at the heart of making computers do what we want them to do for us.

Programming is not likely to become obsolete in the near future, but it will certainly evolve and become more sophisticated, as the relationship between people and machines evolves and become more sophisticated.

"Programming is never going away; programming gives the instructions to computers to perform more of the mundane, routine tasks. Automation frees people up to do more creative things, solve other problems or even become more sophisticated programmers," he says.

CODING FOR COMMUNICATION

Cox also believes that basic proficiency with code is a useful skill for everyone to have, regardless of age or discipline, especially in an era of hyper-customisation or personalisation of devices and apps. It's the difference, he says, between using more of the functionality of an Excel spreadsheet or getting better results from a Google search. He calls it "speaking Google" fluently.

"Speaking" to computers is one element of building skills for the future. The other is better communication. Cox says that communication allows for better collaboration across disciplines and that the ability to factor in different perspectives allows creativity to flourish.

"It's why we teach in a way that's that not about giving students all the answers or all the ways to find answers. Allowing them to figure out things for themselves, to follow their own leads, teaches them adaptability and resourcefulness, which are the skills they will need to survive," he says.

EMPOWERING HUMANS

Preparing the next generation at foundation phase level are the likes of school teacher Dorian Love. He teaches coding at a private all-girls school in Johannesburg and believes coding skills recalibrate the power balance between people and computers in human beings' favour.

"For me it is about finding the most humanising approach so humans determine how machines serve us," he says. Love completed his Master's at Wits University researching the role of knowledge in Information Communications and Technology (ICT)

integration at his school, through the principles of Legitimation Code Theory (LCT – a sophisticated framework for exploring practices in terms of their organising principles or 'legitimation codes').

Love says it's as much about making all teachers less afraid of technology as it is about convincing girls to become interested in coding. Demystifying coding and showing its real life implications can help close the gender gap that still exists in the world of tech.

"I tell the girls that men still dominate when it comes to things like developing computer games and, because men and women experience colour differently, men get to decide on the colours, even in games. It's one way to get them [girls] thinking about why having coding skills can mean women have a greater say in the world," he says.

“Coding skills recalibrate the power balance between people and computers in human beings’ favour.”

DIGITAL FUTURE POTENTIAL

Lesley Donna Williams, who heads up Wits Tshimologong digital innovation incubation hub in Braamfontein, says coding introduced at school level allows young people to have an extra "language", even if they choose not to become programmers.

"It's a bit like you may never know what's going on inside your TV that makes it work, but you want to know how to use the remote so you can get to the channel that you want," she says. Williams adds that the current panic – about the digital divide and people who don't code falling through the cracks – is not productive.

"We need to create a way of thinking that allows people to use technology as an enabler. We need to help children find their unique value and to think like entrepreneurs in using this unique value, together with technology. For that, we all need to be continuous learners, be agile and be attuned to the world around us – we should be connecting more across the continent right now for digital innovation."

It means there's work to be done in the present and opportunities in the moment that need to be seized so that our digital future is to be one that holds more potential for more of us.

Says Williams: "While there will be job losses in digital transformation, new unknown industries will be birthed giving rise to new forms of employment. We need to focus on developing adaptable skills, because technology will keep becoming obsolete. Coding as a language needs to penetrate the ranks of the education system so we bridge the ever increasing digital divide that low-income communities are not accessing." ■

Craftivists are cracking codes through the duality of handicrafts and activism. They ravel and unravel with knit, crochet and embroidery while coding and decoding without a computer. These hooking hackers have been savvy cryptographers for aeons longer than any computing geek.

STACEY ROZEN

An undercover operative dodging adversaries on a secret assignment makes for a gripping spy novel. Yet, this intriguing yarn about codes and craftivism is a real-life story. During World War II, a secret agent, perceived to be an innocent grandmother, was stealthily observing while clicking her knitting needles.

Granny's stereotypical feminine façade hid encoded espionage messages knitted into fabric. The Belgian resistance had recruited her to record the type and time of trains passing her kitchen window overlooking the railyard.

Granny was a learned artisan with the technical prowess to transform stitch alphabets and patterned configurations into data for intelligence gathering – hidden to the uninformed eye yet decipherable to those privy to steganography [the technique of hiding secret data within an ordinary, non-secret, file or message].

The Office of Censorship banned the postage of knit and crochet patterns abroad, suspecting they held coded classified communications. Yet, it was the knitted garments themselves encoded that the censors never spotted.

CODE NAME: PAULETTE

British spy and proficient knitter, Phyllis Latour Doyle, parachuted into Normandy under the code name Paulette. No ordinary coder, Paulette had handicraft skills she inherited from generations of knitters in her family that resulted in her becoming a brave craftivist with the ability to code in dangerous contexts. She knitted encoded information into scarves and beanies while riding a bicycle through enemy territory. Seventy years later, the 93-year-old heroine received the Legion of Honour in recognition of her courage in assisting the Allied forces. James Bond is an amateur sleuth in comparison. Perhaps he should take up knitting ...

Charles Dickens was inspired by knitting codes to create the fictional character, Madame Thérèse Defarge in *A Tale of Two Cities*. As a tricoteuse, Madame Defarge encoded the name of the beheaded in her knitting as the guillotine fell at public executions during the French Revolution. A gory story captured through the hands of a craftivist.

Even though the term craftivism was only coined by sociologist Betsy Greer in 2003, brave women have been craftivists for centuries. The earliest woven fabric, created using a technique called nalebinding, was found at Dura-Europos archaeological digs and dates back to 265AD.

KNIT-AS-CODE

Computer code is a descendant of knit and crochet code. The analogue code of threaded fibre and the digital code of Internet fibre co-create. Similar to the 0s and 1s of binary computerese, there are two stitches in knitting: knit and purl. An index variable with incremented and decremented operations echoes a knitted row with increased and decreased stitches. Knit and crochet patterns are like computer programmes: input a thread of yarn and output a sweater.

Morse Code knitters use a single purl stitch for a dot and three in a row for a dash creating short and long coded signals. The

“So, contrary to popular belief, Granny is actually on par with her millennial granddaughter’s generation of computer fundis.”

compiler is the craftivist. Knit-as-code is being formally researched by Dr Elisabetta Matsumoto in her physics lab at Georgia Tech. She investigates yarn as a programmable material with stitch patterns more complex than the ones and zeroes of binary.

Granny's knitted espionage secrets were mathematical topologies of slipknots, which makes a grandmotherly Elder a highly qualified tutor at *Knit to Code*, an organisation using knitting as a teaching simulator for computer coding. Both media use the same logic: Learning to knit assists in learning to code. So, contrary to popular belief, Granny is actually on par with her millennial granddaughter's generation of computer *fundis* [experts].

The preservation of traditional handicraft skills for craftivism continues today. Susan Hewes is an extreme handcrafter with two Guinness World Records: the first for knitting the longest scarf and the second for crocheting the longest chain... both whilst running marathons! That's an incredible feat in coding-while-multitasking and raising money for Alzheimer's research.

YARNS THE TELLERS OF US

Another layer of code allows handicrafts to carry personal and collective narratives embodied with thought and emotion. The suffragettes, protesting for women's right to vote, had colour codes for their embroidery threads – purple for dignity, white for purity and green for hope. From Pussyhats, handcrafted to raise awareness about women's issues in the USA, to protest banners handcrafted by Story Scarves to stop gender-based violence in Soweto, craftivism artefacts hold coded clues inciting mindful dialogue in the social fabric of our lives, globally.

Some of these stitched stories are invisibly submerged awaiting decoding. The coded fabric's significance is in its potential to make meaning. Human beings have an innate ability to decipher these meaningful codes. Craftivism is indelibly shaped by code that make our yarns the tellers of us. 



Stacey Rozen is a story-weaver, craftivist, creative arts practitioner and interdisciplinary designer. She will graduate with an MA from Wits in December 2019. Her dissertation focusses on craftivism and the use of handicrafts to inspire social change. She is currently working on a series entitled *Our Yarns are the Tellers of Us*, which delves into the synergy between analogue and digital craftivism for personal and collective narratives. She was director of *Story Scarves*, a craftivism project for young women in Soweto.



STREET TALK:

BEHIND THE TAG

UFRIEDA HO 📍 LAUREN MULLIGAN

Even when the writing is literally on the wall, it can be difficult to understand – particularly in the case of graffiti, which thrives on being different things to different people.



Graffiti is by its nature confronting, contrary and coded. It's the collision point between the two worlds of the mainstream and an urban sub-culture. It's also full of contradictions of being publicly seen, but only truly known to a closed group. It's often bold and deliberate but also fleeting and ephemeral. It makes statements, but hides in anonymity.

The mainstreaming of graffiti in the last few years has also seen graffiti change to include a broad range, from tagging (graffiti artists' signatures) and throw-ups (stylised versions of signatures), to stencil works, street art, public art and even corporate commissions and advertising. These are discrete categories but

share the streets and together they bring a different dimension to the visual language and feel of a city.

COLOUR-CODING JOZI

Wits University's own backyard is a canvas from that which pops up periodically across campus, to what appears throughout Braamfontein and home to Grayscale Gallery and Store, a hub for sub-culture art forms of graffiti, tattooing and street art. The owners are also behind the annual City of Gold Urban Arts festival, which has focused on Braam's unique alleyways for transformation by street artists. There are also artworks under flyovers on the routes to and from Wits, and *The Star* graffiti wall at the throbbing



intersection of Jan Smuts Avenue and Empire Road has been a public canvas for years. The street art in these spaces hints at clues and codes of the clashes, mood and shifting urban agendas of the City.

Jo Buitendach is founder of city tour company Past Experiences. A self-confessed lover of graffiti, one of Buitendach's popular tours takes visitors on a deep-dive into Joburg's thriving graffiti culture. Buitendach completed her BSc in Archaeology at Wits and her Master's on political graffiti at UCT.

KINGS, TOYS, STREET CODE

"All the great cities of the world have a strong graffiti culture," she says of how graffiti and urban identity entwine in a tangle of blight and beauty and the unapologetic bending of laws to breaking point.

"Graffiti culture is not ever going to go away – it's about leaving a mark," she says, even as individual pieces are created to fade, be scrubbed off, or themselves vandalised. She says graffiti culture is about belonging, identity, social hierarchy and structure and even as an alternative form of family.

"Graffiti is about family. Artists work in crews where there's a king at the top and toys at the bottom, so there's structure. There's a code of the streets and the movement too – like not tagging over someone else's work.

Graffiti artists also tag for different reasons; tagging is often seen as vandalism but I think tags are beautiful and they give voice to people – often young people – who are on the margins," she says.

THE TAG VS. THE MAN

Codes are changing though and the rules of the game keep blurring as graffiti becomes a casualty of the era of social media, conspicuous consumption and commoditisation. An artist's Instagram handle may be standard with a tag nowadays as a way to boost profile and



personal brand-building, and to draw work prospects. Corporate commissions of wall murals come with corporate dictates that can reduce free expression to paintjob and sales pitch, and the average passer-by may never know the difference.

Professor Melissa Tandiwe Myambo is a Research Associate with the Centre of Indian Studies in Africa and an honorary research fellow at the Wits City Institute. She says graffiti, street art, public art and paid commissions should be read as parts of a spectrum of what is on city walls today. The rule-breakers have to fight for space with corporate conformists and the dividing lines are sometimes deliberately fuzzy.



"Graffiti suffers from the same fate as a lot of hipster culture. It may begin as counter-cultural but ends up getting co-opted by the corporate sector and then deployed as a tool to market something or other. Ironically, even counter-cultural critiques of mass marketing and consumption get used this way. The growth of social media and branding means everyone is playing the same game now, so sub-cultures quickly become monetised and commodified. When they become popular enough, they are no longer sub-cultures but part of mainstream consumer capitalism," says Myambo, who edited the book *Reversing Urban Inequality in Johannesburg* (Routledge, 2018).

