FEBRUARY 2024 — ARTIFICIAL INTELLIGENCE

SCIENCE VICTORIA

Humanity-Shaped Humanity

Reimagining Humanity in the Age of Generative AI — pg 23

Housing for Clouds

AI's Sustainability Challenge — pg 27

Teacher's Toolkit

Using AI in the Classroom – Friend, not Foe — pg 18

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Generative AI model Midjourney (midjourney.com) was prompted to create an "abstract colourful liquid background", with the result resembling swirled paint. Source: Midjourney

In This Issue

This Edition: Artificial Intelligence

As a simple definition, artificial intelligence (AI) attempts to create machines that are capable of intelligent behaviour. From speech recognition and search algorithms, to the many types of machine learning models that can recognise patterns in data, AI has fundamentally changed the course of humanity. Whether it will be for better or worse remains to be seen.

In this edition, we look at some of the different types and uses of AI.

On the Cover

The generative AI tool Midjourney (**midjourney.com**) was prompted to create an image of humanity shaking hands with an artificially intelligent robot.

Upcoming Submission Deadlines

For all 2024 editions and deadlines, refer to page 45.

MARCH 2024	DUE DATE
Victoria's Fauna	*5pm, 16 February*

APRIL 2024	DUE DATE
The Four Planetary Crises	*5pm, 15 March*

From the Editor

SCOTT REDDIEX
Editor-in-Chief — The Royal Society of Victoria

Welcome to the first edition of *Science Victoria* for 2024. You'll notice some small changes as we continue to refine the magazine, like listing the topics for the year in the Guidelines for Authors section.

If one of these topics is in your area of expertise and/or interest, we'd love to hear from you! You can send questions and pitches to me at any time, at **editor@ScienceVictoria.org.au**.

The slow death of a blue bird

Twitter was once a great tool for science communications and engagement. It had a thriving scicomm community, particularly in Australia, and provided a unique and novel platform to hear directly from scientists working in all fields. Successes were celebrated, community support was always available, and presentations were succinctly summarised for all to read.

Unfortunately, this 'golden age' has passed, and many of us have left the cesspit that Twitter has become. It's time to look for alternatives to ensure that STEMM is an even louder, more accessible voice against the increased misinformation. While a number of options are emerging (BlueSky, Post, Mastodon, etc.), I'd also suggest writing a letter to us here at *Science Victoria*. If you have informed thoughts relating to STEMM that are worth sharing, I'd love to provide them a platform.

Artificial Intelligence

In this edition, we look at a topic in dire need of clearer communications: artificial intelligence (AI). The field is broad, and our pages few, so we have selected a few interesting aspects to explore.

Two important points about AI to remember:

Firstly, always consider the data that is used to build a model. If a large language model is asked to write a story, and the model was trained *only* on the works of Shakespeare, then the output will be a play in Early Modern English, with plenty of uses of 'Hark!'. It couldn't tell you about a mobile phone, or write with the perspective of someone who wasn't a 16th-century English man.

Secondly, an AI model might be able to complete similar tasks as people, but it is incapable of actively taking jobs. It is still *people* who choose to replace humans with AI. With the IMF estimating that AI will affect ~40% of jobs globally, it remains firmly in the hands of people to ensure that it reduces rather than increases inequality.[1,2]

In this edition, **Anam Javed** looks at how educators can use generative AI like ChatGPT in the classroom. **Gordon Noble** addresses the sustainability of infrastructure that powers AI, and **Dr Muneera Bano** writes about humanity and inclusion in the era of AI.

We hope you enjoy this edition of *Science Victoria*.

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Acknowledgement of Country

The Royal Society of Victoria acknowledges our headquarters are located on Wurundjeri land, never ceded, and convey our respect to Elders past and present. The RSV welcomes all First Peoples, and seeks to support and celebrate their continued contributions to scientific knowledge.

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The Development and Applications of Different AI Models

ROB GELL AM MRSV
President — The Royal Society of Victoria

"The good thing about science is that it's true whether or not you believe in it."

— Neil deGrasse Tyson

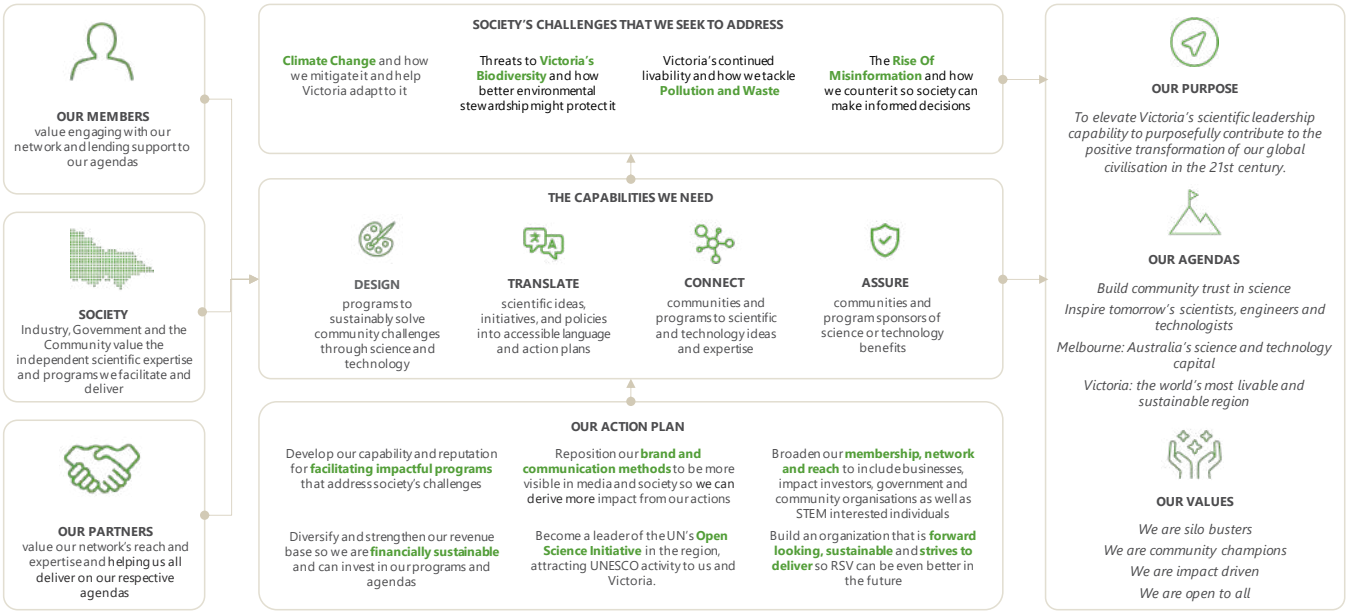
What does the Royal Society of Victoria – Victoria's Science Society – have in common with the World Economic Forum (WEF)? In 2023 the RSV redefined its Strategy to focus on four key 'pillars', reflecting society's challenges that we seek to address:[1]

1. Climate Change and how we mitigate it and help Victoria adapt to it,
2. Threats to Victoria's Biodiversity and how better environmental stewardship might protect it,
3. Victoria's continued livability and how we tackle Pollution and Waste, and
4. The Rise of Misinformation and how we counter it so society can make informed decisions

The first three are the United Nations Environment Programme's acknowledged existential threats, referred to as 'the triple planetary crisis'.[2] The RSV's fourth pillar reflects the Society's primary objective: the promotion and advancement of science. The need for evidence-based decision-making is critical, and science provides the cornerstone for this.

The rise of artificial intelligence (AI) is providing myriad opportunities for bad actors to spread misinformation, so much so that the WEF's latest Global Risks Report, released for its January meeting in Davos, Switzerland stated:

"Emerging as the most severe global risk anticipated over the next two years, foreign and domestic actors alike will leverage misinformation and disinformation to further widen societal and political divides."



The RSV's current strategic plan (2023-2027)

The WEF Global Risks Report 2024 confirmed a deteriorating global outlook.[3] It found that that an array of environmental risks pose the greatest threats in the long term, but that misinformation (wrong or misleading information) and disinformation (falsehoods designed to mislead or cause harm) constitute the greatest risk over the next two years.

Perhaps this means that the Society's 2023-2027 Strategy was prescient. AI, *Science Victoria*'s theme this month, provides us with both a risk and an opportunity in the world of misinformation and disinformation.

AI has facilitated an explosion in false information, so-called "synthetic" content, including "deep fake" videos that utilise facial manipulation and voice cloning to counterfeit a person's likeness. As AI tools become more accessible, the production of synthetic content will increase, as will its usage by malicious actors.

Governments are endeavouring to introduce new and evolving regulations to target both hosts and creators of online disinformation and illegal content. This is time consuming and costly, but in a year with 64 national elections (including USA, UK, Indonesia, India, Mexico, and Pakistan), the risk is brought into sharp focus. In April 2023, the Republican National Convention produced a video, entirely with AI, depicting an alternative reality USA with Joe Biden as President.[4]

The corollary of this is that AI is also being used to fight fake news, but at this stage with limited success. Google will require advertisements that use AI for the November US Presidential election to include a disclosure on them.

"All verified election advertisers in regions where verification is required must prominently disclose when their ads contain synthetic content that inauthentically depicts real or realistic-looking people or events." - Google, Updates to Political content policy (September 2023).[5]

Meta has a parallel policy for Instagram and Facebook:

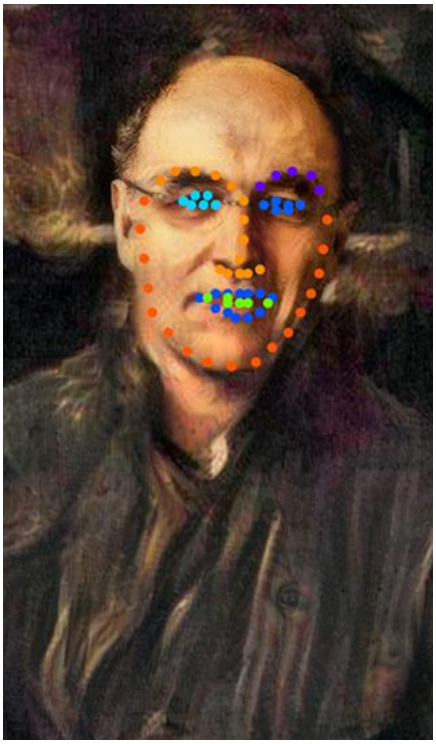
"Advertisers will have to disclose whenever a social issue, electoral or political ad contains a photorealistic image or video, or realistic sounding audio, that was digitally created or altered".[6]

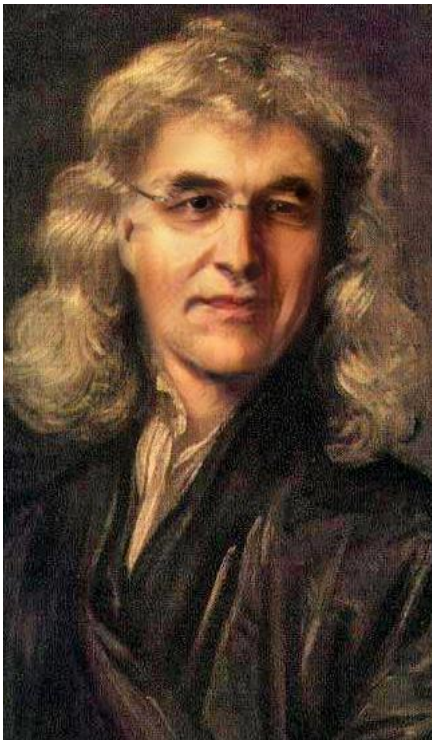
We will all watch with interest as the US Presidential election comes closer.

All this is important, but doesn't disguise the fact that the WEF report identified extreme weather events as the second most important short-term risk, and the number one threat over the next ten years, together with the four other environmental risks. This brings us back to The RSV's four strategic pillars, which will continue to frame our programmes throughout 2024.

We have a number of new initiatives in development, and I will be corresponding directly with our members and stakeholders in the coming months to inform you of these. The RSV Council, together with Mike Flattley and his small but dedicated team, are working to create new opportunities for positive engagement with all sectors of the community including through our new Organisational and Affiliate membership categories. We encourage you to consider joining your organisation to be involved with our new Emerging Scientists Network (ESN) of undergraduate and graduate scientists who have an appetite to learn about your company and the mutual benefits of membership of The Royal Society of Victoria.

▶ As usual, your ideas are welcome as we continue to strengthen the RSV as a valuable independent voice supporting the need for evidence-based decision making based on good science. Email me directly at **president@rsv.org.au**.





RIGHT: AI neural networks analyse images and videos, detecting shared elements, like facial characteristics, across two sources. It then combines one set of features with the other, producing a convincing 'deepfake' output. Image: Stephen Wolfram, denstoredanske.lex.dk/deepfake (CC BY 2.0)

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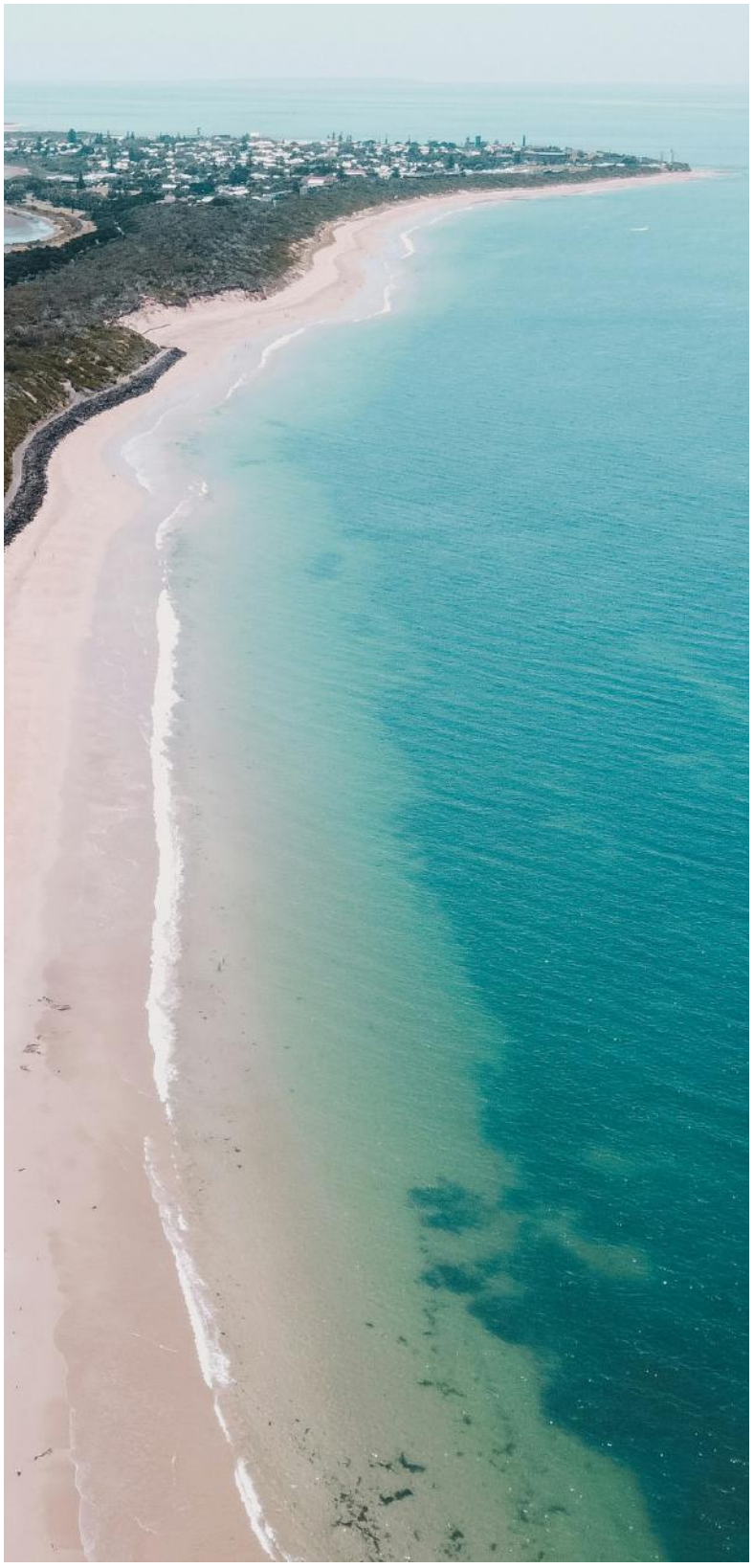

Photograph: Pat Whelen (via Unsplash)

Port Phillip Climate Hazard Assessment and role of the RSV

JEFF WEIR OAM

Executive Director, Dolphin Research Institute
dolphinresearch.org.au

I write in response to the recent disclosure of the Port Phillip Climate Adaptation Report.[1,2]

I have not been able to fully digest the report but there is a realisation that the 0.8m sea level rise by 2100 in current policy is much higher – and the consequences to our coasts, ecosystems, economy, and communities are far greater – than openly discussed.

