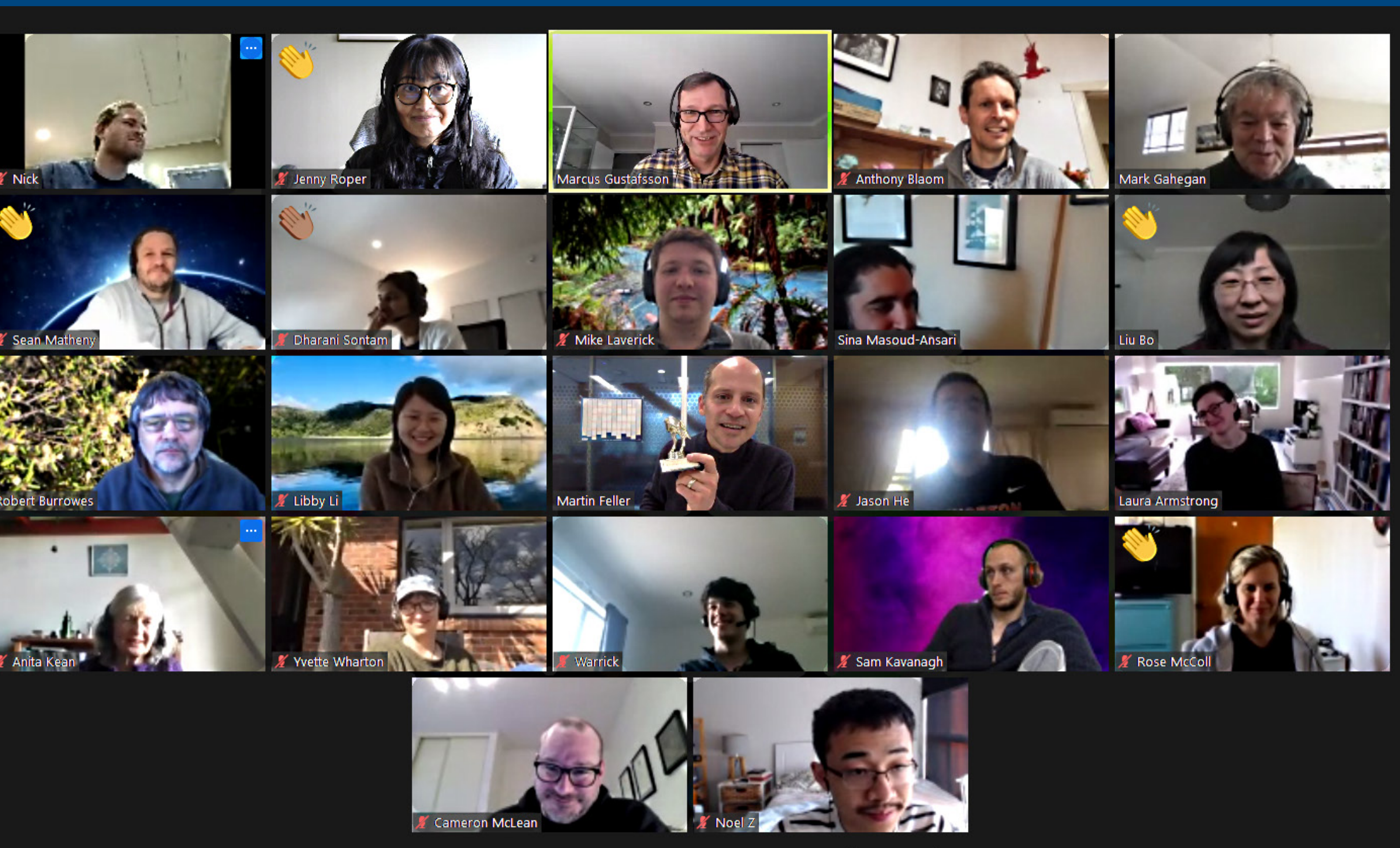
Centre for eResearch

Annual Report 2020



THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

Contents

Welcome from the Director

2020 was, as we all know, a year of disruption. We instructed all staff to work from home a few days before the first lockdown was declared, so we were set up and ready to go with our own remote working from the outset. During those first few weeks of lockdown, hundreds of researchers found themselves unable to access their data, labs and computers. We moved into triage mode and began offering daily drop-in sessions and workshops to researchers (over Zoom) to help with moving files, accessing remote computational resources and navigating the University's VPN client. We experienced very high demand during this time, and kept the daily drop-in sessions going for an entire month whilst the University's researchers adjusted to the new normal of working from home.

During this time, we also helped Connect, who were inundated with service requests, by working on their service tickets directly. Our special project work took a back seat during this time, but we kept the lights on.

The change in working practices that COVID-19 precipitated also brought some unforeseen benefits. We learned that (most) researchers prefer Zoom-based workshops for their digital skills development rather than face-to-face encounters, and attendance and satisfaction levels increased accordingly. By the time the second lockdown came around, we were ready to deliver an entirely virtual Research Bazaar (RezBaz, our annual, 3-day skills workshop), this time in collaboration with the Victoria University of Wellington. Over 200 researchers from UoA took part in one or more of the scheduled activities.
2020 also provided the usual growth challenges, as more researchers take up our services. Our Nectar research cloud now empowers over 160 research projects, our various research data services support more than 700 research projects. We are actively managing about 0.5PB of University research data. Additionally we undertook 26 special projects and delivered 30 research data management workshops across all faculties.

2020 also saw the Centre for eResearch begin to work closely with ORSI (the Office of Research Strategy and Integrity). Our ResearchHub is now being expanded to act as a gateway to all kinds of researcher-focussed services and information sources across the entire University, and we are helping to lead the University's review of its research data strategy.

Professor Mark Gahegan
Director, Centre for eResearch

Our Values

- Computing power is easily accessible to researchers, in the right form for them to use.
- Research data is a valuable long-term asset that require carefully managing to leverage its value.
- Researchers require new technology skills and competencies to embrace fully the digital transformation occurring in research.
- Advanced computational methods provide a research advantage, so it is important that the University is ready to adopt emerging tools and methods that improve research effectiveness.
- Good research support services are easy to find, to request, and to use.

Our vision

Be the best eResearch services of any university within New Zealand, enabling us to be the first choice for international researchers who wish to collaborate or join our team.

Our mission

1. To grow strategic research infrastructure and resources,
2. to create effective and efficient computing services and workflows to support research, and
3. to provide consultancy to help researchers using advanced computing tools in their research.

2020 in Brief

Key strategic projects 2020

Research Delivery Programme - Office of Research Strategy & Integrity

- Research Data Management
- Researcher Skills Development
- ResearchHub Expansion

(more details in later sections)

Connect Digital Services

- Connect Nectar onto UoA internal network to be able to access UoA-internal services (e.g. research data).
- Consolidate two virtual machine environments that are used by eResearch into a single environment.
- Increase GPUs capacity in Nectar and develop a more flexible scheduling mechanism to allow for more efficiency.

University Strategic Programme Office

- Visaulisation Suite expansion and training in Grafton Campus
- MyTardis scientific instrument data

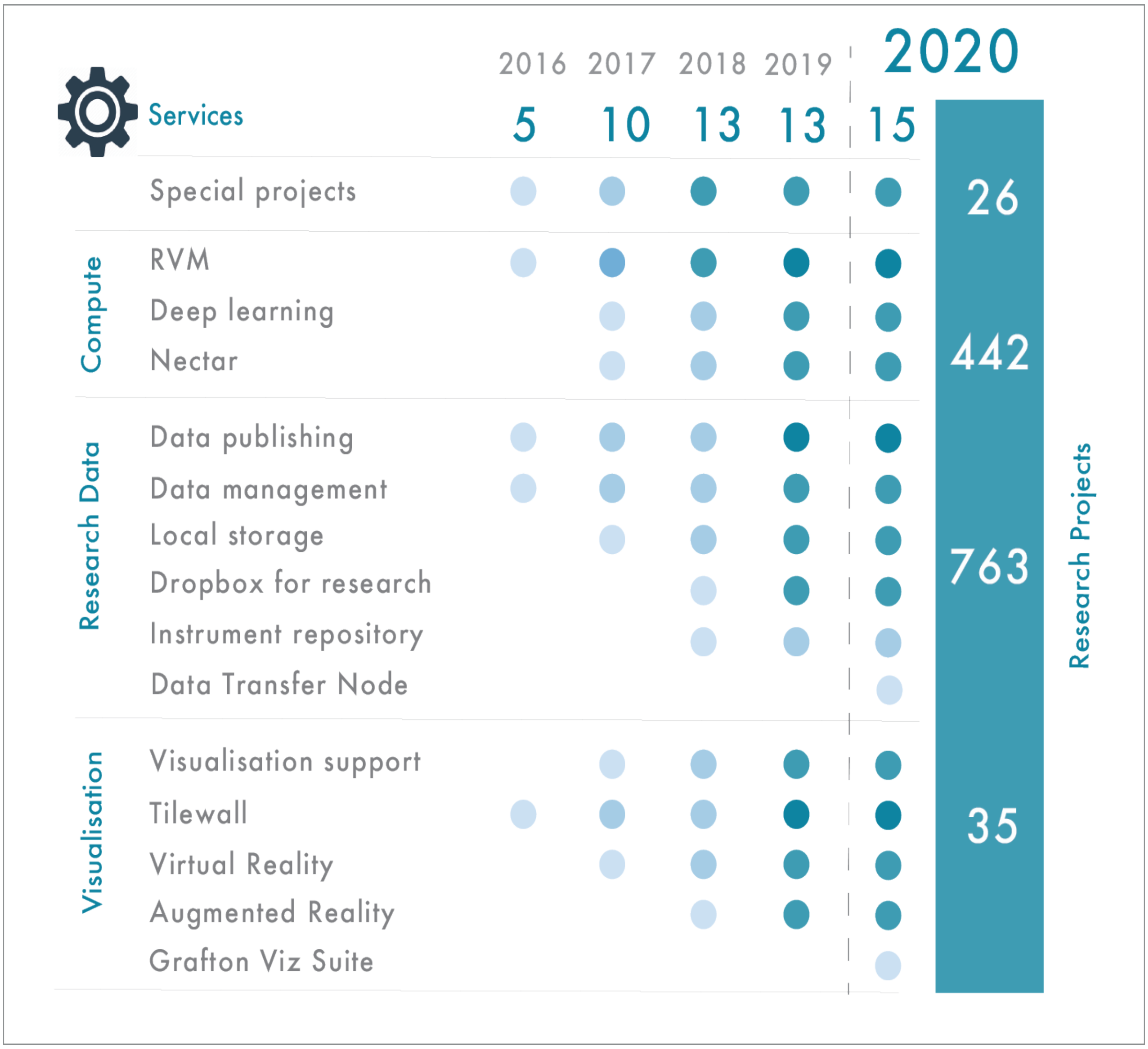
Projects funded by UoA faculties and external collaborators

- Tumour Evolution Visualisation (with FMHS, CAI)
- eResearch Genomics Lab Transformation (with Prof. Cris Print, FMHS)
- Data Science Infrastructure & Education (FoS, MBIE Data Science Platform)
- Data Maturity for High Value Nutrition (National Science Challenge)
- SPOC Science Payloads Operations Centre (AirNZ, ASI, University of Michigan, NASA)
- Machine Learning in Julia (Alan Turing Institute and FoS)

Internal projects (CeR)

- Researcher-facing Dashboard automation: allow researchers to manage virtual machines and storage themselves (within limits).
- Ongoing improvement of our backend processes to allow continuous reporting and consistency of standard workflows.

Our research support activities and maturity across various services



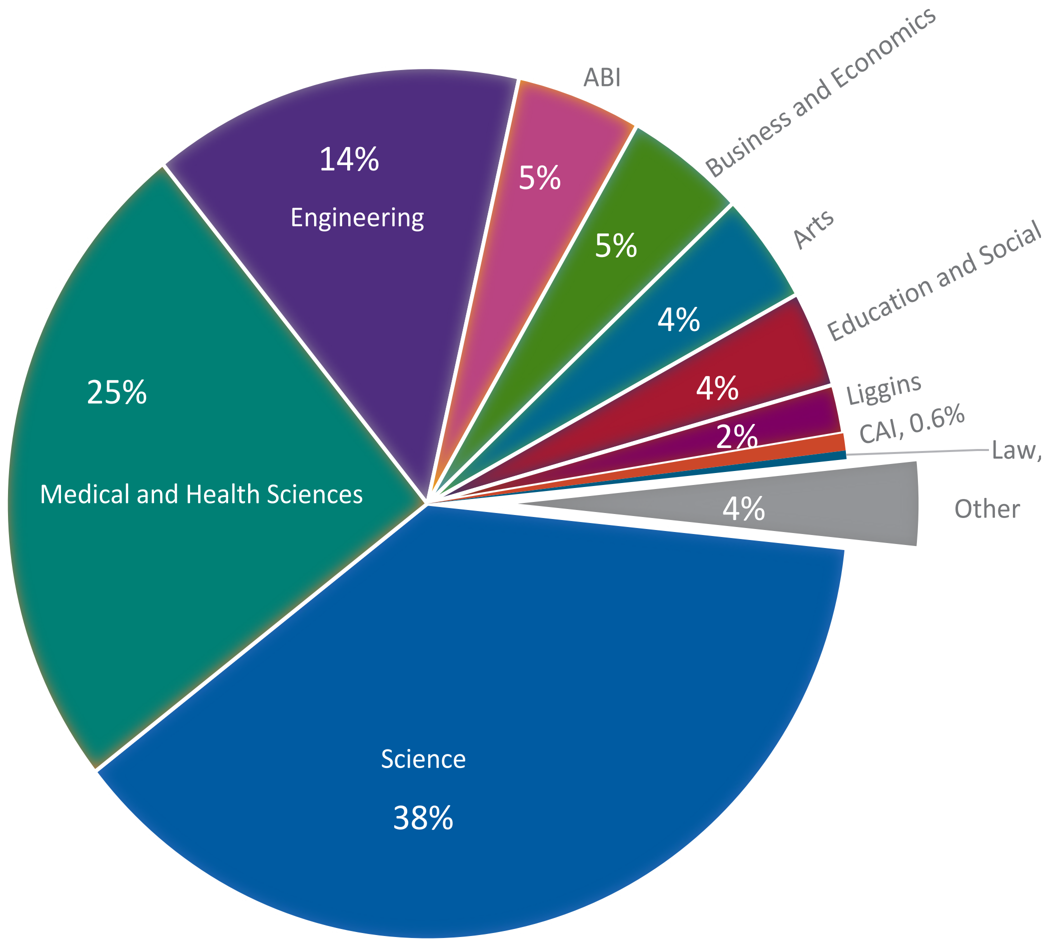
1068
total number of active projects

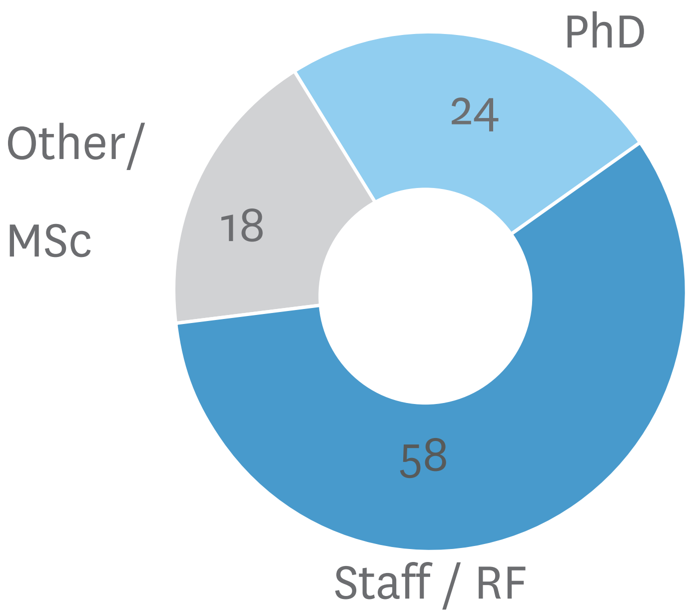
2133
total number of researchers supported

0.5PB+
total research data storage

1,000+
data & compute service requests and monitoring

Percentage of Researchers supported across faculty





MSc: Masters
RF: Research Fellow

Our People

Leadership team

Directorship, Scholar

Professor Mark Gahegan
Director

Bo Liu (Visiting scholar)
Assoc Professor
Beijing University of Technology

Irene Leathwick
hD Candidate

Euan Forsyth
PhD Candidate

Operations

Marcus Gustafsson
Operations Manager

Solutions team

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Special Projects Manager

Yvette Wharton
Solutions Lead

Nick Young
Snr Solutions Specialist

Dr Chris Seal
Snr Solutions Specialist

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Solutions Specialist

Dr Mike Laverick
Solutions Specialist

Rose McColl
Solutions Specialist

Libby Li
Solutions Specialist

Bianca Haux
Solutions Specialist

Andrew Leathwich
eResearch Analyst

Platform and Services team

Martin Fellow
Platform & Services Lead

Rob Burrowes
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Sean Matheny
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Engagement team

Dr Cameron McClean
Engagement Lead

Sina Masoud-Ansari
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Laura Armstrong
Snr Engagement Specialist

Dr Dharani Sontam
Engagement Specialist

Sam Kavanagh
Engagement Specialist

Bessie Olsen
Engagement Specialist

Warrick Corfe-Tan
Engagement Specialist

Julius Macrohon
Engagement Specialist

Research Data Solutions

Research data and artifacts created during the research process are valuable and this year has highlighted the growing requirements for accessing data remotely and working collaboratively. At the Centre, we provide services and training across the research data lifecycle with different capabilities, practices and tools required at different stages and in different styles of research. We have focused on developing and expanding Research Data Management training; supporting access to appropriate storage and data transfer; maturing our provisioning of institutional Dropbox for research; and creating instrument data management tools.

Data Management Planning

Throughout 2020, we have worked with researchers to incorporate the FAIR* and CARE** principles (Figure 1), when planning, creating/collecting, analysing and managing research data. This has included running data management workshops for generic groups and research teams as well as research data consults. Our research data education and outreach programme is detailed in the Digital Skills section.

Data storage, transfer and collaboration

Together with Digital Services, we have supported and expanded researcher's access to storage, collaboration, data transfer and publication tools - using either the on-campus research drive and vault storage, institutional Dropbox or the Figshare publishing platform. Use of Institutional Dropbox and UoA Globus data transfer endpoint has grown steadily in 2020 and has enabled researchers to share and transfer data to/from external collaborators (Figure 2) and platforms around the world including the NeSI HPC platform.