Graffiti though remains a story and a social record. Myambo describes graffiti as "an art form that is meaningful because it's contextual and is open to various interpretations, which can make how it is perceived unpredictable", which is also its nature.

MOOD AND MOMENT

Capturing change, context and being able to offer insight into some connecting points between graffiti and deciphering the mood and the moment of urban life has informed a GCRO (Gauteng City-Region Observatory) project.

GCRO researchers Dr Alexandra Parker and Samkelisiwe Khanyile have been working with Open Data Durban on developing a mobile friendly website that works like an app to create a digital repository of graffiti and street art. It's expected to be ready for public use this spring and will focus on Johannesburg and Durban as its launch cities.

Parker says that a digital archive means that something that is temporary is recorded for analysis and public access. She points to the iconic "We wont [sic] move" graffiti in Sophiatown during the forced removals of apartheid. Photographer Jürgen Schadeberg captured a street scene in 1955 of three men sitting kerbside under the defiant slogan even as the bulldozers were ready to

move in. The photograph is what remains to tell that story.

Khanyile says: "We don't see that much political graffiti as before though there were works from #FeesMustFall that tell a story of that time and that's the kind of graffiti that should be recorded."

ARTISTIC ARCHIVE OF IDENTITY

Parker and Khanyile say that building an archive will allow researchers to use graffiti to understand the identity of a place and what is expressed in public spaces even when it may go against municipal bylaws. They say it maps urban evolution, the evolution of graffiti itself, and the interplay between the two.

The mobile website will allow the public and street artists to upload photographs of works. Its location will be picked up from the metadata of the photo and the person uploading the photo will be prompted to submit details of the artist and the work and to comment. There will be an edit function so information can be verified and updated. Eventually people will be able to search graffiti and street art by neighbourhood and by artist.

Parker adds: "Over time graffiti becomes a collective visual language. It adds texture, vibrancy and colour to dull infrastructure and it raises the question of who gets to decide about the identity of our shared urban environments."

Khanyile says graffiti has given her a different connection to the city that is her home but can sometimes seem given over to crime and grime.

"I'm a scaredy-cat but even if it's just a shift of one percent, graffiti and street art makes me feel more welcome and a little safer and it makes me want to leave the office and go onto the streets to see it. And when I'm driving around the city I'm always excited about new pieces of graffiti and I can't help talking about the different styles and possible meanings to whoever may be with me in the car," she says. 📍

EDITING DISEASE IN SOUTH AFRICA



BETH AMATO

Gene therapy has the potential to alleviate South African burdens of disease but there's a long road ahead to mainstream techniques and ensure that the technology is cost-effective for the majority.

Consider the following scenario: a young South African woman, whose mother developed breast cancer, wants to have a baby. But because breast cancer is often hereditary, the young woman gets tested for the pathogenic BRCA1 gene, a mutation that causes breast cancer. Her result is positive so the woman decides to have a baby via in vitro fertilisation (IVF) – a more precise way to control what the baby inherits.

After undergoing the process, a few embryos are created. Let's imagine the male embryos aren't viable, and that two female embryos are healthy. However, both female embryos test positive for the pathogenic BRCA1 gene. How does one eliminate the chances of developing breast cancer? One way is to edit the genome of the embryo.

ETHICAL BY DESIGN

Human genomes comprise the entire set of genes within an individual and encode a series of messages within the DNA

sequence. A scientist, with molecular scissors, could chop and change the sequence to alter the message it relays. If this is done with this embryo, it may grow into a woman free from breast cancer and its consequences.

Germline editing – the process of changing the genetic code of an embryo – is no longer relegated to the pages of a 1970s science fiction novel. In 2017, a Chinese scientist, He Jankui, used genome-editing technology, CRISPR-Cas9, to produce twin girls (through IVF) that were naturally immunised against HIV. Jankui crippled the production of the protein CCR5, which HIV uses to drive an infection.

Germline editing has been widely criticised by scientists, including US scientist Jennifer Doudna, who helped develop the CRISPR-Cas9 gene editing technique. Molecular scientists and ethicists at Wits University are wholly against germ cell editing, and the misuse of powerful gene editing technology.

Professor Ames Dhali, Director of the Steve Biko Centre for Bioethics, says that the making of the so-called designer CRISPR



“Gene and cell therapies present novel alternatives to disease management, offering the promise of a single treatment and a lifelong cure”

babies could spell disaster for future generations and, indeed, this experimentation has been banned in many countries. “We don’t have enough information about the effects of germ cell gene editing. If you chop something out, we need to know what effect that has on other systems in the body,” says Dhai.

ANTIDOTES FOR AFRICA

The use of CRISPR-Cas9 and other gene editing technology is powerful, however, if used to recode somatic cells – these being any cell in the body that are not gametes (sperm or egg), germ cells (cells that go on to become gametes), or stem cells. Dr Stuart Ali, director of Precision Medicine for Africa, says somatic cell gene editing is particularly useful in targeting viral and bacterial infections, and doesn’t affect the human genome.

Somatic cell gene therapy research (which includes gene editing technology) in South Africa is focused on “high burden” diseases,

such as HIV, hepatitis B, tuberculosis (TB), and cancer. Research Professor at the Perinatal HIV Research Unit at Wits and President of the South African Medical Research Council, Glenda Gray, says that there could be a “serendipitous breakthrough” in curing HIV with gene editing technology, and that this could happen within the next decade at the current rate of scientific innovation.

“Gene and cell therapies present novel alternatives to disease management, offering the promise of a single treatment and a lifelong cure,” says Professor Patrick Arbuthnot, Director of the Antiviral Gene Therapy Research Unit (AGTRU) at Wits. AGTRU is currently researching a cure for hepatitis B, a contagious virus that wreaks havoc on the liver. The team uses CRISPR-Cas9 and TALENS gene editing technology to disable the virus. “We deliver the CRISPR-Cas9 system to the liver, hone in on the hepatitis B virus to deactivate the DNA, and halt the infection process,” says AGTRU Associate Professor Abdullah Ely. TALENS (Transcription Activator-Like Effector Nucleases), on the other hand, are enzymes that can be coded to cut DNA sequences, thus inactivating the hepatitis B virus.

Tuberculosis is another disease burden in South Africa. The bacteria that cause TB have a very thick cell wall, which prolongs the duration of treatment. “These cell walls are like thick armour capable of blocking the strongest of drugs,” says Professor Bavesh Kana, Director of the Centre of Excellence in Biomedical TB Research at Wits. Gene editing technologies can weaken this cell wall. “Ultimately we’d like to inactivate the enzymes responsible for building the bedrock of the cell,” says Kana. He notes that TB treatment has come a long way in South Africa, with shortened treatment regimens and a better understanding of managing the effects of TB, such as reducing inflammation in damaged lung tissue.

Cancer is the toughest disease to treat with gene editing technology, notes Paul Ruff, Professor and Head of Medical Oncology at Wits and the Charlotte Maxeke Johannesburg Academic Hospital. “There are so few cancers with a specific gene. In addition, cancer is very clever, outsmarting many attempts to cure it,” says Ruff. Currently, the pillars of cancer treatment have been surgery, chemotherapy and radiation therapy. However, cancer research is advancing each year – a patient’s own immune cells can even now be engineered to treat cancer. “While modern immunotherapy [a component of the gene editing field] is an exciting field, it’s prohibitively expensive,” says Ruff.

UNIVERSAL HEALTH COVERAGE

The health budget is stretched in South Africa, and not enough is done to address the systemic injustices in the healthcare system, say Dhai and Kana. “The debate needs to be about how to provide universal and quality healthcare to everybody, not just to the 20% who can afford it,” says Dhai. “I am not saying we must halt science – I am saying we need to place social justice first.”

This is why AGTRU is pioneering accessible and affordable technology. “We need our work to serve everybody and to tailor what we do to ensure scalability,” says Ely. This will change the health landscape in South Africa. Gene therapy is able to treat a wide range of diseases previously thought untreatable.

“Our view is that the need for gene therapeutics is immense, particularly in a country like South Africa. The cost of living with HIV, for instance, needs to be assessed against that of a possibly expensive, yet single therapeutic cure. If gene technologies

“somatic cell gene editing is particularly useful in targeting viral and bacterial infections, and doesn’t affect the human genome.”

become mainstream, costs will be significantly reduced,” says Arbuthnot. “South Africa must prioritise this so we can reap the benefits of this very promising medical intervention. While not a panacea, gene therapy holds significant promise to combat intractable medical problems. We feel strongly that South Africa needs to invest in these promising technologies to gain maximum benefit rather than relying on researchers in the developed world.”



Wits University haematologist, Professor Johnny Mahlangu is leading research set to revolutionise the treatment of haemophilia, a genetic blood disorder. Gene therapy for haemophilia offers a single administration of the therapeutic to potentially produce a lifelong cure and in so doing to overcome many of the shortcomings of traditional replacement therapy. Haemophilia gene therapy

in South Africa is burgeoning, with several FVIII and FIX programmes having started. Two South African patients who received gene therapy for severe haemophilia in Europe are currently being followed up locally. A regional gene therapy infusion centre has been set up in Johannesburg, and patients for several gene therapy studies are currently being recruited. Participation of patients of African origin in gene therapy is particularly important, as they have generally been under-represented in global gene therapy studies.



Professor Michèle Ramsay, Research Chair and Director of the Sydney Brenner Institute for Molecular Bioscience at Wits has been selected to serve on an international commission to develop principles, criteria and standards for the clinical use of genome editing of the human germline, should it be considered acceptable by society. The Commission, convened by the UK’s

Royal Society, the US National Academy of Sciences, and the US National Academy of Medicine, comes at a time when reports of the first genetically edited babies were publicised at the end of 2018. The Commission’s final report will be issued mid-2020.





DIAGNOSING THE DEAD AND PREDICTING MORTALITY

SHAUN SMILLIE

In the near future, a new generation of apps could soon be helping health professionals decode causes of death, or protect the living by predicting the likelihood of dying from heart failure.

Two academics in the Wits Institute of Data Science are investigating the use of machine learning (ML) to sift through masses of data and, through coded algorithms, identify patterns that will give health practitioners real time lifesaving information.

Dr Dineo Mpanya is a PhD candidate in the Division of Cardiology at Wits.

She is a specialist in Nuclear Medicine and Molecular Imaging and is passionate about cardiovascular research.

Mpanya is working on a project that, if all goes well, will assess a patient's probability of being hospitalised or dying as a result of heart failure.

Heart failure is a common pathway for most heart conditions such as hypertension and coronary artery diseases.

"Machine learning refers to the ability of the computer to learn without any form of explicit programming, meaning that the computer analyses pre-existing data, learns patterns and subsequently makes predictions," explains Mpanya.

Her project involves mining data collected since 2009 in the Division of Cardiology at Charlotte Maxeke Johannesburg Academic Hospital. These data were captured electronically from patients who were admitted to the hospital with heart conditions. Mpanya plans to use this data to create a risk model that predicts a patient's likelihood of mortality and hospitalisation.

"This risk stratification is important because if a patient is at a high risk of mortality, then such patients can be seen more frequently at a hospital, optimising therapy," says Mpanya.

"Already we have such a high burden of patients with heart diseases in South Africa and there aren't enough cardiologists. So, with my model, once you have risk stratified the patients, those that are at low risk will be seen less frequently and may even be seen by doctors at a primary or secondary health care level. And those that are high risk will be seen by specialists."

South Africa has a growing cardiovascular disease epidemic and one of the biggest problems facing doctors is identifying those at risk.

Recent statistics show that one out of three South Africans over the age of 15 has hypertension (high blood pressure), which puts them at risk of a heart failure. Most don't even know they have hypertension.

This risk calculator, Mpanya hopes, will take the form of an app.

