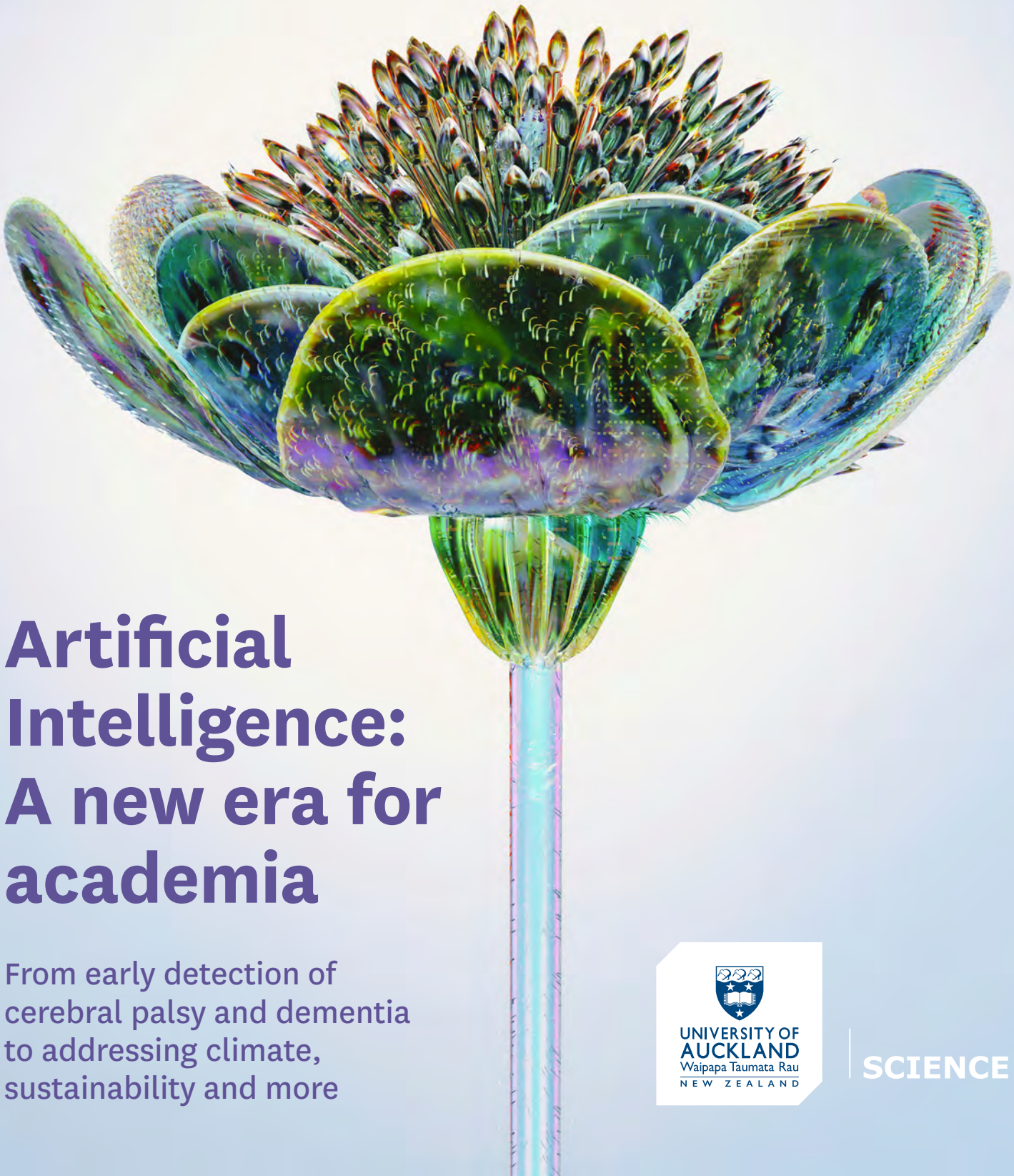
inSCight

He kōrero whakahihiko nō roto mai i Te Whare Pūtaiao
Inspiring stories from the Faculty of Science

ISSUE 18 | 2024



Artificial Intelligence: A new era for academia

From early detection of cerebral palsy and dementia to addressing climate, sustainability and more

UNIVERSITY OF AUCKLAND
Waipapa Taumata Rau
NEW ZEALAND

SCIENCE

inSCIght 2024

FEATURES

REGULAR SECTIONS

On the cover: An artist's illustration of artificial intelligence (AI). This image depicts how AI could be used in the field of sustainability from biodiversity to climate. It was created by Nidia Dias as part of the Visualising AI project launched by Google DeepMind. Image: Unsplash.

A word from the Dean

Welcome to the 2024 edition of inSCIght. It's a pleasure to write my inaugural introduction to this edition as the new Dean of Science at Waipapa Taumata Rau, University of Auckland.

This publication focuses on Artificial Intelligence and the key research and expertise our faculty is contributing to this area.

AI is a term used in computer science that refers to processing tasks that require more sophisticated synthesis than ordinary computing applications. There are two main forms of AI, one that uses algorithms and one that utilises neural networks.

AI already plays a key role in our lives, and every day you will be exposed to a system harnessing this tool – such as banking apps, service centres, Siri or Google Assistant, for example. However, the evolution of generative AI has gained worldwide attention. This type of AI uses neural networks to learn about the connections between different sets of data to produce an output. Doing this requires the processing of huge amounts of data and the more sophisticated generative AI, such as Chat-GPT and the like, uses large language processing to generate text in different styles and genres. You may think this is all new, however, this type of AI was actually first developed over fifty years ago. There are so many different applications of AI. Being new to Auckland, I've just utilised Chat GPT to develop a large database to help me navigate and summarise details on the Auckland housing market. In less than three minutes, I had a large spreadsheet of data summarising things such as median and average sale price, ratable value, price per m2, days on market, sales volume, interest rates, rental yields, comparison on similar sized properties over the last five years and so on. Of course not everything with AI is so easy or straightforward. Within this edition our staff working at the forefront of AI will outline the complexities of AI, the opportunities it provides us, as well as the predictions of how AI will behave in the world.

We have a diverse breadth of research expertise in the faculty and some of our incredible researchers are using AI and machine learning to help us address issues that challenge our society and also harness AI to improve our quality of life. Dr Daniel Wilson is using AI to diagnose and predict dementia whilst Dr Angus McMorland is harnessing the power of AI to reveal early signs of cerebral palsy in infants. Both these approaches aim to diagnose the conditions at a much earlier phase of the disease, to start treatments sooner and reduce morbidity.

AI can also be used to monitor our environment, from animals to waterways and oceans, with a focus of maintaining species and preventing and managing climate emergencies. You will read about the approaches some of our emerging and established researchers are taking to developing AI solutions to detect and mitigate harmful algal blooms in NZ lakes or cyclone risk in the Pacific.

At the Faculty of Science, we are committed to ensuring that our students have transferable skills that allow them to make an effective transition into the workforce. As such it is crucial that we train our students to learn about AI including the ethical considerations and using it with integrity. Students are also routinely using AI to help with synthesising their notes, acting as a personalised tutor and critiquing their work. Of course, the risk of this to academic integrity and the legal status of data is something we are mindful of and we are navigating carefully. We also know many students have an appetite for studying AI. One of our newly minted professors, Prof Yun Sing Koh, co-director of the Centre of Machine Learning for Social Good, is leading one of our new degrees, Master of AI.

Human civilization evolved from how humans used their intelligence to navigate their environment and find solutions to problems. Prof Michael Witbrock explains how AI is set to disrupt this with an 'explosion' of many different kinds of strong intelligences imminent. While this may sound like some sort of sci-fi fantasy, I hope this publication gives you pause for reflection and thought about how this technology revolution is helping us to live better lives.

PROFESSOR SARAH YOUNG
Dean of Science,
Waipapa Taumata Rau,
University of Auckland

Integrating AI and academia

A look at the future of academia and research

Professor Andrew Luxton-Reilly, Professor Mark Gahegan, and Associate Professor Paul Denny

AI IS REDEFINING our society's future, and we must adapt. The Faculty of Science at Waipapa Taumata Rau, University of Auckland, is well-positioned to embrace this challenge with the measured consideration it demands. With several thought leaders in the field to boast, the University is an established voice in the global discourse.

AI in education: a revolution in the classroom

Generative AI is a disruptive technology fundamentally changing the workforce and revolutionising our social structures. For education, it heralds the most significant democratisation of education since the printing press, at an unprecedented speed. With this great opportunity comes a significant challenge: how do we maintain the value of human-led education? When a student can learn effectively from an artificially intelligent tutor with human-like interactions that provide personalised, adaptive responses on demand, then what value does university education offer? In a future world where machines can complete intellectual tasks more effectively than graduates, what is the purpose of the University? In the short term, we are grappling with adjusting assessments, communicating expectations to students, and upholding academic integrity. In the long term, we must consider how the role of universities is evolving and how teaching and learning will change as scientific knowledge is accessible to all and the artefacts produced by humans and AI models become increasingly indistinguishable.

One of the core functions of universities – credentialing – will likely remain a key value. However, with AI making independent learning more feasible, universities must ask: what value do we offer students if credentials are insufficient? The answer lies in fostering deep, relational and scientifically grounded learning experiences. To be human is to learn, and the sense of accomplishment and joy associated with mastering new knowledge and skills is deeply embedded in the human condition. Universities, at their best, facilitate the development of synergistic learning communities, where like-minded individuals gather in the same space, often leading to transformative connections that are hard to replicate elsewhere. Many great scientific and technological innovations started with people physically meeting at University, sharing ideas, and thinking similarly. Such communities accelerate learning and provide a platform for developing future core capabilities: discerning what is real, what is credible and what is not, how to work effectively with a range of AI tools, and making ethical decisions about how to interpret, evaluate, and use output from Gen AI. Students who master these skills will take a leading role in shaping our future.

Certainly, the widely discussed concerns surrounding AI – plagiarism, over-reliance, and the erosion of independent thinking – are real. As a faculty, we are responsible for teaching students how to engage critically with AI tools. The future of education lies in striking a balance between preserving the uniquely human capacities that make learning a personal process and leveraging AI's strengths. Several courses within the Faculty of Science have already begun to explore the use of AI-powered tools and feedback mechanisms for enhancing student learning. Such tools can provide personalised and timely feedback, and enable curiosity-driven learning in a way that is otherwise difficult to scale. Academic teaching staff remain essential for motivating students, fostering curiosity, and helping to develop the sense of community critical for collaborative learning and intellectual growth.

The Faculty of Science is world-leading in several aspects of the emerging use of AI in education, locally and internationally. Our staff have organised international events such as the "Generative AI in Education" workshop at NeurIPS (the world's premiere AI conference) and developed impactful pedagogies and tools, for example, to train students in formulating effective prompts to guide AI models to solve computational tasks. Collectively, we must continue to explore and share efforts to embrace generative AI, to enhance learning and to equip students with essential future skills.

AI in research: a revolution in the laboratory

When computers first emerged in research (1950s-70s), they were used primarily to scale up analysis and modelling activities. Their impact was huge in some fields (such as physics, chemistry, and biology), but marginal in others: analysis and modelling is just one step on the research lifecycle, and not all fields needed this scaled capability.

This time round is different. As we begin to grasp what Gen AI can do or will do soon, it is clear the impact on research will be massive: every aspect of the research lifecycle will be affected.

Gen AI is already helping to augment human researchers, automating tasks such as reading and summarising the relevant literature, proposing new hypotheses, writing computer code and scripts, describing computational code, data and workflows in text and diagrams – in other words helping with many research tasks, including the authoring of scientific articles, along with further improving analysis and modelling. And soon, we can anticipate AI tools that can reliably make and explain new scientific discoveries across many research areas. We can also expect that the current GenAI methods will improve rapidly as they are taught to avoid some of the errors and hallucinations they currently exhibit.

These developments may seem astonishing, but the foundations have been in place for some time. Gen AI was first developed in the 1960s, and language models have existed since the 1980s. Scaling these technologies up proved challenging, but once that problem was solved, it suddenly became possible to learn from extensive and broad data collections (such as the 'common crawl' of the whole Internet). The amazing, emergent behaviour we see in these GenAI tools results from what Peter Norwig calls the "unreasonable effectiveness of data" – the remarkable ability of large datasets to produce highly accurate models, even when the algorithms used to analyse them are relatively simple.

How will researchers adapt to these challenges in the longer term? As we always have, hopefully, with a sense of wonder at the discoveries we can participate in and with the humility to recognise that non-human intelligence has many useful qualities we can learn from. Better science will improve our citizens' lives and our planet's health. Ultimately, this is more important than how research gets done.

Automated pose estimation for prediction of cerebral palsy

CEREBRAL PALSY is the most common cause of child-onset physical disability in New Zealand, and there's no known cure, but Faculty of Science researchers believe that artificial intelligence can play a key role in supporting early identification of the condition – and help facilitate early intervention.