Data publishing and discovery

The self-service platform institutional data publishing and discovery service (Figshare) is managed by the Centre and enables our researchers to share and publish - with Digital Object Identifiers, their research data, supporting reproducibility and increasing research impact. Our community - all staff and doctoral candidates, have used this service to publish *380* items in 2020, bring the repository total to *1931* items that generated *353,419* views and *91,364* downloads in 2020. Published datasets

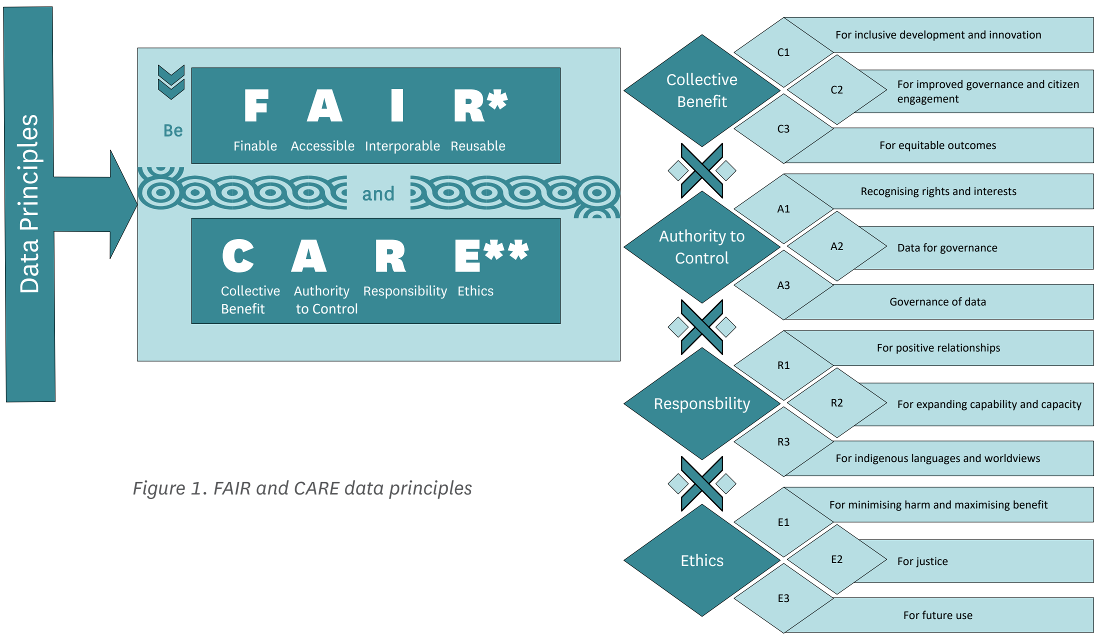


Figure 1. FAIR and CARE data principles

are also discoverable via Google dataset search and via *data.govt.nz.* through our membership of the national DataCite DOI consortium as of mid-2019. Through 2020 we collaborated with researchers to create four research groups and event specific group subsites - (e.g. *auckland.figshare.com/liggins, auckland.figshare.com/apru-sci).*

Instrument data

During 2020 we worked to extend the functionality of the instrument data platform *MyTardis*, a community driven platform initially developed at Monash to improve search capabilities and access management.

Site-specific additions for the UoA implementation are being incorporated into the community edition of MyTardis with uptake by the wider user group across Australasia. This deepens our understanding of instrument usage, providing the capability to connect instrument use with research outputs and impact.

In 2021 we will expand the use of MyTardis to other instruments, and pilot instrument data pipelines linking to analysis platforms (Figure 3) such as NeSI and virtual computing platforms running in Nectar such as the Genomics Virtual Lab.

Figure 2. In 2020 our University of Auckland Institutional Dropbox provided data sharing to collaborators across more than 360 cities in over 50 countries around the world.

360
Research Drive projects

403
Dropbox research data projects

4.3TB
Instrument data

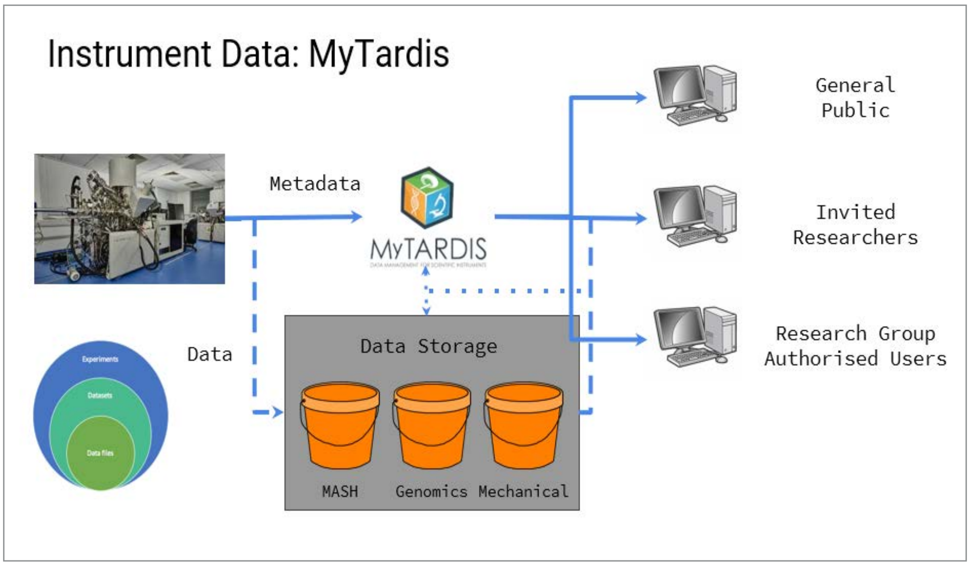


Figure 3. MyTardis pilot instrument data pipelines linking to analysis platforms

Research Compute and Platforms

Many researchers require computing facilities beyond the capability of their desktop or laptop computer. These computing needs may include using different operating systems, more computational power, running long-running simulations/analyses, or access to High Performance Computing.

University researchers have access to two virtual machine platforms and the national High Performance Computing platform hosted by the New Zealand eScience Infrastructure (NeSI). Each of these research compute services have their strengths and disadvantages. To help researchers find the service that best meets their requirements, the Centre offers consultations to individual use cases. Information and metadata about the projects, people, types of data stored, and any other access needs are captured to fulfil the institutional data records requirements.

Nectar research cloud

A part of the Australian Research Data Commons, Nectar is a federated private cloud dedicated to supporting research. Together with many of the Australian research institutions, the University of Auckland is a partner of Nectar. In contrast to research virtual machines set up and managed by the Centre, Nectar follows a self-service model similar to public cloud providers, where researchers can set up and manage virtual machines, storage, databases, network resources, etc. within a given allocation themselves. The Auckland Nectar infrastructure, while part of the University network and hosted in the University data centres, is operated outside of the institutional border firewall, which allows a certain amount of operational freedom which in turn makes it well suited for collaboration with national or international colleagues.

Research Virtual Machine service

This service is offered in collaboration with Connect. From a researchers' perspective, using virtual machines feels similar to using a desktop computer, but they are hosted in the University's data centres on centrally managed hardware and are usually more powerful than a desktop computer. The Centre supports launching and managing virtual machines for computational research, including researcher-facing configuration and software installation. Connect hosts the hardware, it supports the virtualisation layer and provides networking and operating system support. This service predates the Nectar service, and will eventually be merged into Nectar.

New Zealand eScience Infrastructure (NeSI)

NeSI offers a specialised High Performance Computing (HPC) platform, analytics software and services. The University works in a collaborative partnership with other NZ research institutions to access NeSI national research platforms. NeSI's main systems are Linux-based, command-line driven and controlled by batch scheduling systems. It is suitable for high-performance or high-throughput use cases that can operate in such a manner. For more details about NeSI, and how to access HPC, see *www.nesi.org.nz*.

Below is a summary of projects and researchers supported by the Centre for eResearch Research Compute and Platforms services (excluding national-run NeSI platform).

169
Research Virtual Machine projects

224
Nectar clould projects

913
researchers supported

Visualisation & Analytics

As one might expect, the COVID-19 lockdowns negatively impacted the physical utilisation of the Visualisation Suite. It was encouraging to see during a year of COVID-19 pandemic, borrowing of the equipment enabled researchers to continue development on AR/VR platforms.

Visualisation (Viz) Suites and equipment

Researchers now have access to visualisation infrastructure and equipment at the City Campus and in a shared space at the Grafton Campus. The use of Visualisation Suite and equipment is free and available to all University researchers. Researchers use visualisation technology to enhance research insights, uncovering trends and patterns that would otherwise be obscured. The technology and equipment enable research collaboration and communication with the wider public and their stakeholders.

The available equipment across the two spaces now includes a variety of Mixed Reality (MR) equipment. At one end of the MR spectrum, we have the capability to display dense high quality information in the real-world with no technological overlays, including high resolution 8K transportable screens and a 6-screen tile wall. At the other end of the MR spectrum, virtual reality equipment can be used in a completely immersive environment such as the Oculus Quest and HTC Vives. Between these are Hololens 1 and 2 augmented reality headsets where digital information can be overlaid on real-world environments. More information on booking the visualisation facility and the relative services can be found within the ResearchHub - *research-hub.auckland.ac.nz*

Collaborative projects

Our visualisation and analytics team work collaboratively with researchers to enable the application of new technologies and digital techniques to research data across a diversity of research areas. Our consultations and in-depth collaborations continued through remote support sessions during lockdowns. This year, collaborative projects included a number of COVID-19 projects, sea level and coastal dynamics modelling, 3D visualisations in archaeology, simulation of beach environments for understanding the dangers of rips, and a multi-dimensional tumour evolution augmented environment for clinicians and patients (See “Special Projects” and “Case Studies” sections)

35
in-depth consultations

233
researchers booking of Viz Suite

100+
researchers/ PhD trained to use the facility

Deep Learning

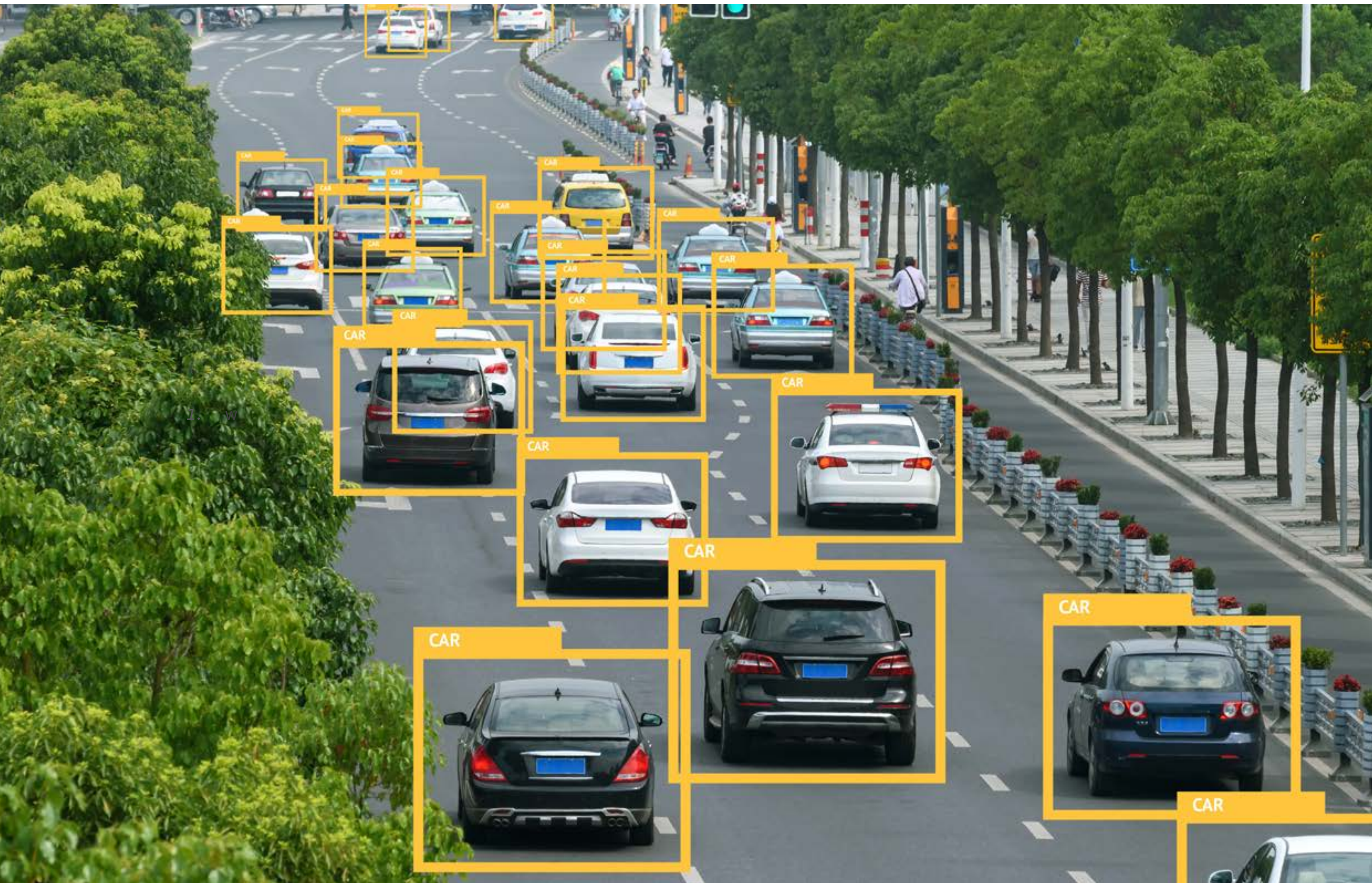
There is an increasing demand to support data intensive research using techniques in Machine Learning. In particular, deep learning is of interest to researchers across a range of data intensive disciplines as it is used to automate labor intensive tasks and to develop more accurate predictive models.

We are continuously exploring options to better support deep learning by expanding the number and capability of GPUs available in the Nectar research cloud and where possible, directing researchers to the High Performance Computing facilities available through the New Zealand eScience Infrastructure (NeSI). In some cases, researchers require more in-depth support in organising their datasets and implementing machine learning solutions for their research problems.

For more information and to request a consultation, visit ResearchHub- *research-hub.auckland.ac.nz* search for this service.

20 researchers at 3-month blocks

49 research projects supported by GPUs



Digital Skills and Community Building

As resources permit, the Centre organises digital research skills development opportunities that are complemented by our community building activities to support researchers with data management and use of storage infrastructure, specialised computing and visualisation, as well as providing broader digital skills training to help empower and equip our researchers to work effectively in modern computationally enabled research domains.

Online delivery

The year began with plans for regular digital skill workshops and eresearch community events, but by April we had pivoted to online delivery and a dynamic programme that developed in responses to research community' needs.

The monthly Research Data Management workshop (2 hours in-person) moved online and settled into a rhythm of more regular part 1 and part 2 sessions, each an hour. Over the year our team delivered 34 online sessions, including 3 for specific research groups, to 714 attendees.

34
RDM
workshops

714
RDM
attendees

"I just wanted to drop you a note to thank you for a very useful, interesting and skillfully run workshop last week." Professor Alan Merry Deputy Dean, FMHS

Other online deliveries included:

- Nectar workshops - maturing into video tutorials for self-paced learning.
- Future Research Computing
- Dropbox training

The planned mid-year Research Bazaar (ResBaz) intended to provide around 150 UoA postgraduate research students and researchers, with a campus-based 3-day digital skills and community building cohort event, had to be postponed. Our continued hope of offering some sort of ResBaz experience found momentum with an opportunity to collaborate with colleagues at Victoria University of Wellington (VUW). Leveraging existing resources and goodwill from session contributors, we created an online programme of mostly 1-hour introductions with a handful of longer practical workshops and keystory presentations from researchers. Online delivery enabled us to invite the wider Aotearoa New Zealand research community to cherry-pick the sessions they wished to register for - ***ResBaz 2020 : Pick and Mix.*** *(https://resbaz.auckland.ac.nz.)*

Session topics included: research compute, social network analysis, bash shell, literature reviews with NVIVO, working with social media data, survey creation using Qualtrics, research data management, R for social scientists, research impact, REDCap, creating infographics, LaTeX, topic modelling, Tidy Data, data publishing, python, etc.

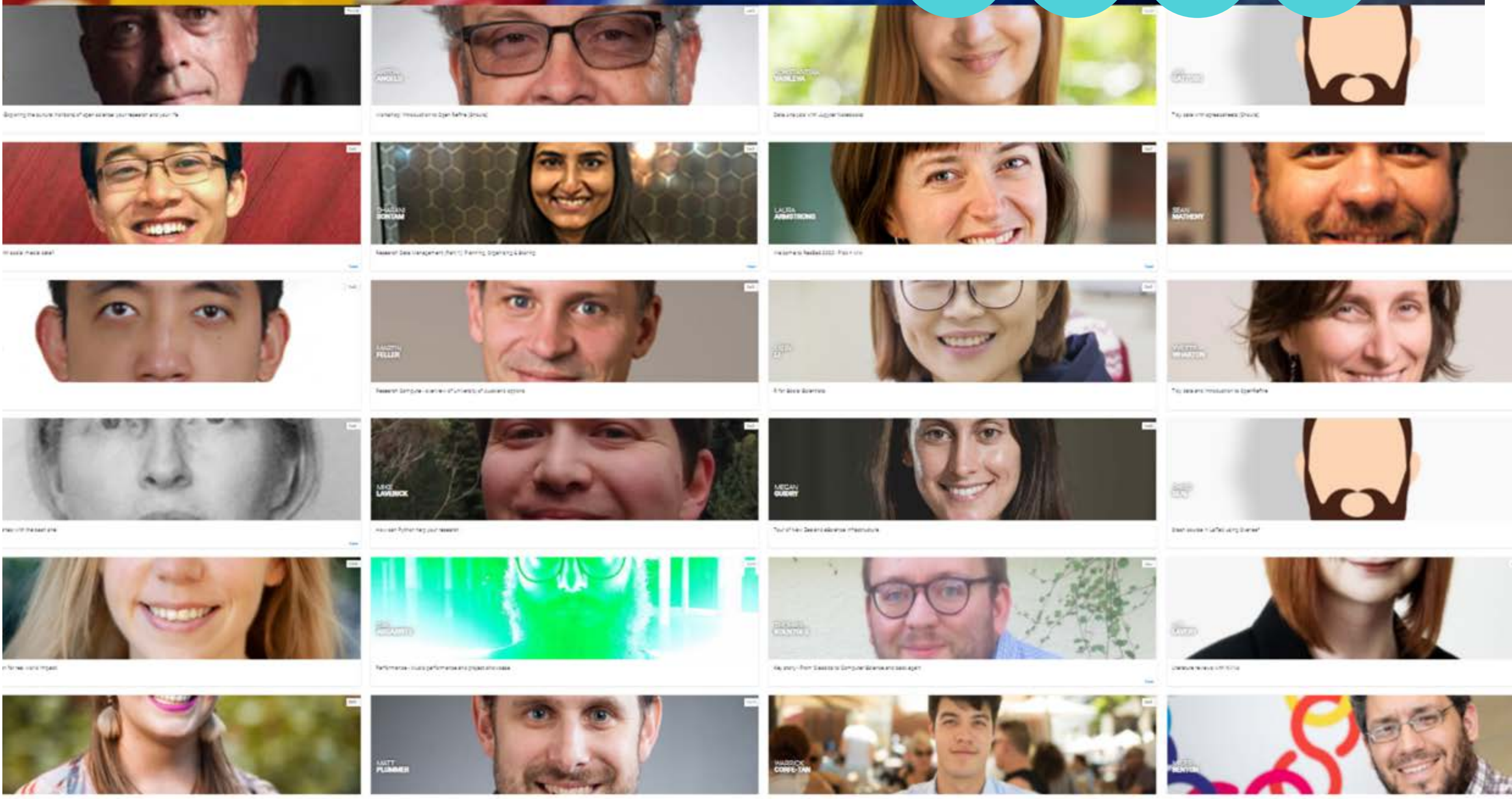
We are presenting our ResBaz 2020 experience including post-attendance survey results at the eResearch NZ 2021 conference.