"So, if you are in a rural area and you are treating a patient and you don't know what is wrong with them, that risk calculator will tell you that patient is high risk and send them to a hospital," she says.

The app will work by requesting a doctor to input details such as the patient's demographic and clinical parameters and thereafter will estimate the probability of mortality and hospitalisation.

PATHOLOGICAL PATTERNS

While Mpanya's work deals with the prevention of mortality, her colleague Michael Mapundu is using machine learning to diagnose the deceased.

Verbal autopsies are often used as a method to establish cause of death in low- and middle-income countries. Most of the world's annual deaths are undocumented, meaning there are no autopsies.

How verbal autopsies work is that health professionals will gather information about the deceased, collected from those who knew them and from learning about the circumstances around

Mpanya plans to use this data to create a risk model that predicts a patient's likelihood of mortality and hospitalisation.

their death. The World Health Organization has a set of guidelines governing how verbal autopsies should be performed.

The Medical Research Council/Wits Agincourt Health and Social Demographic Surveillance System has been performing verbal autopsies in north-eastern Mpumalanga. It is this data, collected between 1993 and 2015, that Mapundu is using in his research.

Through machine learning, this data and future data could alert authorities to disease patterns that they are not seeing in hospitals and clinics.

"Those verbal autopsy narratives, they have a diagnosis which is labelled by an expert who might be a doctor," says Mapundu, in the Wits School of Public Health. "From these narratives a possible cause of death might be added and that gives us a label that you can use to train our machine in order for it to possibly predict a possible cause."

As with Mpanya, Mapundu envisions an app that will be web based, easy to access and work in a rural setting.

"It will have real time classification where a user can feed data and those narratives can be automatically classified by our machine learning model," he explains.

Machine learning prediction models are in use in the Global North, but their introduction here in South Africa promises to save lives through data gleaned from the living and the dead. **■**

MACHINE LEARNING

Data science is the new kid on the block, having only developed as a field of study in the last decade or so. It grew out of the need to mine and utilise big data, which for a long time was considered the domain of the IT specialist.

Increasingly, however, these masses of unstructured information are being seen as gold – not only in business, but in medicine, science and a host of other disciplines. The problem is accessing this information effectively and efficiently. This has made data science a growing discipline that requires a unique skills set and which the Wits Institute of Data Science (WIDS) is working at providing.

"Generally speaking, data science is an emerging transdisciplinary field to study 'data'", says Professor Turgay Celik, the head of the Institute. "Data science integrates a number of relevant disciplines such as statistics, computing, communication, management, and sociology to turn data into useful predictions and insights."

There is an increasing demand for data scientists who have the requisite skills, adds Celik. The problem is that both the local and global education systems are unable to keep up with this demand. This is where WIDS steps in by setting up various training programmes, creating research opportunities and partnerships between academia and industry.



RECREATING EARTH THROUGH CODE

SCHALK MOUTON

What does it take to recreate Earth? A couple of thousands of line of code, throw in some data from all the weather stations around the world, and a supercomputer.

Add to that mix a specialist climate model developer such as Professor Francois Engelbrecht from the Wits Global Change Institute and you've got the first Earth System Model developed and based in Africa, which is to contribute to the World Climate Research Programme's Coupled Model Intercomparison Project Phase Six (CMIP6).

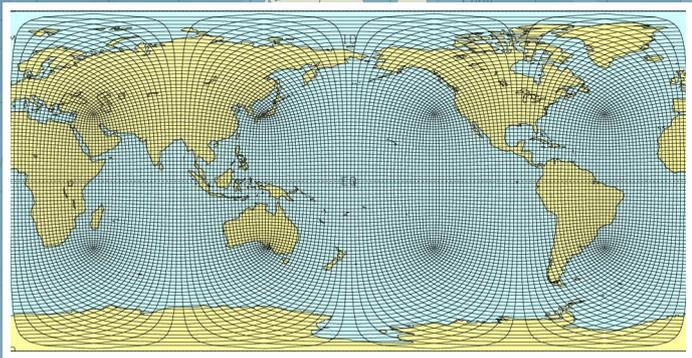
Engelbrecht, who joined Wits in January 2019 after working at the Council for Scientific and Industrial Research (CSIR) for a decade, is working to build a mathematical model of Earth, including all the atmospheric, oceanic, land and carbon cycle processes and their interactions, in order to be able to project the impacts of future climate change in Africa and across the globe. Towards this end, he is working in close collaboration with scientists from the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia, the CSIR in South Africa, the University of Cape Town (UCT) and the University of Venda.

"Coding is part of my life. I code every day," says Engelbrecht,

who is one of only a handful of climate model developers around.

Building an Earth System Model is no simple task. To do this, Engelbrecht needs to process data from 50 layers of Earth's atmosphere, which is approximately 50km deep; the ocean from its surface to the bottom, divided into 30 layers and the land, divided into six layers to simulate soil moisture and temperature. An Earth System Model provides a numerical sampling of all the physical processes occurring in the three-dimensional coupled ocean-atmosphere-land system. He also needs to include ocean and atmospheric chemistry, including the effects that the carbon cycle has on the climate system.

"Both the ocean and the land are large sinks (absorbers) of carbon. There are also natural processes that release carbon dioxide into the atmosphere. We need to see how these processes work and model how the carbon cycle will impact climate in the future in the presence of increased carbon dioxide emissions emanating from our dependence on fossil fuels for energy," says Engelbrecht.



An Earth System Model is based in a set of mathematical equations that describe how Earth changes over time to changing radiative forcing (for example, increasing concentrations of carbon dioxide). That is, when the laws of physics is applied to the atmosphere, one obtains a set of partial differential equations. These equations can be solved numerically to get a picture of our future climate.

“The moment that you work with these types of data and numerical mathematics, you need a supercomputer to process it,” says Engelbrecht.

“The mathematical model breaks up the atmosphere in a number of layers, and the Earth in horizontal grid points. The larger the computer, the more grid points you can add, which makes the model more accurate.”

Engelbrecht only in recent years gained access to a supercomputer with sufficient processing power to undertake these computationally expensive simulations and process the enormous of data. This is the Lengau cluster of the Centre of High-Performance Computing (CHPC) of the Department of Science and Technology based in Rosebank, Cape Town. A single climate simulation requires the use of hundreds to thousands of processors on the cluster, applied in parallel to solve the intricate equations of the Earth system.

Even on the fastest supercomputers of the world, the spatial

resolution of Earth System Models remain limited to about 100 km in the horizontal. In a recent development, Engelbrecht and his colleagues are also moving into the world of Artificial Intelligence, to utilise specially engineered algorithms that can represent the finer details of the system at spatial scales not directly resolved by the Earth System Model.

“Traditionally the representation of fine-scale processes in Earth System Models was based on conventional statistics informed by field observations of how the fine-scale processes relate to the large-scale flow features of the ocean and atmosphere. Machine learning allows for more complex and thus more realistic relationships to be formulated between fine-scale and larger scale flow features in the climate system,” Engelbrecht states.

Engelbrecht, who did his PhD in numerical meteorology at the University of Pretoria leads the development of the global ocean model applied within the Earth System Model. The CSIRO provides to the system sophisticated global atmospheric and land-surface models, while the CSIR is providing and developing the carbon cycle model and atmospheric chemistry applied within the Earth System Model.

In order to describe an initial state of the ocean and atmosphere to the Earth System Model, Engelbrecht and his colleagues use information from weather stations all over the world, which is compiled and shared through the World Meteorological Organisation.

Engelbrecht points out that understanding the climate and carbon cycle of the Southern Ocean and the dynamics of the Antarctic sea-ice and ice sheets is critical to the reliable projection of future climate change.

“The Southern Ocean is a massive carbon sink, and we (South Africa, through the Southern Ocean Carbon and Climate Observatory (SOCCO) of the CSIR), have the best knowledge in the world about the Southern Ocean chemistry and physics, which makes our Earth System Model incredibly relevant for the rest of the world,” says Engelbrecht. “Our model is built through the lens of Southern Ocean and African climate processes.” SOCCO of the CSIR and UCT’s Marine Science Institute are therefore important partners in the development of the Earth System Model.

“A National Research Foundation Earth System Science Research Programme (ESSRP) project is providing important initial momentum to this collaboration,” says Engelbrecht.

Building an Earth System Model is a completely interdisciplinary task, involving experts from a variety of fields, including climatologists, oceanographers, ecologists, mathematicians, physicists, chemists and computer scientists. Engelbrecht intends to increasingly attract experts in all these fields to work together in building and improving the African-based Earth System Model.

“One of the reasons I came to Wits was to expose the Earth System Model development process to colleagues whom have leading expertise in oceanography, climatology, numerical mathematics, high-performance computing and artificial intelligence so that we can collaborate and jointly contribute to this truly multi-disciplinary field. We have already assembled at the GCI and the Wits Schools of GAES and APES a strong group of post-graduate students that will have the opportunity to work in this exciting multi-disciplinary field, while contributing their novel thinking to the Earth System Model,” he says.

“We are creating one of the most reliable and most detailed modulations of climate change for Africa. If we can reliably project our likely climate change futures in Africa, then we can estimate risks to aspects such as water security, agriculture, biodiversity, and human health, and take timeous action through climate change adaptation and mitigation projects.”



REPTILE LAUNDERING AND ILLEGAL LIZARDS ONLINE

DELIA DU TOIT 📷 SHIVAN PARUSNATH

PhD candidate Shivan Parusnath's research on a threatened reptile species has already led to changes in the South African legislature. Now, he plans to use social media and machine learning to take on the illegal reptile trade on a global scale.

In 2017, a man who had travelled to South Africa from Japan was caught by Malmesbury police with 48 lizards he had poached from the wild and intended to smuggle out of the country. His sentence was 13 years imprisonment or a R1 million fine. A month later, another Japanese man was caught for the same offence, and a few months after that, two German men.

Shivan Parusnath, a PhD candidate in the School of Animal, Plant and Environmental Sciences at Wits, plans to help clamp down on the rampant illegal reptile trade, starting on social media. His post-doctorate, for which he is currently procuring funding, will focus on the sale of South African reptiles on online forums, social media, and at international reptile fairs. His initial research reveals how crucial this study will be.

"Without much difficulty, I found several reptile trade groups selling South African reptiles on social media. I've even done some searches on the dark web, which came up empty-handed. Chances are that social media already provide such an easy means to conduct illegal trade that using the dark web isn't

even necessary," he says – the dark web, often used for illegal trade, refers to websites that exist on encrypted networks and cannot be found through traditional search engines

Although some platforms have banned the sale of live animals, the rules are not always enforced. "There are many loopholes, such as creating secret groups on Facebook, or pretending to 'rehome' animals – those in the market will know that it's code for a sale, and will contact the person privately," explains Parusnath.

Getting a better idea of the species being sold in this manner, and in what quantities, will help inform legislature and scientific authorities to better protect species threatened by trade.

Besides manual searches and visiting international trade shows, Parusnath also employs machine learning for his research. After feeding an algorithm with training data (images of reptile species to be searched for), the software will be able to access data on which species are being sold online, where they are sold, and at what price, and even identify false keywords or guises used to cover up sales.

GENETIC BARCODES

Parusnath has so far concentrated most of his research on sungazer lizards (*Smaug giganteus*), named for their upward-arching stance when basking in the sun. Over the past decade, several of these vulnerable lizards were shipped or smuggled from South African shores into the hands of exotic reptile collectors, fetching thousands of dollars each. The biggest markets are in Europe, Japan and the USA.

In his PhD, Parusnath focused on investigating the genetic structure of the species by 'DNA barcoding' almost 200 sungazers in 13 different colonies in Mpumalanga and the Free State – their only natural habitat. This was done using microsatellites, special genetic markers he developed especially for the sungazer.