As a neuroscientist and senior lecturer in Exercise Science, Dr Angus McMorland heads a project funded by the Friedlander Foundation that is harnessing the power of AI to reveal the tell-tale signs of CP within the first few critical weeks after birth.

"Where you can make a meaningful difference for their whole life really has a maximum impact, and that's what attracted me to it."

It's estimated that one baby is born with CP every three days in New Zealand, resulting in abnormal brain development and affecting functions like muscle control, posture and balance. Unfortunately for many youngsters, the more mild cases might not be diagnosed until around two years of age when the time-sensitive window for the optimised benefits of early intervention has passed.

"So then it becomes a much more physical condition rather than just a neurological one," says Angus. "If we could intervene earlier on, then we can potentially reduce some of those consequences."

Following the recent introduction of new best practice guidelines for the early prediction of CP, clinicians have begun using short video clips of babies younger than three months to complete a General Movement Assessment (GMA), which determines whether movement patterns are normal, abnormal or absent in newborns.

As Angus puts it, "We've been watching babies lying on their backs squirming around for thousands of years." However, the main focus of the GMA is on the 'writhing' movements that take place up to nine weeks of age and the 'fidgety' movements that occur up to 20 weeks.

"These movements wax and they wane in amplitude, and they show elegance and complexity and they're smooth and fluid – all these sorts of things. So those are the hallmarks of healthy General Movements."

Unfortunately, there are precious few trained clinicians in New Zealand, many of whom Angus says are conducting GMAs "on the side" in addition to their day jobs.

"There's no way that the existing number of clinicians can do the number of tests that we would like the system to be doing."

Which is where AI comes in. Using the video clips of 87 babies identified by Waikato Hospital as high-risk, researchers have been training what Angus describes as a "naïve" off-the-shelf AI motion-tracking platform called DeepLabCut™ to recognise infant body positions.

It's been a painstaking process for research fellow Dr Hamid Abassi and PhD student Manpreet Kaur, involving the

"Where you can make a meaningful difference for their whole life really has a maximum impact, and that's what attracted me to it."

– DR ANGUS MCMORLAND

Dr Angus McMorland.

manual labelling of hundreds of video frames with wrist, elbow and shoulder movements – although Angus and his team have gone a step further by including rotational movements and some facial features that the AI platform can also recognise.

"They're getting 98 percent accuracy in terms of where each of those markers is on the body now, so that's working really well."

The next phase in the creation of an automated GMA is to train a second AI system to determine whether movements are normal, abnormal or absent, which involves labelling movement patterns based on relevant clinical assessments.

"We think we've got some good ideas about how to do it really well, it'll definitely work, and we think we can improve on some of the other approaches," says Angus, referring to similar research being conducted elsewhere in the world.

The ultimate goal is to create a mobile app on a clinician's phone or device which will automatically upload video content to the New Zealand eScience Infrastructure (NeSI) supercomputer which will process the images and send a determination back to the user.

Automating the process will hopefully remove some of the current time-consuming challenges involved in identifying high-risk babies, meaning that more babies will have the opportunity to be assessed.

"That's one of the benefits of our system" says Angus, "identifying in a much more specific way which babies are really going on to develop cerebral palsy will help with the development of these interventions – or the testing of them."

Conventional interventions are generally based around increasing sensory feedback through play and time spent with parents, but testing these interventions has been difficult because of the challenges involved in identifying soon enough which babies will develop the condition.

Indeed, random samples of high-risk babies suggest that most wouldn't be affected, which is why Angus says there needs to be better testing of current interventions. "Maybe there's something else that we can do that's even more targeted and going to have more of an effect."

Looking ahead, he would like to develop AI systems that can track neurological outcomes at the age of two years when movement and cognitive and behavioural impairment may start to show – or not – although he admits that there's likely to be some complexity involved in comparing video content and patient outcomes over a longer timeframe.

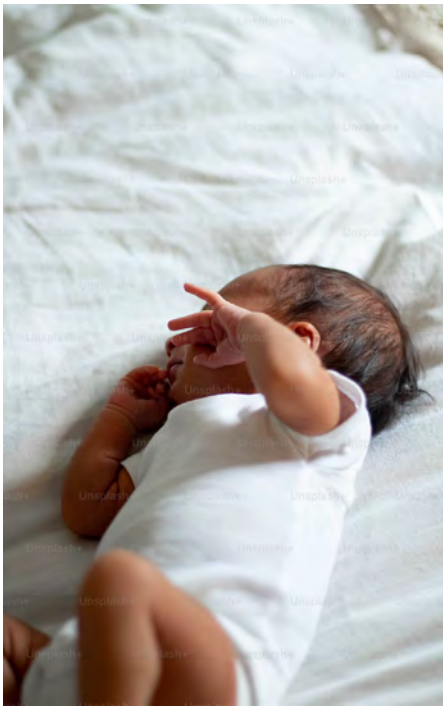


Photo: Leighann Blackward for Unsplash+.

"What we don't know is how that impacts the networks of neurons and therefore the way that different parts of the brain are communicating with each other and how that impacts development to cause – ultimately – cerebral palsy.

– DR ANGUS MCMORLAND

"Because we've got these measurements of movements, we could start to improve upon what the clinicians can do. Is there something subtle in these movement patterns that tells us about this less severe condition at two years of age?"

Given that a child's movements essentially provide a "window" into what's going on in the brain, Angus also wants to investigate, as part of his blue-sky thinking as a neuroscientist, what changes have taken place at a neuron level – say from low oxygenation – to cause cerebral palsy.

"What we don't know is how that impacts the networks of neurons and therefore the way that different parts of the brain are communicating with each other and how that impacts development to cause – ultimately – cerebral palsy.

Yet another long-term goal is to make the AI technology for CP diagnosis universally available, perhaps through Plunket, much in the same way that his son's hearing difficulty was picked up by the nationwide programme to screen the hearing of newborns.

As he points out, the current practice is to look only at high-risk babies because that's where the resources have to go. But the reality is that of those diagnosed with CP, something like 45 percent had no appreciable medical history to suggest that they would develop the condition.

"The only way you could possibly pick them up is with a broad screen, and then you could intervene earlier than we do at the moment."

Given the wide range of risk factors for CP, including infections, prematurity and complications at birth, Angus says the condition is "not going away." And while the incidence in the Māori and Polynesian communities is equivalent to the wider population, "the consequences of that in terms of interacting with the health system are not necessarily equitable, so the outcomes are different."

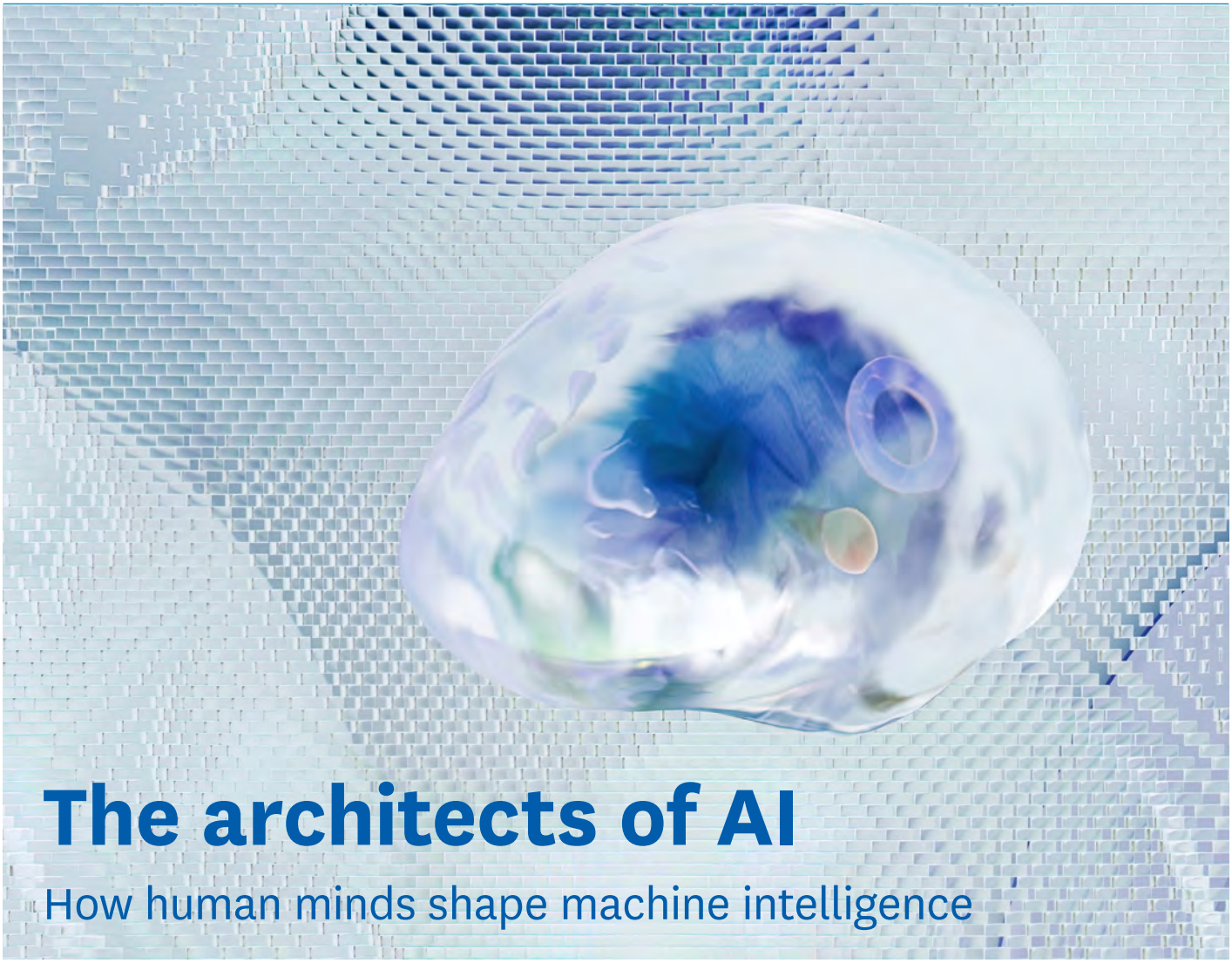
With that in mind, he would love to see the AI-generated diagnostic tool become widely available within the health sector, although it might require additional funding – perhaps from a not-for-profit organisation – to keep it going.

"My end goal is just to put it out there and make it available," says Angus. "There's no way that people should be paying for this privately, as far as I'm concerned."

Find out more:

Abbasi, H. et al. (2023). Deep-learning-based markerless tracking. *Journal of the Royal Society of New Zealand*, 53(4), 567-589. https://doi.org/10.1080/03036758.2023.2269095

Haggie, P. et al. (2023). Linking cortex and contraction. *Frontiers in Physiology*, 14, 123-145. https://doi.org/10.3389/fphys.2023.1095260



The architects of AI

How human minds shape machine intelligence

WHILE THE AGE of artificial intelligence is poised to change society as we know it, our future relies on human intelligence to guide us towards a society in which we want to exist.

Human civilisation evolved from the minds of humans, enhanced by various computational systems. Artificial intelligence is set to disrupt this reality, with an explosion of many different kinds of strong intelligence imminent.

Michael Witbrock is a professor at the School of Computer Science and the founder of two AI-focused organisations, the NAOInstitute, and the Strong AI Lab (SAIL), hosted by Waipapa Taumata Rau, University of Auckland.

The NAOInstitute exists to understand the evolving natures of Natural, Artificial and Organisational Intelligences (NAOI), and the increasingly strong relationships amongst them. This includes the development of AI in the context of social responsibility and its impact on the Earth and our civilisation.

The Strong AI Lab (SAIL) functions within the NAOInstitute, focused on improving the capability of AI systems in pursuit of the long-term goal of seeing AI transcend its current limitations with social responsibility embedded in all of its objectives.

> ***"We are about to enter an age where human intelligence is not the only kind of strong intelligence around."***
>
> – MICHAEL WITBROCK

Witbrock's life's work is in the field of artificial intelligence, where he is dedicated to improving the modelling and algorithms that influence the functionality of AI.

One aspect of his research aims to prevent AI from replicating the same flaws human intelligence suffers from. To do this, he is working to help AI learn from data without preconceptions. The hope is to increase modelling accuracy and help address errors like confabulation – where an AI system generates incorrect information without a source.

"I'm most excited about progressing towards more reliable kinds of thinking to influence how these systems learn. For example, embedding reliable causal inference," he says.

Witbrock's opinion is that the rapid development of AI technology will see many automated systems become more powerful, disrupting and potentially improving our lives on a scale we have not seen before.

"We are about to enter an age where human intelligence is not the only kind of strong intelligence around."