Research Bazzar (ResBaz) 2020 statistics

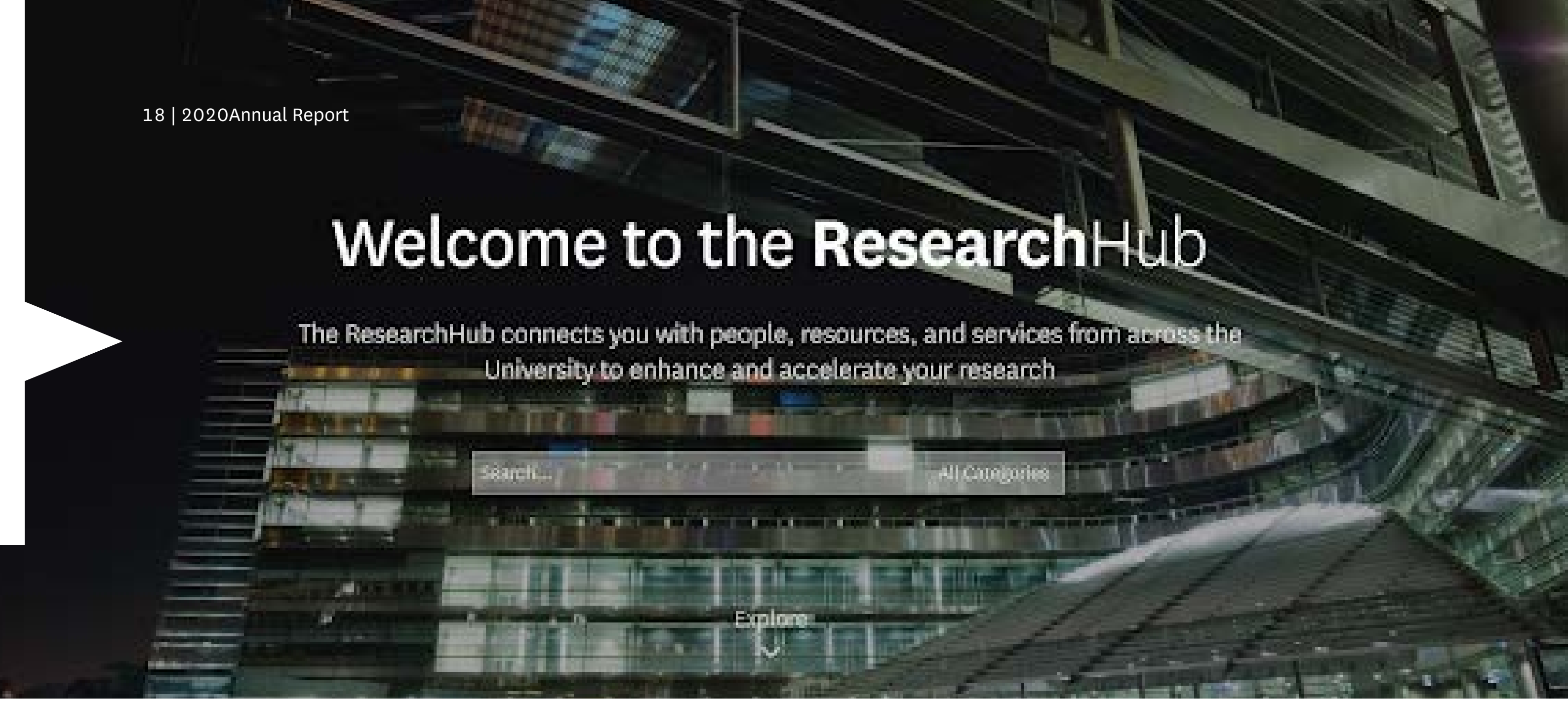
37
sessions,
UoA (18), VUW (12), NeSI (3) and others (4)

500+
individuals registered for 1 or more
(200+ UoA)

2020



2019



Research Delivery Progamme Projects

ResearchHub

The ResearchHub Expansion project commenced in 2020 through to Q3 2021, and has been incorporated as one of twelve priority projects of the Research Delivery Programme.

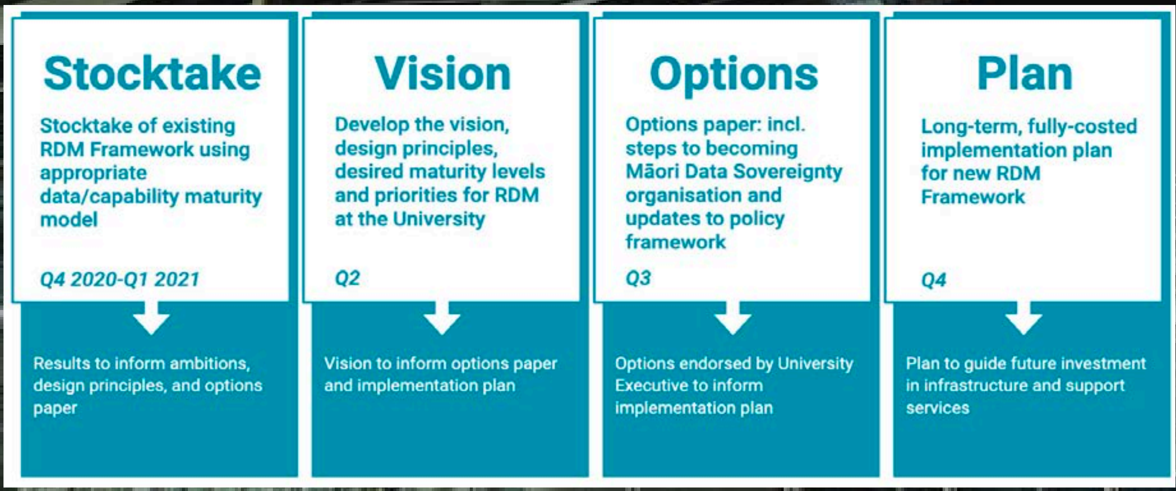
In response to increasing demand from both researchers and support staff, the expansion project seeks to extend the development of the ResearchHub as a platform for research service providers, and enable the inclusion of research support services from across the entire research value chain - beyond those focussed on just research IT or the research conduct phase.

Expanding ResearchHub functionality addresses immediate and near-term needs for research service providers, and enables:

- Scalable processes to publish and expose research support services across the value chain, while permitting devolved ownership for content and services/service areas.
- Lower barriers to disseminate and connect service information into an integrated ecosystem.
- Increased discoverability of research support services.
- Creation of better metrics and reporting on research support utilisation.

Progress continues with an expected launch date for the new Hub at the end of Q1 2021. Ongoing development and content work will carry on until project completion at the end of Q3 2021. Key content areas of the project will focus on supporting Research Impact, Engagement with and responsiveness to Māori and Researcher Skills and Development. In scope and expected deliverables for the expansion project include:

- Design and develop an editorial model and publishing workflow with clear governance to support devolved ownership of research service publication.
- Implement a SaaS content management solution to support authoring and linkage of service descriptions, compatible with multiple Hub information architectures and systems integration.
- Evolve Hub architecture and technical implementation to the cloud, creation of training materials and business processes to support new features, accessibility, and long-term maintenance.
- Develop long-term Hub ownership and business support model, and ongoing BAU resource requirements.
- Develop a service capture and content model for various aspects across the full research value chain and populate with offerings as appropriate.
- Design and validate Hub information architectures for each service area/category that supports key research activities over the entire lifecycle and is understandable across research disciplines.



Researcher Skills and Development

Working closely with stakeholders across the University, the Centre continues to be a key contributor in the ORSI-led Researcher Skills and Development (RSD) Working Group, and in 2020 this initiative was incorporated as an additional project within the Research Delivery Programme. The project brings together stakeholders from across the University, including faculties, Organisational Development, Libraries and Learning Services, UniServices, School of Graduate Studies, Digital Services, ORSI and the Centre for eResearch, to build a framework that enables the University to nurture and recruit outstanding research talent through the provision of researcher training and capability building.

Analyst work contributed from the Centre rounded out the conclusion of phase one in April 2020, and included a review of centrally provided RSD initiatives across the University between 2012 and 2019. The analysis and report resulted in the endorsement of a paper presented to senior leadership and the subsequent move to phase two. Phase two moves to publish better connected RSD offerings in the expanded ResearchHub, and develop a capability framework and additional offerings in strategic support areas. Ongoing RSD work both informs and aligns with the new draft University Strategy and the development of an updated Research Code of Conduct.

Research Data Management Project

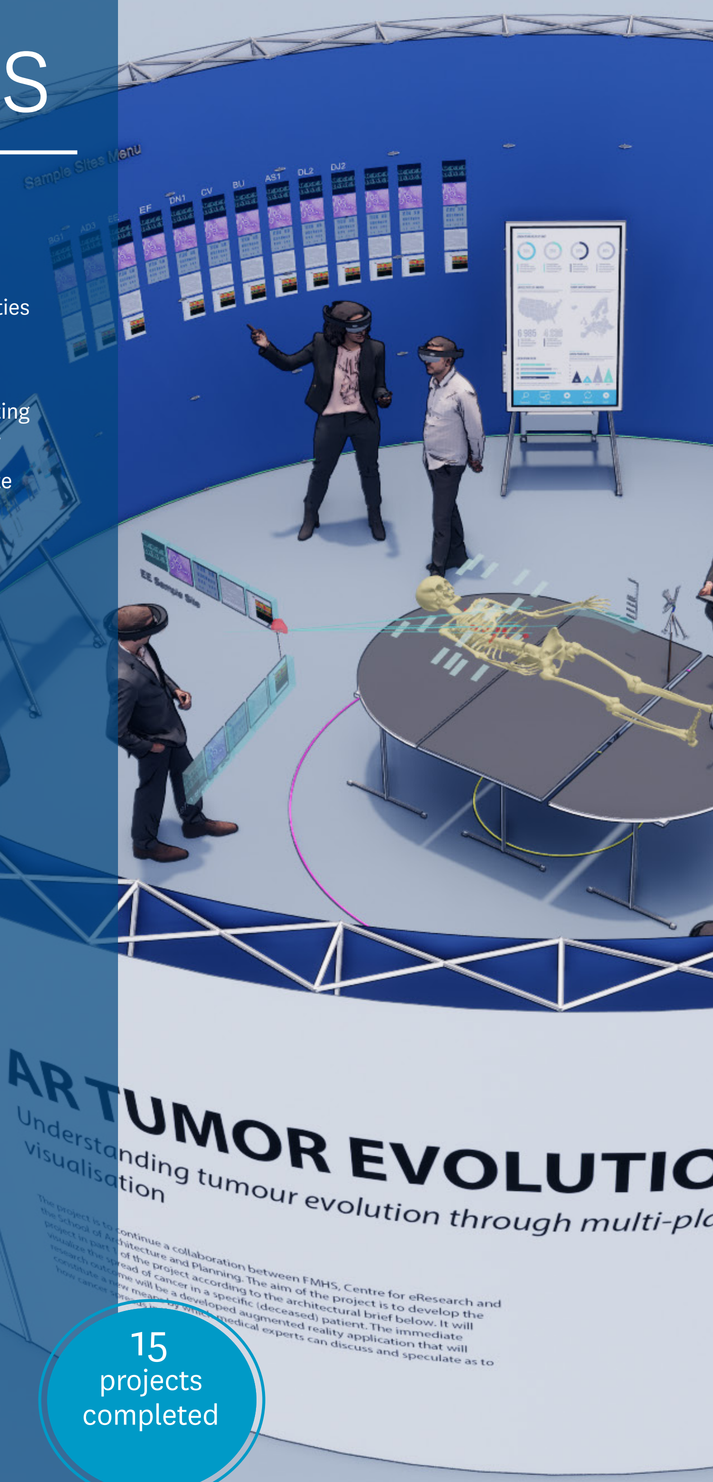
In response to increasing internal and external drivers, ORSI developed a paper, "Towards an integrated Research Data Management Framework", in consultation with the Centre and others. The University Executive endorsed the creation of the Research Data Management (RDM) Project with four stages - Stocktake, Vision, Options, and Plan.

This project, part of the University's *Research Delivery Programme* and sponsored by the DVC-Research, is seeking to develop an integrated RDM framework that is consistent with international standards, including *FAIR data principles* to improve data sharing and the principles of *Māori Data Sovereignty*. This aim is articulated within the University's Taumata Teitei – Vision 2030 and Strategic Plan 2025, p4, *"… guide our progress towards becoming a Māori Data Sovereignty organisation."*

The first stage of the project has been to undertake a current state assessment of existing RDM policies and practices. The results from this assessment will be reviewed by an Advisory Panel chaired by *Professor Mark Gahegan* and a Māori Data Sovereignty Kāhui chaired by *Andrew Sporle,* and a series of options will be then put to the University leadership team for consideration. The current state assessment has included a university-wide online survey of the research community, generating 283 responses when closed late 2020. We are now seeking to supplement the survey findings with semi-structured interviews with researchers and research groups that are representative of the diversity of research data practices and data workflows across the University. These interviews are being completed in partnership with Whakauae Research Services (*www.whakauae.co.nz*).

The Centre is supporting this project through Mark Gahegan's work as Chair of the Advisory Panel and a secondment of a Senior eResearch Engagement Specialist to the ORSI-led project team.

Special Projects



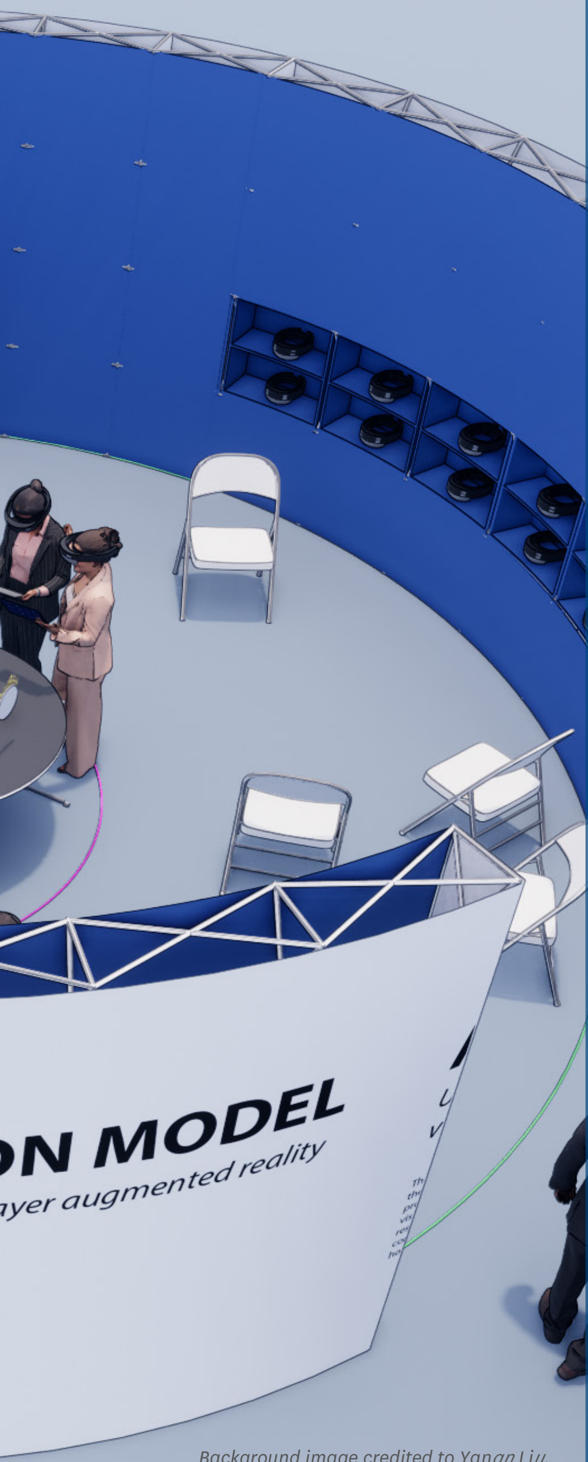
Our special projects are for those researchers who require more heavy-lifting customised solutions. These extra work are usually funded through researchers' existing internal or external grants. We welcome the opportunities to partner with research groups for grant applications where our skills and services offer value. Examples of these projects include: using machine learning to identify stone artefact's types, voice recognition of birds, simulating virtual capabilities of the Science Payload Operations Centre, Leaflet map of digital repositories of Pacific knowledge, network map of citations for climate change, 3D GIS applications for Environment, Architecture and Planning, Biological Sciences and Archaeology etc. Due to the uncertain nature of research, we work with researchers on a time-spent basis to the best of our ability to meet the project goal. If a project requires a long term support, we will provide training to researcher's own resources to enable their self-sufficiency. The following is a list of this year's completion, on-going across year projects and new projects planned for 2021.

1. Visualisation Suite expansion to Grafton Campus
2. Researcher skills development initial phase
3. eDNA virtual hub
4. Genomics into medicine
5. SPOC data repository and visualisation
6. High Value Nutrition - National Science Challenge
7. 3D visualisation of indigenous Roonka burial sites
8. Community engagement platform
9. Machine learning to achieve recognition in rifleman bird
10. Hosting Te Pūnaha Matatini (TPM) COVID-19 programme dashboards
11. Climate change related simulations
12. Centre for Innovation and Entrepreneurship dashboard
13. North Island Māori rock art database
14. Arbitrary hand gesture recognition using Leap motion tracking
15. Mapping the influence of Linda Tuhiwai Smith's decolonizing methodologies
16. Researcher skills development (Research Deliver Programme project)
17. Research data management (Research Deliver Programme project)
18. ResearchHub expansion (Research Deliver Programme project)
19. ResearchHub upgrade
20. Mass Spectrometry Hub
21. Tumor Evolution - Phase 2
22. A pilot e-Atlas for policy intelligence
23. Data analytics and visualisation for improving public transport planning
24. Technology readiness to resilience of NZ construction companies
25. Apply machine learning to identify stone artefact's types
26. Scientific Instrument data
27 SPOC data repository and visualisation
28. MBIE Small satellite radar to monitor NZ's oceans and coasts
29. High Value Nutrition - National Science Challenge - 2021
30. Data Science - Beyond predication: explanatory and transparent data science for life and social sciences

15 projects completed

11 projects on-going

4 new projects



Background image credited to Yanan Liu, Architecture and Planning

Case Studies

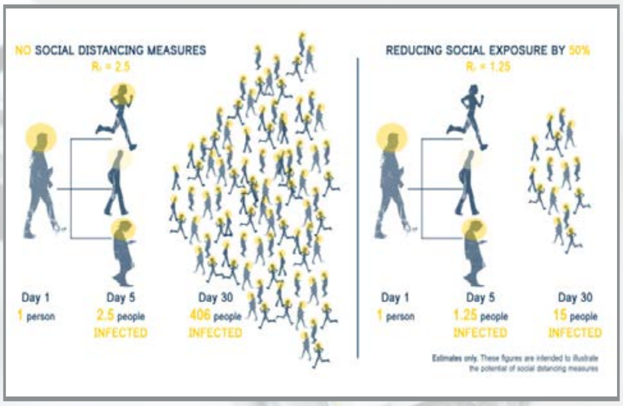
1. Hosting visualisation and analytics tools for COVID-19 studies
2. COVID-19 exponential growth visualisation
3. Remote temperature monitoring to reduce the spread of COVID-19
4. Antibiotic resistance and the “end of modern medicine ”
5. Developing virtual capabilities for the Science Payload Operations Centre
6. Analysing text data by time-series feature engineering
7. Developing short-term eruption warning systems for Whakaari and other volcanoes
8. An investigation into Leap motion device for “gesture-as-sign”
9. Determinants of translation efficiency in the evolutionarily-divergent protist Trichomonas vaginalis
10. Anti-corruption regulations for promoting socially responsible practices
11. Calcium signalling in salivary gland acinar cells
12. Coastal image classification and analysis based on convolutional neural networks and pattern recognition
13. Exploring perceptions towards climate change over time on Twitter
14. Haka on the move: sport circuits and cultural performance
15. Data maturity project in High Value Nutrition-National Science Challenge
16. Proteins under a computational microscope: designing in-silico strategies to understand and develop molecular functionalities in Life Sciences and Engineering

Hosting visualisation and analytics tools for COVID-19 studies

Platform and Services team, Centre for eResearch.