There is a need for strong thought leadership in this space to help the community better cope with the inevitable changes that are already locked-in, with extremes that will make nonsense of the idea of "gentle incremental changes that we don't need to worry about for decades".

I believe that the idealistic "visions" for the future of our coast that we see in all the policy and strategy documents let us down. Instead, we need to realistically "envisage" what the future will look like under different scenarios. Not gloom or doom, but helping to shift the narrative from 'co-designed' visions that aim at something like our tainted memories of childhood.

I believe that there is an important role for the RSV to lead conversations that otherwise won't happen and the Dolphin Research Institute would value supporting where we can.

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The RSV

News for February from Victoria's Science Society

MIKE FLATTLEY
CEO, The Royal Society of Victoria

The RSV's support for STEMM continues in 2024, as we prepare our presentations, events, and awards for the coming year. We are excited to be entering the final stages of our website redevelopment, which is expected to launch in the coming months.

The revamped **rsv.org.au** site will host both *Science Victoria* and the *Inspiring Victoria* initiative, and provide a more up-to-date experience for reading articles, finding events, watching video presentations, and more.

Outcome of Nominations to the RSV Council, 2024-6

As advertised in the November and December editions of *Science Victoria*, the closing time for nominations to the Royal Society of Victoria's governing Council was 3:30 pm, Monday 18 December 2023.

As only one eligible nomination was received for the next biennial term, an election for appointment to the five vacant positions is not required. There are currently vacant positions on the Society's Council as follows:

- Places until May 2024: 4
- Places until May 2025: 4

There will be a further 4 vacant positions for the term commencing in May 2024 until May 2026.

Under Rule 25 of Society's governing Rules, "the Council may appoint a member of the Society to fill these vacancies and the member appointed shall hold office, subject to these Rules, until the conclusion of the two-year term aligned with the vacant position, subject to formal re-election."

Introducing Associate Professor Anita Goh MRSV, RSV Councillor 2024-6

We are delighted to welcome A/Prof Anita Goh to the council of the RSV. Anita has provided the following message to our community:

"I see serving on the RSV Council as a key opportunity to promote scientific knowledge for the benefit of Victoria.

"My dedication to the Society's mission and vision is evident in my long-standing commitment to science and science literacy, promotion and communication. As a Homeward Bound alumna (global leadership initiative for women in STEMM), and as a previous Science and Technology Australia Superstar of STEM, I developed advanced communication skills to connect with broad audiences, including via the media. I value opportunities to promote science to students, and regularly contribute to National Science Week.

"Working strategically to achieve common goals is a personal strength, and I have skills in strategy, diplomacy, engagement, and networking, and expertise in providing evidence to policy-makers and government.

"I have extensive experience in leadership in Australian STEMM, including skills in governance and as a Board Director (most recently Vice

President of Science and Technology Australia from 2021- 2023 and Co-Chair of its Equity, Diversity, and Inclusion committee).

"I will bring my unique perspectives, expertise, networks, and energy to RSV, to work with the team to contribute significantly to the Society's mission and enhance its success."

We again welcome Anita into the fold, and look forward to seeing all of you at some of our events throughout the year.

Geography Victoria

After a 100 Year Hiatus, Victoria has a Geographical Society Again

THE GEOGRAPHY VICTORIA TEAM
geographyvic@gmail.com

Recent headlines truly validate the importance of a geographical society in Victoria.[1,2,3]

Geography Victoria offers Victorians of all ages the opportunity to get together, to understand and learn about the world around us. We are proud that Geography Victoria has recently become registered as a Not For Profit, and is the newest affiliate of the Royal Society of Victoria (RSV).

With our new website soon to be launched, we are very much looking forward to opening for membership, and hoping to have widespread support in our founding year. Becoming a member will help ensure the future growth of Geography Victoria.

Geography Victoria is run by volunteers, and much was achieved in 2023. Multiple field trips have been made possible by being auspiced to the RSV, and many RSV members have already enjoyed being a part of a Geog Vic event. All events have proven to be popular due to their relevance, quality of presenters, and our commitment to make them accessible and affordable to everyone.

In May the focus was to discover Docklands with a Space Aero drone forum (**space-aero.org**) followed by a boat trip exploring the Port of Melbourne (**portofmelbourne.com**).

Fortunately, the Melbourne sun shone on the June coastal field trip led by Dr James Driscoll and Rob Gell AM around Port Phillip Bay.

The Thornbury Picture House was a great winter venue for our private screening of The Lost City of Melbourne (**thelostcityofmelbourne.org**).

Our Science Week field trip was inspirational, as conservationist Gio Fitzpatrick outlined the extraordinary transformation from Elsternwick Golf course to the Yalukit Willam Nature Reserve, and Matt Chester shared the sustainability practices that have been in place for over 100 years at the National Trust property Rippon Lea (**ripponleaestate.com.au**).

In November Rob Adams AM, City of Melbourne Architect provided an engaging CBD walking tour that focussed on the ongoing transformation of Melbourne in response to the changing climate.

2023 Christmas Treasure Hunts – a great day for all!

As Geography Victoria continues to grow, we are delighted that there has been success in obtaining small grants to assist in providing some key events for the broader community.

With the assistance of a grant from the City of Melbourne, the year certainly ended on a high note with the Treasure Hunt Day, a part of the City of Melbourne Christmas Festival.

Geography Victoria (supported by Spatial Vision) produced the Melbourne Christmas Decorations Walking tour maps for the Festival, and two concurrent treasure hunts across the CBD – one for children and one for adults on Sunday December 10.

The event was a huge success with over 1,650 participants. It was wonderful to see so many people from such a diverse range of backgrounds and ages with maps in their hands exploring the city.

What is on the horizon for 2024?

Life Saving Victoria, the Victorian National Parks Association, and the Association of Bayside Municipalities have provided the opportunity via a small grant for Geography Victoria to reach out to a broader audience. In February we will conduct a coastal field trip for them.

Look out for upcoming opportunities to be involved in more Geog Vic field trips and events in 2024. Do be sure to register early as events book out quickly. Our events team is currently working on plans for:

- ▸ Where are all those tunnels going - CBD Melbourne
- ▸ Discovering the wonders of the Australian Synchrotron
- ▸ Heading out west - the Western Treatment Plant
- ▸ More CBD Treasure Hunt Adventure Challenges
- ▸ Yalukit Willam for primary school aged children and those a little bit older
- ▸ The Goldfields is not just history!
- ▸ Hot rocks in western Victoria - exploring the volcanic plains

Geography Victoria is a volunteer organisation and in 2024 we need your support – we especially will need you to become a member via our website.

We hope to continue to offer field trip opportunities but also to expand to become advocates for this important subject and to support individuals and organisations in their geographical endeavours. It is an exciting time ahead.

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Snapshots of STEMM

Marilyn Hewish photographing a moth at a light trap in Great Otway National Park. Photograph: Heath Warwick, Museums Victoria.

Dr Theresa Fruth from The University of Sydney and the ARC Centre for Excellence in Dark Matter Particle Physics preparing the SABRE South vessel (that is currently located at Swinburne University) to be placed in the Stawell Underground Physics Laboratory when complete. Photograph: The ARC Centre for Excellence in Dark Matter Particle Physics

Leadership in a Time of Change

Celebrating the International Day of Women and Girls in Science

Join us for a special, future-focussed panel discussion, broadcast from the Parliament of Victoria, to mark the International Day of Women and Girls in Science.

This event will convene four remarkable women leaders in the fields of science, technology, engineering, mathematics, and medicine (STEMM) to discuss *Leadership in a Time of Change*. The discussion will address the cultural and structural barriers to the advancement of women in Australia's STEMM workforce, and the increasingly dynamic nature of leadership in a world that is changing rapidly in many ways.

Having just returned from a warming Antarctica as part of the acclaimed Homeward Bound program, our speakers bring fresh insights to the pivotal role leadership plays in navigating the unknown and the uncertain, both in the scientific realm and beyond.

The discussion will be hosted by ABC Science journalist and presenter Natasha Mitchell with the support of Speaker of the Legislative Assembly, The Hon. Maree Edwards MP.

We invite you to join us online via Facebook Live at **facebook.com/VicParliament** to hear from these STEMM leaders.

DATE/TIME:
Friday 23 February, 1–2pm

PRICE:
Free

LOCATION:
Online

LINK:
facebook.com/VicParliament

Parliament of Victoria

The Royal Society of Victoria

Inspiring Australia Victoria

ABOVE: Last year's Inspiring Victoria International Day of Women and Girls in Science panel. L-R Dr Tim Read (Victorian Parliamentarians for STEM), Dr Marguerite (Maggie) Evans-Galea (Australian Academy for Technology & Engineering), Dr Gillian Sparkes (Commissioner for Environmental Sustainability), Dr Sophie Adams (Austin Health), Professor Madhu Bhaskaran (Women in STEMM Australia), Natasha Mitchell (ABC Radio National), Dr Isabelle Kingsley (Office of the Women in STEM Ambassador). (Photograph: Catriona Nguyen-Robertson).

Dr Catherine Lopes

Catherine is a Non-Executive Director on the Governing Board of the Environmental Protection Authority (EPA) Victoria in Australia. With over 25 years of professional experience, she was the first Chief Data and Analytics Officer at Merkle ANZ, the Head of Enterprise Data and Analytics at AGL Energy, and the Head of Data Strategy and Analytics at ME Bank, ANZ Bank.

Additionally, Catherine's passion for empowering women in Analytics, Data science, and AI (ADA) led her to establish ADA's Tribe, an inclusive community that aims to uplift and support women in these fields.

She also contributes her expertise by serving on multiple university advisory boards at Australian National University and Monash University. Catherine was an invited participant on the recent Homeward Bound (HB) Women in STEMM leadership program Antarctic voyages in 2023.

Ms Fern Hames PSM FRSV

Fern is the former Director of the Arthur Rylah Institute for Environmental Research (ARI) in Victoria. She is deeply committed to effective, inclusive leadership and participated in the first HB expedition in 2016.

Since then, she has become a member of the HB Visibility Faculty and was part of the HB onboard Faculty in 2019 and 2023. Fern has a research background in Antarctic algae and freshwater fish, but in recent years has been exploring multi- and transdisciplinary research and ways of knowing, and the wider dimensions of socio-cultural-ecosystems.

She has extensive experience in engagement, environmental education, and citizen science, from Australia's wild deserts and Wet Tropics to India, and is passionate about connecting people with nature. Fern has volunteered in Australia, Tanzania, Myanmar, and Pakistan, and was a founding member of the Jane Goodall Institute Australia and was appointed a Fellow of the Royal Society of Victoria in 2022 in recognition of her achievements.

A/Prof Jen Martin

Jen founded, leads, and teaches the University of Melbourne's acclaimed Science Communication Teaching Program. She spent many years working as a field ecologist, until she decided the most useful thing she could contribute as a scientist was to teach other scientists how to be effective and engaging communicators. She is deeply committed to helping scientists develop the skills they need to be visible, make connections, and have impact.

Jen also practises what she preaches: she's been talking about science weekly on radio for more than 18 years, hosts podcasts (including @letstalkscicomm), MCs events, writes for a variety of publications, and was named the 2019 Unsung Hero of Australian Science Communication.

Jen's first popular science book, 'Why am I like this? The science behind your weirdest thoughts and habits' was published this year. Jen is a member of the Visibility Faculty for HB and was part of the onboard Faculty in 2019 and 2023.

A/Prof Vanessa Wong

Vanessa is a soil scientist in the School of Earth, Atmosphere and Environment at Monash University. She is passionate about studying the world beneath our feet. Her research focuses on dynamic soil ecosystems in natural, wetland and agricultural environments, seeking to understand how environmental change, land use and land management, affects biogeochemical cycling belowground.

Vanessa is currently a member of Science and Technology Australia's Policy Committee, the former Chair of the Australian Academy of Science, Early Mid-Career Researcher Forum, and immediate past President of Soil Science Australia. She has been Science Facilitator for the past two and current HB cohorts.

Dr Zoe Xirocostas. Photograph: Future Science Talks.

Future Science Talks - Comedy Edition

Do you like the idea of making science and research fun? Interested in better connecting with audiences while exploring your inner comedian?

Then join the Science Comedy Program by **Future Science Talks** and the **Sydney Comedy School**. Funded by *Inspiring Victoria*, the program includes five workshops where you'll jazz up a 10-minute science talk, so that it's 80% science and 20% humour.

All program participants will then give their talk at the Melbourne International Comedy Festival in April.

About Future Science Talks – Comedy Edition

The program is for anyone working in science, research or an adjacent field – particularly those in the early to mid-phase of their careers.

As part of the program, you'll partner with comedians and speechwriters who will guide you on the science behind comedy, storytelling tips and tricks, and how to present like a pro.

The program is aimed at increasing the skills of science and research professionals so that you're more confident when presenting to colleagues, funding bodies, and the general public.

The developers of the program have deep experience in science and health communications, including running sci-comm teams at WWF-Australia, Neuroscience Research Australia and the Rural Doctors Network.

Applications

The expression of interest (EOI) form is available at **forms.gle/4A9wY91CcfhkdYNj7**.

Over 40 people were trained in Sydney as part of the 2023 Science Comedy Program. This is the first time the Program is being offered in Melbourne.

Topics in the 2023 talks included climate change, emojis, health, ecology, engineering, psychology, drugs and many more.

You can see example talks from 2023 on YouTube at **youtube.com/watch?v=Ss1KLc-35N8** and **youtube.com/watch?v=xjh5Wj_FeHI**.

Photograph: Klemen Vrankar via Unsplash

Space to the Rescue

AUSTRALIA'S NATIONAL DEPENDENCIES ON SPACE TECHNOLOGIES

The debate over the Australian federal government's investment in the "space sector" has intensified.

In 2023, the budget for the Australian Space Agency was reduced, leading to the cancellation of the National Space Mission for Earth Observation, and cuts to investment in launch sites. Uncertainty remains regarding the alignment of space technologies with AUKUS plans or the National Reconstruction Fund.

Despite competing priorities on Earth, understanding the importance of investing in space technologies is crucial. Space technologies and infrastructure play a significant role in Australia's dependencies, critical infrastructure, and national priorities. Issues such as climate change, disaster response, agriculture, mining, urban planning, housing, water and coastal region health, fisheries, Indigenous land and water management, and telecommunications hinge on space-based services and infrastructure.