He says many examples of technological developments in the past have displaced workers by carrying out tasks more efficiently and accurately. However, he dismisses the argument that AI is just another example of humans needing to adapt to change as a grave underestimation of the situation.

"People often argue that humans have

Above: An artist's illustration of artificial intelligence (AI). This image represents how machine learning is inspired by neuroscience and the human brain. It was created by Novoto Studio as part of the Visualising AI project launched by Google DeepMind. Image: Unsplash.

Michael Witbrock.

"Suppose we decide the end goal is for people to be free to pursue interests unrestrained by the obligations our current systems require – what would that look like, and how can we achieve it?"

– MICHAEL WITBROCK

always adapted to technological advances replacing jobs in the past, and this is another evolution of that happening – well, I think exactly not."

He predicts it is likely AI will replace many tasks previously carried out by people, and we need to plan to ensure society is prepared for this change. Or, at the very least, ensure that the decisions made at this critical moment don't prevent us from benefiting in the future.

With the significance of this rapidly evolving technology in mind, he still maintains a cautiously optimistic outlook because he believes a more AI-integrated society could result in more equitable and inclusive communities. Suggesting AI could enable us to expand our perspective and consider the interests of more organisms and entities affected by human civilisation.

"I think we [New Zealand] can do a good job of working out how to handle this change, which we should expect to eventuate over the next five to ten years, so not a long time."

He attributes this belief to New Zealand's relatively small and well-resourced population, which he believes is also socially well-positioned to adapt.

While Witbrock acknowledges there are valid reasons to be concerned about safety, he pushes back on the argument that all applications of AI must be 100% safe before deploying them. He argues that this argument is unrealistic and ignores that our current systems, which are largely controlled and operated by humans, are not entirely secure and often cause unintentional harm. This reality is experienced to a greater extent by minorities, to whom many of these systems are not designed to cater.

Further, he says almost all our concerns about AI are true of humans, too.

"Hallucinations, a problem better described as confabulation, is something humans do all the time." He laughs.

His rough bet is that AI systems will continue to become increasingly powerful until they are generally more capable than humans at many tasks. He believes the technology poses exciting potential with far-reaching and unlimited benefits if we implement it well. An opportunity he thinks we should embrace.

"Suppose we decide the end goal is for people to be free to pursue interests unrestrained by the obligations our current systems require – what would that look like, and how can we achieve it?"

There are economic benefits, too. Witbrock suggests that by embracing this transition, New Zealand could increase its collective wealth more rapidly than other countries. However, with rapid growth, the associated risks must be considered.

Possible solutions include gradually increasing income support means or taxing the productive output of AI systems.

"We still want the work of an AI to be significantly cheaper than the cost of a human to do the same thing, but the cost does not need to be reduced to zero."

He elaborates, "At the moment, we're taking up to 39% of the money a person receives, and there's no reason we shouldn't take 39 or 40% of the increased value produced by an AI system, which would otherwise have had to be paid to a person and taxed – but I'm not an economist."

Witbrock assures us these conversations are happening here and around the world. He has just attended a Microsoft event Exploring AI Adoption in Aotearoa New Zealand, and is speaking from Wellington following a meeting with the Ministry of Business, Innovation and Employment (MBIE).

He says it is an interesting process because the subject is so big, and the consequences are so disruptive.

"There are people who are highly, publicly concerned about the ethics and the cultural aspects of AI use and are very active in enumerating those risks. They are not wrong to do so. But I think it would be wrong if we were not to set that against the enormous potential benefits the technology offers."

Find out more about the NAOInsitute and the Strong AI Lab:

auckland.ac.nz/naoInstitute

ai.ac.nz

Artificial intelligence, sustainability and causality theory

PhD Student Gaël Gendron just touched down back in Aotearoa after attending the Global Sustainable Development Congress in Bangkok.

GAËL GENDRON is a PhD student at the School of Computer Science whose research is focused on artificial intelligence, machine learning and causality theory.

At the invitation of Julie Rowland, the Deputy Dean of the Faculty of Science, Gaël recently participated in a panel discussion about the impact of AI on sustainability and higher education.

"The panel discussion was a tremendous opportunity to discuss topics I'm passionate about that have many societal implications with world-renowned experts. The room was packed, and I got positive feedback from the audience, so it was a great experience!"

Can you tell us more about the panel discussion?

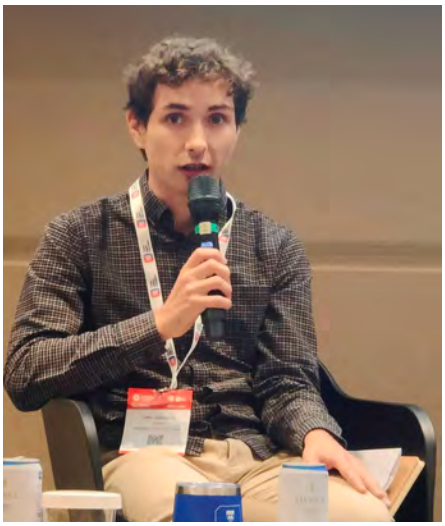
"I was honoured to join a panel of impressive thought leaders, including Professor Siah Hwee Ang, director of New Zealand's Southeast Asia Centre of Asia-Pacific Excellence, Professor Teck Seng Low, senior vice-president for sustainability and resilience at the National University of Singapore, and President Banchong Mahaisavariya of Mahidol University and moderated by Professor Julie Rowland. We debated and answered questions from the audience on the future impact of artificial intelligence on sustainability, how it could help or prevent us from achieving our climate change goals, and how it would impact our lives, particularly in information and education."

What is your main takeaway from the event?

"I learned a lot about sustainability and how people worldwide are trying to tackle its challenges. I thought I would feel out of place as 'just' a student, but I realised that I had a lot to offer from my knowledge and perspective, and I wish to see more young people and students appropriate these questions and intervene in these kinds of events."

Gaël is completing a PhD in computer science (artificial intelligence, machine learning and causality theory) at the University of Auckland.

He moved here from France to complete the Research Internship element of his Masters in AI degree and decided to stay on and complete a PhD.



Gaël Gendron.

"I was looking for academic excellence, and a high-functioning AI research centre in a desirable location – New Zealand and the University of Auckland ticked all the boxes."

"I joined the Strong AI Lab, which had just been founded by Professor Michael Witbrock, for six months. I enjoyed the experience in every aspect and was in contact with AI experts who provided me with excellent supervision, so I decided to stay for at least three more years and do my PhD here."

What is your research/thesis topic?

"Improving the capacity of AI systems to reason and think more "human-like." AI cannot currently form strong abstractions that can be reused in multiple contexts. They either reason in a narrow way: they are very good at a specific task but fail if you tweak a few settings; or, in a shallow way, they provide good answers on the surface but without proper understanding. For instance, ChatGPT can give you a confident answer on almost every topic, whether wrong or right, like a student who did not study and is bluffing in front of the teacher. I'm trying to solve this issue by making them understand cause-and-effect relationships and build proper causal reasoning structures when answering a question, which can reduce their tendency to confabulate.

What excites you most about artificial intelligence?

One of the most fascinating aspects of AI is the speed at which research progresses. If you look back five years ago, many of the AI technologies available today would have seemed like science fiction. If you extrapolate this success to five years in the future, you can imagine many incredible or worrying applications! One that fills me with concern and excitement is the creation of an 'Artificial General Intelligence' that would equal human thinking on most topics and could make new scientific discoveries that would otherwise take years for human researchers. However, whether or not this can be achieved is heavily debated. A more grounded application I'm particularly excited about is the use of AI for medicine. There are many ways AI can help, ranging from drug discovery (DeepMind's AlphaFold has already considerably sped up research by solving protein-folding problems) to doctor assistance and personalised diagnostics (generative AI and causal models have already shown great promise).

Can you share any accomplishments or milestones you've achieved?

I've had four papers accepted to top AI conferences and one of them was awarded the "University of Auckland Best Student Published Paper in Computer Science." My PhD topic has also been accepted for presentation at a doctoral consortium at a top AI conference.

Finally, tell us something about yourself that we can't learn by Googling you.

I'm actually very shy! A few years ago, I would never have imagined that I'd be talking about AI in front of a crowd, let alone enjoying it!

Find out more:

dl.acm.org/doi/abs/10.24963/ijcai.2023/361

www.ijcai.org/proceedings/2024/693)

dl.acm.org/doi/10.5555/3635637.3663132

arxiv.org/abs/2402.02636

A catalyst for change

Xingyu Wang is developing environmentally friendly chemical catalysts with the help of AI.

BORN AND RAISED in China, Xingyu Wang completed her undergraduate studies at Sichuan University and moved to New Zealand to complete a PhD in the application of machine learning in chemistry.

Using Artificial intelligence in her research enables her to streamline what would otherwise be a time-intensive task to develop safer chemical catalysts for the environment.

Xingyu is excited about finding a direction that interests her and where her research might take her, embracing the challenge of the unpredictable and unknown in her work. She hopes to secure a postdoctoral position within a group that aligns with her interests.

Xingyu Wang.

Tell us about your research

My work aims to develop highly efficient, selective, eco-friendly catalysts to produce commercially valuable chemicals like methanol. In the field of electrocatalysis, a catalyst is a substance that increases the rate of an electrochemical reaction without being consumed in the process.

Environmentally friendly catalysts are considered green and sustainable because they are abundant, cost-effective, easy to recycle and reuse, and have minimal environmental impact. By reducing reliance on precious and rare metals, we help decrease environmental pollution and provide significant support for developing green chemistry and sustainable energy.

Can you explain how you use AI in your research?

A simple application of AI involves handling the vast volume of literature that is impractical for manual review. We employ large language models to extract data from numerous articles efficiently. This extracted information can quickly enhance our knowledge base or serve as descriptors in traditional machine-learning models for predicting catalyst behaviours and experimental conditions.

Manual experimentation (without implementing AI) incurs significant costs in terms of both resources and safety, and precise theoretical calculations consume excessive computational resources. This is where machine learning comes in. To streamline the process, we use AI modelling, which significantly accelerates the discovery of effective catalysts.

What is the AI system you use for your research?

Because my current research involves using information from a large volume of literature to design experiments, we use open-source large language models similar to GPT-4 (though GPT-4 is a closed-source commercial software). We deploy these open-source models locally, running them on an A100 GPU. During use, we input literature and prompts into the local LLM to extract knowledge from the literature according to our requirements.

What do you like most about the programme and why?

I particularly enjoy the unpredictability and the challenges this project brings. While the unknown can be risky, it also adds excitement. Moreover, it can assist many chemistry beginners, which I find fascinating.

Where do you hope this qualification will lead you?

I hope to continue my research by pursuing a postdoctoral position or finding a faculty position. Post-graduation, I plan to continue my research in electrocatalysis. Artificial intelligence will remain a valuable tool to expedite my studies, although it is not the primary scientific challenge I intend to address.

Have there been any significant challenges that AI has helped you overcome?

I feel that GPT-4 has helped me a lot. For instance, when I'm studying unfamiliar fields, it acts like a teacher, always providing me with suitable answers.

What excites you most about artificial intelligence?

It can streamline processes quickly, saving manpower and allowing us to avoid repetitive tasks so we can focus our energy on more valuable areas.

Finally, tell us something about yourself that we can't learn by Googling you.

I love puzzles and building blocks. When I engage in these activities daily, I feel a sense of pleasure, which relaxes me tremendously.

The complexities of artificial intelligence

Professor Markus Luczak-Roesch is Co-Director of Te Pūnaha Matatini, Aotearoa New Zealand's Centre of Research Excellence for complex systems, hosted by the University of Auckland.

JUST UNDER TWO years ago, ChatGPT was launched. Within a few months, it had become the fastest-growing consumer application in history and is still one of the most visited websites on the Internet. In this remarkably short timeframe, many generative artificial intelligence (AI) tools like ChatGPT have become household names. They have been widely accepted in workplaces, and the government is actively working to increase their uptake by business.

AI refers to computer systems designed to perform tasks that typically require human intelligence, such as visual perception or language translation. The underlying principle of most current AI systems is to learn a "model" that allows them to computationally reproduce patterns found in large amounts of historic data. This can be as simple as a mathematical function or as complex as a network inspired by neuronal pathways in the human brain. These models can then be used to classify previously unknown data or predict the future trajectory of data.