"Microsatellites allow one to understand more about the population and social structure of a species in the wild. You can, for example, determine if a baby belongs to a certain parent, if two animals are first cousins, or if they are not related at all. You can then use this information to learn more about their social behaviour, for example if babies and parents live together in a burrow or not," says Parusnath.

Secondly, the information can be used in regulating trade in the species. Sungazers are listed on CITES Appendix II, a multilateral treaty to protect endangered plants and animals, and species on this list may only be traded if bred in captivity. Microsatellites can help clarify whether animals were indeed bred in captivity when a trader applies for a permit.

The technology is so effective that it's been used to identify poaching hot spots for elephants. When a detailed enough network of DNA barcodes is collected from across a species' distribution, it can be used to determine where an animal came from. Parusnath's network is already big enough to determine if a confiscated sungazer came from the East or West Free State, for example.

CODE RED

For his Master's, Parusnath reassessed the conservation status of the species, which was last done in 1978. Sungazer populations had declined 30% since the last assessment, and they're at the same level as rhinos on the National Environmental Management: Biodiversity Act (Nemba) list of Threatened or Protected Species.

His research led to the finding by the South African scientific authority that trade in wild-caught sungazers would be detrimental to the species. A legislative change followed, and trading in sungazers now requires proof of captive breeding before a permit is issued, effectively stopping what is known as reptile laundering, where wild-caught animals are sold under the guise of captive breeding.

Parusnath is also a professional photographer with a number of awards under his belt and uses his wildlife images to educate and raise awareness. "A good photo can make people see an animal differently, and make even spiders, snakes and scorpions more relatable. Some scientists judge their career on the number of papers they've published. For me, it's about making a difference." 📷



Parusnath's documentary on sungazers, *Saving Dragons*, recently won the Simon Mabhunu Sabela Award for Best Environmental Conservation film from the KwaZulu-Natal Film Commission. Watch it at <https://www.youtube.com/watch?v=v3TmKQ5dzKM&t=35s>

UNIVERSAL CODE

The possibility of one day striking up a conversation with visitors from outer space will require a common language and not one found in a dictionary, but rather in the lingua franca of mathematics.

SHAUN SMILLIE

One day, when extra-terrestrial aliens finally make contact with us Earthlings, we'll need to communicate. Such an historic occasion will demand that we make a good impression, and that might mean leaving the introductions to a mathematician or a physicist.

"The natural place to start conversing with aliens would be to use mathematics because it is universal," says Professor Vishnu Jejjala in the Wits School of Physics. "Aliens might not have the same biology as we do. We are carbon based, they could, for instance, be silicon based. Who knows? But whatever their physiology is, the mathematics that we have is exactly the same as the mathematics that aliens have."

THE PERSISTENCE OF PI

Across the universe, the same numbers keep cropping up in unexpected places, much like an invisible code that appears to unite unrelated principles. The famed mathematical constant, Pi (or π), which describes the ratio of a circle's circumference to its diameter (with a value of 3.14...) is one example. Another example is the so-called 'Golden Ratio' – also known as the Divine Proportion – which is expressed not only in the geometric shapes of nature (such as in the shape of the Whirlpool Galaxy, Nautilus shells and hurricanes) but also in many human creations. The Pyramids of Giza were allegedly built using the Golden Ratio, and artist Leonard Da Vinci apparently used its eye-pleasing proportions to paint the iconic Mona Lisa.

Wits Emeritus Professor Francis Thackeray and the late Professor Jan Boeyens suggest that there's a strong case that the Golden Ratio (1.61803...) can be related to not only aspects of mathematics, but also to physics, chemistry, and biology. The Golden Ratio could even be identified in the topology of space-time, Boeyens claimed.

UNIVERSAL LANGUAGE

Jejjala explains that numbers such as Pi and the Golden Ratio recur because the language we use to analyse physical phenomena – mathematics – is in itself a universal language. "As a physicist, I work on various problems and the same sort of numbers appear in various places. It is not just the same numbers appearing, it is also the same equations that are appearing; the same phenomena that manifest in vastly different situations." Pi, for instance, appear everywhere because circular forms appear in various places in nature, says Jejjala. "Pi is just a reflection in phenomena in which these things happen."

Other examples of where numbers appear across a variety of disciplines appear in periodic phenomena.

"The infection rate for disease might be one example. Such periodic behaviour is characterised by trigonometric functions,

like sine or cosine. The period for such a function is 2π , which relates back to the circle [the circumference of a circle is $2\pi R$]."

Various other phenomena are exponential. The half-life of radioactive isotopes, the inflationary phase of the cosmos, the population growth of various organisms are all described as "e" raised to the power of something.

"The number 'e' – or Euler's Number, which is approximately 2.71828, pops up everywhere, like in calculations of compounding interest and probability theory, while other numbers, such as the Euler-Mascheroni constant, the zeta function evaluated at special points and the Golden Ratio that all appear in different contexts."

E.T. PHONE HOME

So, because mathematics is universal, it would be the natural lingua franca for a conversation with Martians. But what form would such a conversation take? How would we say hello?

"The conversation might start with teaching each other prime numbers," says Jejjala. "The distribution of prime numbers is described by Riemann's zeta function. The famous Riemann conjecture states that all of the non-trivial zeroes of the zeta function have real part equal to 1/2. No one has been able to prove this statement. We could, for instance, describe the function in terms of the prime numbers and ask the aliens for help."

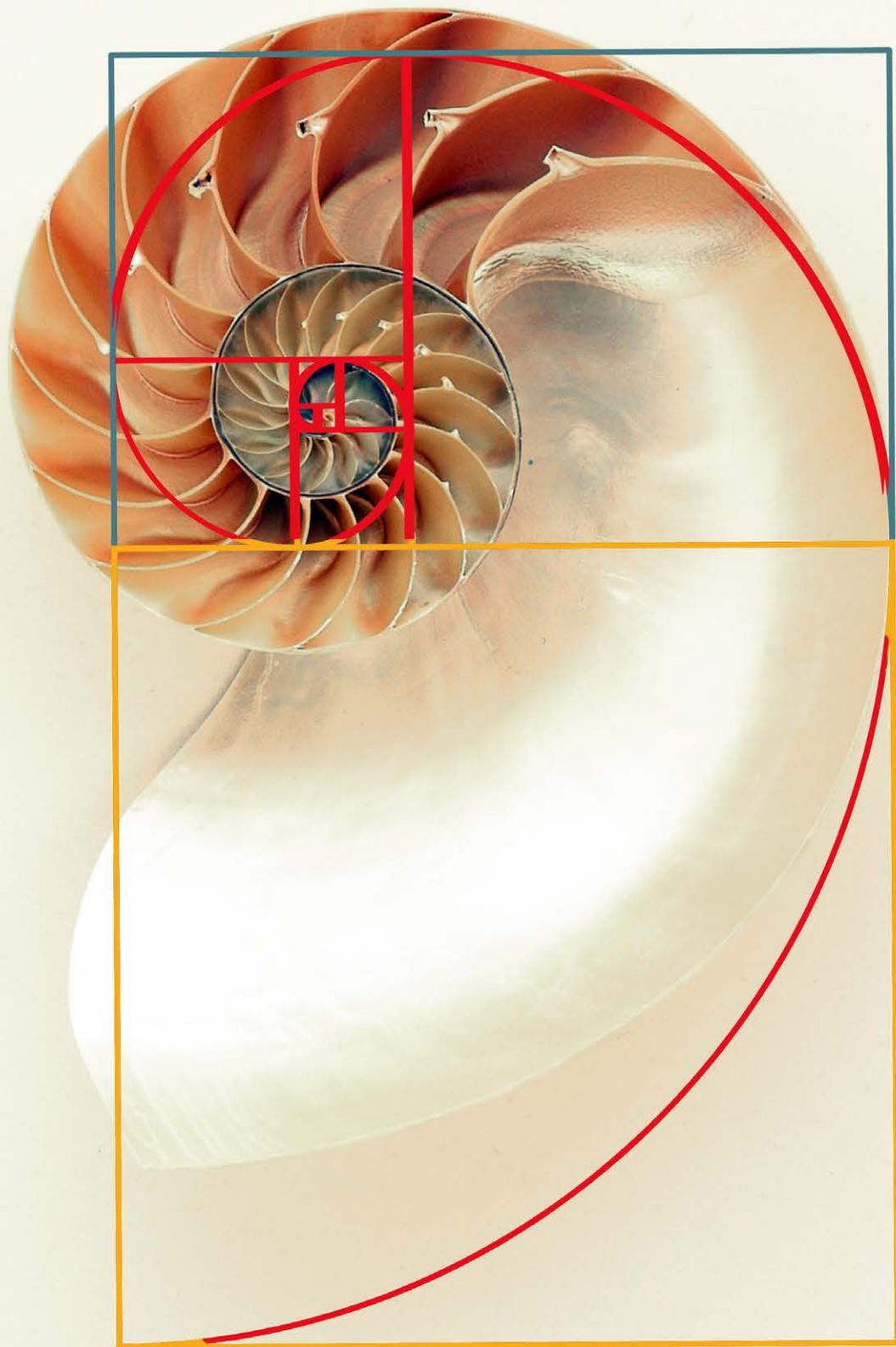
Mathematics has been described as "unreasonably effective at describing the natural world". The fact that everything in nature works so well (through mathematics) have had philosophers, mathematicians and physicists puzzled for years, but, up until now, there are only partial answers.

"In the end, it seems that every bit of mathematics has some utility in physics," says Jejjala. "The second thing to note is that there are only certain equations we can solve. So we are bullying whatever we thought into one of the equations we can solve." And while progress is slow in deciphering newly discovered equations that could advance our understanding of the world, Jejjala believes we are on the right track.

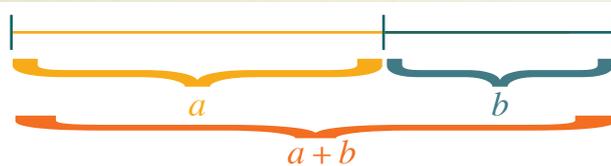
"One of the key insights in science is that the same patterns appear in many places and the methodologies for describing those patterns is largely the same irrespective of the subject. This is how we translate developments in one area to other areas." 

DEFINING PI

Pi (π) describes the ratio between a circle's circumference and its diameter. Pi's decimal representation (3.14...) never ends and never settles into a permanently repeating pattern. The Guinness World Record for a person to memorise the value of Pi is 70,000 digits.



The Golden Ratio exists when, for example, a line is divided into two parts and the longer part (a) divided by the smaller part (b) has a value of 1.618... The sum of (a) and (b) divided by (a) is equal to the same ratio.



$$\frac{a}{b} = \frac{a+b}{a} = 1.618... = \varphi$$

Visiting gayle

DELIA DU TOIT ✉ ERNA VAN WYK

It might never be one of South Africa's 11 official languages, but that would defeat the purpose of Gayle – a language of secrets and the research focus of Film and TV postgraduate, Lauren Mulligan.

Patsy. hilda. mavis. carol. Women’s names, clearly. But to those in the know, each of these names has a secret meaning: party. hideous. effeminate. cry. Such is the nature of gayle, a coded language developed in the Cape LGBTQIA community that has since spread across the country. Still, tell the average Jo’burger to “carla that paula bag” and they would likely look at you with a rather perplexed expression. Say the same thing in Cape Town, and that bewilderment would be directed at someone else (“Look at that ‘posh’ man”).

And that’s exactly why gayle was created, explains Lauren Mulligan, formerly a multimedia officer at Wits who completed her Master’s in film and television on gayle in 2018. “Initially, it was used as a way of protecting each other – you could tell your friend to be careful around a specific person, or that a certain power dynamic was at play – without the subject of your conversation understanding,” says Mulligan.