Join Dr. Cassandra Steer, Chair of the Australian Centre for Space Governance, as she discusses positive aspects of Australia's involvement in space, and highlights potential risks due to foreign and commercial dependencies in an upcoming session.

DATE/TIME:
Friday 15th March 2024, 6 pm - 7:15 pm

PRICE:
In-Person: $10 (non-members) / $5 (RSV members)
Online: $5 (non-members) / Free for RSV members

LOCATION:
The Royal Society of Victoria
Wurundjeri Country
8 La Trobe Street, Melbourne
(Simulcast on Zoom)

BOOKING LINK:
rsv.org.au/events/space-to-the-rescue/

Photograph: Tony Tran via Unsplash

Defying Burnout & Thriving Through Change

As part of the Melbourne Centre for Behaviour Change (MCBC) conference - Behaviour Change: Achieving Impact Using Behavioural Science, Sophie Scott (OAM) will be delivering a public lecture on Monday 26 February titled Defying Burnout & Thriving Through Change.

Sophie's "Defying Burnout" public lecture is a fascinating journey into the science of burnout as well as sharing her personal experience with the debilitating syndrome.

In the one hour session Sophie helps participants understand and identify the difference between anxiety and stress and full blown burnout. She also outlines how to recognise the early signs of clinical burnout.

Governance, as she discusses positive aspects of Australia's involvement in space, and highlights potential risks due to foreign and commercial dependencies in an upcoming session.

For more events running as part of the MCBC conference, visit **events.humanitix.com/behaviour-change-achieving-impact-using-behavioural-science**

DATE/TIME:
Monday 26 February 2024, 5:15 pm - 7:30 pm

PRICE:
$30

LOCATION:
The Forum, Melbourne Connect
700 Swanston Street
Carlton, VIC 3053

BOOKING LINK:
events.humanitix.com/defying-burnout-and-thriving-through-change-oam-sophie-scott

What's On

The RSV hosts many STEMM-related events, public lectures, and meetings throughout the year.

These are predominantly held at the RSV Building at 8 La Trobe St, Melbourne (unless otherwise indicated), and simulcast online via YouTube. Our public lectures comprise the "Scientists in Focus" component of the *Inspiring Victoria* program in 2024.

MARCH

Space to the Rescue

DATE *15 March 2024*
MORE INFO **rsv.org.au/events/space-to-the-rescue/**

Join us as Dr Cassandra Steer (Australian National University Institute for Space) presents *Space to the Rescue: Australia's National Dependencies on Space Technologies*.

APRIL

Holocene Climatic Fluctuations in the Australian Region (RSV Research Medallist 2023 Lecture)

DATE *18 April 2024*
MORE INFO *rsv.org.au/awards-and-prizes/research-medal/*

Please note that this event has been rescheduled from December 2023 to April 2024.

Professor Patrick De Deckker, the 2023 winner of the RSV Medal for Excellence in Scientific Research, will present a lecture to RSV members and guests on the **18th of April at 6pm**, at which the Medal will be presented.

LATER

RSV Phillip Law Postdoctoral Award Lecture

DATE *Rescheduled*
MORE INFO **rsv.org.au/awards-and-prizes/phillip-law-award/**

Please note that this event has been rescheduled from November 2023 to mid 2024.

The winner of the RSV's Phillip Law Postdoctoral Award for 2023 will present their work to a special meeting of the RSV at a public lecture. This will be professionally filmed and shared online.

ESN EMERGING SCIENTISTS NETWORK

Are you a high-school student considering studying science?

Or are you a current uni student or recent graduate, looking for future pathways and opportunities in science?

The Emerging Scientists Network is for you.

Find us on Facebook at:
tinyurl.com/6ya4kkyp

Missed an RSV event?

You can catch-up on presentations from world-leading minds at youtube.com/@RoyalSocietyVic

Don't have time to watch a full presentation? Try one of the summary videos to catch the highlights.

YOUTU.BE/JL6SIKT9JSI
Aiming Higher: Improving Science Education in Victorian Schools

YOUTU.BE/ODSSDCSUO0O
Reimagining Humanity in the Age of Generative AI

YOUTU.BE/HJNBCCQ5N8G
Green Chemistry: Reinventing the Chemical Industry

YOUTU.BE/1SYKWQKZF48
Glaciers and Ice Sheets in a Warming World

Awards & Prizes

Nancy Millis Medal

NOMINATIONS OPEN *Thursday 15 February 2024*

Nominations for the 2025 round of the Nancy Millis Medal for Women in Science open on the 15th of February 2024.

The Nancy Millis Medal of the Australian Academy of Science has been established to honour the contributions made to science by the late Professor Nancy Millis AC MBE FAA FTSE and recognises her importance as a role model for women aspiring to be research leaders.

The award is open to women mid-career researchers, eight to fifteen years post-PhD in the calendar year of nomination except in the case of significant interruptions to a research career, in any branch of the physical and biological sciences. Recipients will have established an independent research program and demonstrated exceptional leadership.

► For more information, visit: **science.org.au/supporting-science/awards-and-opportunities/nancy-millis-medal-women-science**

National Cancer Institute via Unsplash

Discovery Projects Scheme Grants

CLOSING DATE *5pm, Tuesday 27 February 2024*

Applications are currently open for the Australian Research Council's (ARC) Discovery Projects scheme, for commencement in 2025.

Applications are currently open for the Australian Research Council's (ARC) Discovery Projects scheme, for commencement in 2025.

The objectives of the Discovery Projects scheme are to:

- support excellent pure basic, strategic basic and applied research, and research training, across all disciplines excluding clinical and other medical research, that addresses a significant problem or gap in knowledge and represents value for money;
- expand research capacity in Australia by supporting excellent researchers and teams;
- foster national and international research collaboration;
- create new knowledge with economic, commercial, environmental, social and/or cultural benefits for Australia; and
- enhance the scale and focus of research in Australian Government priority areas.

Discovery Projects for funding commencing in 2025 will be run in a two-stage application process, commencing with an Expression of Interest (EOI). Shortlisted applicants will be invited to submit a full application.

The Discovery Projects scheme provides project funding of between $30,000 and $500,000 per year for up to 5 years.

► For more information, visit: **arc.gov.au/funding-research/discovery-linkage/discovery-program/discovery-projects**

Dan Dimmock via Unsplash

Gottschalk Medal

NOMINATIONS OPEN *Thursday 15 February 2024*

Nominations for the 2025 round of the Gottschalk Medal open on the 15th of February 2024.

The Gottschalk Medal recognises the contributions to science by the late Professor A Gottschalk FAA.

Its purpose is to recognise outstanding research in the biomedical sciences by researchers up to 10 years post-PhD in the calendar year of nomination, except in the case of significant interruptions to a research career. The award is made annually and is restricted to candidates who are normally resident in Australia and for research conducted mainly in Australia.

► For more information, visit: **science.org.au/supporting-science/awards-and-opportunities/gottschalk-medal**

Bill Borthwick Student Scholarships 2024

CLOSING DATE *5 pm, Friday 8 March 2024*

The 2024 round of Bill Borthwick Student Scholarships is now open for applications.

The Victorian Environmental Assessment Council (VEAC) has established the annual scholarships for tertiary students to assist in the costs of research relating to public land in Victoria, including terrestrial, freshwater and marine environments.

The scholarships honour the vision of the Hon. Bill Borthwick, Victoria's first Minister for Conservation and Deputy Premier from 1981 to 1982, and a central figure in establishing the Land Conservation Council (LCC) to advise government on the use of Victoria's public land.

Applicants must be enrolled in an Australian university in 2024, undertaking an Honours, Masters or PhD research project related to public land in Victoria. Relevant fields of study include natural sciences, humanities and social sciences, economics, law and politics.

Scholarships will be awarded in the range of $500 to $2,500. Criteria for selection include the relevance of the research to public land, the potential outcomes for public land, and the quality and achievability of the project (in the context of the level of the enrolled degree).

► Any queries should be directed to Amanda Stajewski, at **veac@deeca.vic.gov.au**. For more information, visit **veac.vic.gov.au/about-us/student-scholarships**.

Zac Porter via Unsplash

Using AI in the Classroom – Friend, not Foe

ANAM JAVED
Victorian Academy of Teaching and Leadership

Artificial intelligence (AI) dominated the news in 2023, as tools like ChatGPT seemed to propel AI from science fiction into everyday life. In response, every aspect of society is now trying to determine what the advent of AI will mean for them. Here, we take a look at how educators can harness AI to meaningfully improve the education experience.

What is generative artificial intelligence?

AI is a branch of computer science that aims to create systems capable of performing tasks that include learning, reasoning, problem-solving, and data analysis.

Generative artificial intelligence (GAI) is a subset of AI, which specifically focuses on generating content, be it in the form of text, images, music, or other media. While traditional AI is often about analysis and decision-making based on existing data (like recognizing patterns or making predictions), generative AI is about harnessing creativity and creating dynamically evolving content.

Chatbot Generative Pre-trained Transformer, or ChatGPT, is an AI model developed by OpenAI that took the world by storm in late 2022.[1] It is part of the GPT series, which are large language models (LLMs) designed to understand and generate human-like text based on the input they receive - a prominent framework for GAI.

It is important to note the limitations of GAI models like ChatGPT. They can only assemble responses based on the data they have been trained with, meaning the quality and depth of responses is only as good as the training data. They also aren't able to access real-time information, but may be periodically 'updated' with new data - comparable to using a textbook published every few years.

What is prompt engineering, and why does it matter?

Even if you haven't tried ChatGPT, you have likely engaged in some form of AI. Whether it be the pop-up help tool on a website, or the automated service that asks you to describe the

The History of Modern Artificial Intelligence

Modern artificial intelligence did not simply appear out of nowhere in late 2022. The public release of ChatGPT is rather the next chapter in a story that began in the mid-20th century.[2]

1950s to 1960s

EARLY BEGINNINGS

AI's history begins in the mid-20th century. The term "artificial intelligence" was first coined by John McCarthy in 1956 at the Dartmouth Conference. This era saw the development of algorithms and the exploration of the potential of machines to solve problems and mimic human intelligence.

1970s to 1980s

EXPANSION AND CHALLENGES

The 1970s and 1980s witnessed the expansion of AI into more practical applications, although the field faced significant challenges due to limitations in computational power and understanding.

reason for your call, you'll know how important it is to phrase your question so that you are given the answer you need.

Prompt engineering is the skill of crafting questions or instructions (prompts) to effectively communicate with an AI system, ensuring that the AI understands and responds in the most useful way. It is a critical skill for interacting with AI models, particularly those utilised in chatbots or content generation tools.

Well-engineered prompts harness the full capabilities of an AI, leading to more accurate, relevant, and valuable responses. Clear, specific prompts minimise the chances of misinterpretation by the AI, reducing irrelevant or incorrect responses. Effective prompts improve the interaction between the user and AI, making it more efficient and user-friendly.

What does a good prompt look like?

While simple prompts can yield decent results, the quality of the output hinges on the amount and nature of information you include in your prompt.

A well-crafted prompt will typically include:

Instruction: The primary question or task you're asking the model to perform.

Context: Additional background information that helps the model understand the query better.

Role: A role assigned to the LLM.

Inputs: Data or parameters that the model might need to generate the desired output.

Output: Examples of what you want the model to generate, and in what format.

Now, let us synthesise this into an example prompt:

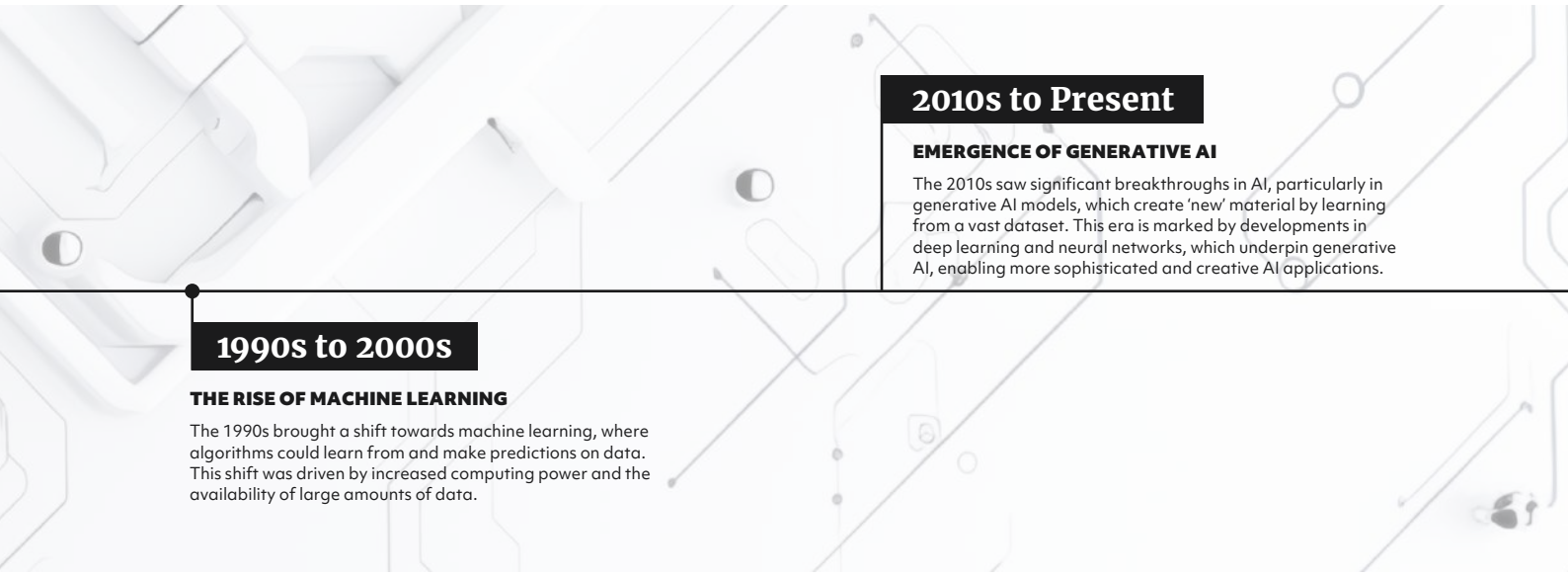
You are a year 10 student in charge of creating a four-episode podcast series to be released over four weeks at your school, focusing on the use of AI to write speculative fiction. Create a list of steps to follow to create this podcast series, with a progressive outline for each episode, including a topic for each week. Each episode is to be 30 mins long and is relaxed and conversational in nature. Generate the episode outlines as a table.

Applications of GAI in a science classroom

AI is becoming a pivotal tool in transforming learning experiences, especially in science classrooms. AI's potential to personalise learning, provide real-time feedback, and create immersive educational experiences is unparalleled.