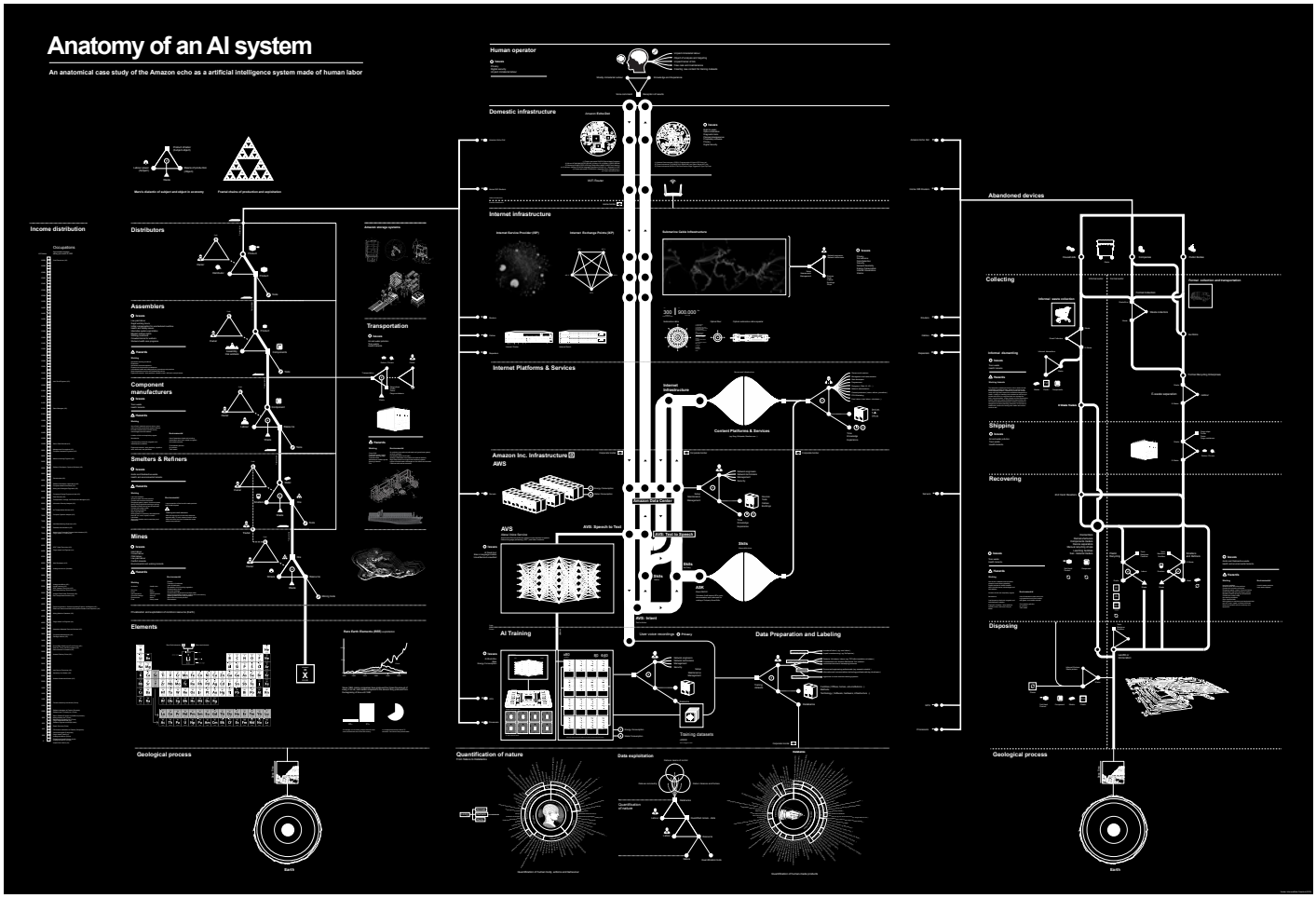
Generative AI, the subset of AI that applications like ChatGPT belong to, focuses on creating content – such as text, images, or music – based on patterns learned from existing data. While generative AI excels at creative tasks and content generation, other AI forms are currently better suited for tasks like data analysis, autonomous navigation, or game-playing.

Predictions of the influence of AI range from utopian to dystopian. Some people expect AI to revolutionise human productivity and flourishing, while others have predicted the ultimate destruction of the human race. Thinking at both ends of this spectrum can be linear or reductionist – seeing AI as a mechanistic solution to mechanistic problems.

But the world is not mechanistic or linear, and there is a lot more that we need to understand about the complex ways in which AI will affect our lives and our planet.

Unveiling the complexity behind AI in our living rooms

In 'Anatomy of an AI System' (2018)**, Kate Crawford and Vladan Joler attempt to capture and map the system that lies behind a seemingly simple request to an Amazon Echo to turn the lights on in a hall. "In this fleeting moment of interaction," they say, "a vast matrix of capacities is invoked: interlaced chains of resource extraction, human labour and algorithmic processing across networks of mining, logistics, distribution, prediction and optimisation. The scale of this system is



'Anatomy of an AI System' (2018). Kate Crawford and Vladan Joler.

Professor Markus Luczak-Roesch.

almost beyond human imagining. How can we begin to see it, to grasp its immensity and complexity as a connected form?"

There is a lot to consider. As Crawford and Joler have shown, "each small moment of convenience – be it answering a question, turning on a light, or playing a song – requires a vast planetary network, fuelled by the extraction of non-renewable materials, labour, and data." And the ever-growing volume of requests to AI systems is collected, analysed, and retained to train the models that underpin these systems.

Consequently, promising positive growth through the deployment of AI falls into the trap of the traditional equilibrium model of economics, ignoring feedback and tradeoffs in the socio-economic fabric that may counterbalance gains. Instead, we need to be thinking about the autonomous agents we are adding to our living rooms and what effects these agents will have on the complex systems they reside within.

We currently don't know how AI will behave in the world

Applications of AI will continue to grow. There are currently no limits to how many individual AI systems can be created and added to our world. And this comes at a great cost in terms of natural resources.

Altogether, there is little research so far about how different forms of AI – from the generative AI tools we know today to all sorts of other forms of autonomous agents and decision-making systems – will interact with and behave within the complex system of our social and natural environment. How will humans adapt when systems like this are brought into the world? And how will the AI systems adapt?

"Complexity science is now a recognised field that pushes the boundaries of our understanding of how to manage a world where everything is interdependent and where all our actions as individuals and collectives have hard-to-predict consequences."

– PROFESSOR MARKUS LUCZAK-ROESCH

Studies have already shown that AI can plausibly add to the so-called marketplace of rationalisations and ideas. At times it does this so well that humans are more likely to adapt their beliefs when presented with AI-generated rationalisations compared with human ones, throwing up novel questions about how we model opinion dynamics and agency in opinion formation, for example.

We have the tools to find out

Luckily, complex systems researchers have been developing the perfect tools to study the behaviour of systems like artificial intelligence over many decades. The field of complex systems emerged in the mid-20th century, driven by the need to understand systems with numerous interacting components that exhibit unpredictable and emergent behaviours.

A series of fundamental ideas in mathematics, physics and the nascent field of computing led people to turn the traditional scientific paradigm – the one that puts disciplines like biology, economics or physics at the forefront of consideration – around and put the universal principles that can be found across all of those first. Some of these principles are scales, information, diversity, feedback, non-equilibrium, adaptation, self-organisation, memory, relationships, and non-linearity.

Complexity science is now a recognised field that pushes the boundaries of our understanding of how to manage a world where everything is interdependent and where all our actions as individuals and collectives have hard-to-predict consequences.

Recent research has suggested that the answers to questions about the effects of AI require network modelling and simulation – methods and tools central to complexity science. At Te Pūnaha Matatini, we go one step further and suggest that countries need reference models of synthetic populations that reflect the private and professional lives of their entire population and infrastructure to reliably simulate the effects when artificial agents are brought into the mix.

We need infrastructures to study AI before and while in use

A lot of claims have been made about how AI will affect our lives. With our current level of understanding, it is clear that many of these effects will be unexpected.

Before pharmaceuticals are released to the public, we conduct clinical trials on them and continue to track their effectiveness and adverse events while in broad use. We need to conduct trials with AI systems before these get rolled out and impact the lives of individuals and communities. We need infrastructures to track their workings, interactions, and adverse events while in use. With network modelling, simulation, and other methods from complexity science, we have the right tools for the job.

Find out more:

**https://anatomyof.ai

Using machine learning to predict dementia

SCIENTISTS AROUND the world have recognised the potential of AI to diagnose and predict a rising tide of dementia, and New Zealand is no exception, with the numbers afflicted by the condition forecast to double by 2050 with an associated healthcare cost of $6 billion.

Given the growing mountain of routinely collected health data, a transdisciplinary team from the Faculties of Science and Medical and Health Sciences is looking to develop machine learning models which Dr Daniel Wilson (Ngāpuhi, Ngāti Pikiao) says could cost-effectively analyse medical records and identify risk factors.

"The idea is that our team could use AI algorithms to look at that information and see whether there's anything that might give a heads-up on whether somebody might have, or develop, dementia."

As a lecturer in the School of Computer Science, Daniel's role in the three-year project is to ensure that different cultural perspectives are taken into account, especially given that dementia – or mate wareware – is increasing faster among Māori, Pacific and Asian populations.

"Māori are less likely to put their family member into assisted care, for instance. That also goes for Asian families," says Daniel, "and it does result in more of a whānau-focused sort of understanding of mate wareware rather than an individual clinical focus."

> ***"The idea is that our team could use AI algorithms to look at that information and see whether there's anything that might give a heads-up on whether somebody might have, or develop, dementia."***
>
> – DR DANIEL WILSON

An anonymous online survey of people aged 55 years and over revealed that more than 80 percent felt comfortable or very comfortable with their data being used in various scenarios. However, it also highlighted the need to include different cultural perspectives – and particularly those of Māori.

"Cultural elements, spiritual elements, connectedness with whānau and the community is a much broader conception than the clinical," says Daniel, "so that was a starting point for thinking about having more detailed interviews about perspectives on data use."

A decision was made to approach a community-based support group to "let the Māori voice be heard in relation to health data", and Daniel says a key consideration was how to overcome the tension between clinical research and Māori cultural norms. "How might we engage in a way that wasn't intrusive in the atmosphere that they had already created?"

The end result was a "wānanga-style" open forum where differing thoughts, opinions and experiences were discussed with those affected by dementia and their carers, and which generated a lot of discussion about consent – and trust – when it comes to the use of health data.

"There are obligations that go with the use of the data," says Daniel, "because it's not something that's simply alienated from an individual by the person who's doing the measuring. The conception is that there are still these obligations of appropriateness and tikanga and so forth."

Understandings around the meaning of trust can also be very nuanced. While trust may be seen as fulfilling one's obligations, Daniel says that in different cultural contexts there's a question around which obligations count.

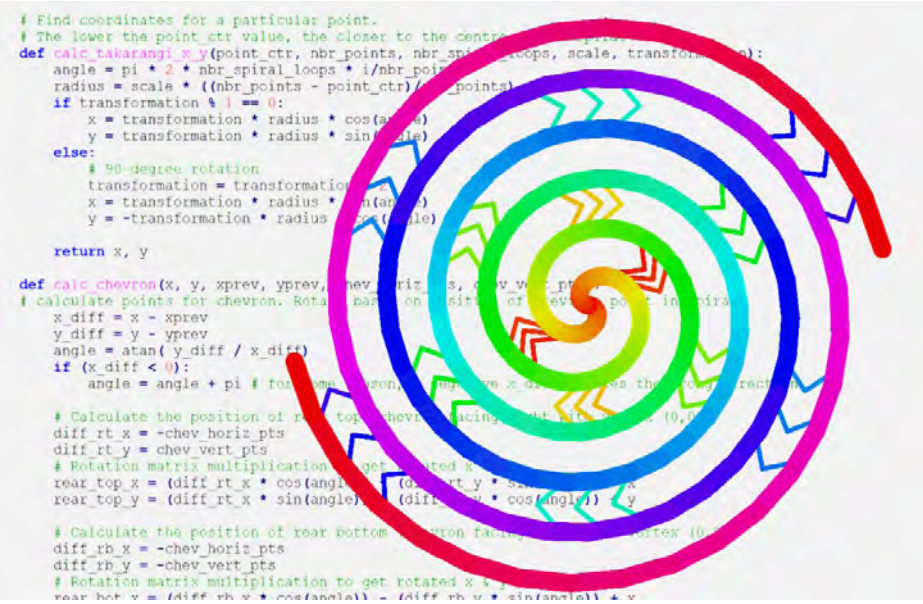
"So, is it individual virtues, OR is it about relationships and making sure that there are flows and benefits going in both directions, for example, in terms of feeding back information."

Another concern is around ensuring that there isn't a massive power differential where people feel that they're handing over everything to someone who has more power than them. "A lot of this was coming through, this sort of tension between having a relationship rather than a transaction, collective versus individual consent, these kinds of things."

Nevertheless, he says there is a general recognition that there are good intentions around the use of health data that might help future generations.

"There's very much this whānau focus of 'we're doing this for our mokopuna'. That's a real motivator to make things better further down the line. But there is also this thought that health information is tapu, it ought not to be used willy-nilly for exploratory investigations."