Nectar research cloud for public access

The Centre for eResearch is actively supporting several COVID-19 related projects at the University and on the national level during 2020 pandemic. These projects range from advising on Qualtrics platform used by Growing Up in New Zealand (*GUiNZ*), developing daily data transfer scripts for a complex contagion model to hosting two interactive COVID-19 modelling applications for public access to support a large number of users. Examples briefly described below:



COVID-19, take control (led by professor Shaun Handy)

The eResearch Platform and Services team has been working with Professor Shaun Handy, the Director of New Zealand Centre of Research Excellence Te Pūnaha Matatini (TPM) to host the *"COVID-19 Take Control"* simulation tool (Fig. 1& 2). The application, developed by Audrey Lustig from Landcare Research, is not a decision-making tool but rather, a model that illustrates and communicates with the public, and allows users to simulate how the COVID-19 pandemic might play out in Aotearoa, New Zealand under different conditions of collective cooperation. For example, the simulator models the effects of social distancing and hand washing hygiene. For detail exploration, visit *(http://covid19takecontrol.nectar.auckland.ac.nz/covid19_takeControl/)*

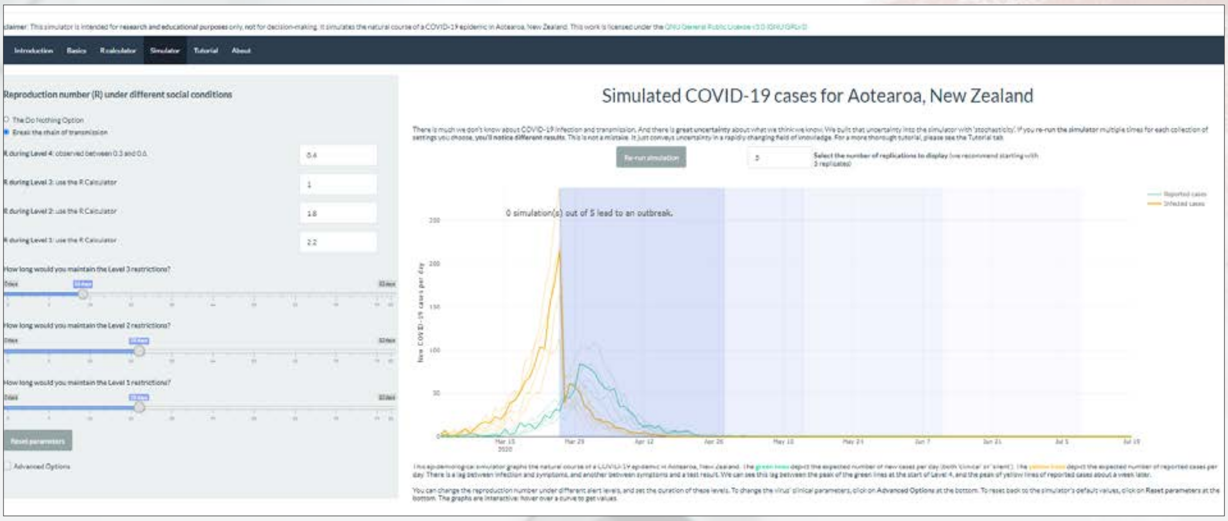


Fig 1. (above) Simulating how different social conditions affect COVID-19 infection numbers. This epidemiological simulator graphs the natural course of a COVID-19 epidemic in Aotearoa, New Zealand. The green lines depict the expected number of new cases per day (both 'clinical' or 'silent'). The yellow lines depict the expected number of reported cases per day. There is a lag between infection and symptoms, and another between symptoms and a test result. We can see this lag between the peak of the green lines at the start of Level 4, and the peak of yellow lines of reported cases about a week later. You can change the reproduction number under different Alert Levels, and set the duration of these levels.

Fig 2. (P23) Controlling R. Explore effects on viral spread of our behaviour, contact tracing, and isolating cases and contacts. Calculate R during Alert Level and based on user's answers to the questions and run the scenario to see how our behaviour shapes the COVID-19 future.

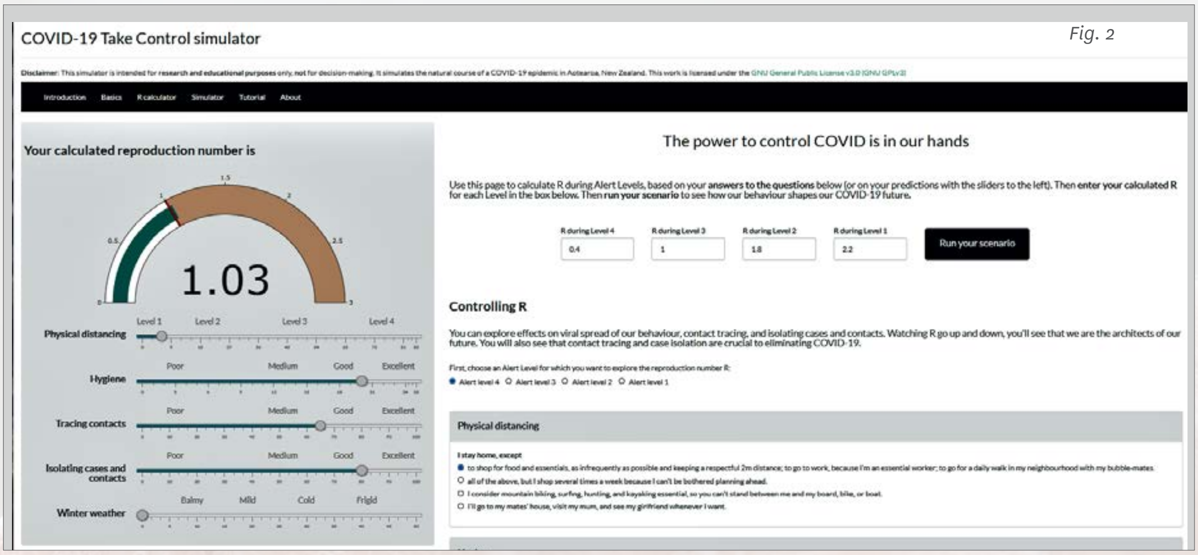


Fig. 2

New Zealand COVID-19 outcome modelling and visualisation (led by Andrew Sporle)

The New Zealand government has adopted a strategy of eliminating the virus from the population. Should elimination not be achieved, the strategy is to mitigate the spread of the disease throughout the population. Overseas reports of the COVID-19 epidemic indicate that it is having different impacts on different populations, ages, and regions. If the epidemic is not controlled in New Zealand, we can expect similar differences in impacts for different populations based on current overseas experience and the high levels of unequal impact of previous New Zealand epidemics. Extra support focused on vulnerable communities can ensure those in needs are maximally protected if elimination fails.

This tool (Fig 3) enables the modelling of a range of possible scenarios if elimination is not successful. It provides an easy to use way to model various outcomes at national and DHB level using the currently available knowledge about the disease. This information is intended to inform intervention at the early stages of the epidemic using low population infection rates. Using higher population infection rates can demonstrate the potential impact if both elimination and mitigation strategies were not successful and the epidemic ran its course in the NZ population. The tool was developed by Daniel Barnett from the Department of Statistics and the study is led by Andrew Sporle, Honorary Academic from Department of Statistics and Director of iNZight Analytics Ltd. The work is also supported by Professor Shaun Hendy of TPM. For detail exploration, software and references, visit *(http://nzcovid19equity.nectar.auckland.ac.nz/covid19-modelling/)*.

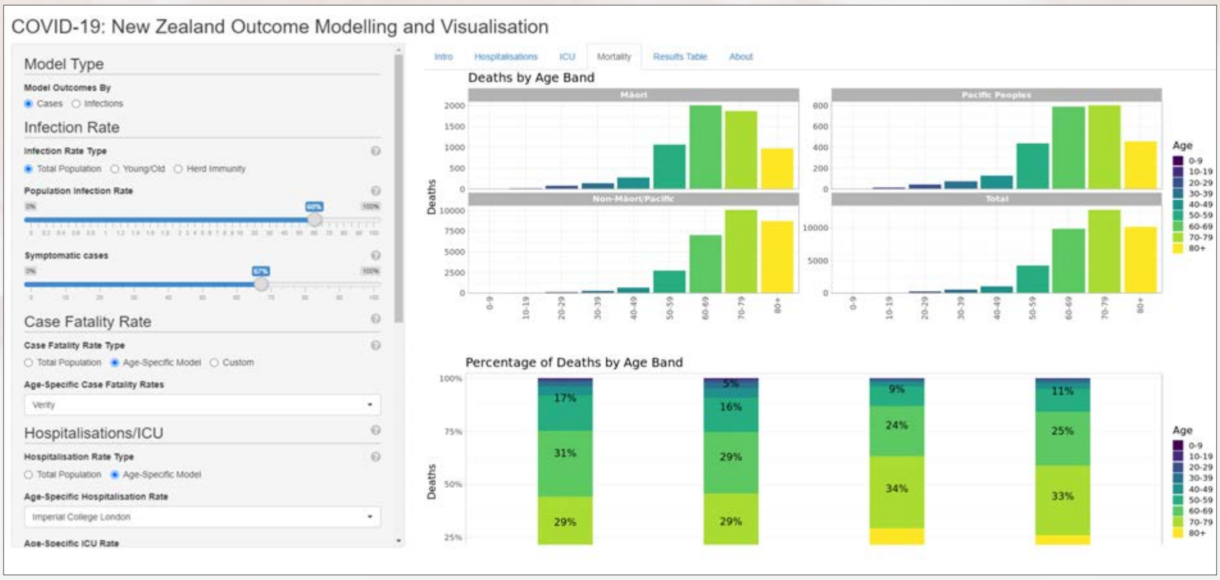
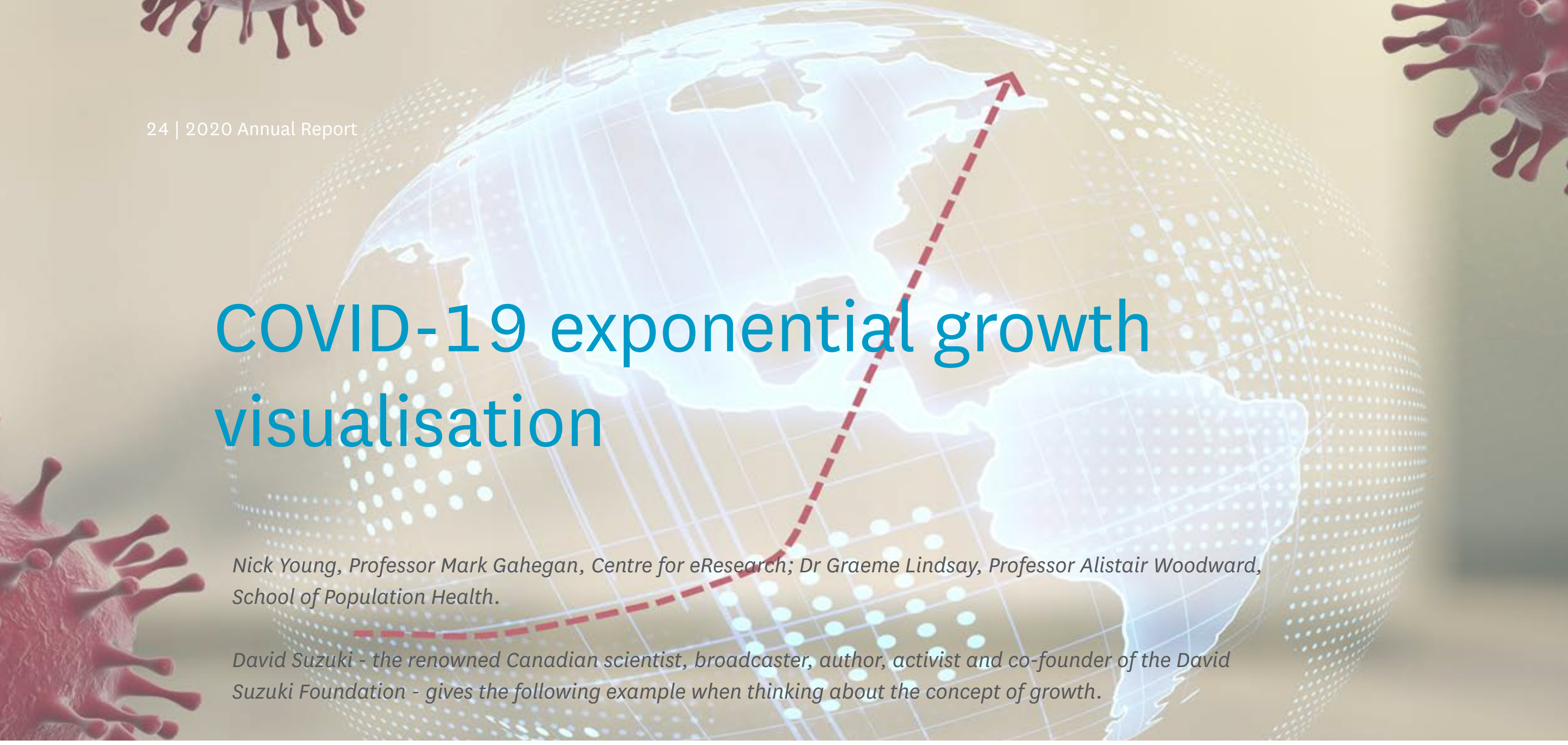


Fig. 3. NZ COVID-19 Outcome Modelling and Visualisation dashboard showing the hospitalisation rate on age-specific model based on Imperial College London model.



COVID-19 exponential growth visualisation

Nick Young, Professor Mark Gahegan, Centre for eResearch; Dr Graeme Lindsay, Professor Alistair Woodward, School of Population Health.

David Suzuki - the renowned Canadian scientist, broadcaster, author, activist and co-founder of the David Suzuki Foundation - gives the following example when thinking about the concept of growth.

Imagine a test tube with one bacteria in it at the start. Exponential growth starts and the number of bacteria double every minute. At one minute, there are two bacteria. Two minutes, four. Three minutes, eight. Four minutes, 16 bacteria and so on. At one hour, the test tube is full. He then asks...*When is the test tube half full?* The answer is at the 59th minute. At 58 minutes it's 1/4 full, at 57 minutes it's 1/8 full.

This idea of steady doubling is exponential growth and it is an important concept to understand in many areas such as population growth, resource use and sustainability. David, in fact, is using the test tube example as an analogy for the human population, resource use and unsustainable growth on Planet Earth (the 'test tube').

Instead of bacteria in a test tube, we now have SARS-CoV-2. Exponential growth is also important to identify and understand when dealing with infectious disease outbreaks and their control.

For this case study, the aim was to visualise trajectories of the COVID epidemic, including both global trends and New Zealand data. We started by exploring *Covid-Trends* – a pre-existing interactive web-based dashboard that shows the trajectory of COVID-19 cases around the world. Data are visualised for each country as well as for Canadian, Australian and US. The tool was originally created by Aatish Bhatia in collaboration with Minute Physics and the code is in the public domain. The *original Covid-Trends* code was adapted by CeR's Nick Young to also show New Zealand Ministry of Health COVID-19 data. Data can be filtered by case definition, averaging period, travel history, age and location (such as DHB) in New Zealand. To support this tool, Nick Young also wrote a Python script to check the MoH website for new cases every 10 minutes, so that the data is always up to date. Adaptation of the tool was supported by the School of Population Health. For detailed exploration of the Covid-Trends version with New Zealand data, visit *https://uoa-eresearch.github.io/covidtrends/*

It is important to note that Covid-Trends focuses on epidemic trajectories rather than absolute numbers of COVID-19 cases or population rates. The aim is to pick up changes on a day-to-day or weekly basis. In this way, the tool provides a fine-grained visualisation of a particular country or region's COVID journey. For example, are they in a phase of exponential growth In which case, appropriate control measures need to be implemented. Detecting when exponential growth stops is also important as it gives clues that an outbreak may be starting to be brought under control.

The *Covid-Trends* default graph is the growth rate of new cases in the past week versus total cases to date. Cases are graphed using logarithmic scales as this enables exponential growth to be seen as a straight line that slopes upwards. The log scale also enables easier comparison between countries with very different cases numbers as they can all be seen on the same graph. Note: a user can also change to a linear scale. Despite many differences in diagnosis and reporting of COVID cases, almost all countries have followed the same growth path early in the outbreak. As would be expected with an infectious agent entering an immunologically naive population with no public health controls in place, the number of cases grows exponentially. The doubling time (2 days) appears to be much the same in this phase nearly everywhere, suggesting it is features of the virus rather than environmental conditions that mostly drive spread early on. When public health interventions are introduced, or transmission of the virus is limited for other reasons, countries 'fall off' the straight line of exponential growth.

See Figure 1 for an example from *Covid-Trends* of the paths taken by selected countries. In some cases, countries (e.g., the UK and the US) have, after an initial dip, experienced further waves of infection and for a time resumed exponential growth.

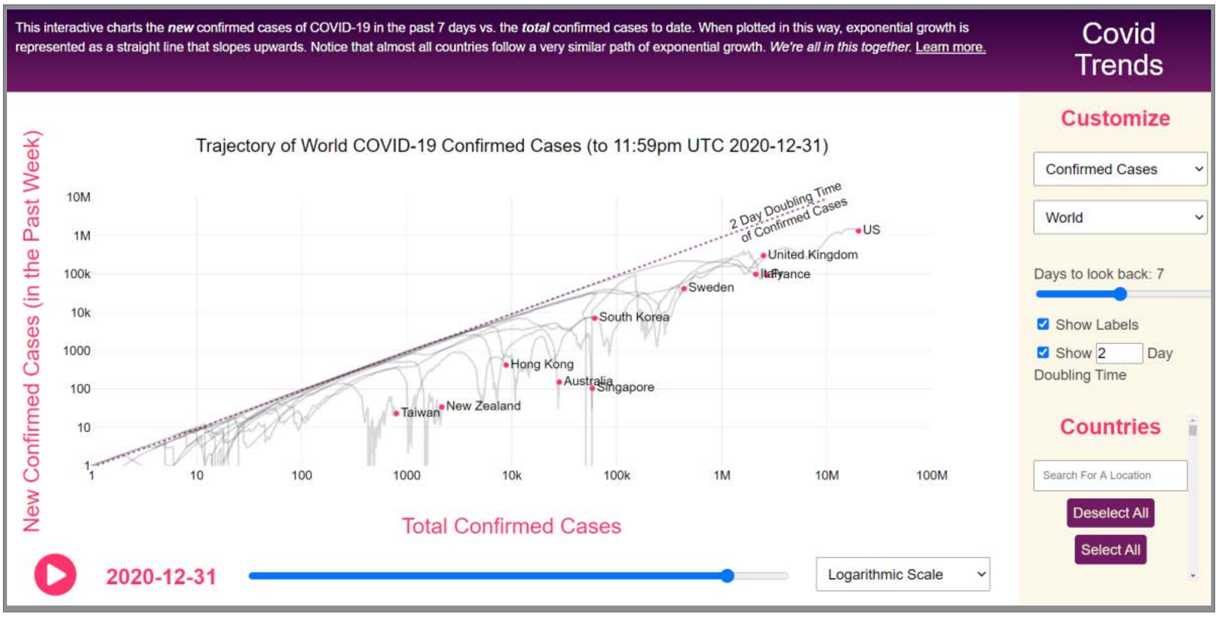


Fig 1. Screenshot of Covid-Trends showing the growth path for confirmed COVID cases for selected countries.