Mulligan first heard gayle as a teenager, when her brother and his friends used it. “It’s pretty jarring when you first encounter it, but equally fascinating. On the way home from his friends, I’d always ask him the meaning of new words I’d heard, and so I picked up bits and pieces along the way.”

gayle, however, is constantly evolving – so much so that when Mulligan, who now lives in Johannesburg, visits her home town of Cape Town, she will wait a few days to pick up the newest words before she starts “gayling” with her peers. “Different generations of gayle-speakers sometimes won’t understand each other because the language changes so much; new words are added, and others take on new forms. mavis [an effeminate man], for example, is maybelline to newer generations, because ‘maybe she’s born with it, maybe it’s maybelline’ – the brand’s newer slogan.”

It was during one of her family visits to Cape Town in 2015 that Mulligan decided to make a documentary about gayle for her Master’s degree. “During that holiday, I was searching for a topic for my research, my friends were gayling and I realised I’d also never encountered gayle on television. There’s this entire community that’s not being portrayed in mainstream media. I wasn’t seeing the characters I wanted to see, and I decided to make a documentary about it.”

According to various sources, gayle originated among coloured people in Cape Town in the 1960s, or even earlier, and was mostly used by the LGBTQIA community. Mulligan’s research, conducted during several trips to Cape Town over two years, points to hair salons in Cape Town’s District Six, and she believes some of the old names used in gayle are indicative of the time that it was invented – but the exact origins are unclear. When Mulligan was once interviewed on air about her research, several listeners phoned in, claiming that they had started the language back in the day.

Some research explores interviews with gay men who said they would never gayle to a heterosexual man or a woman, while other research reveals that there are women and straight men who are well-versed in gayle. The origins have become obscured over time, almost an urban legend, as the language spread and evolved.

What is clear, however, is that besides using female names, gayle borrows from English, Afrikaans and Kaaps, both in structure and vocabulary. In recent years, gayle has emerged from the shadows of subculture to become mainstream. Today, it’s no longer only used as a cloak in dangerous situations, or within the confines of a period of oppression, but has become a way to empower its speakers, a way to bond a community, and a means to play around with words, says Mulligan.

In her documentary, *Visiting gayle*, Mulligan interviews several regular gayle-speakers from different walks of life. For her research



- gayle words are written in lowercase to avoid formalising the code and to maintain its fluidity.
- Watch *Visiting gayle* at <https://vimeo.com/271641846>

“The illustrations are there to show the duality of gayle – that everyday things aren’t what they seem and can have a different meaning.”

paper, she spoke to several more, including the rap artist Dope Saint Jude, who uses gayle in her lyrics and so delivers the language to a much wider audience than in bygone years. “It might never become a fully-fledged, documented language, but that would also defeat its purpose – gayle is a secret between friends, a way to bond, a way to have fun. One person or group can’t own a language, and it means different things to different people,” says Mulligan.

A photojournalist and Fine Arts undergraduate, Mulligan also created several illustrations for the film to visually describe the words as they’re spoken. Through her animated illustrations, pencils transform into prison bars and safety pins into a dog’s head. These also add a feeling of nostalgia to the speakers’ descriptions of the language, clearly near and dear to them. “The illustrations are there to show the duality of gayle – that everyday things aren’t what they seem and can have a different meaning.”

Visiting gayle was shown at the Iziko South African National Gallery in Cape Town – a dream come true for Mulligan, who first visited the Museum as a child and hoped to one day show her work there too. When asked about her own favourite gayle words, her reply is perhaps the perfect illustration of what gayle means to its speakers:

“I probably use hilda [ugly] and milly [crazy] the most,” she says. “Is that milly with a -y or an -ie?”

“It’s whatever you want it to be,” she laughs. ■



TELLING TALES OF AGES ON STAGES

MIRAH LANGER

Theatrical story-telling is universally human and for a Wits postgraduate drama student is the means to bridge generations and mutually empower seemingly disparate groups.

“ perform my story and that is a wonderful feeling ... To be in front of people, telling them my story, I feel a lightness of spirit.” This is the declaration of Flora Mtembu, an elderly woman based in Hillbrow, who in her sunset years has embarked on a new path as a stage actress.

“Finding my identity confused me most of the time and it made me feel like I have no ambition. However, listening to other stories really changed my mindset of how I’m not alone.” So reflects

Tsepang Lebelo, a teenage budding thespian, about what sharing a stage with, not just his peers but also his elders, has come to mean to him.

Another teen, Mbongiseni Mahlangu, adds that through this process: “Now I’m growing... I’m now my real self!”

These are the comments of but three participants in a group of elders and youngsters based in the Johannesburg city centre, brought together through theatre. They have come to share not just a stage, but also their own stories, struggles and support.

Behind the scenes, it is thanks to Wits Master's student, Gcebile Dlamini, that this groundbreaking intergenerational theatrical work is taking place.

"My focus now is on the coming together of these intergenerational stories. The young find themselves by telling their stories and hearing those of the elderly. The elder people, in remembering their stories, also find a sense of purpose." This is how Dlamini explains some of the outcomes of her work in making theatre productions with casts united by a love of drama but decades apart in age.

This year, Dlamini, who has also served as an external examiner at Wits for Applied Theatre Studies, embarked on her Master's in Creative Research through Drama for Life. With funding from the Nedbank Arts and Culture Trust and the National Arts Council, Dlamini hopes to continue the intergenerational theatre work that began many years ago.

INTERGENERATIONAL IMPACT

At that time, as a drama graduate desperate to escape waitressing, Dlamini dropped off her CV at the Hillbrow Theatre Project, now renamed the Outreach Foundation. She was hired as a director of an afterschool programme after proving her mettle by conjuring up a full production, involving over a dozen teenagers, within just two weeks.

As her engagement with these teenagers continued, Dlamini began to realise the impact that creating theatre had on them and their lives.

"These kids didn't have drama at school. They knew they loved it but they've had nowhere to express it; this was their only outlet."

Productions she created with the teenagers featured hard-hitting topics like religion and sexuality, xenophobia and the Rwandan genocide. These works transformed the way in which these young South Africans began to see themselves: "They become fully conscious. They just wanted to do things and take action, they become advocates. They would reflect about how they were coming to understand who they were, in this place, South Africa, on the continent and in the world."

Dlamini began to dream of finding new ways to deepen this kind of exploration through drama. When one of the cast members from a production at the Outreach Foundation mentioned that an old age home in Hillbrow was looking for volunteers to help with things like cleaning, Dlamini decided to take it a step further – she proposed to the staff of the Tswelopele Frail Care Centre that any willing residents join her teenage students on stage.

"The first group that we had was a group of four men. They were aged between about 65 upwards and they were very energetic."

The first key production to showcase the collaboration was called *young@home*.

"The first rehearsal was so scary ... The kids are used to being there to show off themselves and the elderly, well ... for many, firstly, they just want to be able to go out to a theatre! So you have to try and bring these two energies together. They live in two separate worlds. And, as the director, you are in the middle."

Yet, soon the two groups found a synergy.

"At first the elderly kept quiet. We had to teach the teenagers that it was not only them who could offer opinions. They too had to

"So here are the visually impaired people with their sticks walking into the theatre. Here are the old people walking into the theatre, and then you have the kids – three energies together."

give the elderly a platform to talk. And once the elderly started being able to voice their ideas, the kids started understanding them – and then the two groups gelled."

In a production video released by the Outreach Foundation, the care and connection between the group resonates – not just on stage, but also backstage. At one point, a young girl massages the feet of her elderly co-star in between scenes. In another, a grandmother figure holds hands with a young actor while waiting in the wings.

ENVISAGING GROWTH

Still Dlamini remained hungry to weave a web of theatrical magic over disparate groups of people.

In 2018, looking for her next challenge, she approached the Johannesburg Society for the Blind to find out if any of those under their care had ever felt an acting itch.

"So here are the visually impaired people with their sticks walking into the theatre. Here are the old people walking into the theatre, and then you have the kids – three energies together."

Yet, immediately it was the visually impaired who took control of the situation.

"They told the kids: 'Listen, we are like you. We were once your age; some of us one could see at some point; some of us never saw anything. We do not want to be treated like we can't do anything. We have all the feelings that you have ... What you can do, we can do. The only thing we can't do is drive'.

They also told the others: 'And please don't be afraid to say when you speak to me, 'can you see?' 'Because, yes, spiritually we can see'. From then, everything was easy," recalls Dlamini.

ENCORE!

The production that ensued, *In My Mother's Womb*, was performed mainly in the dark, using sound and movement illuminated by flashes of light.

It was one from which the response of the audience was uniform: "They cried."

It is not just the profound personal growth that the cast members undergo, which moves Dlamini about the work she does; it is also the professional pride and integrity with which the participants come to conceptualise their theatrical vocation.

"It is amazing to see the level of artistry that is now in their heads. They are very much aware that they are actors and actresses." ■

THE INVISIBLE IMAGE: HOW ANIMATION DEPICTS BIBLE STORIES

The adaptation of the Bible into visual media has been practiced for centuries. To find out why visual adaptation techniques were used for Biblical accounts into animation, Rachel van Rooyen compared panel-based image story-telling techniques against those of animation.

KARABO KGOLENG

The Bible is one of the most important texts in human history. It has shaped the English language and it has governed many aspects of society in Africa, South, Central and North America, Europe and parts of the Middle East. The laws and codes that govern the behaviour, the socio-political and economic contracts of a large part of our society, and which mediate their lives, can often be traced back to the Bible.

Rachel van Rooyen is a teaching assistant and researcher in Digital Arts at Wits. She holds a BSc in Physics from the University of Pretoria and a Master's in Digital Arts, specialising in animation, from Wits. Exposure in her childhood to KTV, Nickelodeon, and Cartoon Network kindled a lifelong love for animation and storytelling.

For her Master's, van Rooyen analysed two scenes in the depiction of the characters in the DreamWorks Studio film *The Prince of Egypt* (1998). She aimed to examine the symbolism, language, culture and historical context of the Bible, and the audio-visual animation of its stories.

"Bible stories are highly familiar," says van Rooyen. "There are story arcs that even modern films take from biblical sources. For example, *The War for the Planet of the Apes* uses the concept of The Alpha and Omega [the main antagonistic force in the form of a military organisation that goes by the same name in the film], and the apocalypse."

Even if someone has never read the Bible, they still know many of its stories, says van Rooyen. In terms of visual representation,

sequential imagery is a strong part of that history, and even the religious practice of Mass uses storytelling that involves pictures – especially in the re-enactment of the Last Supper.

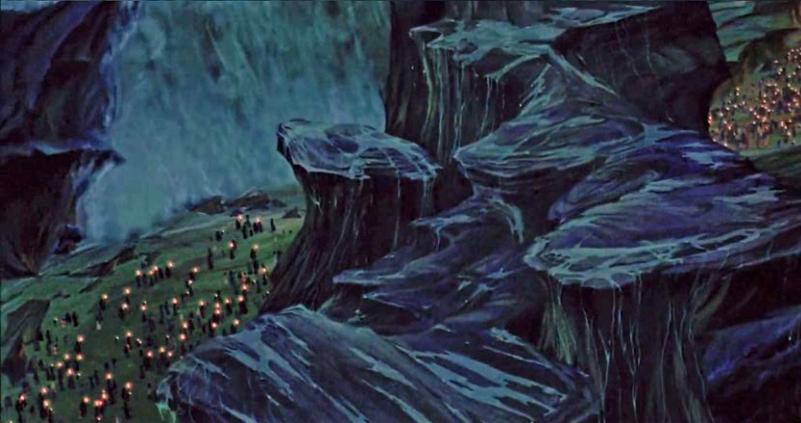
"Jesus is a postmodern meme; very quickly recognised with highly proliferated images over time," says van Rooyen. Indeed, in their book, *Who's Bigger? Where Historical Figures Really Rank* (Cambridge University Press, 2003), Steven Skiena and Charles Ward formulated an internet-based ranking system that revealed the Christian Messiah to be the most recognisable figure ahead of William Shakespeare and Alexander the Great.