And Daniel says that raises a problem with current AI practices where data has been collected and stored without a specific purpose. "They're trying to work out what it might be useful for because you don't know until you look for patterns whether you're going to find any patterns.



The takarangi represents the flow of mauri from Te Ao and Te Pō, symbolising the dynamics of change and balance present in Te Ao Mārama. Image: Daniel Wilson.

"There's very much this whānau focus of 'we're doing this for our mokopuna'. That's a real motivator to make things better further down the line..."

– DR DANIEL WILSON

So there's a real tension there around the practicalities of consent."

The movement of data between different organisations also carries different levels of comfort, particularly if it involves multinational companies that might profit from it.

"There's all this wariness around how data is going to be used, and is it just going to be a form of exploitation, as opposed to maintaining a kind of a relationship. So, expectations of trustworthiness get weakened when you start talking more about government or international organisations."

A case in point is the existence of the United States CLOUD Act (Clarifying Lawful Overseas Use of Data), which enables federal authorities to compel U.S.-based technology companies, like Microsoft for instance, to provide requested data regardless of where it is stored.

In the UK, concerns were also raised after Google obtained the confidential NHS health records of 1.6 million patients when it bought a business that was using the records for AI research. "Given the current drive for more data to create better AI tools, something like this is possible here, too," says Daniel. "So we need to think carefully about how to proceed safely."

Another key focus is in the area of AI Ethics, and he's keen to see data systems that work equitably – and which recognise that data is an extension of the individual and not just an abstract snapshot.

"There are lots of value judgements and assumptions that go into creating data. Like what is measured, how do you measure it? What trade-offs do you make, what other data do you link with, because data is the fuel for a lot of machine learning artificial intelligence."

As a director of the recently launched Centre of Machine Learning for Social Good and part of a team involved in an MBIE-funded Tikanga in Technology project, Daniel is a firm believer in community involvement to make AI systems safer and more culturally appropriate.

Dr Daniel Wilson (Ngāpuhi, Ngāti Pikiao).

"If you've got something that's going to impact on Māori, get Māori involved not just necessarily at an advisory or consultation level but right at the start when you're working out what it is that you think you are doing so that you're on the same page."

As for the dementia study, which is being funded by the Health Research Council, he says there are a range of ethical considerations and discussions still to be had about the role of diagnostic models or support tools which might reduce costs and improve the quality of life for patients.

"It could give a heads-up to people that this is coming. But some people might not want to know that it's coming. So, there's a whole bunch of issues in terms of what this might look like in services because of these issues around the fact that there's no cure at the moment for dementia."

Find out more:

Cristian Gonzalez Prieto, Daniel Wilson, Gillian Dobbie, Claudia Rivera-Rodriguez, Susan Yates, Reshmi Rai-Bala, Tara Puspitarini Sani, Rosie Dobson, Sarah Cullum. "Exploring older people's attitudes and preferences around the use of their healthcare information", *The New Zealand Medical Journal* Vol. 136, Iss. 1582 (2023), pages 64-86.

Preparing the Pacific

Using AI to safeguard the future of Pacific nations

AS THE WORLD prepares for the effects of climate change, many smaller nations are bracing for the impact. With extreme weather patterns set to increase, these regions must prepare now.

Dr Michelle McCrystall's career has been dedicated to uncovering the science of our changing climate, from polar climate research to tropical cyclones. Her latest project is an online accessible resource called EMPIRIC_AI, designed to help regions most affected by the increasing extreme weather events expected as a result.

Previously based in Canada, Michelle's primary area of expertise is large-scale climate dynamics and atmospheric processes, seeking to understand the impacts on the climate of the Arctic and, more recently, forecasting the region's future climate.

"We know climate change is happening, and we know it will have an impact. So, moving forward as a scientist, I believe we need to bring the science to the people who can use this information to plan ahead."

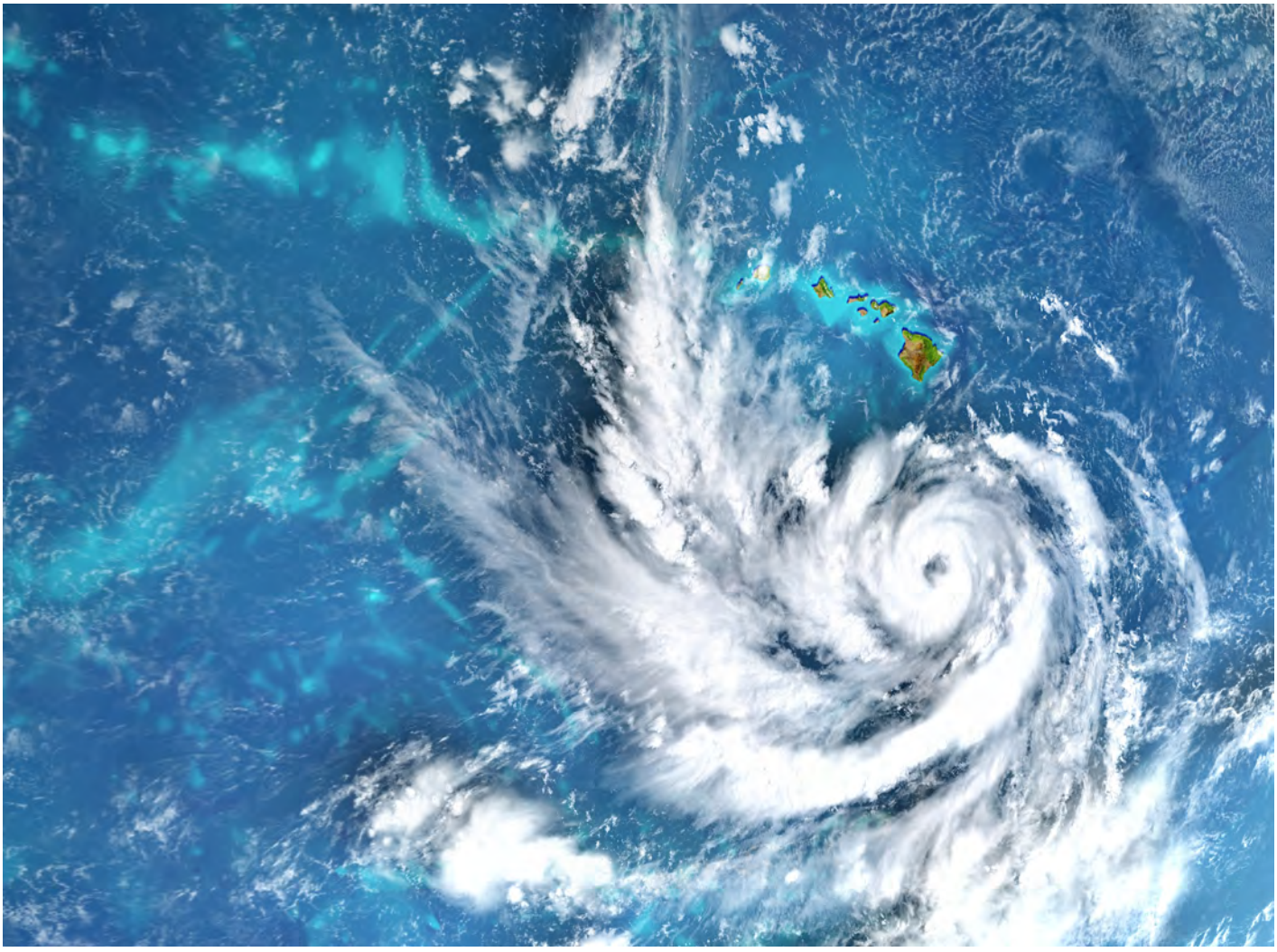
– DR MICHELLE MCCRYSTALL

Her work has taken her around the world. "I have been to Svalbard, Norway, and I spent a lot of time in Canada, including Hudson Bay, which is said to be the polar bear capital of Canada – although I have never seen one."

Since she moved to New Zealand, the focus of her work has shifted to the South Pacific, specifically assessing the impact of tropical cyclones on health infrastructure and, therefore, the health of the populations of these communities.

She has been concentrating on the impact of climate change on the region and developing the EMPIRIC_AI – the AI-enabled ensemble projection of cyclone risk for Pacific Island Countries and Territories health infrastructure – a tool for affected areas to inform their future planning using artificial intelligence (AI).

"We know climate change is



Hurricane Lane approaching Hawaii in August 2018. Elements of this image furnished by NASA. Image: iStock/Harvepino.

"We are working with people in fields that do not immediately come to mind in the context of climate change..."

– DR MICHELLE McCRYSTALL

Tungaru Central Hospital. Photo: Eileen Natuzzi.

happening, and we know it will have an impact. So, moving forward as a scientist, I believe we need to bring the science to the people who can use this information to plan ahead."

The goal is to create a free network and online platform to inform the future planning of health infrastructure for these countries as an increase in the frequency and severity of tropical cyclones in the region is anticipated.

"It's very different to what I've done before. Until now, my research has concentrated on understanding science as a phenomenon. However, this project uses scientific processes to identify the local impact for future generations."

The project was initiated when Chris Hovart was approached by a group of surgeons and public health officials to assist them in making climate predictions for hospitals.

At the time, Chris was a senior lecturer at the University of Auckland and the original Principal Investigator (PI) on the project. Now at Brown University, Chris is a Co-Investigator on the EMPIRIC_AI project.

"Climate models do not represent the Pacific islands, and running long simulations at the resolution required to 'see' them is very expensive. So, we need to devise clever ways to understand the realities of how large-scale climate patterns affect local extreme weather and the statistics of tropical cyclones. We do this by using a complex model we have developed for creating tropical cyclone trajectories and running this for long periods to train a model for cyclone impacts," Chris says.

The cross-disciplinary nature of the project presented a new opportunity for Michelle that piqued her interest. This factor was a significant element of the grant application, which involved collaborating with interested people and vested stakeholders in climate change.

"We are working with people in fields that do not immediately come to mind in the context of climate change. But by bringing the information to different industries, organisations, and groups, we are bridging a gap in communication and collaboration."

The key stakeholders and collaborators Michelle identifies include the Pacific Community – a multi-diverse organisation, various health facilities across the islands, doctors at Harvard, Melbourne, and Cairns Universities who have all worked as doctors and clinicians in New Caledonia, Fiji, and Vanuatu. More recently, the Fijian Ministry of Health has indicated interest in the project.

She also says the Fijian Ministry of Health has said it is willing to provide data on climate events that significantly impact health and health infrastructure so that projections are tailored to include what is most impactful and important for those countries.

Significant cleanup will always occur after a cyclone along the coastline. However, Michelle explains there are connected events that occur off the back of the cyclones that can be overlooked.

"Extreme precipitation is one example. In 2019, a storm hit Vila Central in Vanuatu that caused extreme precipitation and flooded the entire hospital, and they are still rebuilding."

Contamination of drinking water is another big problem. While groundwater was not an initial focus for the team, it is an example of how variable the research can be, depending on the needs of that community.

This is where EMPIRIC_AI will become a valuable tool for these regions. The AI programme is tasked with speeding up data processing and determining various metrics to predict future climate events.

Pre-AI, Michelle explains a model might take anywhere from one to two days to produce feedback, but now, results are available in hours, and the plan is to make that even faster again.

"It's not a Magic 8 ball or a looking glass that tells you an exact answer. More accurately, it provides a range of possibilities based on the collected data," says Michelle.

While this project is very much centred around informing policy and healthcare, the potential applications of this resource are far-reaching.

"Once the model is developed, it should easily adapt to anywhere else impacted by tropical cyclones. For example, parts of the Caribbean that are as heavily affected by tropical cyclones could use this model."

On an even larger scale, the project has changed the trajectory of Michelle's research plans. The broad applicability of the model makes it possible to look at other climate phenomena, like extratropical cyclones, or projects further removed, like building a wind farm.

With a deadline looming at the end of the year, the team has made impressive progress since the project's inception in January.

The EMPIRIC_AI will be up and running within the next couple of years and promises much hope to regions most impacted by climate change, with potential applications that extend beyond the Pacific.

"Often, the research I work on is science for scientists, with the hope that it gets disseminated. But this project has real, tangible benefits that will positively impact people and communities, which is really fulfilling."

Machine Learning algorithms and data pipelines

AS AN 11-YEAR-OLD, Jason Tam moved from Hong Kong to Aotearoa New Zealand. His passion for astronomy inspired him to pursue a BSc at Waipapa Taumata Rau, majoring in physics and applied maths, followed by a PGDipSci and MSc in Physics.

Jason completed a PhD in Experimental Particle Physics at Julius-Maximilians-Universität Würzburg in Germany. After gaining valuable industry experience, he earned an MProfStuds in Data Science in 2018.