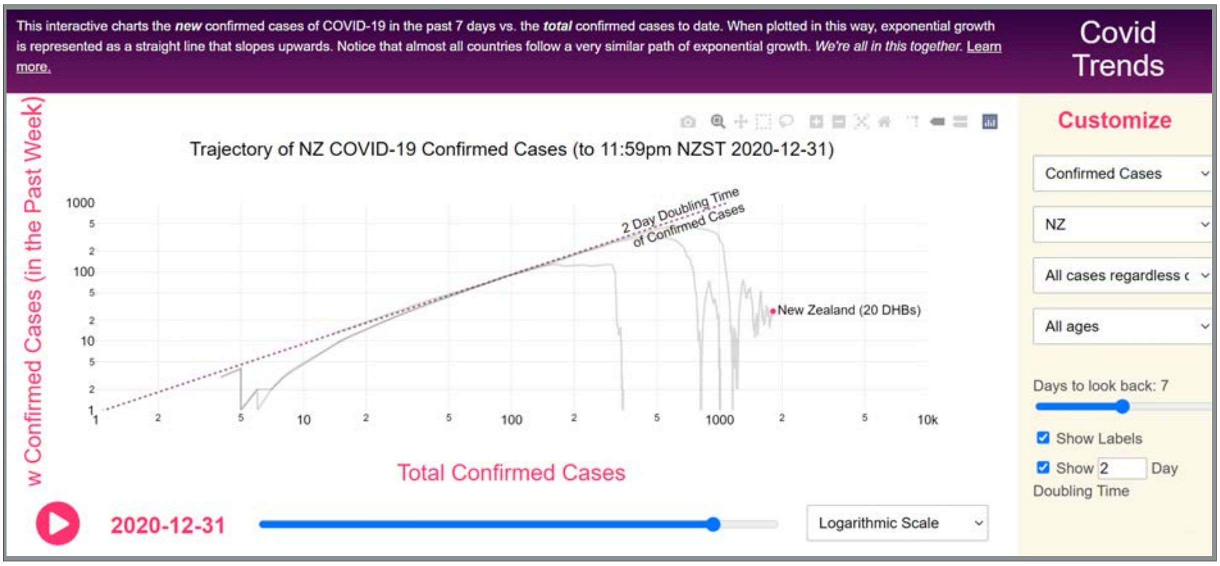


Figure 2 shows Covid-Trends displaying the trajectory of NZ COVID-19 cases using the New Zealand Ministry of Health data. Exponential growth is again displayed as a straight, upward sloping line. Like many other countries, NZ had a period of exponential growth early in the pandemic with around a 2-day doubling time in the number of cases.

For further information on the original *Covid-Trends* tool and the rationale for the exponential growth approach, please see the COVID trends / Minute Physics video at *www.youtube.com/watch?v=54XLXg4fYsc*. David Suzuki's video on the 'test tube' and overpopulation is available at *http://resources4rethinking.ca/en/resource/david-suzuki-speaks-about-overpopulation*.

Remote temperature monitoring to reduce the spread of COVID-19

Dr Charlotte JW Connell, School of Medicine; Dr Mike Laverick, Centre for eResearch.

Research Team: Associate Professor Nicholas Gant, Department of Exercise Sciences; Professor Ralph Maddison, School of Population Health; Dr Charlotte Connell, School of Medicine; Hayden Green, Department of Exercise Sciences; University of Auckland; Associate Professor Toby Mundel, School of Sport, Exercise and Nutrition, Massey University

Figure 1. Matchbox-sized biosensor (called Nightingale).
Image from UoA news - https://www.auckland.ac.nz/en/news/2020/05/07/remote-temperature-device-for-rest-homes-a-world-first.html

Background

Elevated body temperature is an early clinical feature in around 90% of all COVID-19 cases, and a reduction in body temperature to normal levels is a key marker of recovery from the disease. Fever identification is an important tool for identifying possible infection from COVID-19 in lieu of diagnostic testing, and regular monitoring of body temperature can help catch COVID-19 cases early and prevent cluster outbreaks. Existing methods for monitoring measuring body temperature require healthcare personnel to make regular contact with people who may be infectious, increasing the risk of horizontal disease transmission.

One promising approach to mitigate this risk involves using a new technology that consists of a small, matchbox-sized biosensor (called Nightingale, Figure 1) worn under the arm, within an insulated armband, capable of transmitting temperature data long-range directly to frontline healthcare staff. This wearable technology has a battery life of up to six weeks and can provide continuous body temperature monitoring of large groups of patients remotely, and automatically detect the presence of a fever, therein removing the need for physical contact for temperature monitoring.

Associate Professor Nicholas Gant and his research team in the Department of Exercise Sciences have been studying the use of this novel remote temperature monitoring system. The technology was invented in response to the COVID-19 global emergency, and its research and development has been funded by the Ministry of Business, Innovation and Employment (MBIE) COVID-19 Innovation Fund.

Methods and the role of the Centre for eResearch

With the assistance of the Centre for eResearch, Gant and his research team have been able to push the trial data collected on the devices (Figure 2) to a secure virtual machine within the Nectar research cloud, which they have then used to run additional analyses and develop the algorithms that the armbands use to detect the presence of a fever.

In the first phase of the project, the body temperatures collected by the new device were compared against the most accurate methods of measuring core body temperature, such as rectal and gastrointestinal temperature. Although the armpit is one of the most hygienic and convenient places to measure body temperature, this site is not often used because the patient must keep their arm motionless for some time in order to get an accurate reading. Using laboratory tests, the team determined that the new device, through its continual wear, was capable of overcoming the limitations of traditional armpit temperature measurement, and collected enough viable data across a 24 hour period to be able to detect important changes in core body temperature. By using the Nectar research cloud the team were able to test the logistics and scalability of the remote-sensor data collection process.

Now the team will move into the second phase of the project, which involves testing the device in the real world contexts that it is designed for. The device will be offered to clients staying in Managed Isolation Quarantine facilities, run by the New Zealand Government, and the temperature monitoring system will be used by healthcare staff working within these facilities, alongside their usual care. The armband will also be tested in several aged care facilities in the Auckland area, in order to examine the usability of the system for monitoring of vulnerable members of the community.

Figure 2. Clinical trials: data collected from Nightingale biosensor and synced with the mobile app.

Antibiotic resistance and the "end of modern medicine"

Assoc Professor Siouxsie Wiles, Molecular Medicine and Pathology and a Deputy Director of Te Pūnaha Matatini, Centre of Research Excellence.

Background

Antibiotics are a cornerstone of modern medicine, used to treat people with infections as well as to prevent infections in those who are vulnerable, like people who need surgery or treatments like chemotherapy. Because bacteria are so good at adapting to their environment and picking up new genes from their surroundings, many are becoming resistant to the antibiotics that used to kill them. In 2014, the World Health Organization (WHO) reported that drug-resistant microbes are present in every region of the world. Their Director General at the time, Margaret Chan, called this issue "...the end of modern medicine as we know it". The report concluded that within ten years, resistance would make routine surgery, organ transplantation, and cancer treatment life-threateningly risky. Around the world, people are already dying from antibiotic-resistant superbug infections. In late 2016 a patient in the USA died after being infected with a strain of *Klebsiella pneumonia* that was resistant to 26 different antibiotics.

Do novel antibiotics lie in fungi?

Dr Siouxsie Wiles and her team at the Bioluminescent Superbugs Lab are searching for new antibiotics in collaboration with Professor Brent Copp and Dr Melissa Cadelis from the University of Auckland's School of Chemical Sciences and Dr Bevan Weir from the Crown Research Institute Manaaki Whenua. One of the first antibiotics ever discovered, penicillin comes from a family of fungi called *Penicillium*. Just like its flightless birds, Aotearoa New Zealand has fungi found nowhere else on Earth. Manaaki Whenua holds the International Collection of Microbes from Plants (ICMP) which has over 10,000 fungal cultures isolated from plants and soils from around New Zealand and the South Pacific and kept in frozen storage.

Fig. 1. ICMP fungi growing in preparation for antibiotic-testing.

How does the Centre for eResearch help?

At the Bioluminescent Superbugs Lab, Siouxsie and her team use bacteria that have been engineered to glow in the dark to screen fungi from the ICMP collection (Fig. 1) for antibacterial activity. They test lots of different parameters, including growing the fungi on different media and for different amounts of time. Their experiments generates a large amount of data, so they were keen to work with the Centre for eResearch to come up with a better way of visualising it. The visualisation webpage and interactive graphs that the Centre for eResearch developed allow Siouxsie and her team to combine data from various lab members and to look at specific fungi, or media, or incubation times, as well as bacterial species we are testing against, all with a few clicks of the mouse. The screenshot below (Fig. 2) is an example of the interactive web that show a combination of data by selecting different criteria and from different researchers. This project is currently funded by a generous donation from *New Zealand Carbon Farming,* and all the people who sponsor a fungus or who donated to Briscoes and Cure Kids 'Beat the Superbugs' crowdfunding campaigns. Previous financial support was provided by *Cure Kids,* the University of Auckland's Faculty of Medical and Health Sciences through the Faculty Research Development Fund, and the *Maurice Wilkins Centre for Molecular Biodiscovery.*

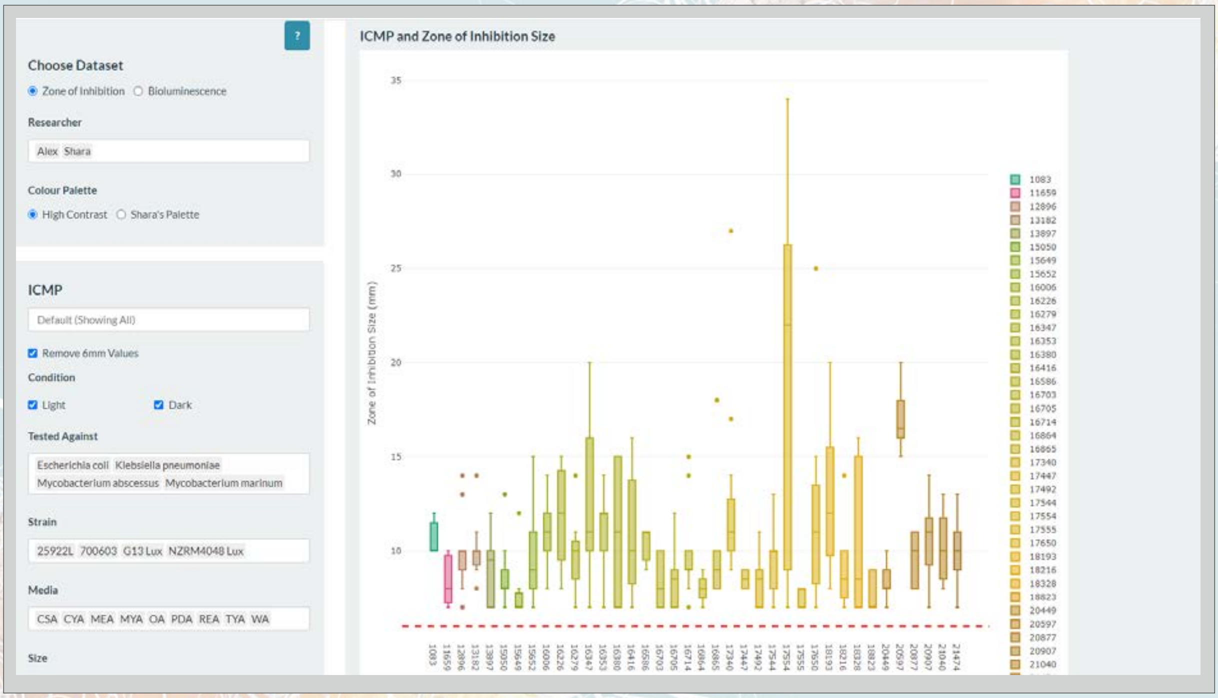


Fig. 2. Interactive web page showing graphs from fungi/antibiotics research data

Dr Wiles is passionate about demystifying science and making her research more publicly available. In 2017 she published her first book 'Antibiotic resistance: the end of modern medicine?' in which she describes the looming crisis of antibiotic resistance and its threat to New Zealand. During COVID-19 Dr Wiles joined forces with Spinoff cartoonist Toby Morris to make the science of the pandemic clear and understandable. Releasing their work under a Creative Commons licence, their graphics have been translated into multiple languages and have been adapted by various governments and organisations as part of their official pandemic communications.

Developing virtual capabilities for the Science Payload Operations Centre

Adjunct Professor Delwyn Moller, Department of Electrical, Computer, and Software Engineering;
Dr Mike Laverick, Dr Chris Seal, Yvette Wharton, Centre for eResearch.

In orbit, the CYGNSS mission has eight small satellites flying in formation. They collect GPS signals that reflect off Earth's surface, which scientists use to infer windspeed over oceans and soil moisture measurements over land.

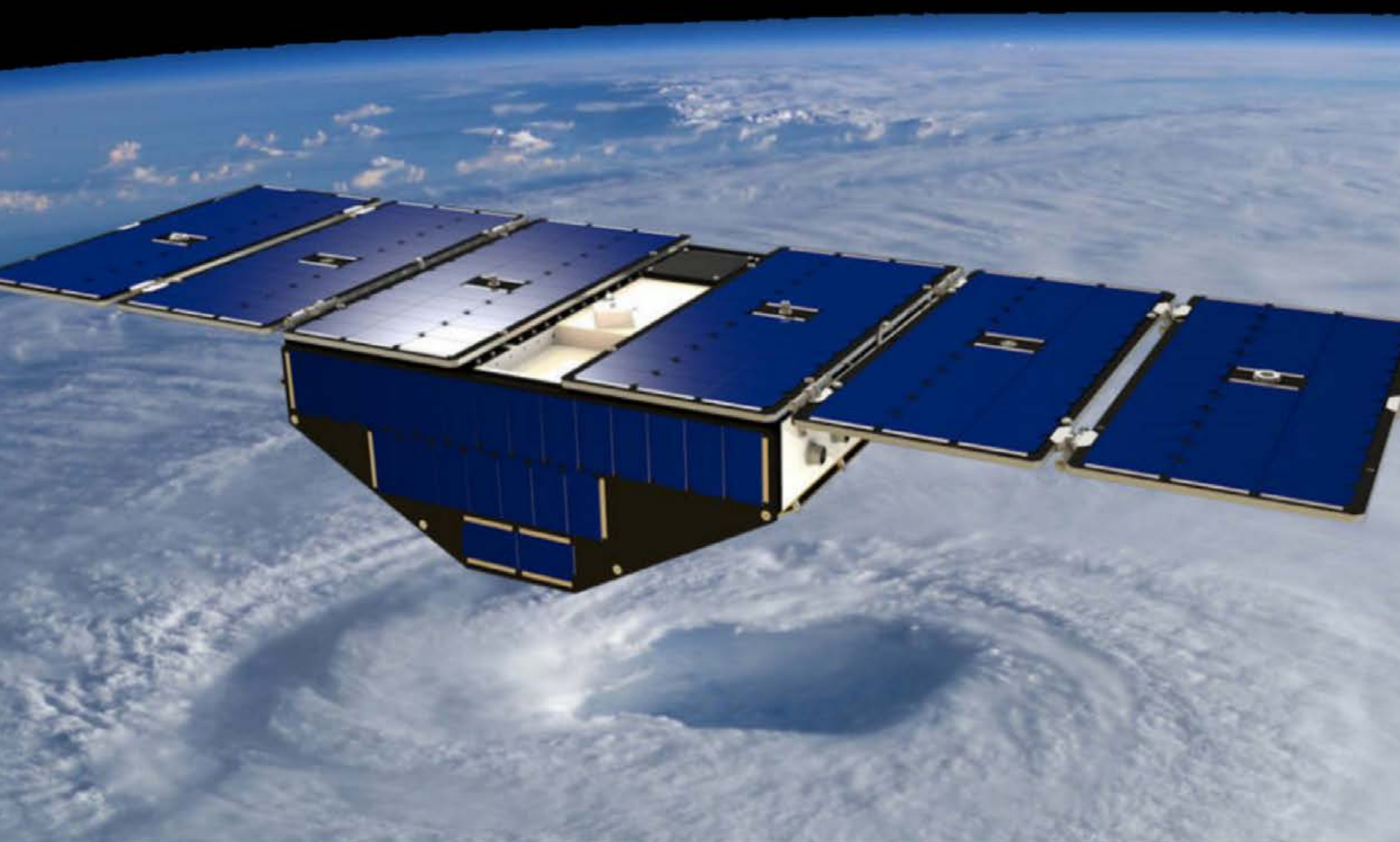


Photo credits: University of Michigan

The Space Payload Operations Centre (SPOC)

A new Science Payload Operations Centre (SPOC) is actively under development at the University of Auckland and the Centre for eResearch, with the aims of more-closely integrating payload operations and science pipelines, and bringing together both payload engineers and the end-user scientists of the payload data.

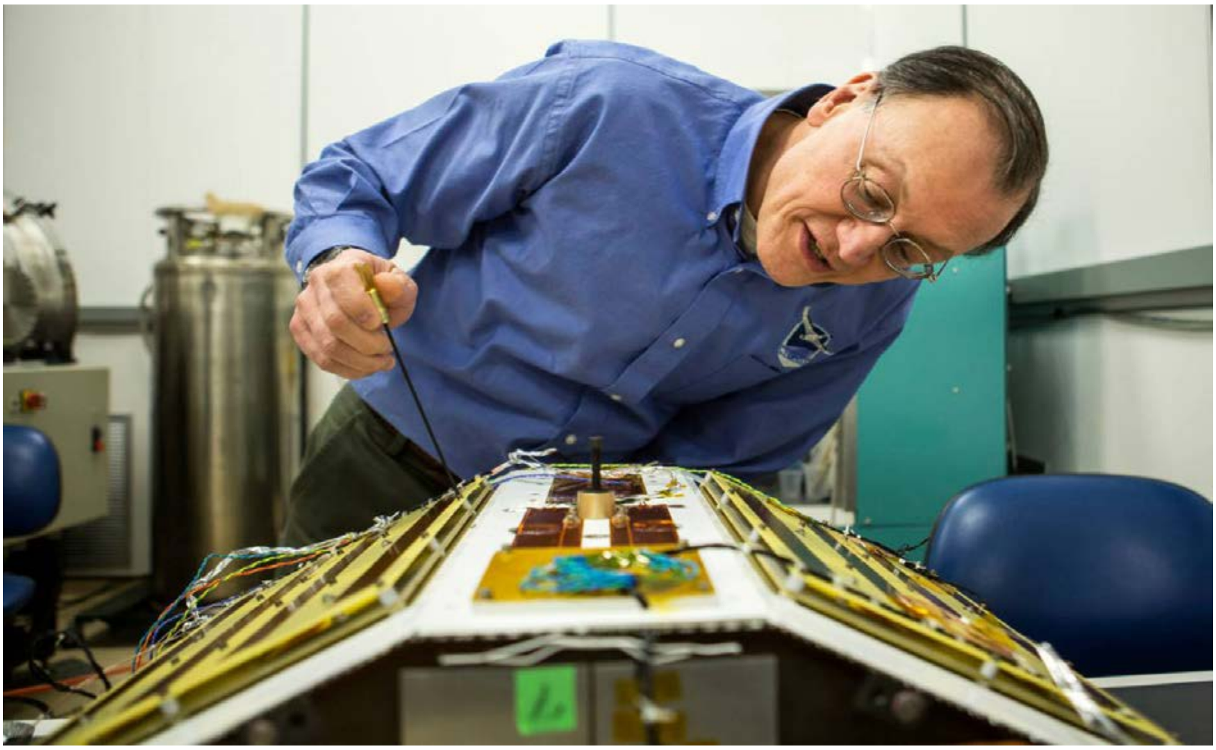
The SPOC will communicate with and control terrestrial, airborne, and space-based remote sensors, pulling their data into the Operations Centre for further processing. Retrieved data will first be processed into L0 data products, before being passed through various scientific pipelines to produce L1, L2, and L3+ level science-ready data products.