Van Rooyen explains how the adaptation of biblical accounts into visual media has a centuries-long history and her research examines the representational processes involved for animation to communicate meaning through semiotics (the study of signs and symbols and their use or interpretation) and discourse theory.

A major feature of animation is its use of exaggeration and its requirement that viewers suspend disbelief, while simultaneously making an implausible situation easy to digest. This makes for a beneficial link with biblical accounts, which require the same from their audiences.

In analysing two case studies from *The Prince of Egypt*, van Rooyen studied how the film uses visual cues – especially colour and scale – to contrast the characters of Moses and Rameses, and how animation can be used to "bring the story of Moses to life".

The scenes of the parting of the Red Sea and the 10 Plagues of Egypt, for instance, respectively express the things that stand in the way of our dreams (the Israelites' quest for freedom), and



God's moral law and justice when dealing with the unrepentant (Rameses refusing to free those in captivity).

"These scenes are supernatural so it is easier to process them in animation than in live action film," says van Rooyen.

In a second case study, van Rooyen examined the depiction of the two Egyptian priests, Hotep and Huy, who served under Pharaoh. The priest characters' physical proportions are exaggerated, using visual cues that audiences find familiar and from which they derive meaning. Hotep has short, rotund features that audiences associate with trustworthiness, while Huy has tall, thin, angular features that viewers have come to associate with evil.

"These qualities are reflected in their characters. While both priests are disdainful towards Moses, Hotep is more passive-aggressive toward him, but Huy is more derisive in his attitude," van Rooyen explains.

"When they both approach Rameses to broach the subject of Moses' crime of killing an Egyptian, yet being unpunished, Huy yells 'death!' in answer to Hotep's explanation of what the law demands as a punishment, even before Hotep is able to finish his sentence. Hotep then finishes with 'we hesitate to say' to try and soften Huy's obvious contempt."

The Prince of Egypt has performed well commercially and has become an animation classic, pleasing audiences while maintaining respect across the Abrahamic religious community, says van Rooyen.

"DreamWorks adapted *The Prince of Egypt* to ensure audience

**“DreamWorks adapted
The Prince of Egypt
to ensure audience
engagement so that people
today could identify with
the various elements
of the story”**

engagement so that people today could identify with the various elements of the story, such as Moses' relationship with his brother, the main characters' personal struggles, marriage and its relationship to kinship, migration, belonging, how the villain is haunted by the legacy of his father, and the wider stories of Egypt and Israel".



DECODING KNOWLEDGE

The transition from matric to first-year university can be daunting for students unfamiliar with the 'rules of the game'. Legitimation Code Theory (LCT) is a theory of learning and teaching that provides a 'toolkit' to analyse knowledge construction in cultural fields, especially education.

Arriving at university for the first time can feel like taking part in a sport where no one's told you what rules apply. Being unable to figure out the demands and expectations quickly enough can be the difference between success and failure. For many new students, the "rules of the game" on campus, and how to acquire knowledge successfully, remain a mystery.

RECOGNISING EXCELLENCE

Making these "rules" more explicit is key to Legitimation Code Theory (LCT). Over the past two decades, LCT has developed as a theory that reveals complexity in knowledge-based practices. LCT provides concepts and codes that enable the study of knowledge in various practices and disciplines, including education.

Professor Lee Rusznyak, Deputy Head of School of Education says, "We often see students work very hard on an assignment but are then disappointed when they get low marks, because they don't yet understand why they have not done well. When students are better able to recognise what excellence looks like, they can work towards achieving that."

ANALYSING HOW KNOWLEDGE WORKS

LCT architect, Professor Karl Maton is the Director of the LCT Centre for Knowledge-Building, University of Sydney, and a Visiting Professor at Wits. He was at the third biennale international LCT conference that Wits hosted in July 2019.

"If you are the first in your family to go to university, like I was, you arrive at university just trying to survive, never mind trying to succeed," says Maton. "LCT is a way to analyse how knowledge works in different practices. Then we can teach these underlying 'codes' to students who all arrive at university with their own socialisations and dispositions. LCT provides the tools for educators to think about cumulative knowledge-building in their fields of expertise."

LCT also offers the possibility for transforming practices. When the sets of codes that are accepted as the basis of success are revealed, they can be challenged and changed if necessary. Maton explains: "There are struggles over the legitimation of practices – struggles over whose way of seeing is legitimate and

whose way of seeing is dominant and how this informs curricula, for example."

AFRICANISATION OF EDUCATION

Embracing these debates make LCT a powerful tool that can contribute towards understanding how to advance social justice within the education landscape. In South Africa, decolonising education, and how to do this effectively, has become an urgent priority.

Paul Maluleka is a Wits doctoral candidate exploring how South Africa can decolonise and Africanise its school History curriculum. He chaired a panel on *LCT and Decolonisation: The quest for inclusion and social justice* during the conference Wits hosted.

"LCT can be a lens into understanding different perspectives and to understand who controls knowledge and who produces and reproduces knowledge," says Maluleka, for whom LCT's focus on getting to the underlying DNA means that transforming education in a socially just way extends to considering all elements of why success eludes many.

AFRICAN-CENTRIC EQUALITY

For Maluleka, decolonisation is not only about how knowledge-practices work in curricula; it must also consider the contextual realities of education in South Africa, like why there are still schools without electricity, why measurements of success – like exams, or being taught in English – apply equally to students with different challenges and lived realities.

"Decolonisation and Africanisation of education are two different concepts and both should be viewed as on-going projects for everyone in this country, everyone in the world, in fact. It's not about replacing one system with another, but it's about seeing African knowledge and African ways of being as equal and bringing these to the table so that we can develop an African-centric approach that builds a more just world that is good for everyone," Maluleka says.

LCT is not a magic bullet to transform education, but it holds potential for educators and students in its ability to work with theoretical ideas and practical realities within a social justice agenda. 



NAVIGATING POLITICAL LAND MINES

SCHALK MOUTON

The words that someone chooses to use often tells you more about the person than what you might think. It could even be used to predict where a person's thoughts are heading, and – in the case of politics – identify where ideological differences or similarities lie that could forge or destroy alliances.

Using text mining techniques, Dr Retha Langa analysed the court papers of the hate speech case that Afrikaans civil rights organisation AfriForum brought against the Economic Freedom Fighters (EFF) leader Julius Malema, over his singing of the song *Dubula ibhunu* (Shoot the Boer), in order to see what the underlying thought patterns were that led to specific future events.

"Text mining is a relatively under-utilised approach in South African humanities research, but one that can help us unlock patterns and relationships that might otherwise go unnoticed," says Langa.

For instance, in 2018, the land issue exploded onto South Africa's political stage with the public hearings about amending Section 25 of the Constitution showing that it is simultaneously a political and a deeply personal one, rooted in our segregation and apartheid past.

DECODING THE LAY OF THE LAND

Threats were made by some to go to war to defend farms, while others called for the restoration of dignity and a return of the land. When analysed, the Malema/AfriForum trial seven years earlier over whether a struggle song constituted hate speech, shed some light on these events. This case featured several high-profile witnesses, including Derek Hanekom, Gwede Mantashe and Malema, who was then still president of the ANC Youth League.

Langa pulled a dictionary closer, tracked the occurrence of specific words, and looked at three recurring themes, namely 'reconciliation', 'transformation' and 'land'. Reconciliation keywords included 'dialogue', 'Constitution' and 'Mandela'. Words such as 'freedom', 'revolution' and 'transformation' formed part of the transformation cluster, while land words included 'farm', 'land' and 'agriculture'.

"Land was the dominant theme with words in the land cluster appearing 335 times – 51% of the total. Reconciliation terms occur 174 times (27%) and words in the transformation cluster occur the least – 144 times (22%)," says Langa.

The ANC's testimonies revealed several interesting patterns. Its transformation cluster was slightly bigger than its reconciliation one, with the party's five witnesses (Mantashe, Malema, Hanekom, Collins Chabane and Professor Mongane Wally Serote) using 120 transformation words compared to 115 reconciliation terms.

Langa says this could point towards the tension between ideas around reconciliation and transformation which has since erupted openly as the party becomes more embroiled in brutal internal battles.

SECRET SYNERGIES

Differences emerged when Langa zoomed into the ANC's testimonies to compare views within the party. To do this, the normalised testimonies of Chabane, Serote, Mantashe and Hanekom were divided by four to create an average ANC 'veteran' witness. This was then compared with Malema's normalised testimony. A very clear difference between Malema and the other ANC witnesses emerged.

"Malema was clearly an outlier," says Langa. "During the trial, the ANC 'veteran' witnesses were still holding on to former president Nelson Mandela's vision of reconciliation, while Malema – who would be expelled from the party 10 months later – was already pushing a more radical agenda, which would see him emerge as a thorn in the ANC's side."

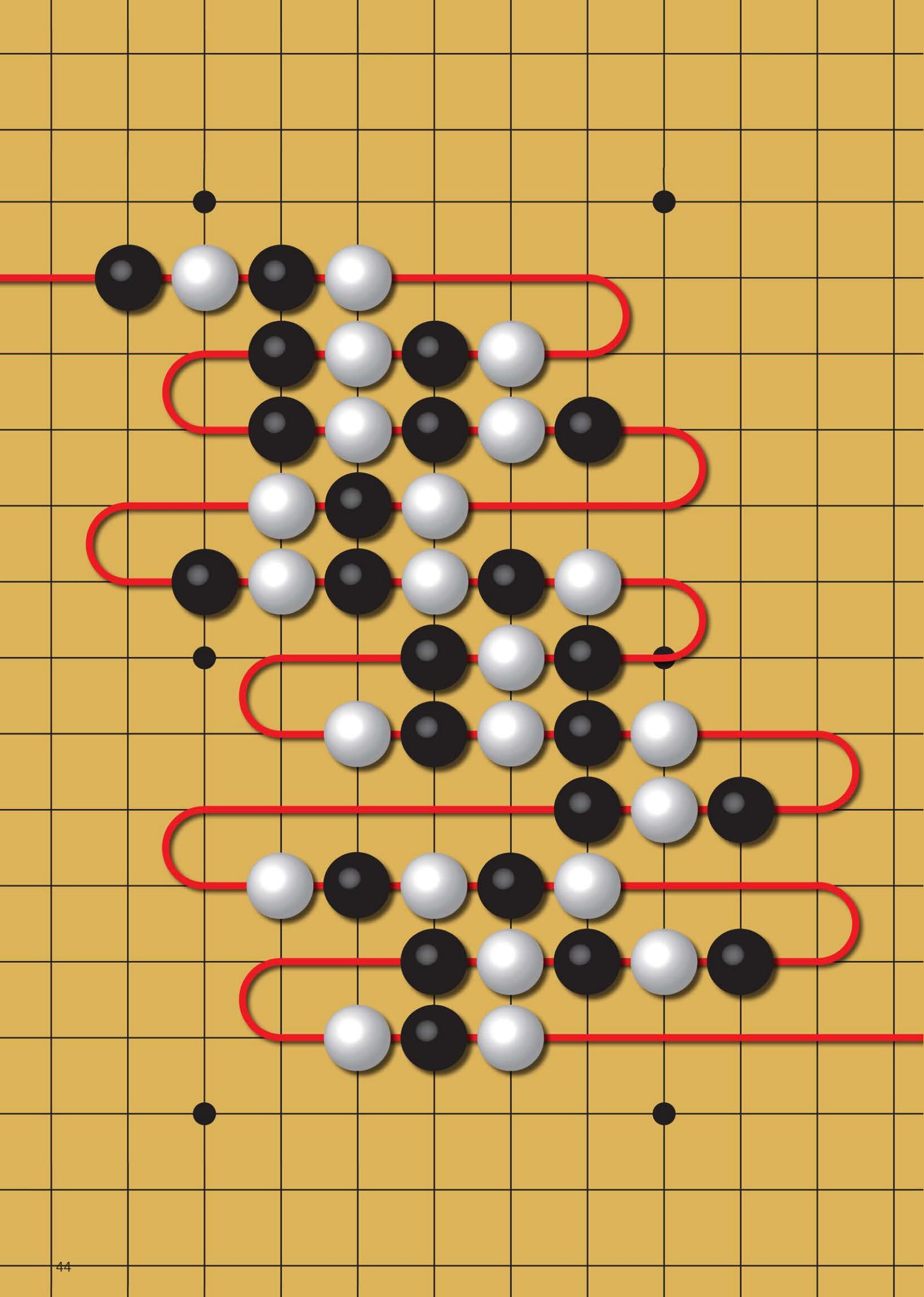
Not long after the trial, Malema would use the failure of both land reform and the reconciliation ideology as foundations for his political revival within the EFF.