He now works as a Senior Statistical Data Scientist at Oritain, a company that verifies the origins of agricultural products with a scientific approach.

Jason Tam.

When did you start using AI in your work?

I started working with Machine Learning algorithms (a core part of AI) during my doctoral student days at CERN, the European Organization of Nuclear Research. We had a lot of data to process from the Large Hadron Collider, and this new approach that was rising in popularity was worth the investment to see if it could help us achieve our goals more efficiently.

How does your current work relate to or use AI Technology?

Building and maintaining pipelines that process data in automation is part of my job.

These pipelines often include components that perform calculations involving Machine Learning algorithms.

What are some of the challenges AI presents in your line of work?

Machine Learning/AI algorithms remain largely a “Blackbox” method, meaning it is often difficult, if not impossible, to determine why it has produced incorrect results.

Particularly in technical/scientific settings, it is therefore important to keep this under control in our projects, often limiting its use only to places where it can remain highly accurate and the imperfections are within manageable levels.

Is there an AI-related project you are particularly proud of?

While working for enviPath, I contributed to developing an application that predicts chemical reactions using Machine Learning algorithms. Pharmaceutical companies consider this to be a great tool in determining successful research directions.

Are there any aspects of AI technology you think are problematic?

Insights from data are traditionally extracted with statistics, reasoning our way from the input to the result. Machine Learning/AI is useful when the complexity of problems becomes too difficult for traditional approaches and where precise predictions have priority over sound reasoning. Therefore, it should be used carefully and only in settings where unexplainable errors are manageable. AI is also developing at a very rapid pace. All sorts of associated tools are popping up to help us in every aspect of our lives. With great power comes great responsibility; therefore, we must remain adequately knowledgeable about how they work while we enjoy their convenience. Aside from remaining within ethical grounds, we must ensure that we do not become overly dependent on them and can spot errors when they appear.

What excites you most about this technology?

The potential. The AI/ML revolution, in my opinion, is comparable to the birth of computers and the Internet. It is a foundation platform for endless creativity to be built on. I am confident that, in time, it will be used in ways that are beyond what we can imagine now, much like the evolution of the use of computers and the Internet.

Do you have any career aspirations you would like to share?

I want to stay involved with the forefront of AI-related work, contributing and witnessing firsthand the wonder it brings.

What advice would you give someone considering AI studies?

I believe AI to be one of the best study options a student can make, as the future will only become more and more technology-dependent, and AI will surely be a part of it. I recommend combining this subject with a second specialty studied in parallel, as the area where two disciplines intersect is often where some of the most innovative ideas are materialised.

Is there anything else you want to share?

I feel very fortunate to witness the wonder of this AI revolution that is rapidly advancing our society. The University of Auckland is a great place that has played a significant part in my career achievements, and I cannot recommend it enough to people looking to start their journey.

Finally, tell us something about yourself that we can’t learn by Googling you.

I have a not-so-common interest in visiting places not commonly travelled to.

Famous places like London and Paris give me the feeling that I can learn a lot about them via the Internet and other channels before going there. In contrast, uncommon destinations often contain the most interesting discoveries.

AI and the silver screen

How computer science opened the door to a career in film

OLLIE RANKIN didn't know what he wanted to be when he grew up. But an open mind and a chance meeting with a friend led to an exciting career in visual FX.

Ollie entered the film industry as a Computer Science graduate in 1998 without a career plan. He took various papers outside his specialisation, from chemistry and astronomy to film studies. Ultimately, his experience in AI landed him the job that would kick-start his career.

What is your current position?

My time is currently split between three roles:

- Creative Director at Pansensory Interactive, I write and direct interactive VR experiences and create short films and games.
- Vice President of Live Entertainment at Sansar, where I produce live virtual events, such as music festivals in the metaverse.
- Director of United Humans Foundation, a think tank and advocacy organisation that is building an open source system for optimal collective decision-making centred on inclusivity, fairness, and science.

What was your introduction to working with AI?

Peter Jackson's announcement to make the *Lord of the Rings* Trilogy was the moment I suddenly knew what I wanted to do. My initial application, which focused on programming, was not successful. However, a chance meeting with a friend revealed Weta Digital were developing software to allow digital orcs and elves to think for themselves and fight each other in epic battles using artificial intelligence. After this project, I helped develop four other crowd simulation systems. Interestingly, I spent a decade progressively dumbing down the crowds I made for subsequent movies to give the film directors precisely what they wanted.

Can you tell us about your current work with AI?

Most recently, I've been using AI in several capacities. Firstly – and probably a cliche at this point – is using generative AI (usually midjourney's stable diffusion tool, but also sometimes DALL-E and Runway) to produce concept art; designing characters and environments for virtual reality productions; creating pitch deck and sizzle reel content. The second application of AI in VR I've been involved in recently isn't as far along in development. We've been experimenting at Sansar with the creation of virtual digital personas, autonomous AI avatars with unique personalities and the ability to interact with real people.

What are some of the challenges AI presents in your line of work?

Stable diffusion, DALL-E and Runway are all pretty effective at producing something that looks "cool" based on a given prompt. But they can't (yet) reproduce precisely what I'm thinking of, and they can't produce multiple pieces of content that are stylistically consistent and with identical subjects (yet). As for the AI avatars, the biggest blockers are nuanced social things, such as the AI knowing when it is its turn to speak and converse with more than one person at a time.

Are there any aspects of AI technology you think are problematic?

Yes, I have a few:

I am particularly mindful of how much people play around with generative AI and the energy that it consumes. I imagine many of the queries being processed by midjourney, DALL-E, ChatGPT, etc., are purely for curiosity. By definition, these models are not creating anything new; training and running them uses enormous energy, inevitably incurring environmental costs.

It is now cost-effective for every commercial brand or political campaign to use an AI chatbot to learn their target audience's preferences, biases and weaknesses.

I think any technology (machine, algorithm, AI) that can mimic a human ability essentially decreases the market value of human labour and, in doing so, increases the value of wealth. Without regulation, wealth inequality will only increase with every new technological advancement.

Finally, It's not unthinkable that an artificial general intelligence, given too much agency, might decide that humans are obsolete and irrelevant to its objectives. Or worse, our existence is preventing it from achieving its objectives.

Do you have any career aspirations you would like to share?

To play a part in transitioning humanity away from exploitation and greed towards an inclusive, fair and sustainable future. That's why I formed the United Humans Foundation (unitedhumans.com). I'm always seeking allies and collaborators because this ambitious goal can be achieved only with massive global support.

What advice would you give to someone considering studies related to AI?

I would encourage anyone considering studying AI to pursue it, but not just for its own sake. Identify a real-world problem we aren't progressing fast enough as a species and figure out how to apply AI to address it.

Finally, tell us something about yourself that we can't learn by Googling you.

I'm Gollum's toenail double. During my first year at Weta, a few of us would play hacky-sack daily in a loading bay. One day, going after a high-flying hacky sack, I accidentally kicked a steel drain pipe and wrecked my toenail. It turned black and fell off the following week. What grew back was such a gnarly, discoloured, unhuman claw that it was scanned in and used as a reference for Gollum's fingernails and toenails.

Find out more:

ollierankin.com

Protecting our ecosystems with smart surveillance technologies

A new era in conservation

DR KATERINA TAŠKOVA from Waipapa Taumata Rau, University of Auckland's School of Computer Science is creating impact-driven artificial intelligence solutions to globally relevant ecological problems. Her current research focuses on reliable machine learning, spatial-temporal data mining, and computational sustainability applications.

There's a reason New Zealand takes its biosecurity very seriously – we are one of the only countries in the world with no large mammalian predators. However, for our native birds, frogs, lizards and plants, this is far from the truth.

Having evolved in isolation for millions of years, our native animals lack vital defence behaviours needed for survival against introduced predators including cats, possums, rats and stoats, and many are now threatened with extinction.

Dr Katerina Taškova from the University of Auckland's Machine Learning Group is working towards Predator Free 2050, a government-funded initiative headed by the Department of Conservation, aiming to eliminate these harmful predators from Aotearoa in the next 26 years.

More than 30 organisations across Aotearoa are working towards this common goal, with Dr Taškova co-leading the Biosecurity Technology Spearhead Research Project tasked with developing new, impact-driven biosecurity technology by leveraging cutting-edge science and mātauranga Māori.

Funded by the Science for Technological Innovation National Science Challenge (SfTI), with co-funding from Biological Heritage National Science Challenge and Predator Free 2050 Ltd, the project's multidisciplinary team has developed a swarm of smart networked sensors that use artificial intelligence (AI) to detect the last predators in vast and complex landscapes across Aotearoa.

Katerina explains how the mission-led design, including workshops and subsequent consultation with scientists, industry experts and key stakeholders, shaped the project significantly. "You cannot mitigate threats with high confidence if you are not able to reliably detect them first. The workshops identified a critical need for scalable predator surveillance technology that will be functional in complex and remote environments, which are otherwise difficult and expensive to manage with conventional tools.

"Conventional surveillance methods use stationary devices, such as trail cameras and traps, and rely on target predators moving and encountering the devices. To maximise encounter rates, devices need to be placed at relatively high densities – this is expensive for large and complex landscapes, or ineffective in case of a small number of surviving predators after large eradication campaigns. For some species, even having just two left can repopulate an entire area.

"A swarm of mobile networked sensing devices could self-navigate through large spaces and automatically detect and identify invasive predators. Advances in AI, robotics, wireless communication, sensors and battery (energy) technology coupled with well-established predator control expertise could make this sophisticated technology a commercially viable product in a matter of several years.

"We want to make it affordable so people can actually use it, like farmers or the Department of Conservation."

Katerina explains that conventional active surveillance from helicopters or hunters with dogs is expensive and requires intensive human effort. However, AI-powered surveillance using swarms of low-cost wirelessly connected sensing devices moved and serviced by drones might be the most cost-effective solution long-term.

"We want a technology that could scale and adapt to different environments, and function autonomously long-term;

Above: A sea urchin barren with superimposed model predictions. Most of the urchins in the images belong to the species Centrostephanus rodgersii. Image: Nick Shears.

as such, AI is going to play a key role in the proposed technology. However, the success of the new technology will depend as much on science and clever engineering as it will co-design and social licence.

"We were fortunate to have worked with an inspiring team of Māori researchers; they created a framework for mātauranga Māori co-design of ngahere technology, which was used to inform the drone design including shape, colour and materials, with inspiration taken from traditional practices like weaving and carving. The same approach can be used to inform the design of the sensing devices, including the algorithms for predator detection and predator search strategies."

Although the SfTI project formally concluded in June of this year, further testing will continue later this year, thanks to the co-funding from Predator Free 2050 Ltd. Katerina explains, "Our current efforts focused on proof-of-concept prototypes, tested in small-scale field trials and using humans to move sensing devices, collect data and replace batteries. Our last field trials will test long-time deployment of the swarm in a forest, and a pilot study that demonstrates a no-human-needed system with drones. The goal is to have a robust operation and full autonomy in the long term. The key to that will be reliable machine learning models for predator search and navigation of rugged native forest reliably, a considerable challenge due to the abundance of branches and vines."

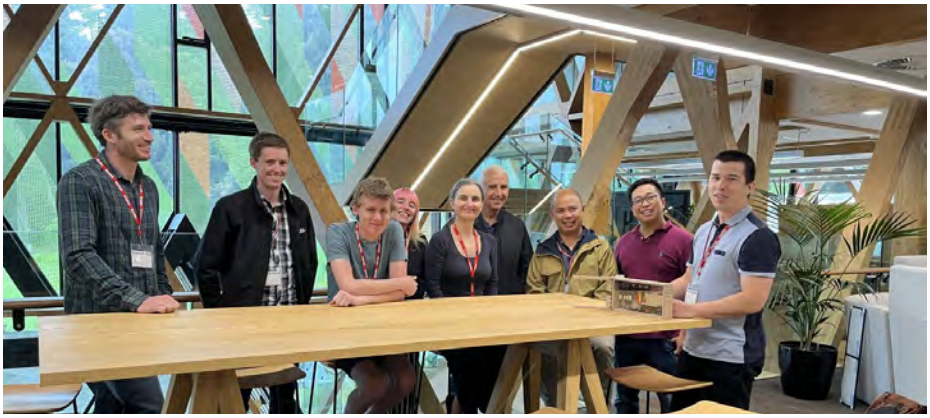
Monitoring our oceans

Artificial Intelligence is a multifaceted vehicle not only driving solutions to existing ecological problems, but also steering our scientific efforts towards the prevention of future climate emergencies. Katerina's most current project focuses on assessing the impact of the longspined sea urchin population expansion on kelp forests in and around New Zealand.

Scientists are currently witnessing a potential boom in sea urchins in Northern and Eastern New Zealand waters, which directly impacts our kelp forests – a pivotal life supply for many marine species.