It will also facilitate the hosting and distribution of all levels of data products, including the running of Visualisation Suites for data produced from the various scientific pipelines and payloads.

First payload: the Next-Generation GNSS-R Receiver (NGRx)

The first payload to be hosted by the SPOC is the next-generation GNSS-R receiver, currently under development in conjunction with collaborators at NASA, the University of Michigan, and the Ohio State University, which will be mounted on a commercial Q300 aircraft flown by Air New Zealand (press articles can be found at the end of this case study)

Global Navigation Satellite System Reflectometry (GNSS-R) provides a unique means of inferring geophysical conditions of the Earth's surface without the need for costly, and often infeasible, in-situ climate monitoring systems. As part of NASA's Cyclone Global Navigation Satellite System (CYGNSS) mission, and in conjunction with Air New Zealand, we are taking the novel approach of mounting a GNSS-R receiver on a commercial aircraft, that shall allow for an unprecedented collection of climate data over and around the islands of New Zealand. Such data includes inundation and coastal dynamics, and soil moisture content and variability, as demonstrated by the existing CYGNSS mission *(https://www.nature.com/articles/s41598-018-27127-4)*, and the data that is produced will be made publicly available to researchers around the world.



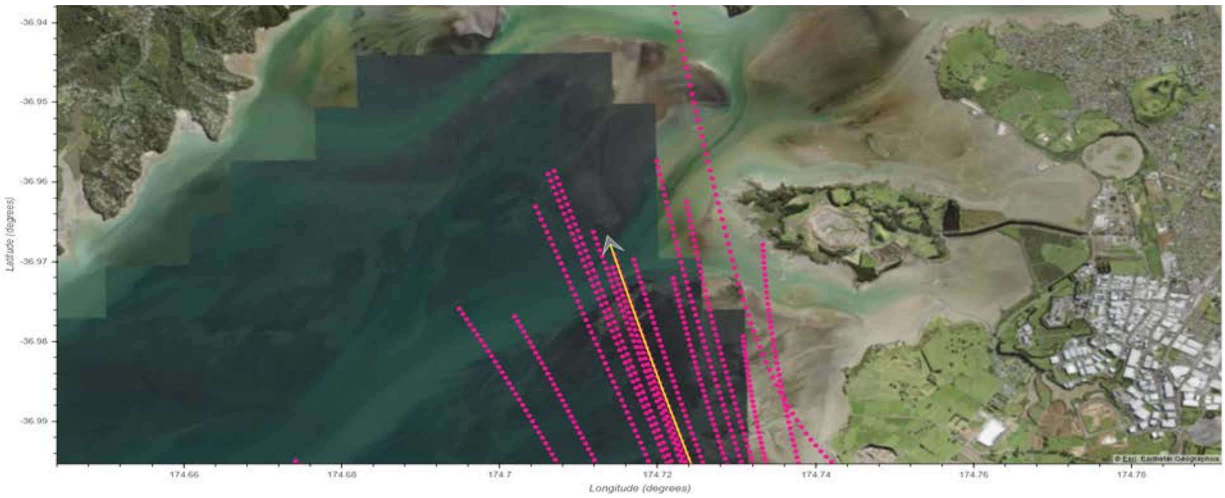
Prof. Christopher Ruf, inspects one of the GYGNSS Satellites before it is deployed into orbit. Photo / Supplied, Nasa

Virtual capabilities of the SPOC: simulation and visualisation

While the building of the physical NGRx payload is underway, on track to be built and mounted during 2021, we can focus our efforts onto developing the virtual capabilities of the SPOC. Leveraging the computational resources available through the Nectar research cloud, we can perform physical simulations of a Q300-mounted NGRx and produce synthetic GNNS-R data, helping us to understand the expected spatial coverage of the data over New Zealand; ranging from a single flight of a craft-mounted payload, up to years worth of data-collection from many payloads across multiple aircrafts.

Being able to synthesise the GNNS-R data allowed us to begin developing scalable data visualisation tools that can interpret and visualise large volumes of data, prior even to the deployment of the payload. As a result we have developed an interactive historical flight visualisation tool, hosted via the Nectar research cloud for in-house access, that can playback a given Q300 flight and "real-time" depict the GNSS-R data as it is detected by the payload. An example of this is shown in Figure 1 below (youtube links for video playback), which is developed in Python using the Bokeh visualisation library.

The developed visualisation tool provides a useful code base from which further data exploration and diagnostic tools can be developed. We have already created a live flight-tracking tool, making use of the OpenSky Network API, which we can use to track our payload location during flight, and future plans involve using the live flight data to perform on-the-fly synthetic data calculations to predict the geospatial data coverage we expect to receive once the payload lands. We also intend to produce intuitive interactive tools to select and retrieve L0+ science data for researchers to use.



An interactive visualisation tool for "playback" of historical flights/payload data. Current visualisations make use of simulated data created by the SPOC. See https://www.youtube.com/watch?v=GbmFFjoQtr8 , https://www.youtube.com/watch?v=xcSlaXDtd8w

Press releases:

1. *https://www.nasa.gov/feature/goddard/2020/nasa-new-zealand-partner-to-collect-climate-data-from-commercial-aircraft*
2. *https://www.mbie.govt.nz/about/news/new-zealand-joins-nasa-science-mission-to-monitor-climate-change-impacts/*
3. *https://www.airnewzealand.co.nz/press-release-2020-airnz-joins-nasa-climate-science-mission*
4. *https://www.nzherald.co.nz/travel/air-new-zealand-joins-nasa-for-special-mission/JVXFHM2LLWHSWKDTRZWEUV4D5E/*

NASA is partnering with the New Zealand Ministry of Business, Innovation and Employment, New Zealand Space Agency, Air New Zealand and the University of Auckland to install next-generation Global Navigation Satellite System (GNSS) reflectometry receivers on passenger aircraft to collect environmental science data over New Zealand.

Analysing text data by time-series feature engineering

Dr Andreas W. Kempa-Liehr, Senior Lecturer, Engineering Science; Yichen Tang, Graduate Teaching Assistant, Computer Science; Dr Kelly Blincoe, Senior Lecturer, Department of Electrical, Computer and Software Engineering.

Language in its diversity and specificity is one of the key cultural characteristics of humanity. Driven by the increasing volume of digitized written and spoken language, the fields of computational linguistics and natural language processing transform written and spoken language to extract meaning.

Both written and spoken language are temporally encoded information. This is quite clear for spoken language, which for example might be recorded as electrical signal of a microphone. Yet, written language appears static due to its encoding in words and symbols. Our recent work has shown that the classical approaches for feature engineering for text samples can be extended by integrating techniques which have been introduced in the context of time series classification and signal processing (Tang et al., 2020). The general idea of our feature engineering approach is to tokenize the text samples under consideration and map each token to a number, which measures a specific property of the token. Consequently, each text sample becomes a language time series, which is generated from consecutively emitted tokens, and time is represented by the position of the respective token within the text sample (Fig. 1). The resulting language time series can be characterised by collections of established time series feature extraction algorithms from time series analysis and signal processing (Christ et al., 2018). Our approach maps each text sample (irrespective of its original length) to 3970 stylometric features.

Our proposed feature engineering technique for short text data is applied to two different corpora, which are discussed as examples for authorship attribution problems: the Federalist Papers data set (Hamilton et al., 1998) and the Spooky Books data set (Kaggle, 2018). The latter comprises 19579 sentences from spooky novels of three famous authors: Edgar Allan Poe (EAP), HP Lovecraft (HPL) and Mary Wollstonecraft Shelley (MWS), so both the genre and the topic of the documents have been controlled. We demonstrate that our proposed language time series features can be successfully combined with standard machine learning approaches for natural language processing and have the potential to improve the classification performance. Furthermore, our suggested feature engineering approach can be used for visualizing differences and commonalities of stylometric features. This is demonstrated in Fig. 2, which shows discrimination maps for the first three principle components of the Spooky Books data set. The separation of the three primary colors demonstrates that the extracted features indeed capture differences between the three authors. The figures also indicate the location of two example sentences.

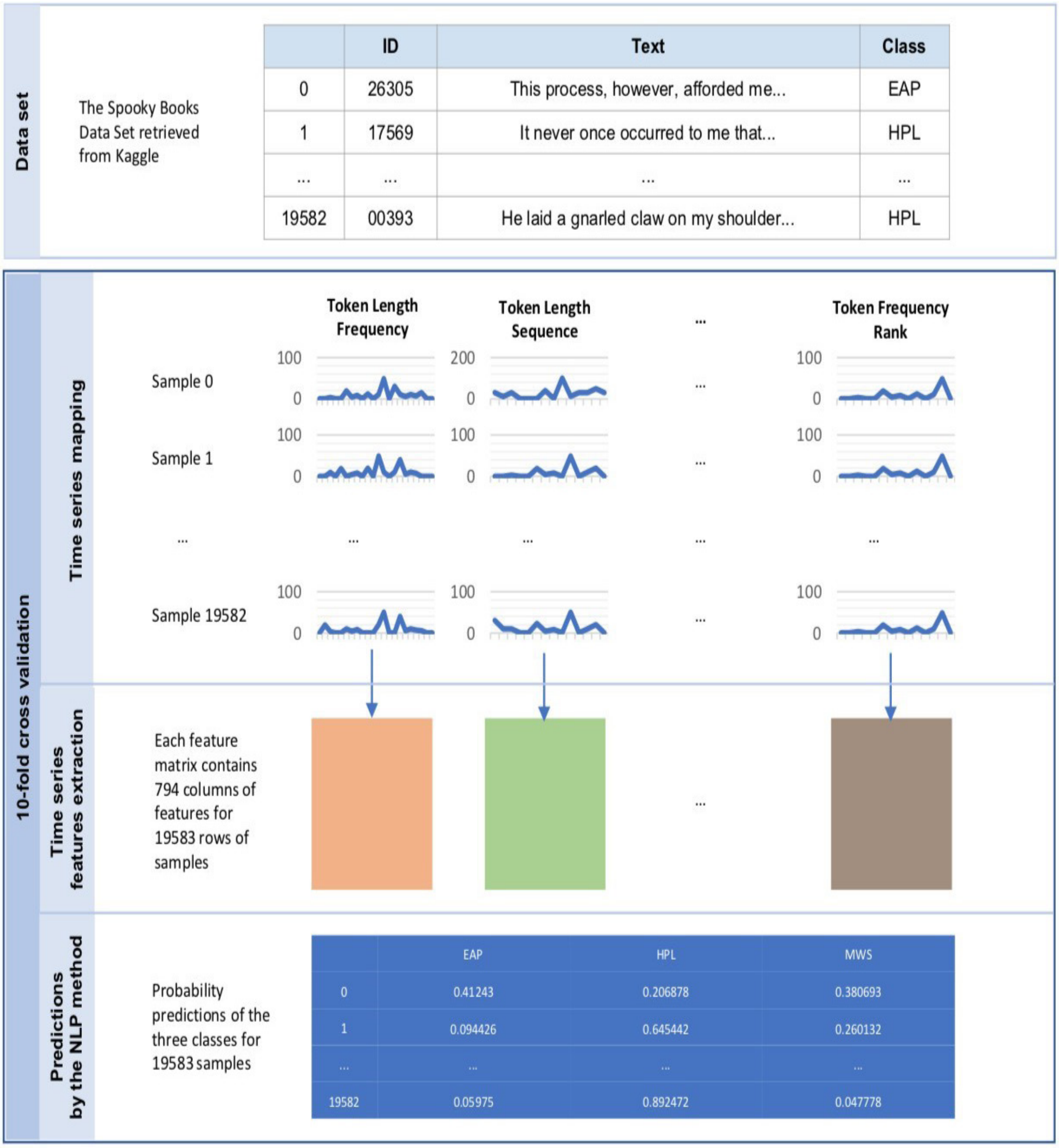


Figure 1: Interpreting short text samples as language time-series, allows to characterizing them with 3970 stylometric features from time-series analysis and signal processing, which can be used for an authorship attribution task. (Figure adapted from Tang et al., 2020, Fig. 6).

The sentence indicated by the white cross was written by Mary Wollstonecraft Shelley: "'Let me go,' he cried; 'monster Ugly wretch You wish to eat me and tear me to pieces." The sentence indicated by the plus symbol was written by HP Lovecraft: "The rabble were in terror, for upon an evil tenement had fallen a red death beyond the foulest previous crime of the neighbourhood."

The sample from HPL is located in bins that are typical for both EAP and HPL and, therefore, are coloured in shades of purple (white plus in Fig. 2a,b). In Fig. 2c, the HPL example is located in a bin that is dominated by red, which indicates that the respective sentence resembles stylometric similarities with texts from EAP. The sample from MWS is located in a greenish bin in Fig 2b, but also has a strong resemblance with EAP and HPL, such that the white cross is located in reddish bins in Figs. 2a and 2c.

In summary, our feature engineering approach enables complete sentences to be considered when extracting features from natural text. This research opens the door to an exciting new line of research which merges two distinct fields of machine learning. The computational resources, which we needed for evaluating this new feature engineering approach, were provided by the New Zealand eScience Infrastructure (NeSI) High Performance Computing facilities and the Nectar research cloud.

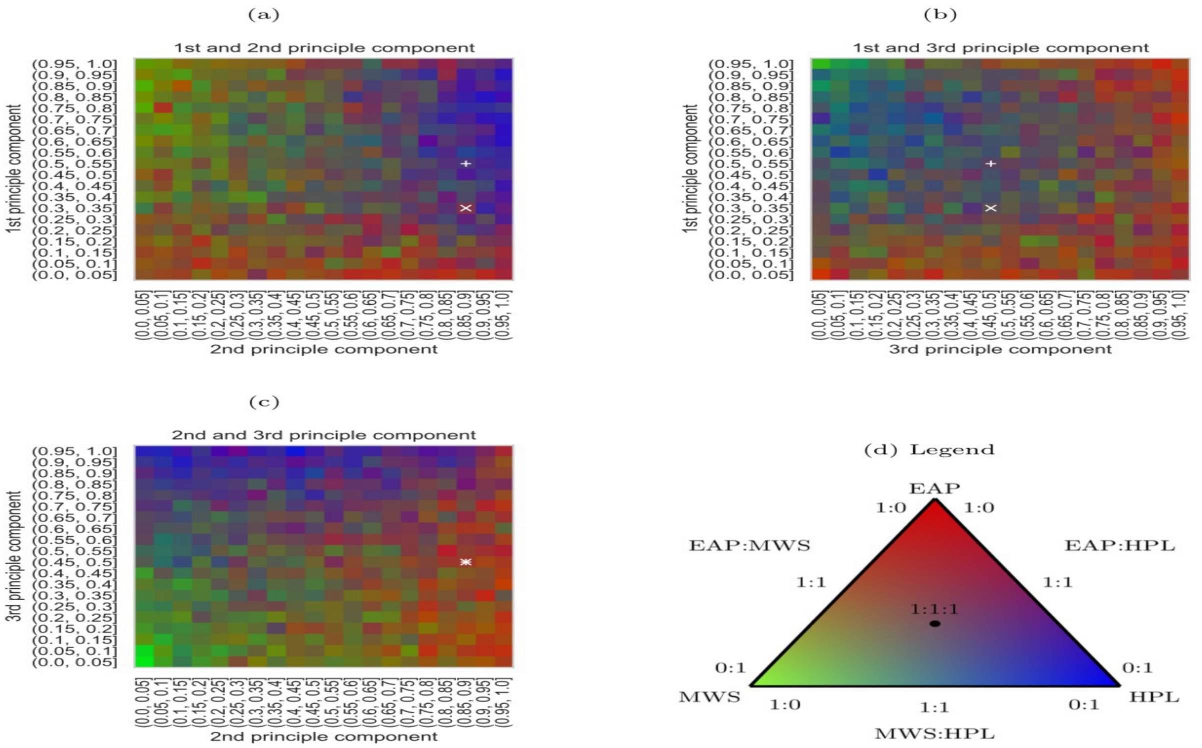


Figure 2: Discrimination maps for the first three principle components derived from 400 statistically significant language time-series features and 19,579 sentences of the Spooky Books data set. Red bins indicated stylometric features, which are dominated by Edgar Allan Poe (EAP), blue indicates HP Lovecraft (HPL), green indicates Mary Wollstonecraft Shelley (MWS). The white cross and the white plus symbol are discussed in the text. (Adapted from Tang et al., 2020, Fig. 4.)

References

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Developing short-term eruption warning systems for Whakaari and other volcanoes

Dr David Dempsey, Senior Lecturer, Engineering Science.

Whakaari/White Island. Photo credit: Shane Cronin

On 9th December 2019, at 2pm, Whakaari volcano erupted unexpectedly, killing 21 tourists and guides on the island. The high cost underlines the hazards in our backyard and the difficulties facing those estimating volcanic risk. Since this tragedy, we have been working to develop short-term eruption warning systems for Whakaari and other volcanoes.

Whakaari/ White Island is an andesite stratovolcano in the offshore Bay of Plenty, part of a chain of volcanoes extending across the North Island to Mt Ruapehu. In spite its regular eruptions – five in the last decade – it has also been a popular tourist destination, with regular boat and helicopter tours from Whakatane. GNS Science monitor volcanic activity at the island using seismometers that continuously stream data to the mainland.

We took nine years of seismic data from Whakaari and extracted the component that is particularly sensitive to the volcano state, called tremor. We then searched for patterns in the tremor that were especially unusual in the days before eruptions. We found strong 4-hour bursts of seismic energy in the hours before many of these eruptions, which we interpret as hot magmatic fluids entering the shallow groundwater. Once mixed, they cause heating and pressurisation that eventually leads to an explosive eruption.