CATCHING FEELINGS

Langa went one step further, aiming to explore emotion in the witnesses' testimonies. By using sentiment analysis, with a lexicon containing thousands of English words assigned scores for positive or negative sentiment, she again mined the court papers for their hidden treasures. The word "kill", for instance, had the biggest impact on negative sentiment, while "freedom" made the biggest contribution to positive sentiment.

"The testimonies were overwhelmingly negative. Hanekom's sentiment score was the lowest, followed by Malema and AfriForum's Ernst Roets," says Langa.

"The testimonies were generally characterised by a high level of emotion. Witnesses often became emotional during the trial, especially when testifying about land." ■



ALBINISM INSIDE OUT

People living with albinism endure parochial prejudice and medical scrutiny, but their humanity is no less definitive than that of any other along the continuum.

BETH AMATO

In the 1995 film, *Powder*, the protagonist Jeremy Reed (played by Sean Patrick Flanery) lives with albinism. Reed has magical powers in that he doubles as an electricity source. His mother seems to have been struck by lightning when pregnant with him (hence the resultant electrical conduction gift) much to the horror and wonder of the world. Reed, the “albino” and a source of familial and communal shame, is bullied and shunned. At the end of the movie, after teaching the townsfolk some compassion and healing their prejudice, Reed is obliterated by a flash of lightning.

Albinism is a hereditary condition whereby little to no melanin is produced. Melanin is a pigment produced in the cells that gives human skin, hair, and eyes their colour. Unfortunately, there’s no evidence that a person with albinism possesses super powers. While *Powder* treats albinism glibly, those living with this condition endure people’s precarious belief systems – in some parts of the world, those living with albinism are hunted and murdered for their body parts, seen as an HIV cure and raped, or something to be solved medically. Where albinism occurs, mythologies include the mother being touched by an “albino”, having been unfaithful, or the result of a curse. To “prevent albinism”, people may walk past a person with albinism and spit on them.

The erroneous labelling of those living with albinism must be contested and the codes applied to them dismantled. British artist and academic Professor Raimi Gbadamosi, who lives with albinism, intended to contribute to this de-codification through the seminar, *46 Chromosomes: Querying Albinism*, hosted by the Wits Institute for Social and Economic Research (WiSER), where Gbadamosi is currently a Research Associate.

TWO COPIES OF AN ABNORMAL GENE

The human body’s 46 chromosomes contain the genes that code all the information our bodies need to know so that they can function. Albinism is inherited in an autosomal recessive pattern whereby an individual receives copies of a gene from both the father and the mother to develop albinism. Google ‘albinism’ and phrases such as “a group of hereditary disorders”, “characterised by a deficiency of melanin in the skin, hair and eyes”, “skin cancer”, and “mutated genes” come up. Seminar speaker Nomasonto Mazibuko, a person with albinism who founded the Albinism Society of South Africa, points out that when a baby is born with albinism, the midwife often asks the mother “What did you do to have this kind of baby?”

While living with albinism certainly has its medical challenges – indeed, the condition has recently been deemed a disability

in South Africa so that critical accommodations are made – Gbadamosi insists that those living with albinism should not be seen from the outside in. Those living with the condition are multitudinous. “Western medicine treats albinism as if it’s a fundamental flaw in the makeup of a person, while non-western medicine simply regards the whole body with albinism as dispensable. We need to shift this discourse. There are no “albinos”, just people living with a hereditary condition that causes albinism,” he says.

BEYOND THE BINARY

Medical humanities specialist, Professor Catherine Burns, explained at the seminar that albinism exposes humanity’s inherent struggle with doubles and opposites. She suggested that albinism is not a binary concept, much like sexuality, gender and race are not. “We don’t know how to handle nuance. People exist on a continuum, with binary concepts trapping and caging them.”

Burns spoke about the contestations around the concept of “intersex”. A case in point is Caster Semenya’s battle against the International Association of Athletics Federation’s ruling that women with high testosterone levels competing in races over 400 metres and up to 1 500 metres must take medication to lower testosterone levels. But Semenya defiantly said: “I am a woman. And I am a world-class athlete.” She defined herself from the inside out.

“The desire to box people with albinism is linked to the fanatical historical pursuit of racial purity and an eradication of what was deemed to be abnormal ... We know now that there is no such thing as a stable racial and sexual body,” added Burns.

Mazibuko has worked closely with hospitals and communities to reduce the stigma around albinism. Instead of judging the mother, nurses and midwives are encouraged to be compassionate and to arrange counselling sessions for the mother. “To change how people treat us, we must begin in the labour ward,” said Mazibuko.

In the quest to decode and debug the culture that insists on homogenous and distinct human categories, Gbadamosi questions the meta-narrative and the violent structures that govern our language and social systems. “We must open ourselves to the plethora of possibilities of what it means to be a man, a woman, and a human being,” he says, even as he concedes that this is not an easy task. “I still get asked weird, intrusive questions. It’s hard when people see the ‘uniform’ and not beyond and behind the camouflage.”



DATA AND DOMINANCE

IMRAAN VALODIA

Data is currency in the new knowledge economy and those who have it have power, but data domination by Big Tech, both nationally and internationally, has ominous implications for economies – and privacy.

The so-called 4th industrial revolution, the associated growth in artificial intelligence (AI), and the use of data science has become a key feature of our current economy. The data aspect has seen a number of universities, including Wits, developing new programmes that combine data science with finance, health, engineering and related fields.

While there is potential for these developments to generate new sources of economic growth, there are some concerns too, which policymakers need to address.

One concern has been the use of data by technology giants like Google and Facebook, and the associated concerns about privacy, use of data without consent, and, as the notorious Facebook-Cambridge Analytica case shows, concerns about the political use of data and AI.

EXCLUSION BY DOMINATION

An area that has not received much attention – at least in public debates about data-related issues – is the fact that data collection and its use (or misuse) may be creating conditions in some instances for firms that dominate economic activity to exclude other players in the market, especially new and innovative entrants. Competition economists and lawyers have been grappling with these issues for a number of years.

In June 2019, the United States Federal Trade Commission announced that it was investigating a potential anti-competition case (or antitrust case, as the US refers to it) against Amazon, which has a market share of almost 50% of all online sales in the USA. It operates both as the provider of a platform for online sales, and as a retailer in its own right, using its own platform to sell goods. Third parties also use the Amazon platform to sell their goods.

The allegation against Amazon is that it may be using the data generated on its platform to exclude its retail competitors that sell their products on Amazon's platform. The problem is that third party retailers have no option but to use Amazon's platform.

GAFA GANG

The Amazon case follows a number of other similar cases in the European Union (EU), where the region's competition authority recently fined Google 2.4 billion Euros for anti-competitive behaviour in its comparative shopping service. Google is used for over 90% of all internet searches. Google also has interests in goods and services that people purchase when they search using Google's shopping search facility. Google was fined because it changed the algorithm that displays shopping search results from a neutral algorithm to one that favours search results in which it has interests – essentially, the search results prioritised Google's own shopping companies and demoted those of its rivals to much lower in the search results. Since no one looks beyond the first page or two in a Google search, Google's rivals were effectively excluded in the search results. The EU competition authority argued that this behaviour is anti-competitive and illegal. Furthermore, in the largest competition law fine in history, Google was fined 4.3 billion Euros for forcing cell phone manufacturers that use its (supposedly free) Android software to preload the Google browser (Chrome) and search facility (Google Search).

The EU is also investigating Facebook for anti-competitive behaviour. The German competition authority has banned Facebook from combining users' data across its own platforms without their consent, because this places Facebook in a position to exclude its competitors from competing fairly.

These and a number of similar cases against the so-called GAFA (Google, Amazon, Facebook and Apple) raise important questions about the use and abuse of data in the economy. Many of these cases are on appeal and it will be interesting to see the final outcome.

KILLER ACQUISITIONS

From an economic perspective, the developments in these cases raise a number of policy questions. One is the question of 'killer acquisitions' – are large digital companies purchasing virtually all smaller tech companies that could blossom into competitors? The economic question here is whether these mergers and acquisitions entrench power over information, and remove small companies from the market before they become competitive rivals. For example, when Facebook purchased WhatsApp, Facebook argued that the companies operate in different markets and it would be impossible to combine data from these markets. The reality has proven different.

A number of these data industries are characterised by what economists call a 'two sided market' – these are markets with

“These and a number of similar cases against the so-called GAFA (Google, Amazon, Facebook and Apple) raise important questions about the use and abuse of data in the economy”

two distinct user groups. Credit cards are a good example of a two sided market – card holders and merchants engage and trade through an intermediary's platform. The rise of data has created a number of these platforms. The competition policy challenge is that these two-sided markets often 'tip' – that is, a number of firms compete in the market but, at some point, the market tips so that only one player – or a few players – come to dominate the market. Google's dominance of the search industry exemplifies such a tip.

BIG TECH BULLIES

The difficulty from a policymaker's perspective is that there is a lot of innovation and competition in these markets to begin with, but once the tipping point has been reached, one firm or a group of firms then dominate the market and may well be stopping smaller, innovative firms from growing. And, they may well be acquiring and 'killing off' very innovative new competitors, thus reducing the rate of innovation and technological development. The challenge is the difficulty in predicting the 'tipping point', so often these challenges have to be dealt with when firms are already dominant and possibly abusing their dominance of data. ■

Prof. Imraan Valodia is Dean of the Faculty of Commerce, Law and Management. He holds a doctorate in economics and his research interests include inequality, employment, and competition policy. He led the establishment of the Southern Centre for Inequality Studies at Wits and he is a part-time member of the Competition Tribunal. He advised the Minister of Economic Development on amendments to the Competition Act, legislated in 2019. In 2016, President Cyril Ramaphosa appointed Valodia to chair the Advisory Panel on the National Minimum Wage, introduced in 2019.





HOW NOT TO WIN THE LOTTO

Today, I am coming clean. Like most South Africans, I am in desperate need of cold, hard cash. And not just a little cash. I need real money, real fast.

SCHALK MOUTON

Life in the fast lane is catching up with me, and a Wits salary can only get you so far. The cost of living is quickly increasing, we are renovating our house and each new week the builder comes with an increasing bill. Also, my car is starting to fall apart.

Where am I going to get all the cash I need for financial freedom in my lifetime? I have tried all kinds of ways to make extra cash, but so far, I have nothing to show for it.

Two weeks ago, when depressed and deflated, I loafed in my office, trying to work out a scheme to make cash, quickly. I walked a colleague, whom I know only from taking the occasional lift-ride together.

"How can I easily win the Lotto?" I ask him spontaneously.

"Easy," he responds, without any hesitation. "You just buy a Lotto ticket for every conceivable combination that is possible."

Huh?

He explains.