Katerina explains, "Climate change-driven sea urchin proliferations and overgrazing pressure can turn productive kelp forest habitats into persistent underwater deserts, called 'urchin barrens'. With drastically reduced productivity and biodiversity, urchin barrens provide fewer ecosystem services than kelp, while significantly reducing support for important cultural practices, fisheries and tourism.

"Longspined sea urchin expansion, due to climate change, is the most urgent threat to kelp-dominated reefs in south-eastern Australia, as well as our kelp forests. However, the extent of this habitat loss is unknown, due to data deficiency. Robust ecological monitoring at spatially relevant scales is therefore needed to gain an understanding of the current impact, and to prioritise areas for protection and active management."



January 2023 Project Workshop in Rotorua. Right to left: Lachlan McKenzie, Simon Knopp, Liam Brydon, Sandra Gómez Gálvez, Katerina Taškova, Bruce Warburton, Yi Chen, Jamie Bell.

With funding from Climate Change AI, a global non-profit organisation, Katerina (Co-PI) is leading the development of a machine learning (ML) toolbox that will enable rapid surveillance of kelp forest changes and the spread of sea urchin barrens. In a joint effort with researchers from across Australia and New Zealand, including Dr Arie Spyksma (PI) from the University of Auckland's Leigh Marine Laboratory, they have "developed open-source ML algorithms and models for sea urchin detection and habitat classification, leveraging historic benthic imagery sourced from across south-eastern Australia and northern New Zealand. Although this project is yet to finish, our models are already proving effective in improving the accuracy and speed of image annotation, with ongoing development to improve model generalisability across new locations as new data is becoming available, including detection of new urchin species."

Arie adds, "A well-designed AI tool, like we have developed, can significantly reduce the time required to analyse large imagery datasets. Across datasets containing 1000s of images, what would have taken days to analyse is now taking hours and still producing highly accurate results."

Katerina further highlights, "Models and data generated in this project have already been integrated within Squidle+, an open-source platform for centralised marine image data management and annotation, used widely by marine scientists in Australia. This will increase the utility of the models and data and allow us to perform post-deployment evaluations of the models. The latter will inform further refinements and development of models and algorithms so they can be applied to kelp forests and urchin species globally."

Although the team currently focuses on streamlining the automated data annotation, the goal is to use the data to inform mitigation strategies. Katerina adds, "Automated analysis of timely collected data could unlock the full potential of AI-driven solutions for proactive management of underwater ecosystems, freeing up valuable resources for conservation activities and restoration projects."

The modelling framework underpinning the sea urchin barren detection can be repurposed to address other ecological questions with relative ease, provided there is data available to train it with. Katerina says, "The team has data from the Hauraki Gulf during the 2021/2022 summer marine heatwave; leveraging them to detect sponge species showing signs of necrosis or bleaching as a result of marine heatwaves, which will allow us to better monitor sponge health prior to, during and after future marine heatwave events."

Find out more:

ml.auckland.ac.nz

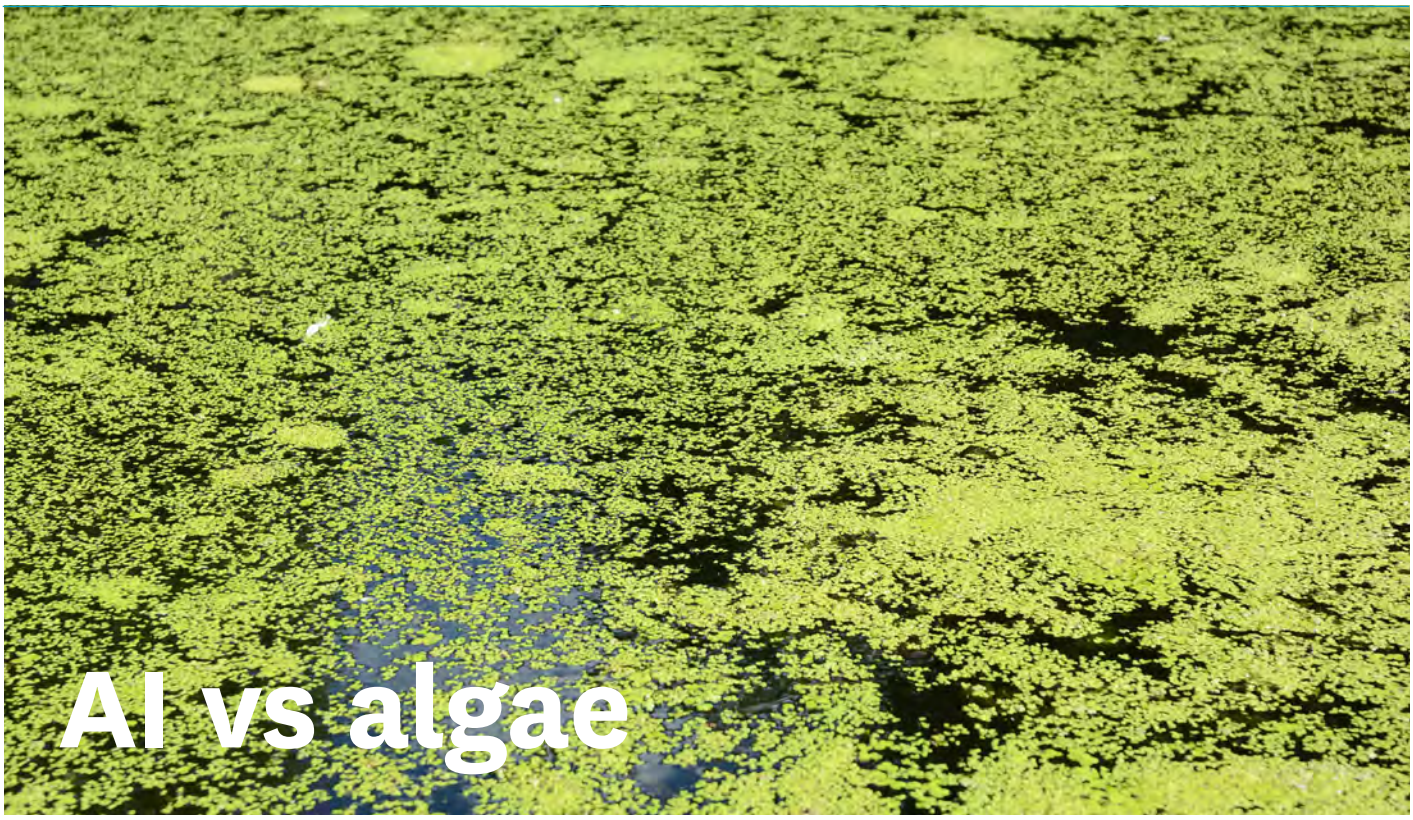
wickerlab.org

sftichallenge.govt.nz/news/ biosecurity-research-to-develop-smart-connected-robots-that-seek-out-aotearoas-last-predators

data.bioheritage.nz/dataset/a69d5380-70fb-403b-b106-7cb7bb0379da/resource/309d675f-c503-452a-bb43-9bb0b5721a30/download/swarm-tech-2.pdf

auckland.ac.nz/en/news/2024/07/03/ai--urchinbot--will-find-sea-urchins-ravaging-our-coasts.html

allaboutai.com/nz/ai-news/ai-powered-urchinbot-tackle-sea-urchin-overpopulation



AI vs algae

Image: iStock/Lex20.

Cleaning up Aotearoa's lakes with machine learning

COMPUTER SCIENCE PhD candidate Olivier Graffeuille is helping develop solutions to the problem of detecting harmful algal blooms in New Zealand lakes using satellite data and applying machine learning techniques.

Harmful algal blooms frequently affect lakes in New Zealand and other parts of the world, where a rapid buildup of algae mass becomes toxic to human health, ecosystems and aquaculture. Freshwater scientists monitor these algal blooms by collecting water samples and analysing them in a lab to estimate algal concentration to identify when water becomes unsafe. This process is expensive and time-consuming.

Olivier's work is part of the Machine Learning to Monitor Harmful Algal Blooms project, based within the Centre of Machine Learning for Social Good.

The centre's primary goal is to advance fundamental knowledge in machine learning and data analytics to address the most challenging and pressing health, environmental and societal problems for the benefit of our society.

Machine learning is a branch or subfield of artificial intelligence (AI). AI as a field covers a wide range of applications, including recent popular generative AI tools. The process typically uses data and algorithms to imitate how humans will learn, and it can also be used for decision-making.

"We are developing machine learning techniques that can monitor water quality in lakes from satellite data, which is more efficient than water sampling," says Olivier. "Our goal is to create models which take satellite data and then use that information to indicate that an algal bloom is occurring."

> ***"We are developing machine learning techniques that can monitor water quality in lakes from satellite data, which is more efficient than water sampling,"***
>
> – OLIVIER GRAFFEUILLE

"As these environmental data sets are quite small and expensive to collect, our main challenge is to develop machine learning problems that learn from very little data. Most people have heard of tools like ChatGPT, but unlike other machine learning or AI systems where there is a lot of data to train the models on, a key difference here is we have very little data to work with.

"I witnessed a data collection process during the first year of my PhD at Lake Waikare, located between Auckland and Hamilton. The lake is very eutrophic. It's dirty, shallow and continually full of algae, so it's an interesting site for that reason. We went out on a boat and collected the water sample from the middle of the lake, which was then sent out to a lab for analysis.

"Every data point is hours and hours of work from environmental scientists, so it was great for me to see that process in person. Now whenever I go past a lake anywhere in New Zealand, I know I've seen that lake in my data set.

"There's a lot of diversity in lake ecosystems, both within New Zealand and around the world. I still have a shallow understanding of lake ecosystems, and when I talk to my supervisors, I'm always impressed by the depth of their knowledge of this space. This diversity challenges us to work in different ways by applying diverse machine learning systems to make predictions."

Olivier enjoys working as part of a multidisciplinary team, especially learning more about environmental applications and how scientists in other fields work.

"As computer scientists, we're all a bunch of nerds. We see a bunch of data and want to make models with it. Environmental scientists must understand every detail, every data point and why the information is significant. It's good to help build understanding between the different fields and to see how the data is used in real life."

"My environmental supervisor, Moritz Lehmann from the University of Waikato, has been learning more and more about artificial intelligence while I have been doing my PhD. As I've been learning about environmental science and its applications,

Moritz has been learning about the machine learning process in return. He has been an applied environmental scientist his whole life and is now able to incorporate these methods in his work, too."

"We're also working with Mat Allan from Waikato Regional Council, who has been helpful with supplying data and interesting conversations about the lakes."

One of Olivier's supervisors is Professor Yun Sing Koh from the University of Auckland, who is also a co-founder of the Centre of Machine Learning for Social Good.

Yun Sing is excited about the Machine Learning to Monitor Harmful Algal Blooms project, citing it as a good example of a concerted transdisciplinary effort to address a challenging concern, embodying the centre's foundational principles. She says, "This is the first machine learning for social good centre in Aotearoa. There have been other models out there in other parts of the world, but this is the first one that we have here. Our mission for the centre is to advance fundamental machine learning and data analytics while addressing the most pressing challenges in health."

"I'm very passionate about what we're doing for New Zealand here as we potentially tackle problems within our own backyard which can then be applied in a global context.

"Machine learning is a useful tool, but it's not a silver bullet. Tackling these questions requires a concerted transdisciplinary effort across all sectors of society from the onset of a project and we can see that occurring here.

"I can also see how the learnings from this project can be translated to other questions and also applied to our knowledge of machine learning."

Olivier is also excited about the local and global possibilities of the project.

"I think there's many possibilities with the techniques we're developing here. The nature of satellites means we have global coverage of data all the time and the scalability is exciting.

Olivier Graffeuille.

"Currently, the data is being collected to monitor algal bloom, but we could get to the stage where we've got these accurate remote sensing models. Within the next decade this could potentially be used to provide accurate water quality models globally, which would be a huge societal benefit, at little added cost because the satellites are already there.

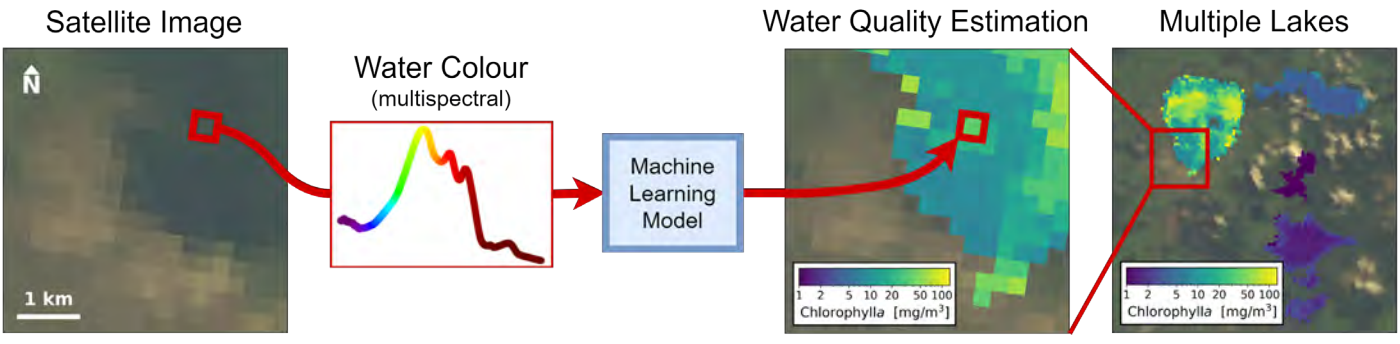
"Natural hazard monitoring for things like bushfires is another important issue where this approach could be applied, using global data."