The table below outlines how AI can be used in a science classroom to make learning more accessible and engaging:

APPLICATION OF AI	DESCRIPTION	BENEFITS
Personalised Learning	*AI systems adapt to each student's learning pace and style.*	*Enhances student engagement and learning*
Automated Grading	*AI tools can grade assignments and provide instant feedback.*	*Saves time for teachers*
Virtual Labs	*AI-driven simulations for experiments.*	*Safe and cost-effective practicals*
Data Analysis	*AI tools to analyse scientific data.*	*Enhances research skills*
Interactive Educational Content	*AI-powered interactive modules and games.*	*Makes learning more engaging*
Predictive Analytics	*AI to predict student performance and learning gaps.*	*Helps in early intervention*
AI Tutors	*Personal AI tutors for individual support.*	*Provides additional, tailored learning support*



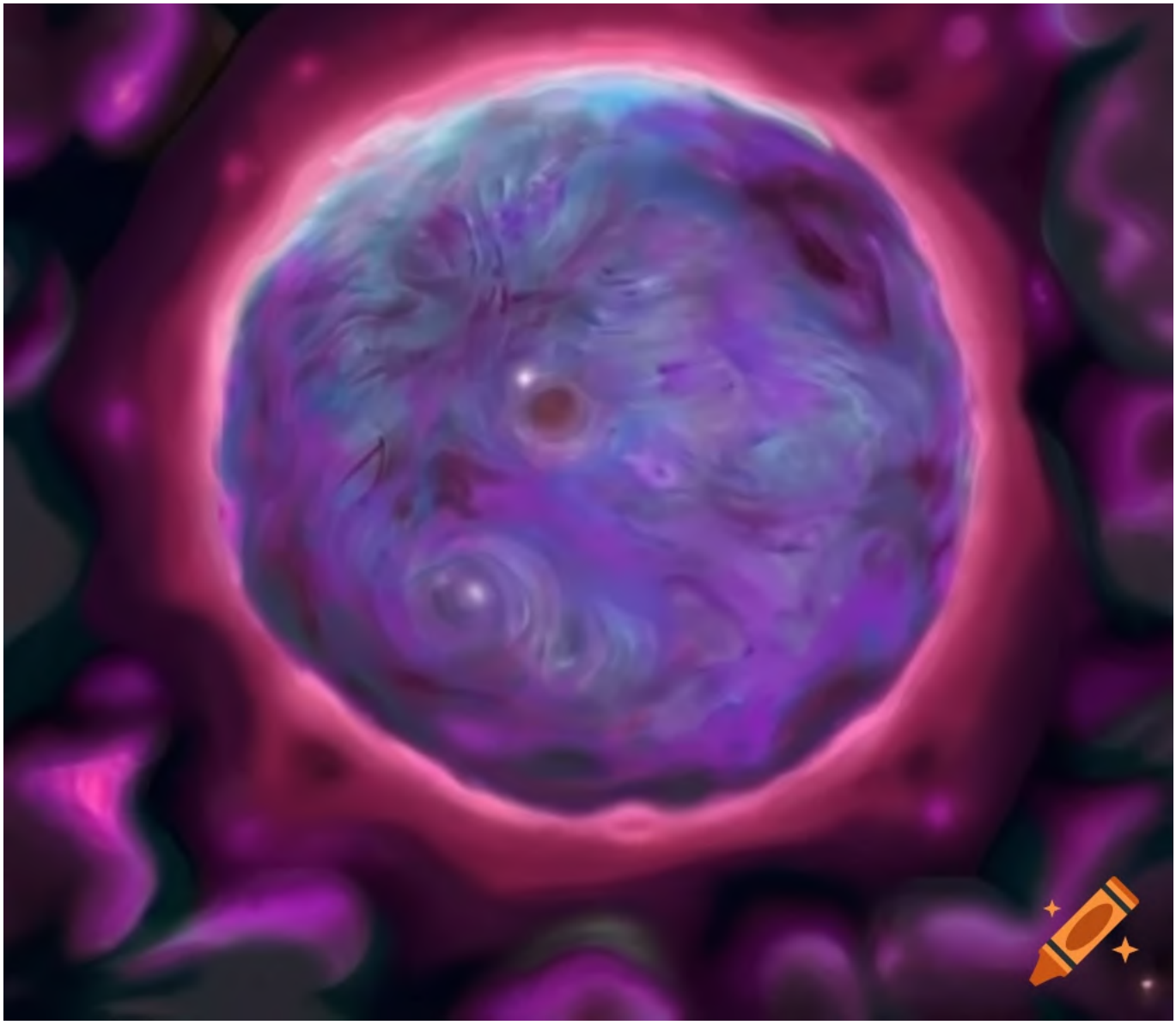


Image generated using Craiyon, based on the supplied prompt. Generative AI constructs images using the same principles as for text responses, with models trained using a massive dataset of images. Source: Craiyon.

GAI can also be used to promote interdisciplinary learning with science as a central focus. Consider the following prompt, which can be fed into the freely-accessible ChatGPT 3.5:

Use NASA's Exoplanet resource to create a fictional planet beyond our solar system where humanoid creatures thrive. Consider elements like the terrain, weather, and gravity, and how they impact the type of species that can survive on this planet. Use Future Timeline to describe sociopolitical issues impacting this planet if it was to exist 500 years from now.

Note that this particular prompt works because NASA's Exoplanet resource[3] and the concept of a Future Timeline[4] form part of ChatGPT's training data.

Next, you can use Craiyon[5] to generate some images of this fictional exoplanet, using the following prompt:

Generate an image of a fictional exoplanet densely populated with pink foliage, and surrounded by a dense layer of purple gases, in the style of Van Gogh's 'The Starry Night'.

Victorian teachers harnessing GAI in the classroom

Teachers' views on AI in education are diverse and multifaceted, reflecting a blend of optimism, caution, and curiosity.

Many educators see AI as a tool to enhance the teaching and learning processes, not as a replacement for teachers but to complement their skills. With the release of the Australian Framework for GAI in Schools,[6] school teachers and leaders are now being gradually equipped with knowledge and frameworks that guide the responsible and ethical use of generative AI tools in ways that benefit students, schools, and society.

There is apprehension about the ethical use of data about and created by students, with teachers emphasising the need for robust data privacy and security measures. The eSafety Commissioner has published a range of resources to mitigate risk associated with the use of AI in schools.[7]

The following are some ways in which educators can bring students onboard with using AI ethically, collaboratively, and effectively to boost learning and engagement in the classroom, across all disciplines:

1. AWARENESS AND EDUCATION:

Create a shared, agreed upon school-wide framework for the use of AI tools. Raise community awareness by running workshops that enlighten and empower teachers, students, and parents about the ethical use of AI tools like ChatGPT, along with academic integrity and its implications. Through this lens, educators can clarify what constitutes cheating and its consequences. This can be used as a culture-building opportunity, and hence encourage a culture of honesty and integrity, linked to school and community values.

2. ADAPT ASSESSMENT DESIGN:

Modify the design of assessments to reduce the likelihood of cheating. As much as possible, weave in opportunities to co-design assessment tasks with students. This could include:

- Implementing project-based assessments where students must demonstrate their learning process over time.
- Incorporating oral exams or presentations where students need to explain their understanding verbally.
- Considering alternative forms of assessment like portfolios, lab work, or practical demonstrations.

3. ENCOURAGE CREATIVITY AND PERSONALISATION:

Assign formative assessment tasks that require the use of student voice and creative thinking, as these are harder to replicate using AI.

4. PEER REVIEW AND COLLABORATIVE WORK:

Implement peer review systems where students evaluate each other's work, promoting accountability. Students are often very well-equipped to recognise and honour each other's work.

5. TEACHER INVOLVEMENT AND FOLLOW-UPS:

Have teachers engage in an ongoing manner with students' work, asking follow-up questions or having discussions about their submissions, with this being reflected in assessment rubrics.

The key is to create an educational environment where learning is valued over grades, and where students understand the importance and benefits of honest academic practices.

Where to next?

With a range of generative artificial intelligence platforms on the market, ongoing professional learning for teachers will have an increasingly significant role to play in making sure that no teacher gets left behind.

Organisations such as the Australian Centre for the Moving Image (ACMI) and Digital Learning and Teaching Victoria (DLTV) are playing a pivotal role in connecting educators across the state via the sharing of resources and professional learning, while peak curriculum bodies such as Victorian Curriculum and Assessment Authority (VCAA) are providing targeted support to teachers to leverage resources with regards to curriculum design and implementation.[8,9,10] The Department of Education Tech Schools are currently offering a range of interdisciplinary programs to partner schools which harness the power of artificial intelligence to embed interdisciplinary knowledge and skills into learning and assessment.[11]

The Teaching Excellence Program[12] offered by the Victorian Academy of Teaching and Leadership (VATL)[13] is one such avenue, featuring a year-long professional learning program curated to connect teachers to like-minded peers, while upskilling them using evidence-based approaches, including in the field of generative artificial intelligence. Teachers are equipped with the skills and resources to undertake authentic inquiries where they explore problems of practice and collaborate with peers to come up with viable and transformative solutions and learnings. Once teachers graduate, they are able to join the Alumni Network, which offers alumni the opportunity to engage in professional learning and networking events. Alumni also have access to an online community where they can engage in discussions, share resources, and support one another.

The integration of AI in science education offers an exciting frontier for enhancing both learning and engagement. By personalising education, providing interactive learning environments, and revolutionising assessment methods, AI not only makes science education more effective but also more engaging for students in the long run. As we continue to explore the capabilities of AI, the potential for further innovations in the educational sector remains boundless.

Anam Javed is the Master Teacher for Technologies at the Victorian Academy of Teaching and Leadership. Anam is passionate about harnessing the potential of digital technologies to combat social inequity and improve educational outcomes for students from all backgrounds.

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[13] Victorian Academy of Teaching and Leadership (VATL). academy.vic.gov.au

Reimagining Humanity in the Age of Generative AI

When asked to generate an image of "a diverse crowd", the generative AI tool Midjourney draws from the relevant data it was trained on to complete its task - including photographs of humans and crowds on the internet. But when the source material is an AI-generated image, the output drifts further from the source, creating 'hyper fakes'. Source: Midjourney, with each output becoming the input for the next image.

DR MUNEERA BANO
Data61, CSIRO

The advent of generative AI and large language models (LLMs) has marked a new era in human history, a period characterised by both innovation and concern.[1]

More than a year since the introduction of tools such as ChatGPT, Bard, Midjourney, and DALL·E, these technologies have caused significant disruption across various fields. While they have sparked excitement about their potential, they have also raised fears regarding their impact on jobs - and even the future of humanity.[2,3]

Generative AI has revolutionised many sectors, such as healthcare, education, and retail. In medicine, AI algorithms are assisting in disease diagnosis and drug development.[4] Education is being transformed, as personalised learning experiences become more accessible through AI tutors.[5] This technology has also significantly impacted areas like customer service, where chatbots and virtual assistants have become increasingly sophisticated, offering more human-like interactions and supporting many customers simultaneously.

The underlying concerns

Despite these amazing advancements, generative AI raises substantial concerns. Deepfake technology – a byproduct of generative AI – poses a significant threat to privacy, security, and truth in media. It can be misused to create convincing fake videos or audio recordings, potentially destabilising democratic processes, influencing elections, or causing personal harm.[6] The rise of AI-generated content also brings up issues of copyright and intellectual property, as distinguishing between human and AI creations becomes increasingly challenging – especially where an AI model was trained using copyrighted material, and sometimes without permission.

Humans possess a profound ability to interpret the meanings of words and pictures. It is a skill that extends far beyond simple recognition or replication, and is deeply rooted in our unique experiences, emotions, and cultural contexts. When we encounter language or imagery, we don't just process the information at face value; we attach meaning to it, drawing from memories, societal norms, and emotional responses.

LLMs and Generative AI, on the other hand, lack this intrinsic capacity for understanding. They can recognise patterns, predict word sequences, and generate images based on data, but they cannot grasp the value of underlying meanings, or the emotional and cultural significance that these words and images hold for different people. This difference is fundamental: while AI can mimic or recreate, it cannot experience or empathise, leaving a significant gap between artificial generation and human understanding.

A more subtle, yet potentially profound, impact of generative AI is the creation of a 'synthetic reality loop' within cyberspace. As the internet becomes saturated with AI-generated content, future AI models may be trained predominantly on data created by their predecessors, leading to a cycle of 'hyper fake' realities.[7] These synthetic data training loops would remove humans from the training process, and could detach AI from human experiences and perspectives, leading to the generation of content that echoes an increasingly artificial understanding of the world. The implications of such a loop are vast, potentially resulting in a digital landscape that is less reflective of the diversity of human experience and more a mirror of algorithmically generated perspectives.

Diversity and inclusion in AI

As we delve deeper into the age of generative AI, the significance of diversity and inclusion in these technologies cannot be overstated.[8] *"Diversity and Inclusion in Artificial Intelligence refers to the 'inclusion' of humans with 'diverse' attributes and perspectives in the data, process, system, and governance of the AI ecosystem"*.[9] When generative AI overlooks diversity and inclusion, the implications are both deep and wide-ranging.

Since its inception, AI development has predominantly been shaped by Western scientific methods, which often define intelligence in terms of logical reasoning, problem-solving, and data processing. However, this perspective of human intelligence is just one of many, which differ across cultures and societies.

In other cultures, intelligence is often perceived through the lens of social harmony, emotional awareness, and holistic thinking. In various Indigenous communities in Africa, Asia, and Australia, intelligence might include communal knowledge, storytelling, and a deep connection with nature. These diverse understandings of intelligence reflect a rich picture of human experiences and wisdom that are largely absent in current AI models.

The impact of generative AI is also unevenly distributed across different economic backgrounds. People from lower-income groups or underrepresented communities often lack access to the latest technologies, including AI. This digital divide not only limits their ability to benefit from AI-driven advancements, but also means their data and perspectives are underrepresented in AI training data.

Could AI, with its roots deep in Western data, inadvertently become a tool of digital colonisation? As AI systems are trained mostly on data that is influenced by Western perspectives, there's a risk of them acting like modern-day digital colonisers, spreading a uniform cultural narrative across diverse global landscapes. This isn't just about data imbalance; it's a story of cultural domination in a new, digital guise.

Envision a world where generative AI models, from language generators to image creators, operate with a narrow lens, shaped predominantly by a homogenous dataset. Such systems could struggle with understanding and representing the rich variety of global dialects, accents, and cultural contexts, leading to a skewed digital representation of human diversity.

They would risk becoming an echo chamber of limited perspectives, potentially alienating diverse communities by failing to acknowledge their unique narratives and experiences. This lack of diversity

As the internet becomes saturated with AI-generated content, future AI models may be trained predominantly on data created by their predecessors, leading to a cycle of 'hyper fake' realities[7]

isn't just a flaw in technology; it's a catalyst for reinforcing stereotypes and deepening societal divides. The concern isn't merely theoretical; it's about the potential real-world impact of AI shaping perceptions, decisions, and cultures in non-Western societies, echoing historical colonial patterns.

However, this narrative is not yet set in stone. We stand at a crossroads, where AI has the potential to evolve into a multicultural mosaic, reflecting and respecting the richness of human diversity. It's a call to action, urging a reshaping of AI development to embrace the vast array of human experiences and viewpoints, transforming AI from a potential digital coloniser into a tool that celebrates and elevates our global cultural diversity.

The potential of generative AI to truly revolutionise our digital experience lies in its ability to capture and reflect the vast spectrum of human diversity - in language, imagery, and thought. Inclusivity in generative AI isn't just an ethical consideration; it is fundamental to the creation of advanced, equitable, and genuinely innovative AI systems.

Addressing these challenges requires a concerted effort to make AI development more inclusive. This includes diversifying the teams that design and build AI systems, ensuring they represent a wide range of cultural, socio-economic, and geographical backgrounds. It also involves being intentional about the data used to train these systems, actively seeking out and including data from underrepresented groups and regions.[10]

Participatory design, where communities are involved in the development process of AI tools intended for their use, can ensure that these technologies are adapted to their specific contexts and needs. Additionally, policies and frameworks should be established to ensure equitable access to AI technologies, so that the benefits of AI can be enjoyed by a broader spectrum of society.