“You just buy a single ticket for every possible number combination, and you are guaranteed to win the Lotto.” To do this, he says, you would just need to buy a couple of hundred thousand Lotto tickets. It will cost you about R10 million, but you are guaranteed to win the jackpot! And what is more, you will not only win the jackpot, you will win all the secondary prizes in the draw. If you play at the right time, you will win around R140 million, plus change, which gives you a R130 million return on investment!

That’s it! He must be right! After all, he’s a computer dude, and he’s even written an algorithm for it, he says. And, as we all know, algorithms can do anything. They are the new virtual Superheroes of our society.

I’m sold. The math makes complete sense to me. And so, although I’m probably one of the few people in South Africa who has never bought a Lotto ticket, I concede and head off to my local Spar to get in the queue. Standing in line, I phone my wife.

“I’ve got a cunning plan!” I say and roll it out excitedly, confident that by next week, I won’t need to work another day for the rest of my life.

After a long silence (I am not sure whether she was trying to find a polite way to set me straight or whether she was wondering how exactly she got stuck with someone with such obvious limited mental capacity), she says: “But Schalk, dear love of my life, if we had R10 million, we would not need to play the Lotto, do we?”

Doh!

But still, I’m determined. I’m going to win the Lotto. There’s just the small matter of how to fund it.

Crowdfunding!

If I can get enough people to give me R500 each, we can raise the R10 million in no time, and share the spoils.

The first person I proposition signs up immediately. He’s excited. He hands over his R500. As a former news photographer he is used to being led into riots, explosions and violence without asking any questions.

Right, now for the next investor. I’ve got a R1 000 cash in hand, which I count as I grab a calculator.

To raise R10 million from asking one person to invest R500, I need 20 000 investors. If I win the Lotto of R140 million, and we share it equally, we would each make R7 000 return on investment – which, still is an impressive 1 300% on my initial investment.

But R6 500 profit is hardly worth the effort, is it?

I need a second opinion. Perhaps, this time, a real expert.

I contact Phumlani Khoza, Associate Lecturer at the Wits School of Computer Science and Applied Mathematics. Here is where the wheels really come off my scheme.

Firstly, he says, to buy every single combination of Lotto tickets, I would need to buy 13 983 816 of them. This would cost slightly more than R10 million I initially estimated – the actual investment would be R69 919 080.

If I am so sure about my model, Khoza challenges me, why don’t I take a loan from the bank and prove my theory by actually winning. After all, that is how American Mathematics Professor Edward Thorpe got rich. He worked out to beat the system at

the Blackjack tables in Reno and Las Vegas by counting cards, and then writing a book about it. Using \$10 000, Thorpe won \$11 000 in the first weekend, proving his model was successful. He later became a hedge fund manager extraordinaire and laid the foundation of an entire generation of what we now call quantitative analysts. This is where he made his big bucks.

Khoza warns me, however, that while there are cases where “under-sampling” can yield reliable results (for instance, in the case of the lottery, buying fewer tickets than the possible number of combinations), it comes with risk. It is impossible to get “guarantees”, as the actual pool of the outcome of the Lottery results is much smaller than the pool from the number of possibilities that my 13 983 816 tickets are obtained from. In other words, in reality it matters whether my model predicts {1, 4, 6} as opposed to {4, 1, 6} because of the elimination process and the how the balls are arranged initially. As a result, model risk would be a more serious factor to consider than initial appearances would suggest, even if the combinations the model produces yield (temporary) financial gains.

But surely there must be a way – what with all our fancy tech and computers and Superhero algorithms that we can predict the winning Lotto numbers?

Nope. Not so! Predicting the outcome of the Lotto through analysing past outcomes of the lottery is just about as effective as predicting a possibilities of having a hurricane at a certain time in a certain place – virtually impossible. The problem, says Khoza, is sensitivity to initial conditions.

Even if the model is completely accurate – which in reality it almost never is – you cannot predict an event with accuracy. There are just too many variables, including the initial way that the lotto balls are organised, the timing of the “ball releases” by the machine operator, to the dynamical system itself which generates the lottery numbers. This dynamical system could very well be “chaotic”, much like the comparable billiard ball problem, where it is impossible to predict where billiard balls on a pool table end up after bouncing on the boundaries, says Khoza.

In chaos theory, small changes to the initial state of a dynamical system might lead to huge errors (or variables) down the line. One such an example is the “butterfly effect”, where, in theory, a butterfly flapping its wings in China can actually cause a hurricane in Texas. In other words, small differences to the way the Lotto numbers are generated may lead to countless combinations down the line. One would even have to consider the if there was a small Earth tremor when Nimrod pressed the “release button”.

The situation is actually not difficult to assess, says Khoza. If a guaranteed strategy to win the Lotto existed, then its implementation would bankrupt the lottery system. If the lottery operators detect the problem before they become bankrupt, then they would increase the ticket price in order to make it uneconomical to implement this strategy.

So, in short, I am stuck – and there I was thinking experts were supposed to make life easier for us! There is no way that I am going to get a quick, guaranteed fix to win the Lotto. Seems like I should perhaps withdraw my resignation ... and I now owe my photographer friend R500. ■

WHEN COMPUTERS CAME TO WITS

DEBORAH MINORS  BERNARD SOOANE

The University bought its first computer from IBM 59 years ago. Today, Wits and IBM are partners in quantum computing.

In 1960, Wits was the first university to have a computer in South Africa. Professor Guerino Bozzoli, Vice-Chancellor from 1969 to 1977 purchased an IBM Model 1620 Mark 1. At this time, International Business Machines (IBM) sold computers to universities at an 80% discounted rate so that IBM could dominate the fledgling computer market.

The computer required its own room and a special cooling plant. Data were fed into the computer by means of a punched tape and the output printed on a telex machine. The capability of the IBM 1620 Mark 1 was approximate to a then R50 calculator. Dr Derek Henderson was director of the Wits Computer Centre and the first Professor of Computer Science at any South African university.

The Wits Computer Centre was firmly established by the mid-1960s. A card machine soon replaced the punched tape input and a fast electronic printer was acquired. Later, an upgraded IBM System 360 could very quickly solve simultaneous equations, which enabled Wits to service business and industry.

By 1988, the Collins Dictionary of Computing published that year declared ASCII "the most important code for microcomputing purposes" and noted that 'modern' programming languages and terminals made coding sheets largely obsolete.

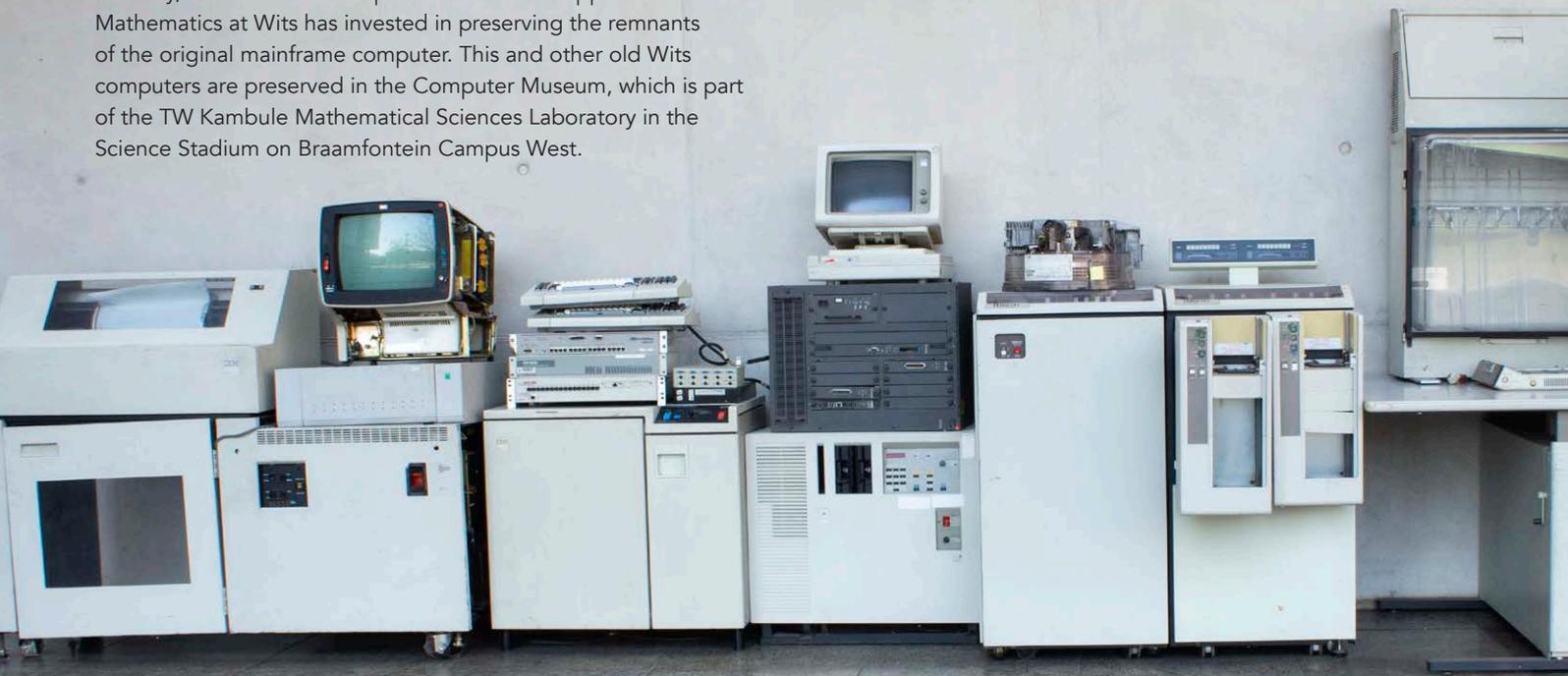
Fast-forward to the 21st Century and in June 2019, Wits University and IBM announced a new collaboration that makes Wits the first African partner on the IBM Q Network. This enables Wits to access the 20 qubit-IBM Q quantum computer.

Today, the School of Computer Science and Applied Mathematics at Wits has invested in preserving the remnants of the original mainframe computer. This and other old Wits computers are preserved in the Computer Museum, which is part of the TW Kambule Mathematical Sciences Laboratory in the Science Stadium on Braamfontein Campus West.

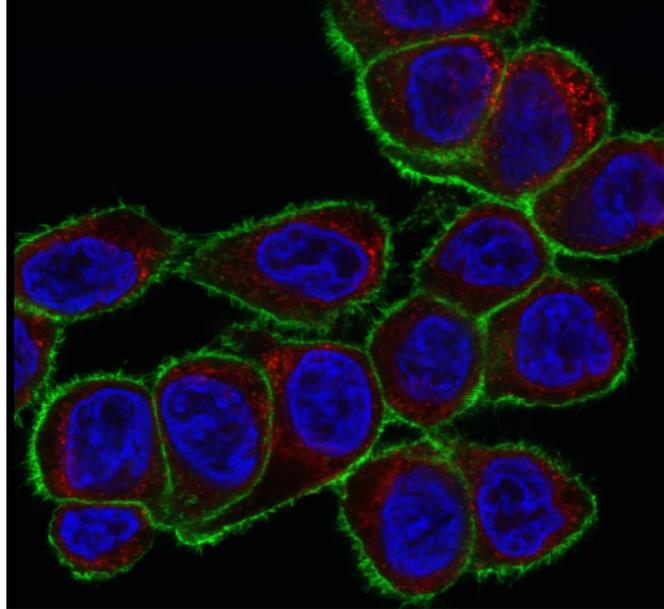


Sources:

G.R Bozzoli (1995), *A Vice-Chancellor Remembers, The Computer Era and The Nineteen Sixties*, pg. 94-97, Wits University Press
 Ian R. Sinclair (1988), *Collins Reference Dictionary Computing, Code, Code Conversion, Coding Sheet*, pgs.48-49, Collins
 Mr Shunmuga Pillay, Manager: Scientific and Research Systems, Mathematical Sciences and Curator, Wits Computer Museum



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