Olivier would like to pursue a career in industry once he completes his PhD.

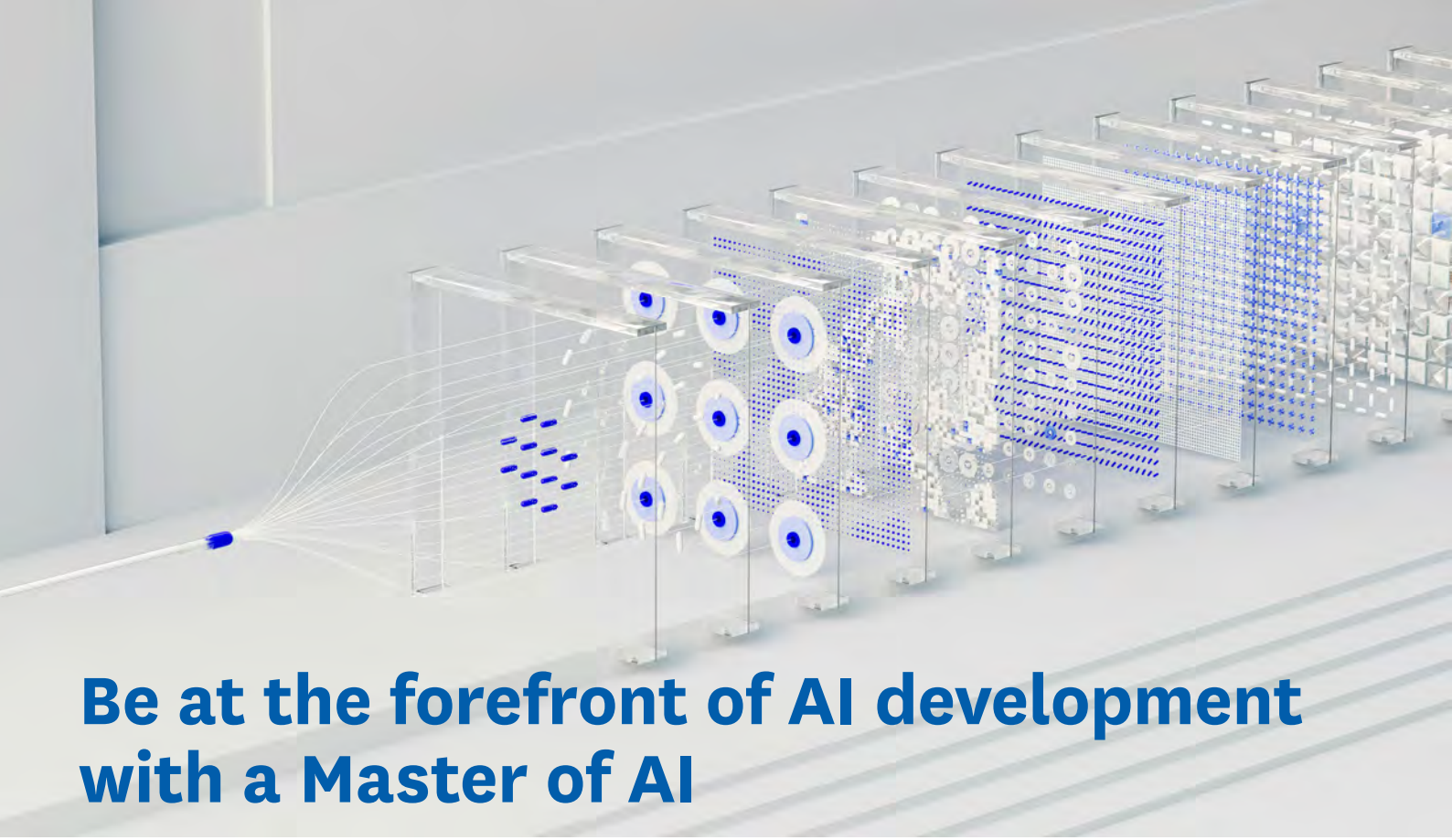
"I hope to find a position where I can use my knowledge to help a company in Auckland or overseas. Ideally, where I can make meaningful positive change, using the knowledge I've gained here to help solve environmental problems."

"I'm very passionate about what we're doing for New Zealand here as we potentially tackle problems within our own backyard which can then be applied in a global context."

– YUN SING



Water quality remote sensing model applied to Rotorua Lakes. Illustration by Olivier Graffeuille.



Be at the forefront of AI development with a Master of AI

ARTIFICIAL INTELLIGENCE is rapidly becoming more integrated with our everyday lives. To keep in line with our changing world, Waipapa Taumata Rau, University of Auckland, has established a new Master of AI qualification. The cross-faculty programme equips graduates with the skills required to fulfil the demands of the global job market and push the boundaries of this dynamic field.

Dr Yun Sing Koh, a professor from the School of Computer Science, leads the degree. She is also a co-director of the Centre of Machine Learning for Social Good and an active researcher working on cutting-edge AI research in machine learning, leveraging it for social good in health and environmental applications.

The AI industry is a high-growth field that applies to many sectors. She says the new programme will open doors to many exciting careers.

"The field of AI is constantly evolving, with breakthroughs happening all the time. This rapid development keeps things interesting and regularly opens doors to new possibilities. The technology is being applied in fields as diverse as healthcare, finance, entertainment, and environmental protection."

The programme provides students with hands-on experience with libraries, algorithms and industry-standard software. Graduates will develop a deep understanding of the inner workings of the technology, including subfields in machine learning, natural language processing, and computer vision, that can help you identify areas of interest and may influence your career path within AI.

The transdisciplinary nature of this field goes beyond the technical, and graduates must consider the potential ramifications of their work in the world. For this reason, the programme delves into the critical ethical landscape surrounding AI, ensuring a thorough understanding of bias, transparency, privacy, and societal impact issues.

The programme has been well received by the first cohort of students:

"AI is interesting because it feels like an extension of software, and yet it requires a completely different way of thinking," says Bryn Ward.

"We've got four core papers whose topics cut across each other since we're viewing AI through different lenses: ethical, practical, managerial, and academic. On top of this, I can fine-tune the program to my desired specialisation," says Fiona Bautista.

So, if this issue of *inSCight* has piqued your interest in AI, the Master of AI might be just what you are looking for to kick off your 2025.

The University also offers a Postgraduate Certificate or the Postgraduate Diploma in AI.

"You could become a Machine Learning Engineer, building and deploying intelligent systems. Or pursue a career as an AI Researcher, pushing the boundaries of this dynamic field," says Koh.

Find out more:

auckland.ac.nz/science/pg-ai

Above: An artist's illustration of artificial intelligence (AI). This image was inspired by neural networks used in deep learning. It was created by Novoto Studio as part of the Visualising AI project launched by Google DeepMind. Image: Unsplash.

"The field of AI is constantly evolving, with breakthroughs happening all the time... The technology is being applied in fields as diverse as healthcare, finance, entertainment, and environmental protection."

– DR YUN SING KOH

inSCight
Inspiring stories from the Faculty of Science
auckland.ac.nz/science/inscight
2024

EDITOR
Stephanie Look

WRITERS
Stephanie Look
Owen Poland (OP Media Ltd)
Elise Cacace
Glenn Lambert-Vickers
Andrew Luxton-Reilly, Mark Gahegan, and Paul Denny
Markus Luczak-Roesch
Jonathan Burgess

DESIGN
Jacinda Torrance,
Verso Visual Communications

EDITORIAL CONTACT DETAILS
inSCight
Faculty of Science
Communications and Marketing
University of Auckland
Private Bag 92019
Auckland 1142, New Zealand

science-web@auckland.ac.nz
auckland.ac.nz/science/inscight

KEEP IN TOUCH
If you are a Faculty of Science graduate and have a story to tell about your experiences or achievements, please get in touch. We also welcome feedback and suggestions about this publication. If there's something you would like to see in the next issue, don't hesitate to contact us.

To ensure that you continue to receive *inSCight*, and subscribe to @Auckland, the University's e-newsletter for alumni and friends, please update your details:
Email: alumni@auckland.ac.nz
alumni.auckland.ac.nz/update

SUSTAINABLE
The wrap used for *inSCight* is 100 percent recyclable in Soft Plastic recycling bins at various supermarkets.

Printed by Soar Communications Group, a Toitū net Carbon Zero certified company. We are FSC® certified (FSC® C089459).

inSCight is available digitally – please email us if you would prefer to receive the magazine in this format in future.
Email: science-marketing@auckland.ac.nz

Positional Only
FSC FSC® C000000

Connect with our research centres

University centres

Ngā Ara Whetū – Centre for Climate, Biodiversity & Society
www.ngaarawhetu.org

Faculty centres

The Centre for Computational Evolution (CCE)
auckland.ac.nz/centre-for-computational-evolution

The Future Food Research Centre
auckland.ac.nz/future-food-research-centre

The NAOInstitute
(Natural, Artificial and Organisational Intelligence Institute)
auckland.ac.nz/naoInstitute

Te Ao Mārama
auckland.ac.nz/centre-for-fundamental-inquiry

Te Pūtahi o Pūtaiao
auckland.ac.nz/te-putahi-o-putaiao

School and department centres

The Centre for Antimicrobial Research
auckland.ac.nz/centre-for-anti-microbial-research

The Centre for Biodiversity and Biosecurity
auckland.ac.nz/centre-for-biodiversity-and-biosecurity

The Discovery Centre
auckland.ac.nz/the-discovery-centre-for-fundamental-research

The George Mason Centre for Natural Environment
auckland.ac.nz/george-mason-centre-for-the-environment

The Centre for Goldwater Wine Science
auckland.ac.nz/centre-for-goldwater-wine-science

The Centre for Green Chemical Science
auckland.ac.nz/centre-for-green-chemical-science

The Centre for Health and Rehabilitation Research
auckland.ac.nz/centre-for-health-and-rehabilitation-research

The Centre for Innovative Materials for Health
auckland.ac.nz/centre-for-innovative-materials-for-health

The Centre of Machine Learning for Social Good
auckland.ac.nz/centre-for-machine-learning-for-social-good

The Centre for Mathematical Social Sciences
auckland.ac.nz/centre-for-mathematical-social-sciences

The Cyber Security Foundry
auckland.ac.nz/cyber-security-foundry

The Climate Systems Laboratory
auckland.ac.nz/climate-systems-laboratory

The Centre for Transdisciplinary Biophysical Imaging
auckland.ac.nz/centre-for-transdisciplinary-biophysical-imaging

UNIVERSITY OF AUCKLAND
Waipapa Taumata Rau
NEW ZEALAND

SCIENCE

Alumni and Friends

Everyone who graduates from the University becomes an alum for life. We'd love for you to join us at our alumni and friends events around the world and online. Each year we host several events for our New Zealand-based alumni including *Taumata*, which sees us celebrate our Distinguished Alumni Award winners; Golden Graduates lunch for our older alumni; and Raising the Bar, where academics speak at bars across the city. We also hold Alumni and Friends receptions throughout the world to connect with our alumni overseas.

Update your email and postal address to stay informed of upcoming events and opportunities in your home city: **alumni.auckland.ac.nz/update**

If you update by 28 February 2025, you'll go in the draw to win one of five $500 travel vouchers. Network online by signing up to Alumni Connect, our online alumni mentoring platform. Or reconnect with alumni virtually via our Virtual Book Club, a space for those who share a love of reading and enjoy a selection of good books. **auckland.ac.nz/en/alumni/get-involved**

Keep an eye on all our upcoming events by visiting here: **auckland.ac.nz/science/alumni-events**

Switch to sustainable?

If you would prefer to read *inSCight* digitally in future, please provide your email address by visiting: **alumni.auckland.ac.nz/update**

Support the Faculty of Science

If you would like to support our students, staff and researchers, please visit: **giving.auckland.ac.nz/science**

FACEBOOK
@science.uoa

YOUTUBE
science.auckland.ac.nz/youtube

INSTAGRAM
@scienceuoa

LINKEDIN
linkedin.com/school/uoascience/