The human responsibility in the age of AI

Ultimately, AI is a tool, and its future is in the hands of humanity. We, as a society, are responsible for how these technologies are developed, implemented, and governed. It is crucial to establish ethical frameworks and guidelines to ensure the responsible use of AI.[8] This responsibility includes addressing biases in AI, ensuring transparency in AI-driven decisions, and safeguarding against the misuse of AI technologies.

The innate human trait of curiosity, characterised by the desire to question and explore the unknown, remains a distinctive aspect of our intelligence, largely untouched by AI in its current form. While AI can process and generate responses based on vast datasets, it lacks the inherent curiosity that drives humans to seek knowledge beyond available information. Our desire to question arises from a deep-seated sense of wonder and a quest for meaning, elements that are fundamentally human and not easily replicable by AI, which operates within the confines of its programmed algorithms and existing data. AI, in its current data-dependent model, does not possess the spontaneous spark of curiosity that prompts humans to ask, "What if?" and "Why not?" – questions that have been the bedrock of human innovation and discovery.

Generative AI, with its ability to brilliantly replicate the works of Shakespeare or Picasso, essentially operates as a small portion of human intelligence that has been digitised and made available on the internet. However, despite its impressive mimicry, it lacks the originality and evolutionary depth of human intelligence. While AI draws from a subset of accumulated knowledge, human intelligence is the culmination of millions of years of evolution, encompassing not just information, but deep-seated creativity, emotions, and experiences that cannot be fully captured or recreated by algorithms.

As we reimagine humanity in the age of generative AI, it becomes evident that while these technologies offer incredible possibilities, they also bring forth significant challenges. Balancing the benefits of AI with ethical considerations, promoting diversity and inclusion in AI development, and acknowledging the limitations of AI in understanding the non-digital aspects of our world are crucial steps in this journey. By doing so, we can harness the power of AI to enhance human capabilities while preserving the essence of what makes us uniquely human - our diversity, our creativity, and our ability to experience the world beyond data and algorithms.

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All of the data on the internet is stored somewhere, even if only for a short amount of time. Server rooms like this contain thousands of hard drives, connected to networked computers, which are operated remotely. Data storage centres are buildings dedicated to hosting server rooms. Photograph: imgix (via Unsplash).

Artificial Intelligence's Sustainability Challenge

GORDON NOBLE
Institute for Sustainable Futures, University of Technology Sydney (UTS)

As the uptake of artificial intelligence (AI) grows, how can we manage the energy and water risks that come with machine learning models?

Photograph: Jordan Harrison (via Unsplash)

One of the least understood aspects of the technology revolution we have witnessed over the last twenty years is how energy and water intensive it has been.

There is significant uncertainty on the energy use of machine learning models, such as ChatGPT, due to factors including a lack of reporting.[1] As technology develops, with new applications emerging, understanding and managing the impacts on energy and water demand will be critical.

CO2 emissions from software-related activities currently account for 4-5% of global emissions.[2] By 2040, it is estimated that this number may climb to 14%.[3] This is because the backbone of software use is 'data storage or processing services', that are delivered by the data storage or processing sector.[4]

Data storage principles and infrastructure

Everything digital is stored somewhere, even if it is only for a short amount of time. Every single website, everything in the 'cloud', has associated storage – most of it on hard drives in data storage centres around the world. While these centres vary in size, large data storage centres are essentially thousands (or even tens of thousands) of interconnected hard drives, operating 24/7. These servers consume an enormous amount of energy, and generate an enormous amount of heat – like a scaled-up version of your own computer.

Companies have different options for storing their data, and their choice(s) will reflect their needs. They might have their own server room on-site, or their own data storage centre, requiring them to own and manage the infrastructure. Alternatively, they might use a third-party data storage centre provider, like the Australian Government's use of Macquarie Data Centres, or cloud-based data centres, such as Amazon Web Services (AWS). The largest cloud-based storage providers like AWS have what are referred to as "hyperscale" data centres (i.e., massive facilities), storing data for millions of customers.

The need for electricity and water

According to the International Energy Agency, data centres and data transmission networks accounted for 0.9% of energy-related greenhouse gas emissions in 2021.[5] In the one year, global data centre electricity use was 220-320 TWh, or around 0.9-1.3% of the global final electricity demand.[5]

One of the major reasons why data centres use so much energy is to keep servers cool. Like any large facility, they commonly use cooling towers, which require water to operate. As use of AI grows exponentially, we are already seeing an increased demand for water from big technology companies. Google's onsite water consumption increased by 20% between 2021 and 2022, with Microsoft increasing water consumption by 34% increase over the same period.[6] AI consumes 1.8-12L of water for each kWh of energy usage across Microsoft's global data centres.[6] In the United States, it is estimated that 1 MWh of energy consumption by a data centre requires 7,100L of water.[7]

Data centre demands on the local area

There is an increase for data centres here in Australia, and the challenge is to understand how the growth of AI will impact the demand for energy and water resources. Data centres especially impact the areas in which they are located, often on the urban fringe of major cities. Concerns have been raised that, as the size and number of data centres increases, they will introduce new environmental stresses in additional locations.[7]

As new data centres are built, it is important to consider how the demand for energy varies with weather conditions. As Australia faces the prospect of heat stress across Australia, with the potential that warming of 2°C may lead to 50°C days in Sydney and Melbourne, household need for energy for cooling competes with data centre demand.[8,9]

In Ireland, the cool and wet climate has been an advantage for operating data centres, and Ireland is now home to 25% of Europe's data centres, including newly constructed hyperscale data centres.[10] However, the large number of data centres, with projections for future growth, is now leading to instability in Ireland's energy grid. According to Ireland's Central Statistics Office, electricity consumption by data centres increased by 32% in 2021 alone.[11] Over a six-year period to December 2021, electricity consumption by data centres increased by 265%. According to EirGrid, Ireland's energy grid manager, 28% of all electricity demand in Ireland is expected to come from data centres and other new large energy users by 2031.[12]

Mitigating the resource needs

Singapore is a hub for data centres in South-East Asia, accounting for more than 60% of the region's data centre market. In a country where the temperature rarely drops below 20°C, up to 40% of total energy consumption of a typical data centre relates to cooling.[13] To address the associated energy costs, the Singapore Government launched the world's first standard for optimising energy efficiency for data centres in tropical climates, which will result in data centres gradually increasing their running temperatures from 22°C to 26°C and above.[14]

Singapore's actions demonstrate that it is possible for data centres to operate at higher temperatures. During periods of extreme heat, demand on the energy grid needs to be properly managed, especially by large energy users, to ensure that the grid remains stable for everyone. For data centres, this

will mean needing to respond dynamically to heat events by allowing servers to operate at higher temperatures for short periods of time.

In Australia, which has been an importer of technology rather than an innovator,[15] a lack of understanding on how the growth of AI can impact energy and water consumption has meant that there has been a lack of action. Reviewing data storage facilities and their impact on the local environment is a key step to understanding their national impacts, and deciding appropriate action. This is assisted by particular measures and ratings of facilities.

One measure of operational sustainability is the National Australian Built Environment Ratings System (NABERS) ratings system for buildings Ratings are calculated after consideration of energy efficiency, water usage, waste management, and environmental impact.[16] However, even using systems like this have drawbacks. A 2021 report from CSIRO found that the value of the NABERS data centre database was limited due to the small number of facilities reviewed, the voluntary nature of obtaining a review (skewing the set to newer, more efficient facilities), and the lack of insight specifically about the efficiency of the computing equipment.[17,18]

We therefore need to address the uncertainty surrounding current energy usage before we can accurately project future energy usage by data centres, and subsequently develop data-driven policies.

Understanding the (carbon) cost of addressing business needs

The UTS Institute of Sustainable Futures recently undertook an investigation into the state of sustainability and IT, and revealed an alarming trend.[19] While many Australian companies dedicate time and money to reduce emissions, and sustainability managers understand the importance of data and IT to achieving sustainability goals, few have a clear view of what their company's increasing reliance on digital technologies is doing to create carbon emissions. This is not a trivial issue. It has significant implications for regulators, policy makers, company boards, and the rest of us, who increasingly compete with IT companies and data centres for electricity.

Of the more than 100 sustainability managers surveyed, 81% thought that demand for data management would increase, yet only 22% indicated that their organisation pays sufficient attention to data centre energy consumption. Only 5% of respondents felt that the quality of sustainability-related data received from data centre service operators was detailed enough.[19]

This likely reflects several realities. There may be a communication challenge between IT teams and sustainability managers; and importantly, while data centre operators, including hyperscale data centre providers, are making strides in reducing emissions themselves, and reporting it, there is no standardised or regulatory requirement for IT based emissions reporting in Australia.

Given the urgency of this issue, and the certainty that demand will only increase, there is a need to develop a framework for IT and data centre "Sustainability Roadmaps", which would provide harmonised reporting of IT and data centre-based emissions and water consumption. This would help accelerate the availability of climate-related sustainability data aligned with international climate-related financial reporting standards, and improve social and governance management practices, including reporting of data protection standards and sovereignty of data arrangements.

This article draws upon the report, IT and Data Centre Sustainability in Australia, co-authored by Gordon Noble from the UTS Institute for Sustainable Futures (ISF) in partnership with Pure Storage.

The report is available at **uts.edu.au/isf/news/australian-businesses-unaware-emissions-crisis-it-and-data-centres**

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Reinventing the Chemical Industry with Green Chemistry

DR CATRIONA NGUYEN-ROBERTSON MRSV

The following article follows a presentation to the Royal Society of Victoria and the ARC Training Centre for Green Chemistry in Manufacturing delivered by Dr Paul Anastas (Yale University) and Dr John Warner (Monash University) in July 2023.

Science isn't always the most sustainable of endeavours.

Resource consumption, waste generation, and high energy demands contribute to the large environmental impact of laboratories and research facilities. Biological, medical, and agricultural research alone are estimated to produce 5.5 million tons of plastic waste in a year.[1] Laboratories also can use five to ten times more water and energy per square foot than office spaces.[2]

However, Dr Paul Anastas and Dr John Warner argue that it is both possible and vital to build a global culture of sustainability in science.

'We humans are the product of evolution – we are as much a part of nature as anything else. That puts us in the wrong place when we start to think of ourselves as outside of nature…We can't have no impact, but we should be mindful of what our impact is,' says John.

The building blocks of green chemistry

John and Paul have been developing ways to reduce the environmental impact of chemistry for decades, and encouraging others to do the same. Green chemistry emerged from a variety of existing ideas and research efforts in the period leading up to the 1990s, culminating in twelve principles of green chemistry outlined by Paul and John in 1998.[3]

These principles encourage the design of products and processes that are more resource-efficient, and minimise or eliminate the use and generation of hazardous substances. With increasing attention around the problems of chemical pollution and nonrenewable resource depletion, these principles propose environmentally favourable ways of product design – from appropriate choice of reagents for synthesis to the waste at the end of a material's life.

'Everything we see, touch, and feel is chemistry,' says Paul. 'Green chemistry is about how you use these principles to redesign the material basis of our society and economy.'

Velvet beans (*Mucuna pruriens*) are a natural source of the compound L-DOPA, which John used to create the hair colour restoration product, Hairprint. Photograph: Ton Rulkin via flickr (CC BY-SA 2.0 DEED)

When conducting chemistry, it can be easy to focus on your specific role within a larger picture. John encourages people to take a step back and think about the whole material ecosystem.

We use natural resources to make molecules and ingredients that are then used to synthesise materials and components. From those, we manufacture products – ideally, those products can be reused for a long period of time. But when products eventually break down, we ideally will recycle the materials and components, and if needed, revert those back to the molecules and ingredients to be used again.

John defines this as "materials metabolism". If we consider the individual components of the "metabolism" reactions as we move between ingredients, materials, and products, we can learn to be more sustainable at each step.

Not just a marketing bumper sticker

Green chemistry is not just about validating marketing claims if a product's synthesis is aligned with the twelve principles. It is about rethinking the way we do things – both in the lab and in wider society.

John is a prolific inventor, with over 300 patents in a range of industries, and using green chemistry as the foundation for them all. A product close to John's heart – or head – is Hairprint, which restores grey hair to its original colour (he has even used it himself, having gone grey at an early age). His inspiration for Hairprint was a beetle - as it grows, its exoskeleton begins as white, before becoming black within hours. The black colour is due to melanin, the same pigment responsible for our hair colour. John wondered whether he could use a precursor to melanin, a compound called L-DOPA, to achieve this same colouring.

It turns out he could – and the hair isn't simply painted black with L-DOPA, it reverts grey hair to its original colour. When experimenting with a bundle of grey human hair, John discovered that strands of hair from different people turned various shades of brown and black.

L-DOPA is the key component of Hairprint, and John uses the tropical plant *Mucuna pruriens* (velvet beans) as a natural source of the compound. His other inventions include an asphalt rejuvenator that allows old bitumen to be re-used when the asphalt wears and needs to be replaced, and pharmaceutical therapies for the nervous system disease, ALS.

"Benign by design", green chemistry revolves around making materials with sustainability built-in. There are still Research and Development (R&D) scientists who do not put sustainability and green chemistry metrics into their science. It's an add-on or after-thought – if that. For years, we have been trying to make processes more efficient (e.g., diesel consumption, fuel use, etc.) as a society, but, as Paul says, 'efficiency helps you do the thing better, but won't help you do a better thing.'

The question isn't whether we *can* come up with sustainable solutions to planetary solutions. As Paul points out: we can, and we have. But will we?

The invention barrier

Among all the chemical products and processes that exist, John believes that only 10% tick every box to be truly sustainable. Even if we wanted to flick a switch and create every product using green chemistry principles from now on, he believes that it would not be possible. 'This is not a crisis of desire, but ability…60-75% of the technologies [we need] have not been invented yet,' he says.

While you can receive a degree in chemistry from universities around the world, we lack a workforce that understands how to invent products and methods that are truly sustainable. Universities do not necessarily teach chemists how to anticipate the health and environmental impacts of their processes. To address this, John and his former student Dr Amy Cannon, who holds the world's first PhD in the field of green chemistry, co-founded the *Beyond Benign* program to provide educators with resources to integrate green chemistry into chemistry education.[4]

In particular, their 'Green Chemistry Commitment' campaign encourages higher education institutions to incorporate green chemistry into their curricula. Around the world, 120 universities have now committed, with Monash University being the first in the southern hemisphere. If we teach the next generation of chemists to be green chemists, they will come up with new ideas and invent ways of doing chemistry that support a sustainable future.

Meanwhile, one of Paul's many projects is the Molecular Design Research Network (MoDRN), an initiative that aims to reduce the toxicity of new chemical substances.[5] 'We've been able to design molecules that have all kinds of functionality,' he says. 'But we're not so good at designing things to be non-toxic'. In the same way that chemists can predict what makes a molecule dissolve in water, or melt at a low temperature, he wants to encourage them to predict how these molecules interact with us and the environment before they are made.

Advances in chemistry and ecological engineering research have adopted sustainable practices over the years. Continuing to invest in sustainable industrial techniques and policies will be extremely important in improving the environment and our relationship with it. One of John and Paul's goals with green chemistry is for the term to completely disappear – it should ideally simply become how we practise chemistry and make things.

► You can watch John and Paul's presentation in full at **youtu.be/wgGNhqR8zR0** (or in brief at **youtu.be/hjnBccq5N8g**).

RSV President Rob Gell with Dr John Warner and Dr Paul Anastas. (Photograph: Catriona Nguyen-Robertson)

THE TWELVE PRINCIPLES OF GREEN CHEMISTRY

1
PREVENT WASTE
Design chemical syntheses to prevent waste – it's better to prevent waste than to treat or clean up after it has been created.

2
MAXIMISE ATOM ECONOMY
Design methods so that the final product contains the maximum proportion of the starting materials. Waste few or no atoms.