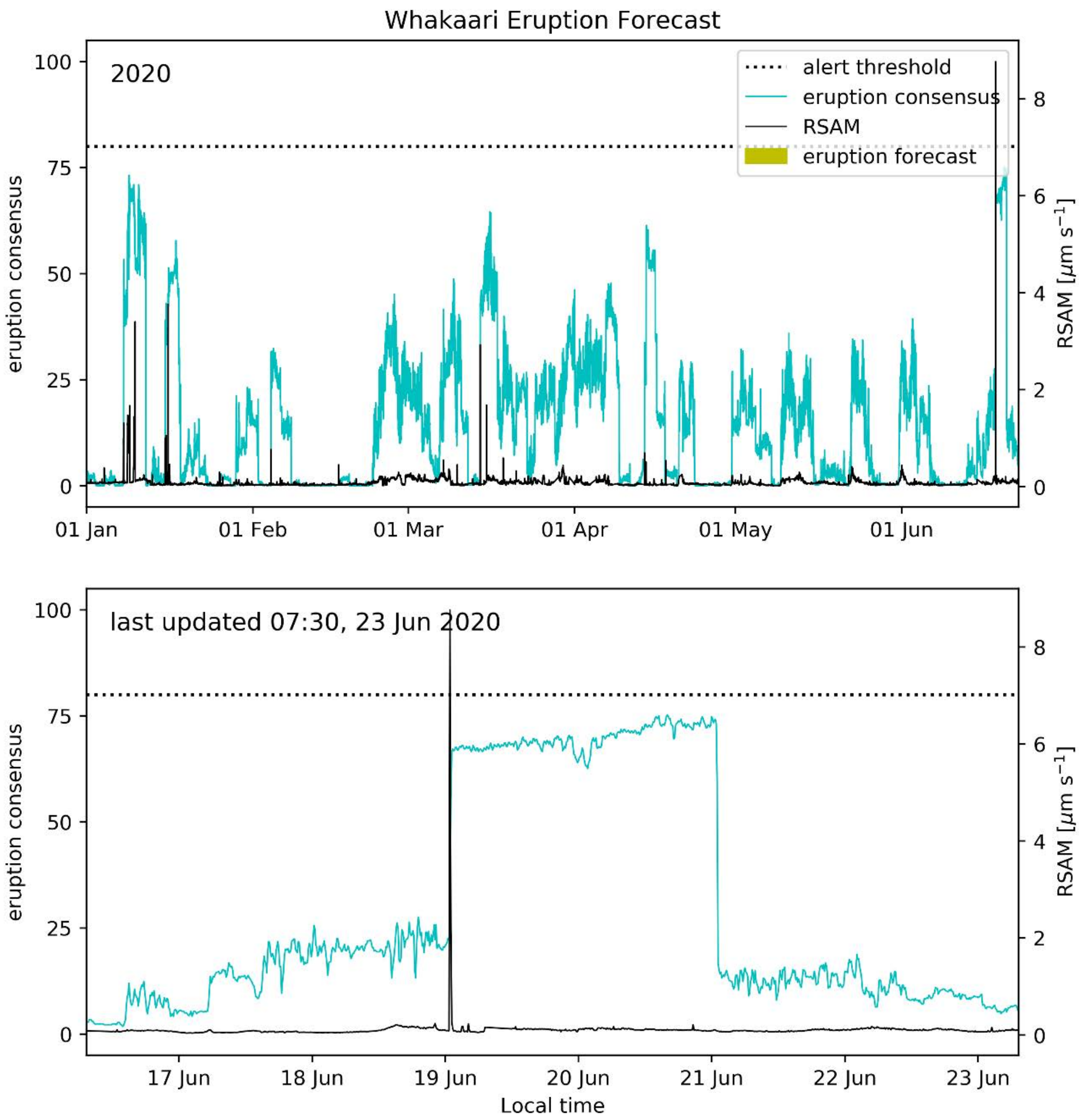
Recognising suspicious seismic activity through modelling

We taught a model to recognise these patterns and to raise alerts when it sees suspicious seismic activity that could indicate a future eruption. This model – trained using four eruptions and tested with a fifth – could anticipate most eruptions, and would have given 16 hours warning of the fatal 2019 eruption.

We have been operating the forecasting system in a 24/7 real-time manner since February 2020. Every 10 minutes, it receives new data from the GNS seismometer and uses this to update its guess about whether an eruption is imminent. If it thinks an eruption is likely, an email alert is automatically sent to key scientists.

The real-time alert system would not have been possible without assistance from the Centre for eResearch (CeR). The key requirement was a continuous computing resource that could operate for months on end without interruption. CeR helped us set up a virtual machine on the Nectar cloud to run our forecaster, and then configured a web portal so that key scientists could access the current state anywhere in the world, at any time.

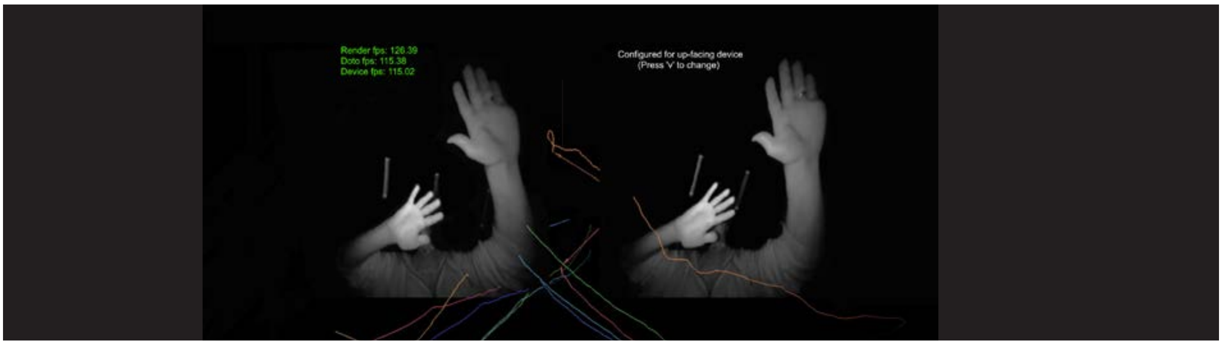
This work was a collaboration between the Faculty of Engineering (Dr David Dempsey and Dr Andreas Kempa-Liehr) and the School of Environment (Professor Shane Cronin). The next step is to see if it could work at other volcanoes in New Zealand and around the world.



The real-time forecasting model (blue) responding to the M 7.2 Kermadec earthquake in June, as seen through the web portal.

An investigation into gesture-as-sign using Leap motion tracking

Lucy Boermans, Master's student, Elam School of Fine Arts ; Andrew Leathwick, Centre for eResearch.



Introduction: relational shifts in society

The rise of social media and digital communication has seen the everyday reality humans live in forever changed; no longer do we live in a purely physical work, but instead 'multi-dimensional being' has become a daily reality for all of us.

Artist Lucinda Boermans' work examines and questions the sociological shift in primary communication from the physical (face-to-face) to the virtual (text-messaging), with the aim of reaching a clearer understanding of this shift, and in turn, its impact upon relational being. At the end of 2019, Boermans' recorded and observed 'on-line communication coupling' via WhatsApp/Skype, in which participants took part in 'sign-as-gesture' conversations, communication through gesture alone. The aim was to investigate sequences of gestures (responsive actions evolving over time); gestures repeat an action of progression in space and time, are an empathic relation through movement in space.

Figure 1 - One of the original 'gesture conversations' between two participants. "A language of gesture develops from the desire to communicate. The language is activated via digital interaction – it is in motion, not static. It is unique to that activated moment. The nature of the gesture is dependant on the interactant; there are no concrete rules. Gestures communicated do not have to be learned or remembered, they evolve; they may change upon each interaction in time. They are embodied responses to each digital interaction." – participant information sheet.

Aim

Boermans turned to the possibility of using deep learning techniques and gesture recognition to facilitate gesture exchanges between participants or even between participants and a computer. In collaboration with CeR, a system for recognizing gestures using deep learning was developed, capable of successfully recognising over 30 gestures. It remains to future work to develop a system that can respond to human input with computer generated gestures.

Training data – curation and feature selection

Deep learning is all about data – without data, no models can be trained. Deep learning uses a set of example input/output pairs to learn the relationship between the input and output, thereby learning to predict the correct output for a given input. In this case, the dataset consists of Leap motion sensor capture data for various gestures, and labels saying what gesture was being performed.

associated gesture labels freely available online, so all data was recorded by various volunteers in-house at CeR. Recruiting a diverse group of people to record training data is important – otherwise, the model may only work with the hands that it has been trained with!

Performance

More than 95% accuracy was achieved across a library of over thirty gestures. Gestures included common ones like waving, thumbs up, and counting, and more abstract gestures such as 'smoothing sand', 'love heart', and 'robotic arm'.

Live prediction & 'affects'

One of the main goals was to achieve live prediction – that is, someone performs a gesture over a Leap motion sensor, and the gesture is recognised real time. This was achieved by constantly feeding in the last second or so worth of live data into the model and updating a visual interface accordingly.

In addition to predicting what gesture was being performed, Lucy was also interested in exploring the 'affective dimension' of gestures – the same gesture may be performed smoothly, roughly, angrily, or happily etc. This was implemented with two metrics:

- Movement: How fast are the hands and fingers moving?
- Angularity: How jerky are gestures?

These metrics, which measure the rate of change of position and speed, respectively, were chosen because they are independent of context – more emotive/abstract affective dimensions such as humour or anger are very context dependent and therefore more difficult to predict.

Live plotting

A live plotting tool was developed to plot gesture predictions, confidence levels of predictions, and movement and angularity. The smoothness of this plotting proved highly dependent on the processing power of the machine being used, so a simple interface was developed with controls to change the frequency of prediction and the frame rate of graph updates, along with some control over how the plotted metrics were calculated.

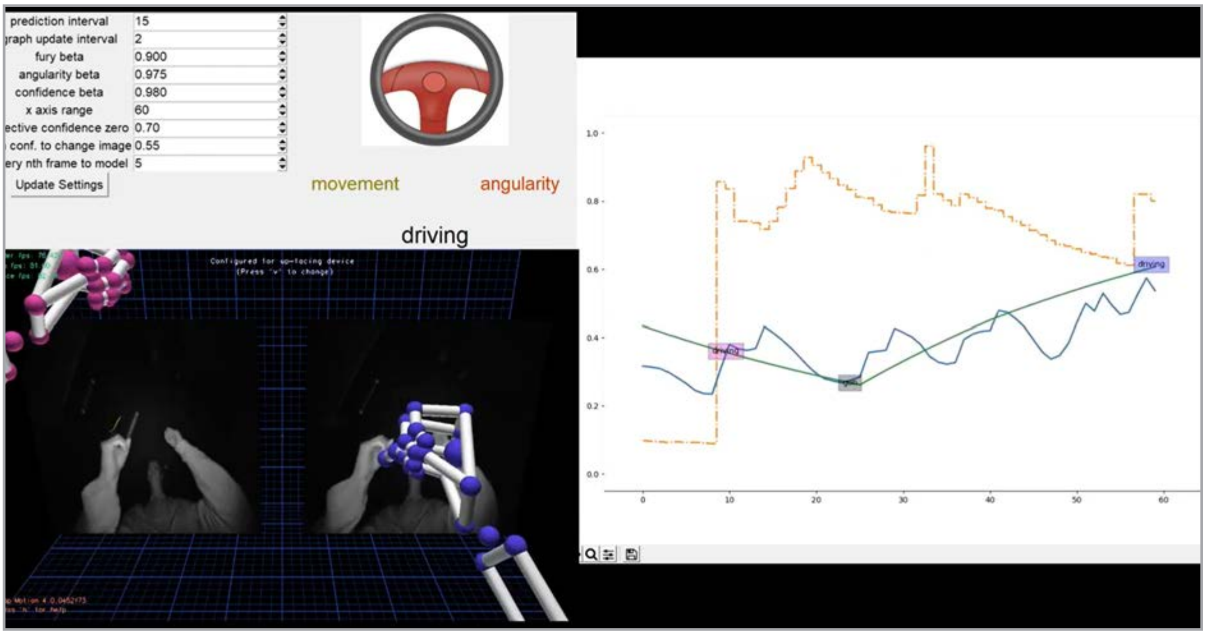


Figure 2 - The live prediction interface. Top left: control interface with icon and text showing current prediction, and text coloured red according to levels of movement and angularity. Bottom left: The interface provided by Leap motion for viewing the positions of detected body parts. Right: Live plotting with green line showing prediction confidence, orange line showing angularity, and blue line showing movement.

Next Steps

The project as it currently stands is a proof of concept, showing that gesture recognition with the Leap motion device is feasible.

Future work will aim to develop this concept further to facilitate gesture conversations with a computer, or with participants who are unable to see one another, as part of an arts installation.

Determinants of translation efficiency in the evolutionarily-divergent protist Trichomonas vaginalis

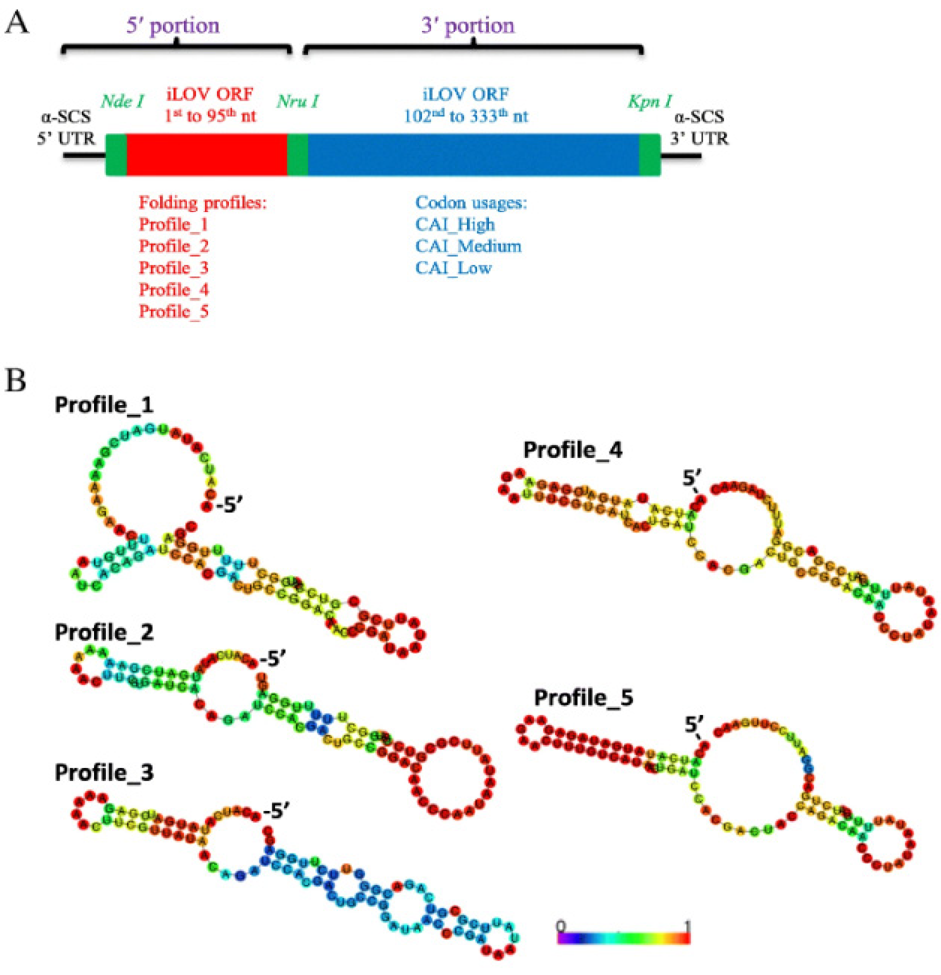
Shuqi E. Wang, Research Assistant, Anna E. S. Brooks, Senior Research Fellow, Professor Anthony M. Poole & Augusto Simoes-Barbosa, Senior Lecturer, School of Biological Sciences.

Background

Trichomonas vaginalis, the causative agent of a prevalent urogenital infection in humans, is an evolutionarily divergent protozoan. Protein-coding genes in T. vaginalis are largely controlled by two core promoter elements, producing mRNAs with short 5' UTRs. The specific mechanisms adopted by T. vaginalis to fine-tune the translation efficiency (TE) of mRNAs remain largely unknown.

Results

Using both computational and experimental approaches, this study investigated two key factors influencing TE in T. vaginalis: codon usage and mRNA secondary structure. Statistical dependence between TE and codon adaptation index (CAI) highlighted the impact of codon usage on mRNA translation in T. vaginalis. A genome-wide interrogation revealed that low structural complexity at the 5' end of



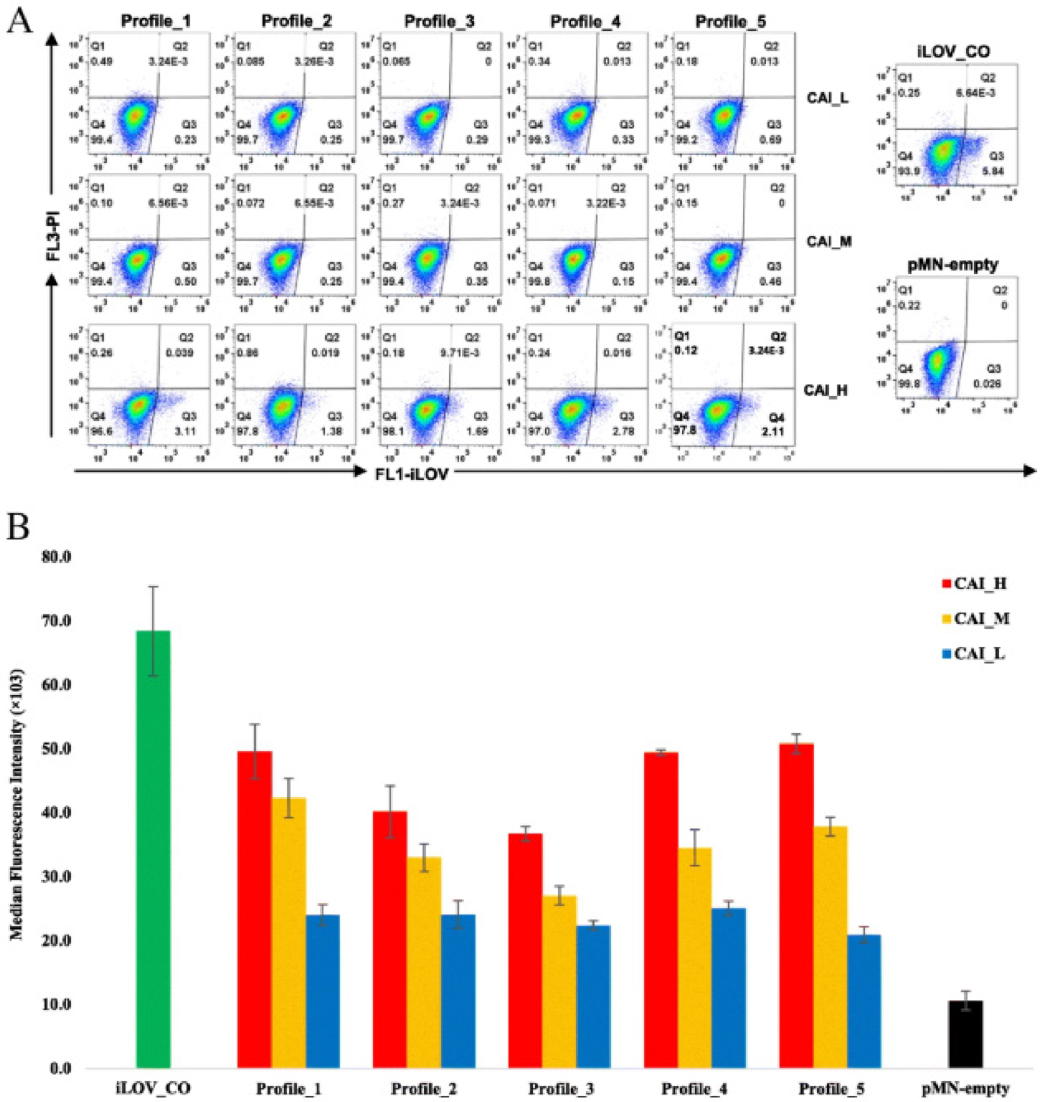
Details of the synthetic iLOV gene library to be expressed in T. vaginalis.a Diagram of the iLOV genes showing 5′ and 3′ portions connected by the Nru I site.

mRNA followed closely by a highly structured downstream region correlates with TE variation in this organism. To validate these findings, a synthetic library of 15 synonymous iLOV genes was created, representing five mRNA folding profiles and three codon usage profiles. Fluorescence signals produced by the expression of these synonymous iLOV genes in T. vaginalis were consistent with and validated our in silico predictions.