3
DESIGN LESS HAZARDOUS CHEMICAL SYNTHESES
Design methods to use and generate substances with little or no toxicity to either humans or the environment.

4
DESIGN SAFER CHEMICALS AND PRODUCTS
Design chemical products that are effective with little or no toxicity.

5
USE SAFER SOLVENTS AND REACTION CONDITIONS
Avoid chemicals for the reaction that are not incorporated into the final product. If you must use these chemicals, use safer ones.

6
INCREASE ENERGY EFFICIENCY
Run chemical reactions at room temperature and pressure whenever possible.

7
USE RENEWABLE FEEDSTOCKS
Use starting materials (feedstocks) that are renewable rather than depletable, often agricultural products or the waste of other processes.

8
AVOID CHEMICAL DERIVATIVES
Avoid using blocking or protecting groups or any temporary modifications if possible. Derivatives use additional reagents and generate waste.

9
USE CATALYSTS
Minimise waste by using catalytic reactions. Catalysts are effective in small amounts and can carry out a single reaction many times.

10
DESIGN FOR DEGRADATION AFTER USE
Design chemical products to break down to innocuous substances after use so that they do not accumulate in the environment.

11
ANALYSE IN REAL TIME TO PREVENT POLLUTION
Include in-process, real-time monitoring and control during syntheses to minimise or eliminate the formation of byproducts.

12
ACCIDENT PREVENTION
Design safer chemistry processes that reduce the potential for chemical accidents.

Summarised by Catriona Nguyen-Robertson

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RSV Young Scientist Research Prize Finalists

The Royal Society of Victoria annually awards four competitive prizes to final year PhD students in all areas of the Biomedical & Health Sciences, Biological Sciences (Non-human), Earth Sciences, and Physical Sciences. In September 2023, we heard from this year's eight finalists about their brilliant work in these fields. Over the coming months, they will share a written summary of their presentations in Science Victoria.

For more information about the RSV's Young Scientist Research Prize, visit **rsv.org.au/young-scientist-research-prizes**

Where do we come from and *when*?

The mystery behind the oldest child

DR. WENJING YU MRSV

RSV Young Scientist Research Prizes (Earth Sciences)
1st place winner

Let's travel back in time, about a million years ago. This story is about a boy – a very, very young boy.

He died when he was only three, and part of his body was carried by an eagle and dropped off at the Cradle of Humankind in South Africa. He died millions of years ago, making him the 'oldest child' in the world. In 1924, his skull was found by quarrymen in a limestone quarry, now known as the Taung Skull Fossil Site. The skull - and the boy it belonged to - was named the "Taung Child".

This discovery threw a spanner into the works in the field of human evolution research. Before, the theory of human origin had been largely Eurocentric, assuming the rise of humankind occurred in Europe or Eurasia. But this single fossil suggested otherwise.

This fossil was clearly more ancient than earlier finds and Australian anatomist Raymond Dart, who first analysed it, claimed it was a human ancestor. He classified it as an extinct species of australopithecine (an entirely new genus) called *Australopithecus africanus*, the "southern ape from Africa".[1] Scientists were initially reluctant to accept that the Taung Child and the new genus *Australopithecus* were ancestral relatives of modern humans – most believed the skull to be from a non-human ape.

It has been almost 100 years since the discovery of the Taung Child, but the *A.africanus* lineage evolution still remains in question. Where does it belong on the human – or hominin - family tree?

LEFT: The skull of the Taung Child, of the species Australopithecus africanus, on display at the Natural History Museum in London, England. Photograph: Emőke Dénes via Wikimedia Commons (CC BY-SA 4.0)

The question has been difficult to answer because we lack sufficient dating evidence at the Taung site. The unique and complicated rock deposits at the discovery site makes fauna fossil dating very difficult.[2,3] Making sense of the relationship of different hominin species in South Africa has always been challenging, largely because of issues dating them accurately.

While the question remains open, the Taung Child itself cannot be used in analyses. It is now protected under the South African Heritage Resources Act and must remain untouched. However, 36 years ago, mammal teeth were also collected in the same layer of rock at the Taung site where the skull was found, meaning that we can assume that they are around the same age. They would, in theory, provide us with the approximate age of the Taung Child.

For the first time in history, we can now directly date these mammal teeth using a combination of technologies. I optimised this method during my PhD, allowing me to date the enamel of teeth older than 3 million years old.[4,5] This method has provided two possible age models. If the first model is correct, then the Taung Child skull and *A. africanus* species could be older than originally suggested, older than 3.33 million years ago and older than the skeleton that is largely regarded as the first human, 'Lucy' (*A. afarensis*). If the second model is correct, Taung Child's age would be within 3 Ma.

It is not possible to decide which model is more accurate – yet – but investigations of human evolution will continue. The methodology that I developed will allow researchers to better understand human evolution as we endeavour to answer: where or when do we come from?

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1874
The Keys of Corio Bay

BY SCOTT REDDIEX MRSV

On the 16th of November 1874, Thomas Rawlinson recounted a mysterious story to the RSV.

He began by presenting a letter recently written by the former Lieutenant Governor of Victoria Charles La Trobe, titled "*The Boucher Lime Kiln, near Geelong, and a Memorandum about Three Keys found there.*" In his letter, La Trobe recalled a visit he had made to an excavation site at what is now Limeburners Bay around thirty years prior "*in the year 1845 or 1846*".

It was there that he had a brief conversation with the kiln operator:

"'I found a bunch of keys yesterday, just where your honour is picking the shells.' 'Keys?' I said. 'Keys, your honour,' he replied. 'What can you mean?' I enquired. 'Yes, here,' he said, laying his hand just upon the shellbed. I asked him 'Where are they?' 'Up at the hut, your honour, he replied. 'Let me see them,' I said.

"He immediately left the excavation and ran up the bank to his hut, returning a minute or two afterwards with two keys, each about two inches in length, which he handed to me, saying that there had been three, but that the children had been playing with them, and he could only lay his hand upon the two."

La Trobe followed with his hypotheses as to how the keys came to be where they were found, in a pit by the shore. Had they been dropped on a beach many years ago, and buried by sand as the shoreline changed? More importantly, when exactly had these keys been dropped? And by who?

With the stage set, Rawlinson addressed the major questions of the case: who was known to have been in the area before the 1840s? If the keys had been buried, how long would it have taken for the natural movement of sand to cover them at the depth they were found?

He wrote that "*The earliest known visit to Port Phillip was about 1802, and the time which has elapsed since then appears very inadequate to produce so great results under present known conditions; and admitting the statements made as within the range of possibility, I do not see any alternative but to extend the period for from 200 to a little over 300 years back, during which period the Buccaneers had made their presence felt in the Pacific; we know that some of them visited Australia in their wanderings, and it is almost a certainty that many of them left little trace of their presence, except in traditions of lost ships and ruined towns.*"

The story of the mysterious keys was reportedly "*notorious, and much discussed*", capturing the interest of many in the years following their discovery. One current member of the RSV recounted that his father frequently alluded to the mystery of the keys, and the story was even covered in *The Argus, The Geelong Advertiser, The Age,* and *The Australasian* newspapers at different times.[1,2]

The mystery may have remained unsolved, had it not been cleared up in 1875 by another RSV member, Ronald Gunn. Gunn had been unable to attend RSV meetings due to illness, and so could not respond to the story at the time it was presented, but afterwards penned a letter that included valuable insight:

"I remember the circumstances of the alleged discovery of the keys in the position named by you perfectly well.

"I saw the two keys (three were, I believe, found) in the possession of my friend Mr. La Trobe, in Melbourne, in the end of September or beginning of October, 1849 (not in 1845 or 1846), immediately after they were picked up."

"I proceeded to Geelong on the above day, and next morning, accompanied by Mr. Addis, visited the spot where the keys were discovered. On questioning the lime-burner, I ascertained that he did not pick the keys out of the stratum of shells at the depth alleged, but found them at the bottom of the hole, mixed with some shells, and assumed that they had dropped along with them."

"I have little doubt but that they had been dropped by some inhabitant of Geelong, lay in the grass for some—not very long—time, and fell to the bottom of the hole from the surface after the excavation was made, the margin being formed of a rather light, crumbling soil."

"I expressed my views and opinions to Mr. La Trobe on my return to Melbourne, and thought the whole question had been considered as settled, until I saw a letter from Mr. La Trobe in The Australasian of June 3rd, 1871".

In the end, there had been no shadowy buccaneers. Instead, there had simply been misunderstanding and misremembering, and perhaps a touch of overactive imagination.

More on the story of the keys can be found in 'Charles La Trobe and the Geelong Keys.' by MW Johns.[3]

OPPOSITE: The Boucher Kiln, on the water's edge at Limeburner Bay, near Corio. Image: Transactions and Proceedings of the Royal Society of Victoria, Vol. XII, 1875.

FROM: *Transactions and Proceedings of the Royal Society of Victoria,* Volume XII, 1875, Article X - Notes on the Discovery of some Keys in the Shore Formation of Corio Bay, near Geelong. By T. Rawlinson, C.E.

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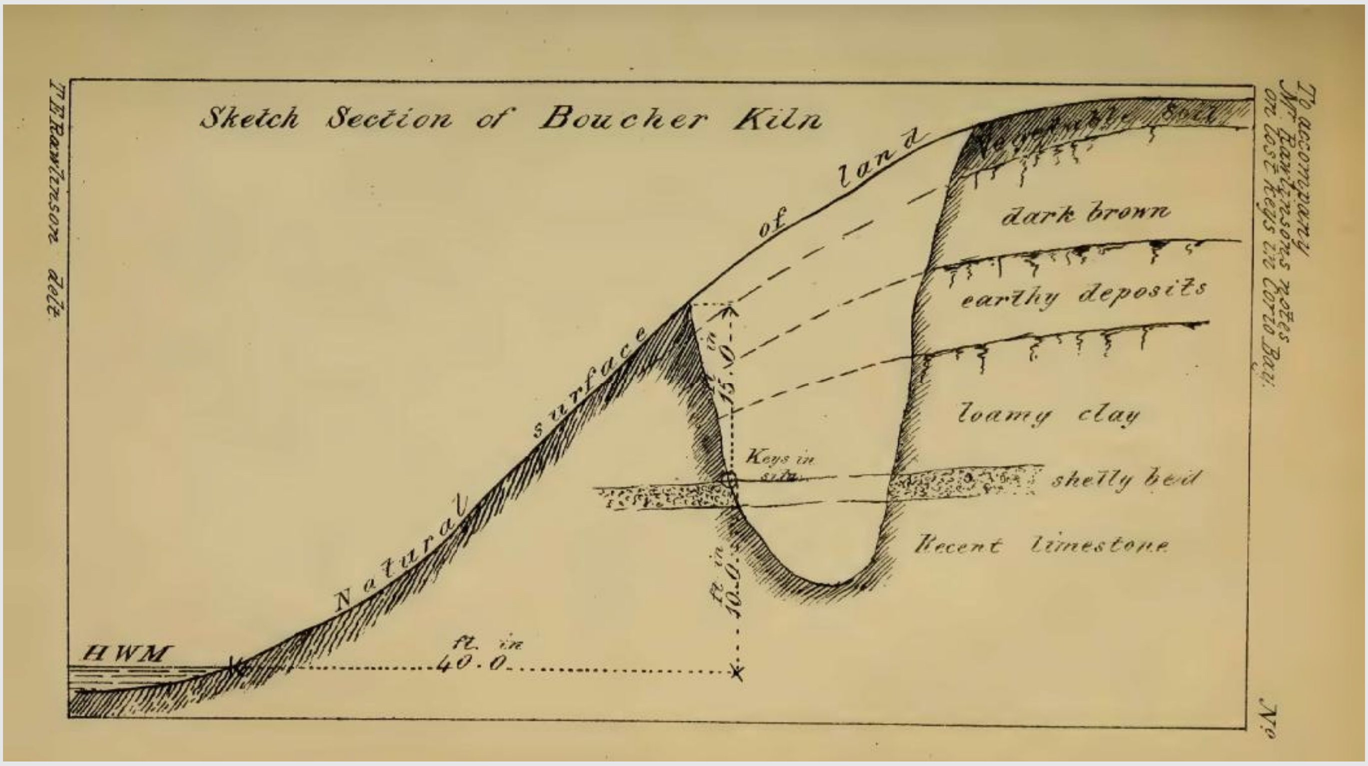

Sketch Section of Boucher Kiln
T.E.Rawlinson delt
To accompany
Mr Rawlinson's notes
on lost keys in Corio Bay.
Natural surface of land
Vegetable Soil
dark brown
earthy deposits
loamy clay
shelly bed
Recent limestone
Keys in situ
HWM
ft. in
40.0
ft. in
15.0
ft. in
10.0
No

Inspiring Victoria

inspiringvictoria.org.au

The Inspiring Australia strategy was developed by the Australian Government to increase general engagement and interest in the sciences by Australians. The *Inspiring Victoria* program is jointly funded by the Australian and Victorian governments with the Royal Society of Victoria (**rsv.org.au**).

Inspiring Victoria encourages involvement in STEM through initiatives (such as National Science Week Victoria - **scienceweek.net.au/your-state/vic**) that are governed and delivered by the RSV's program partners:

PUBLIC LIBRARIES VICTORIA
plv.org.au

NEIGHBOURHOOD HOUSES VICTORIA
www.nhvic.org.au

PARLIAMENT OF VICTORIA
parliament.vic.gov.au

MUSEUMS VICTORIA
museumsvictoria.com.au

ROYAL BOTANIC GARDENS VICTORIA
rbg.vic.gov.au

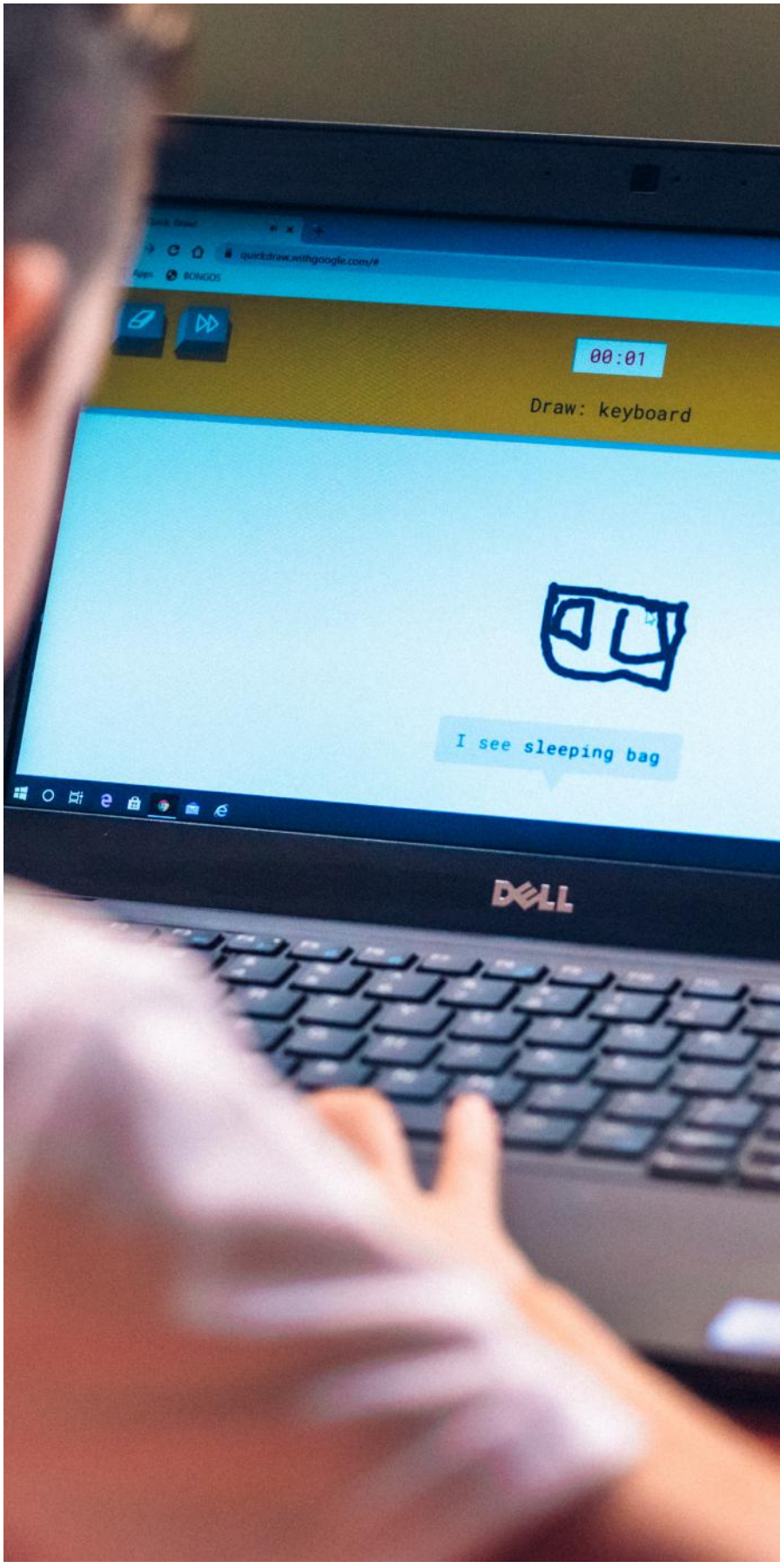
ZOOS VICTORIA
zoo.vic.gov.au

QUESTACON
questacon.edu.au

THE COMMISSIONER FOR ENVIRONMENTAL SUSTAINABILIT
ces.vic.gov.au

THE ARTHUR RYLAH INSTITUTE FOR ENVIRONMENTAL RESEARCH
ari.vic.gov.au

SCIENCE TEACHERS ASSOCIATION OF VICTORIA (STAV)
stav.org.au



Participants of the Explore AI workshop pit their Pictionary skills against AI with the Quick, Draw! program. Photograph: Joel Checkley/Museums Victoria.

Humans Learning Machine Learning

ROSA ZWIER
Education Programs Producer (Physics and Space Science) at Scienceworks, Museums Victoria

Computers are smarter than ever – more than I could have imagined as a child. How do you explain the difference between old-fashioned computer programming and machine learning to an eight-year-old? In 2020, that's the task I found myself grappling with as a science communicator at Scienceworks.

It was a lonely Melbourne lockdown, and I was holed up in my bedroom on my laptop, messaging with various (terrible) AI chatbots to keep me company. It was the days before ChatGPT, and I was developing a workshop about AI for both 8 to 10-year-old children and their adults. I found myself reading about the Turing Test and the Chinese Room Argument, neural networks, and bias in AI.* As I learned more about machine learning, I found myself wondering: how could I explain these very complex concepts to very young people?

We're now at a moment in time where this conversation is critical. AI is becoming a huge part of our world. But as with any new tool, we need to use it responsibly. We also need to make sure that young people who will grow up into a world shaped by AI understand what it is and how it works. Education is a key step in empowering a generation who will use AI daily, so that they can think critically and make informed choices.

Many parents, guardians, and teachers understand the importance of talking about this technology, but it didn't exist when we were children. We're still learning to understand it ourselves, while also learning how to teach it. At Scienceworks, we have a unique opportunity to lead conversations with educators, parents/guardians, and children about emerging technologies that bridge the gap between experts and the public.

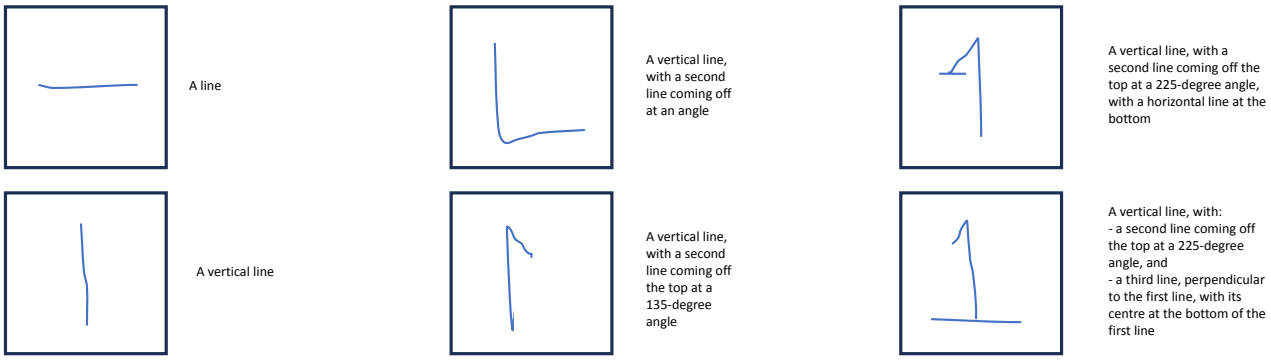
Here's some of what I learned from developing a workshop to teach eight-year-olds about AI, to encourage you to learn or even have your own conversations about machine learning and AI.

Engage playfully

There are plenty of fun and interactive tools that can help everyone, including young children, to understand what machine learning is.

To explain the difference between direct coding (writing a script that tells a computer exactly what to do) and machine learning (the computer learns how to perform a task from training data) in the workshop, we unpacked the idea of trying to get a computer to recognise a handwritten number. How would you write instructions for recognising a number? Pose the question of 'how do you draw a "1"?' to ten children and adults, and draw the lines that they say literally, and you get a variety of things that do not necessarily look like a "1".

It would be surprisingly hard because everyone writes a little differently. But by showing a machine learning algorithm thousands of examples



Examples of how a computer may draw the number "1" with various instructions, based on answers received during the workshop. (Image: Dr Catriona Nguyen-Robertson, Scienceworks Learning Facilitator.)

of handwritten numbers, we don't even need to explain to the computer how it should identify them – it can learn. To demonstrate this, we used Neural Numbers, an AI that predicts the number you draw inside a box.[1]

A favourite in the workshop was the game *Quick, Draw!*[2] It's a great game where you're given a prompt and have to draw it while an AI guesses what the drawing is of. The AI learns from all the previous drawings by other players, which you can look at to see how it comes up with its guesses. It's great fun, and just by playing it you can start to develop an intuition about what machine learning is.

Don't shy away from big ideas

A great way to introduce philosophical ideas is by playing the game where a group of people in a circle add one word at a time to make a story. We played this with parents and children together, and it gave us a framework to discuss very complex topics in a simple way. We could talk about syntax, versus language patterns, versus intention - all in simpler words, of course.

From there, we could then move into a discussion about predictive text, and text generation. Your phone can suggest the next word for you based on what you've written before, but does that mean it understands what it's saying? Is that intelligence?

We introduced the concept of 'black box' machine learning – a term that refers to machine learning models that give a result or answer, without us understanding how they did it. We use an analogy of a mystery box with a bunch of dials, and when you feed in some numbers, like 3x3 for example, it spits out an answer. If the answer is wrong, it adjusts some dials, until eventually it starts getting the answer right. We don't know exactly what happens inside, or what the knobs do, but by iteratively adjusting and telling the box that its output is right or wrong, we can eventually get to something that does work. This is a simplification of how machine learning happens via neural networks, but kids can start to grasp the concept.

We also talked about bias in AI, through the lens of voice recognition. Many children have experienced talking to Siri, and so talking about how things like Siri can struggle with different accents was a really relatable way to show young kids that AI can be discriminatory based on how they're trained. From there, we could talk about citizen science projects like Mozilla Common Voice,[3] which seeks to combat that bias.

Let kids use new technology

A key part of our workshop was a design challenge in which kids created their own AI. We used Google's Teachable Machine,[4] which lets you use machine learning to train an AI to recognise the difference between images, sounds, or poses. This is a fun and playful way that kids can not only use AI, but also take part in the process of creating AI themselves. It was a great culmination of their learning.

It might sound daunting to talk to kids about new and complicated technology. Will they get it, and will they care? But the children who attended our workshops were fascinated, and we stepped them through a journey of understanding some of the basic principles underpinning this new technology.

Remember that you don't need to be an expert, either – I wasn't an expert when I started developing these workshops. Learning is a beautiful and rich experience at any age, and there are plenty of great tools to help you do it either for yourself, or for any little ones you have around you. And it's important – AI isn't going away, and by educating young people, we can make sure these new technologies are used appropriately in the future.

–

**The Turing Test tests the ability of a machine to engage in conversation with a human without being detected as a machine, if it remains undetected as a machine, it has demonstrated human intelligence.[5]*

The Chinese Room Argument is the idea that a person alone in a room who is responding to Chinese characters slipped under the door may be able to return appropriate strings of characters back out if they read enough and follow the pattern, leading those outside to mistakenly believe there is a Chinese speaker in the room.[6]

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[1] Neural Numbers. I AM A.I. i-am.ai/talk-neural-numbers.html

[2] Quick, Draw! Google. quickdraw.withgoogle.com

[3] Common Voice by Mozilla. Mozilla. commonvoice.mozilla.org/en

[4] Teachable Machine. Google. teachablemachine.withgoogle.com

[5] Oppy, G., & Dowe, D. "The Turing Test", The Stanford Encyclopedia of Philosophy (Winter 2021 Edition), Zalta, E.D. (ed.). plato.stanford.edu/archives/win2021/entries/turing-test/

[6] Cole, D. "The Chinese Room Argument", The Stanford Encyclopedia of Philosophy (Summer 2023 Edition), Zalta, E.D. & Nodelman, U. (eds.), plato.stanford.edu/archives/sum2023/entries/chinese-room/

A Mountain Pygmy Possum and (below) a Bogong Moth. Photographs: Zoos Victoria.

MOTH TRACKER

A Citizen Science Project with Zoos Victoria

Help scientists at Zoos Victoria track the migration of Bogong Moths to help them and the Critically Endangered Mountain Pygmy-possum!

Beginning in spring each year, Bogong Moths make an epic migration towards alpine regions in Victoria and New South Wales, where Critically Endangered Mountain Pygmy-possums are waking from their hibernation. Bogong Moths are a crucial spring food source for Mountain Pygmy-possums and declines in Bogong Moth numbers are an urgent threat to the possums' survival. After Bogong Moth numbers crashed by an estimated 99.5% in 2017-18, these small but mighty moths were sadly listed as Endangered by the IUCN in 2021.

Moth Tracker is a citizen science initiative which aims to gather open-source real time data on the dates, locations and numbers of Bogong Moths travelling during the annual migration period.

For the current migration season, Moth Tracker has already received 416 submissions, including 220 verified Bogong Moth sightings.

If you see a Bogong Moth, or a moth you think could be a Bogong Moth, take a photo and upload it to Moth Tracker. It's quick and easy, and will help scientists better understand how to help the moths and if they will make it to the mountains this year.

The migration season isn't over yet, and we are hoping to collect more valuable citizen science data on the epic migration of this Endangered species in the coming months.

Learn more about the moths, the possums who eat them, and the Moth Tracker project at **zoo.org.au/possums/**

Call for Scientific Papers

AVAILABLE ONLINE AT PUBLISH.CSIRO.AU/RS

The Proceedings of the Royal Society of Victoria is our refereed journal, published twice annually by CSIRO Publishing.

The Society invites contributions for the *Proceedings* from authors across the various disciplines of biological, physical and earth sciences, including multidisciplinary research, and on issues concerning technology and the applied sciences.

Contributions on topics that are relevant to Victoria and the south-eastern Australian region are encouraged. The journal also publishes Special Issues and themed collections of papers commissioned by the Council of the Royal Society of Victoria. It is published online in May and November, with two issues constituting a volume.

The *Proceedings* is one of Australia's oldest and longest-running science journals, a terrific platform for establishing an individual research presence, grouping papers derived from symposia on specific subjects, or simply joining a distinguished tradition of science published in or about our region that stretches back to the 1850s.

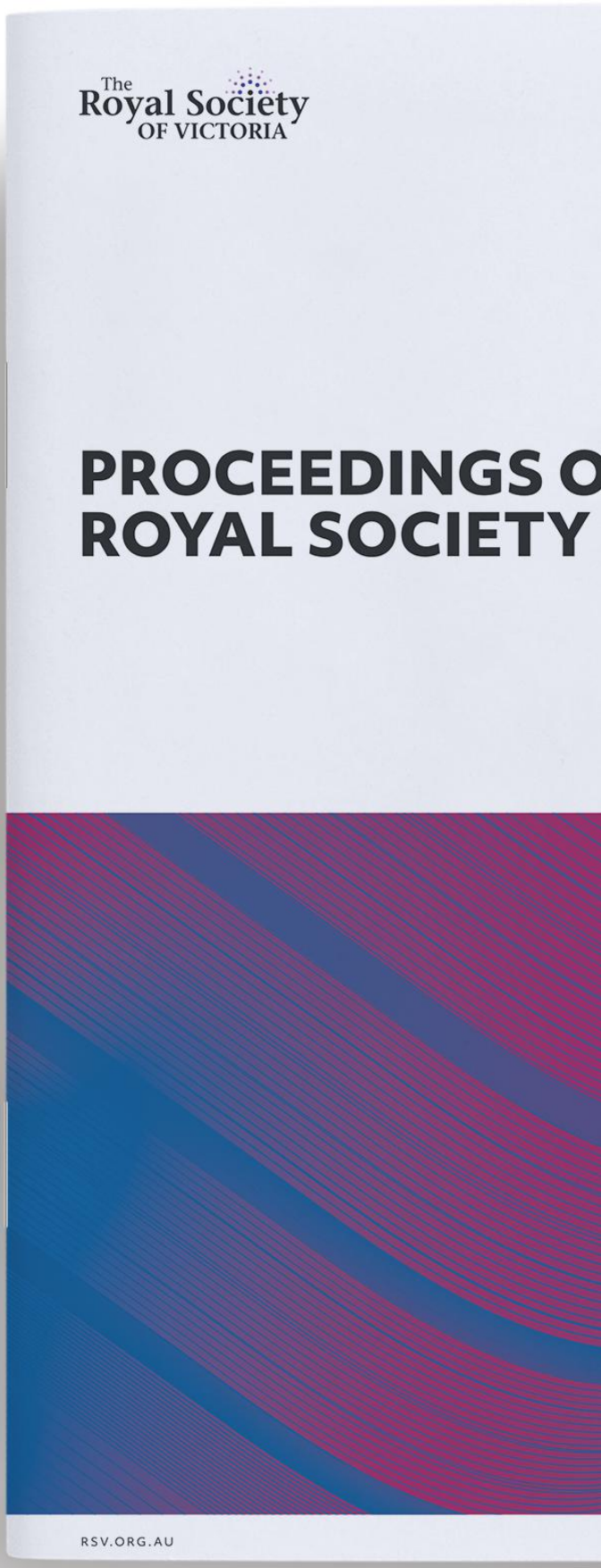
The journal began in 1855 as an irregular publication under the title *Transactions of the Philosophical Society of Victoria,* with the present name adopted in 1889. Since then, volumes of the journal have been published annually, often across one or more parts.

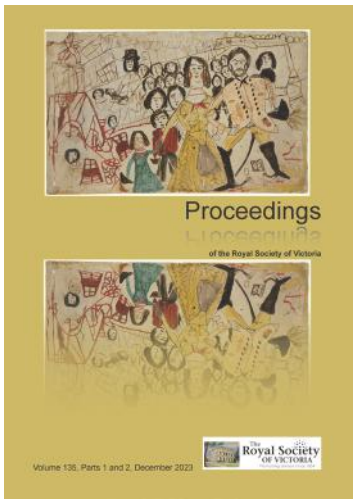
The online content published by CSIRO Publishing extends back to Volume 118, 2006, and is available at publish.csiro.au/rs.

All volumes of the *Proceedings* and its predecessors from 1854 to 2006 are also available free online at **biodiversitylibrary.org/creator/6984**.

Submissions

Those interested in submitting papers should review the Author Instructions at **publish.csiro.au/rs/forauthors/AuthorInstructions**. Manuscript submissions for the Proceedings are now made using the ScholarOne platform. Any enquiries regarding submission can be made to **editor@rsv.org.au**





Volume 135 of the Proceedings of the Royal Society of Victoria is now available online, open access from CSIRO Publishing, hosted at publish.csiro.au/rs/issue/11551.

This volume is substantively dedicated to the theme 'Humboldtian Research Towards a Sustainable World,' drawn from the proceedings of the 19th Biennial Conference of the Australian and New Zealand Associations of von Humboldt Fellows in 2022.

There is an additional paper from Dr Thomas Darragh and Dr Ruth Pullin, translating letters from the celebrated German painter Eugene von Guerrard, then based in Australia, to the Ethnological Museum in Berlin from 1878 – 1880, along with the collected abstracts from colleagues presenting at the RSV's 2022 symposium on 'Next Generation Biocontrol of Invasive Vertebrate Pests.'

Baron Alexander von Humboldt (1769 - 1859). Artist: Julius Schrader. Open access image courtesy of The Metropolitan Museum of Art.

Honouring Humboldt

Research for a Sustainable World

"Alexander von Humboldt has been referred to as 'the forgotten father of environmentalism.'[1] As early as 1844, he wrote that humans change the climate 'by cutting down forests, by changing the distribution of water bodies, and through the production of large vapour and gas masses at the centres of industry.'[1] Humboldt also described the greenhouse effect in his opus magnum, 'Kosmos'. And time and again in his writings and in his lectures, he emphasised the interconnectedness of all living creatures on this planet. In times when the effects of climate change become ever more visible and palpable around the globe, it is imperative that the global academic community addresses the topic of sustainability in all its dimensions."

— Dr Thomas Hesse, Deputy Chair, Alexander von Humboldt Foundation

Papers from Volume 135

Current Government Consultations of Interest to Victoria's Science Community

*Projects open for consultation from **engage.vic.gov.au/project***

CONSULTATION CLOSES 23 FEBRUARY 2024

Review of the Voluntary Assisted Dying Act 2017

The Department of Health wants to hear from individuals, families, carers, organisations, and healthcare workers who have been involved with voluntary assisted dying in Victoria since 2019.

engage.vic.gov.au/review-of-the-operation-of-the-voluntary-assisted-dying-act

CONSULTATION CLOSES 23 FEBRUARY 2023

Fishermans Bend Urban Renewal

The Department of Transport and Planning is seeking your views on the proposed approach to funding essential infrastructure for urban renewal in Fishermans Bend.

engage.vic.gov.au/fishermans-bend-urban-renewal-area-development-contributions-plan

CONSULTATION CLOSES 29 FEBRUARY 2023

Existing Footscray Hospital site opportunities

Help inform the State Government's consideration and assessment of future opportunities for the existing Footscray Hospital site.

engage.vic.gov.au/footscray

CONSULTATION CLOSES 28 MARCH 2023

Reforming Victoria's animal care and protection laws

Have your say on the draft Animal Care and Protection Bill

engage.vic.gov.au/new-animal-welfare-act-victoria

Submission Guidelines

We welcome your pitches relating to current scientific research in Victoria, recent scientific discoveries, social and policy issues, technical innovations, and overviews of impactful research.

Science Victoria's articles are written in plain, non-academic language, and thoroughly referenced (see: References).This is not a platform for scientific journal articles or media pieces. For more information on what we're looking for, see below.

Style Guide

All pieces should have readability in mind. A good litmus test is knowing that most people have read a piece or been to a presentation that managed to make the most interesting topics incredibly boring and/or confusing. This is what you want to avoid.

A general guide for readability is that it should be understood by an educated 16-year-old – or ask a friend or family member to proofread!

Feature Articles

Recommended length: 600 - 1,800 words

Feature articles are more in-depth pieces on a specific topic related to STEMM. A key aspect of feature articles is the narrative – this isn't a journal article, so think about the story that your article is trying to tell.

Avoid using jargon, as it will quickly alienate anyone who isn't an expert in that field. Explaining one or two otherwise irreplaceable terms is fine.

Use of sub-headings and figures to break up longer pieces is strongly encouraged.

Not quite sure about the tone for your piece? Have a look at articles published in previous editions of *Science Victoria*, or in other scientific publications for a general audience, like *The Conversation, Cosmos, New Scientist, or Scientific American.*

Pitch it to us!

Have an idea for an article?
We want to hear from you!

Briefly outline your key message, why it should be shared in *Science Victoria*, and the proposed article type. Pitches can be submitted at any time, but check submission deadlines if you're interested in publishing in a particular edition.

All pieces will be reviewed prior to publishing, and may be edited for length and clarity (although we will not alter the message or context of your work).

Send pitches and any questions to **editor@ScienceVictoria.org.au**.

Opinion Articles

Recommended length: 600 - 1,800 words

In contrast to a feature article, an opinion piece conveys your informed opinion on, or experiences with, a particular topic. Clearly state your argument, outlining the details of the problem you are addressing, and build to a strong conclusion.

For greatest impact, your choice of topic should be one that is broadly relevant to STEMM-related fields in Victoria. Examples of possible topics include how to address a climate-change related problem in Victoria; successes and failures common to STEMM engagement initiatives; ethical problems related to scientific projects or careers in STEMM; your experiences of a career in STEMM and thoughts on how to better support the next generation of researchers; existing STEMM-related studies or approaches that you believe could be applied in Victoria.

We welcome well-informed opinion articles from all authors, particularly from those with significant expertise in a given area. Articles may reference your own work; however, these are not promotional fluff pieces.

Letters

Recommended length: 200 – 1,000 words

Letters have minimal restrictions on style, structure, or subject matter. You are encouraged to submit your thoughts/questions/comments that broadly relate to STEMM in Victoria. Potential subject areas include responses to articles in previous editions of *Science Victoria*, seminars at scientific events, science-related issues and policies, or topics you'd like to see in future editions.

Letters are also the best format to share current or recent news relating to science, with an emphasis on science in Victoria or news that impacts Victoria's scientific community. News could relate to funding announcements/grant outcomes, new STEMM-related projects, high-impact publications relevant to Victoria, successes of Victorian scientists, or relevant STEMM-related policy news.

Where a specific question is asked, we will try to have the appropriate person respond to your letter.

What I've Been Reading

Recommended length: 600 - 1,800 words

This is a column for you to tell us about a book broadly relating to STEMM that you've read. These pieces typically include a summary of the book and its ideas, as well as your interpretations or conclusions. Possible questions to consider: Do you think the author was correct in any assumptions? Was the author's style of writing approachable? Did they do the subject matter justice? Who would you recommend this particular book to? What did it mean to you? What did you learn?

Images and Figures

Images are strongly encouraged, however please only provide files that are either completely original, in the Public Domain, or covered by an appropriate Creative Commons license. Images must include details of the source, license, and any relevant descriptions.

If suitable images are not provided, we may include relevant Public Domain/Creative Commons images.

All images must be of sufficient size and quality – as a rough guide, aim for >1.3 MB in file size.

References

Please reference primary sources/journal articles for any non-trivial scientific claims, or for publications that prompted your writing of the article. If references aren't provided, we will request them for specific statements.

References for all articles should use a modified APA 7th edition format: reference list in author-year format, with numbered in-text citations. Refer to articles in previous editions for examples. Please do not submit pieces that use MS Word's References/Footnote/Endnotes feature, as it forces us to manually re-write your references.

Submission Deadlines

FEBRUARY 2024	**DUE DATE**
Artificial Intelligence	*19 January*
The development and applications of different AI models.	
MARCH 2024	**DUE DATE**
Victoria's Fauna	*16 February*
Everything *Animalia* in Victoria, particularly native fauna.	
APRIL 2024	**DUE DATE**
The Four Planetary Crises	*15 March*
Biodiversity Loss, Climate Change, Pollution & Waste, and The Rise of Misinformation	
MAY 2024	**DUE DATE**
Accessibility & Inclusion in STEMM	*18 April*
Supporting the education, employment, and engagement of everyone in STEMM.	
JUNE 2024	**DUE DATE**
Victoria & Climate Change	*17 May*
The impacts of, research on, and responses to climate change in Victoria.	
JULY 2024	**DUE DATE**
Building Scientific Competency	*14 June*
Empowering individuals and communities to understand the scientific method.	
AUGUST 2024	**DUE DATE**
STEMM Throughout Victoria	*19 July*
The opportunities for learning and engaging with STEMM across the state.	
SEPTEMBER 2024	**DUE DATE**
Pollution in Victoria	*16 August*
The different pollutants, sources, impacts, and responses required.	
OCTOBER 2024	**DUE DATE**
Victoria's Ecosystems	*13 September*
The many and varied ecological niches across Victoria	
NOVEMBER 2024	**DUE DATE**
Science & Policy	*18 October*
From lab bench to front bench: how scientific understanding can positively influence policy.	
DECEMBER 2023	**DUE DATE**
Science & Business	*15 November*
Creating a sustainable industry, start-ups, med-tech, patents, and ethics.	

Hold Your Next Event at the Royal Society of Victoria

The RSV engages communities with scientific knowledge through aligned partnerships, events, festivals, conferences, and education programs.

Services Available

We also provide a number of services to ensure your event is a success. Some of the services we provide are:

- Event management
- Meeting venues
- Grants and awards administration
- Social media campaign management
- Broadcasting and video production
- Recruitment of scientific panels
- Convening community engagement and deliberation processes where scientific work contributes to social, environmental, and economic impacts and benefits.

The Facilities

The RSV's facilities are available for hire to organisations, companies, or private groups.

Audio-visual and seminar equipment is available for use, including videoconferencing facilities for hybrid Zoom/MS Teams meetings.

There is a commercial kitchen on the ground floor, suitable for your own use or by a caterer. Limited parking is available on-site, and a commercial parking operator is adjacent on La Trobe Street.

▶ Take a Virtual Tour of the building at: **matterport.com/discover/space/Royal-Society-Victoria**

▶ Email rsv@rsv.org.au to discuss your needs and ideas!

The Burke and Wills Room

The beginning and end of the ill-fated Victorian Exploring Expedition of 1860-61 is a beautiful, multi-function space with an adjoining kitchen, suitable for a range of events.

SUITABLE FOR

Workshops, roundtables, luncheons, dinners, seminars, and functions.

CAPACITY

Workshops	*≤30 people*
Dinners	*≤60 people*
Catered Functions	*≤80 people*

The Ellery Lecture Theatre

First-floor lecture theatre, with raked seating, speaker's podium, and audio/visual equipment. Perfect for lectures, presentations, and conferences.

SUITABLE FOR

Presentations, seminars, lectures.

CAPACITY

Any Booking	*≤110 people*

The Millis Room

A versatile room on the ground floor, with views of the Carlton Gardens. Suitable for smaller meetings, group/individual work, or seminars.

SUITABLE FOR	CAPACITY	
Meetings, group/individual workspace, and seminars.	*Any Booking*	*≤15 people*

The Cudmore Library

A picturesque room with videoconferencing and projection equipment. Great for larger meetings and seminars, with in-person or hybrid attendees.

SUITABLE FOR	CAPACITY	
Meetings, seminars, and videoconferencing.	*Any Booking*	*≤15 people*

The Von Mueller Room

A light-filled room on the first floor, perfect for smaller meetings and seminars, or group/individual work.

SUITABLE FOR	CAPACITY	
Meetings, seminars, and videoconferencing.	*Any Booking*	*≤15 people*

Support Victoria's Science Society in 2024 and help us to engage individuals and communities with STEMM

WHO WE ARE

Founded in 1854, the Royal Society of Victoria (RSV) is our state's science society.

We are a membership based, non-government organisation, advocating for the importance of science, technology, innovation, and building the skills for Victoria's future industries, governments, community leaders, and research superstars.

WHAT WE DO

We manage the Inspiring Australia program in Victoria (inspiringvictoria.org.au), meaningfully engaging communities with science.

We encourage, profile, and celebrate the achievements of Victorian scientists through public lectures, awards, and prizes, which are supported by the donations and bequests to the RSV Science Foundation.

WHERE YOUR DONATIONS GO

Your donations allow us to continue the work we have been doing for Victoria for more than 160 years. This includes hosting organising/hosting/running STEMM events, running a public lecture series (in-person and online), producing the magazine *Science Victoria*, celebrating Victorian scientists through awards and prizes, publishing Victorian science in our academic journal (the Proceedings of the Royal Society of Victoria), and empowering the next generation of scientists.

HOW TO SUPPORT

We also support a number of smaller organisations, which are listed at **rsv.org.au**.

You can donate online now at **rsv.org.au/support-the-rsv**, or alternatively contact us at **rsv@rsv.org.au** for information about other payment methods.

Become a Member of the RSV

We bring together an independent community of science practitioners, educators, industrialists, and enthusiasts to promote an understanding and utilisation of scientific knowledge for the benefit of the state of Victoria.

	STUDENT $40 PER YEAR	FULL $120 PER YEAR	ORG. $1000 PER YEAR	SCHOOL $1000 PER YEAR	AFFILIATE $500 PER YEAR
Special Membership rates at RSV and affiliate events.	✓	✓			
Networking opportunities – national and local.	✓	✓	✓	✓	✓
Recognition of membership through use of post-nominal affix	MRSV	MRSV			
Science Victoria Digital Edition (Printed copy available for an additional fee).	✓	✓	✓	✓	✓
Free monthly printed copies of *Science Victoria* for school libraries.				✓	
Recognition of achievements through awards programs.	✓	✓			
Discounted advertising in *Science Victoria*			✓	✓	✓
Discounted facility hire at 8 La Trobe Street, Melbourne.			✓	✓	✓
Discounted membership rate for eligible full-time students.	✓				
Discount on purchases from CSIRO Publishing	✓	✓			
'Schools Supporting Schools' Membership Program*				✓	
Listing of membership on the RSV.org.au website.			✓	✓	✓

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PhD Student, Swinburne University

MISS SARAH WEHBE
Student, The University of Melbourne

MR ABBI SHARMA
Entrepreneur, InfoIQ Consulting

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REPRESENTATIVE
Mr Tom Stephenson

STIEBEL ELTRON is a leading company dedicated to providing exceptional home comfort products to help customers create their ideal homes of the future. With almost a century of experience in manufacturing innovative home appliances, **STIEBEL ELTRON** has become synonymous with eco-friendly, energy-efficient heating, ventilation, and hot water.

Our success is based on a set of principles that include high quality, innovation, technical efficiency, reliability, and customer-oriented service. We take pride in our reputation for German engineering excellence, which has enabled us to distribute our products globally from our origins in Germany.

For more information: **rsv.org.au/how-to-join**

* The 'Schools Supporting Schools' membership program allows a school to sponsor the membership of one or more schools at a discounted rate of $750/year, allowing less-resourced schools the same benefits and opportunities of RSV membership.

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