Conclusions

Using complementary in silico and in vivo approaches, this study systematically investigated the impact of codon usage bias and mRNA secondary structure on TE of T. vaginalis mRNAs. In addition to guiding optimal gene expression in this parasite, the results here provide new information that leads to a more comprehensive understanding of the mechanisms by which gene expression is controlled in T. vaginalis. Despite having a translation machinery that is rather typical of eukaryotes, T. vaginalis and other evolutionarily divergent protozoans such as Giardia produce mRNAs with short 5' UTRs. This study indicates that T. vaginalis mRNAs contain information at the level of both sequence and structure that impact their expression, adding a novel layer to our understanding of gene regulation in this divergent unicellular eukaryote.

Acknowledgement:
We are grateful to the Centre for eResearch, the University of Auckland, for access to computing resources such as research virtual machines.



Transient and stable expressions of the synonymous iLOV genes determined by flow cytometry.

Anti-corruption regulations for promoting socially responsible practices

Assoc Professor Srividya Jandhyala, ESSEC Business School, Singapore; Assoc Professor Fernando S. Olivera, Graduate School of Management, University of Auckland.

Background

Firms regularly encounter pressure to engage in corrupt and fraudulent practices in the course of their operations, in supply chain management activities, and in procurement auctions. In particular, corruption - the abuse of public power for private gain - is considered to be the norm rather than the exception around the world, and is highly unreported and difficult to track. In recent years, regulatory efforts at tackling corruption have changed in two significant ways. First, international anti-corruption regulations hold firms accountable in their home country for behavior in foreign countries. In other words, contrary to domestic laws, international regulations monitor and penalize actions of a firm in a foreign location, where the government does not traditionally have jurisdiction. Policymakers contend that these changes in anti-corruption efforts are a major breakthrough in the fight against corruption, emphasizing the de facto enforcement of these regulations to lower corruption in host countries. Multinational firms headquartered in developed countries with stronger judicial system and greater resources for monitoring and sanction would have lower incentives to offer bribes in developing countries.

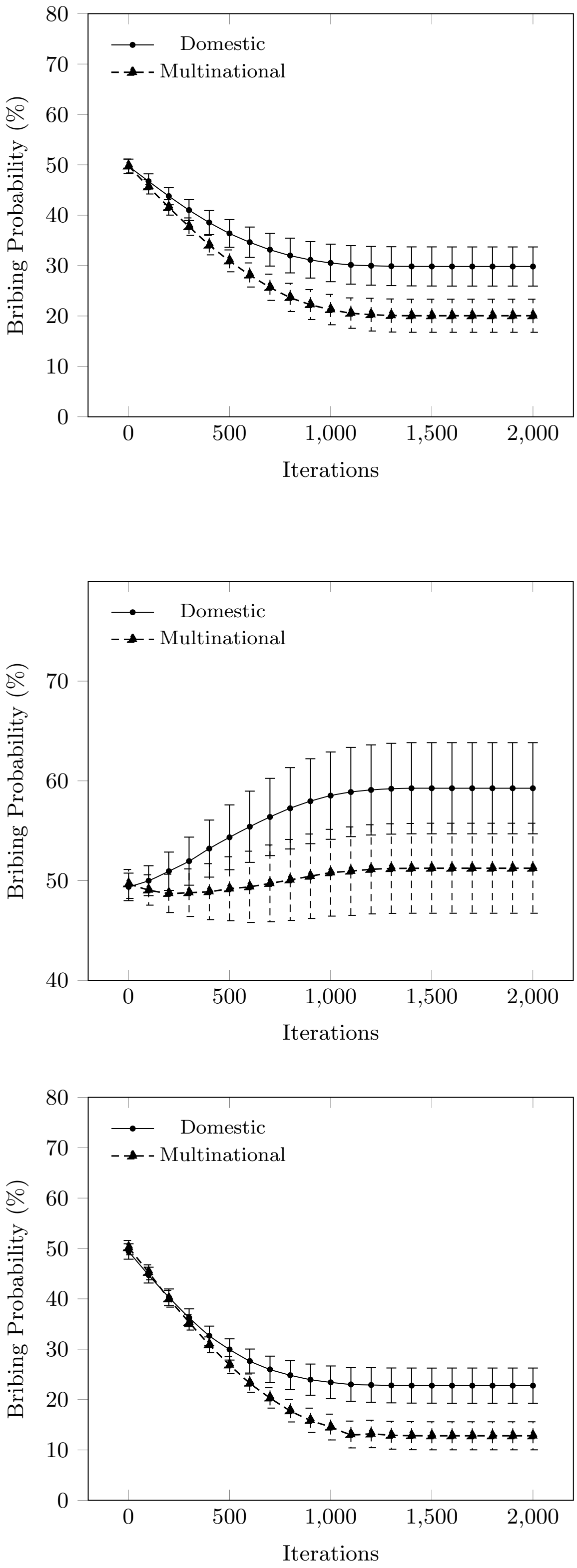
Results

We analyze how firm heterogeneity, within two firm types (domestic and multinational) influences the behavior of the industry and the short and long-term strategies of the firms using an agent-based model, which is able to accommodate firms with different objective functions. The simulation converged to the neighborhood of the Nash equilibrium. In terms of the speed of convergence of the agent-based simulation to the Nash equilibrium it can be faster or slower depending on the prior knowledge of players regarding the optimal strategy.

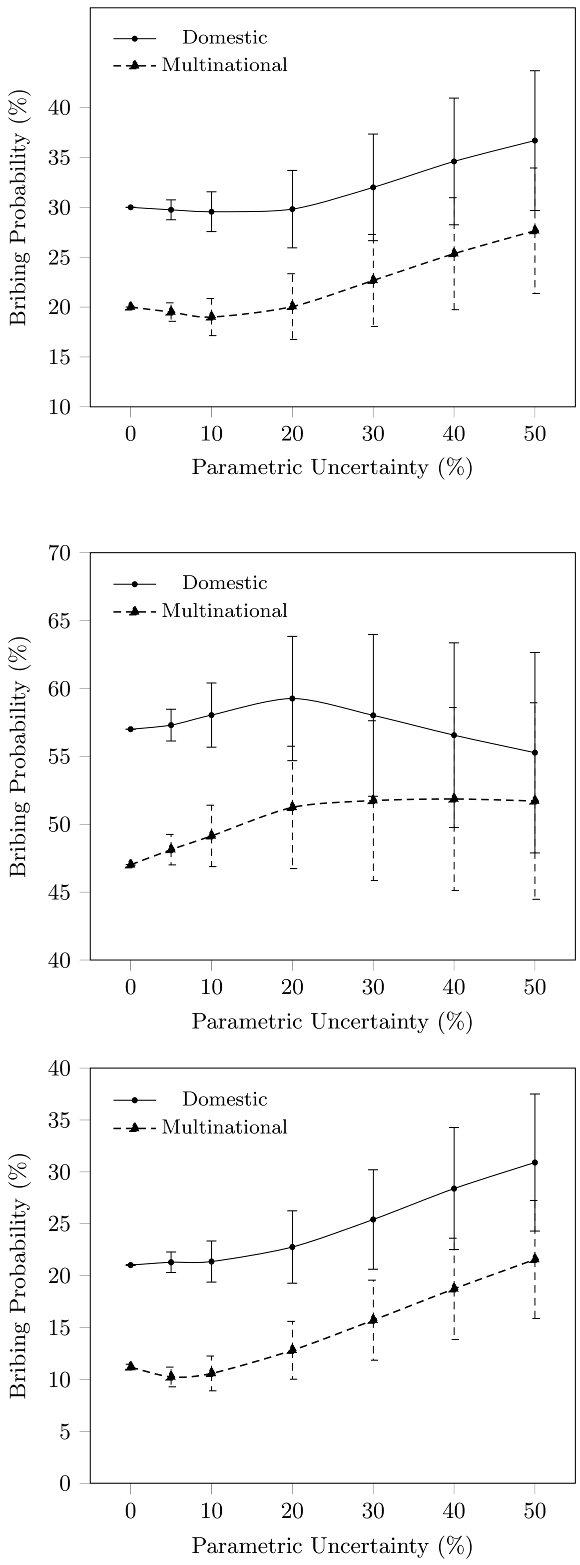
We have also considered the impact of uncertainty on the players' optimal bribing strategies. The major result is that the Nash equilibrium, when uncertainty is low, is a robust predictor of the actual behavior of firms in the conditions described in the game. Even though in the agent-based game the decision space is composed of binary decisions and based on learning, very different from the game theory setting, the optimal strategy, nonetheless, remains the same.

Conclusions

In particular, in some cases the strategic response of domestic firms may well be to increase their own bribing behavior when competing with multinational firms whose actions are exposed to greater monitoring and sanction through international rules and regulations, even if the overall industry bribing probability declines. Thus, increasing bribe penalties for multinational firms can have an adverse impact on domestic firms' bribing behavior if they face consistently lower penalties. Better monitoring and increased penalties on multinational firms through international anti-corruption initiatives may be insufficient in constraining bribing behavior. Notwithstanding the increasing emphasis in the literature on the impact of ethically and socially responsible behavior on firm performance, we find in some instances – such as the benefits from corruption rents in our model – the relationship may not be straightforward. Thus, future work should critically examine the setting in which market and institutional mechanisms can be better coordinated to generate positive social outcomes.



Heterogeneous firms learn the optimal bribing probability.



Impact of parametric uncertainty on the optimal bribing probability.

Acknowledgment:
We very gratefully acknowledge the Centre for eResearch, the University of Auckland, for access to the virtual machines.

Calcium signalling in salivary gland acinar cells

Dr. John Rugis[1], Professor James Sneyd[1], Department of Mathematics, University of Auckland; Professor David Yule[2], University of Rochester Medical Center.

The primary role of salivary gland acinar cells is to secrete saliva, the lack of which causes a host of severe medical difficulties. Thus, an understanding of the mechanisms underlying saliva secretion is vital for the understanding of oral health. In every kind of salivary acinar cell, saliva secretion is controlled by the concentration of cytosolic Ca2+.

Our research group has constructed a spatiotemporal model of Ca2+ dynamics and luminal fluid flow in parotid acinar cells, based on new data about the distribution of inositol trisphophate receptors (IPR). We have demonstrated that coupling fluid flow secretion with the Ca2+ signalling model changes the dynamics of the Ca2+ oscillations significantly, which indicates that Ca2+ dynamics and fluid flow cannot be accurately modelled independently. Further, we determined that an active propagation mechanism based on calcium-induced calcium release channels is needed to propagate the Ca2+ wave from the apical region to the basal region of the acinar cell. A graphical summary or our model is shown in figure 1.

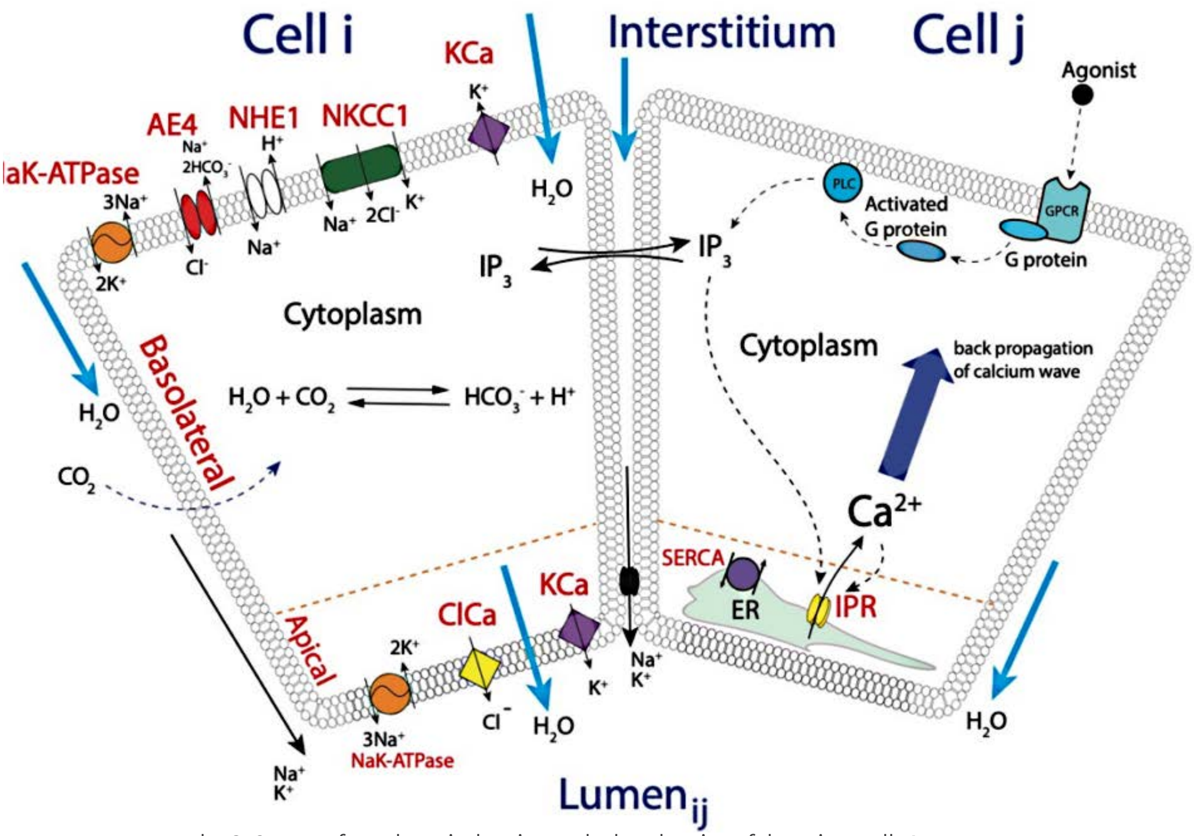


Figure 1 – Graphical representation of the calcium signalling and fluid flow model.

We constructed a three-dimensional anatomically accurate multicellular structural mesh model of a parotid gland acinus to investigate the effects of the topology of both its cells and lumen have on primary fluid secretion. The mesh consists of seven individual cells, coupled via conformal common luminal surfaces. Our mathematical model consists of a system of reaction-diffusion partial differential equations and our model is solved numerically on the mesh using the finite element method. A picture of our 3D seven-cell mesh is shown in figure 2.

We reused our mesh model and constructed an animated interactive augmented reality presentation of simulation results to facilitate interpretation and understanding. Figure 3 shows James Sneyd in the Centre for eResearch Visualisation Suite exploring simulation results.

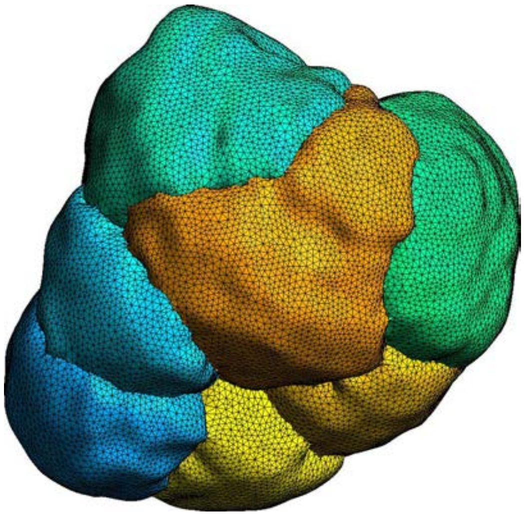


Figure 2 – Seven cell structural mesh, used for numerical modelling.

Acknowledgement:
Our work is heavily reliant on the computer resources and consultation services provided by both the Centre for eResearch and NeSI (New Zealand eScience Infrastructure). Quite simply put, we could not have extended our project to its current scope and depth without these resources. Special thanks to Nick Young of the Centre for eResearch for helping us create a hololens visualisation movie showing our simulation results.

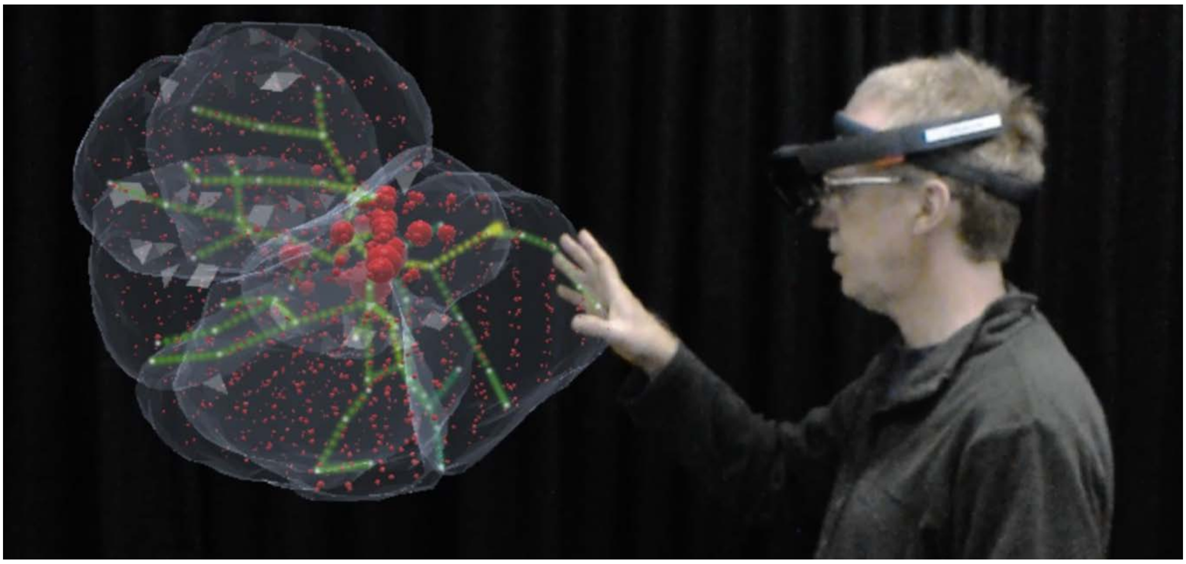


Figure 3 – Calcium signalling and fluid flow simulation results displayed in interactive 3D.

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Coastal image classification and analysis based on convolutional neural networks and pattern recognition

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[1]Beijing University of Technology, Beijing, China; [2]University of Auckland, Auckland, New Zealand.

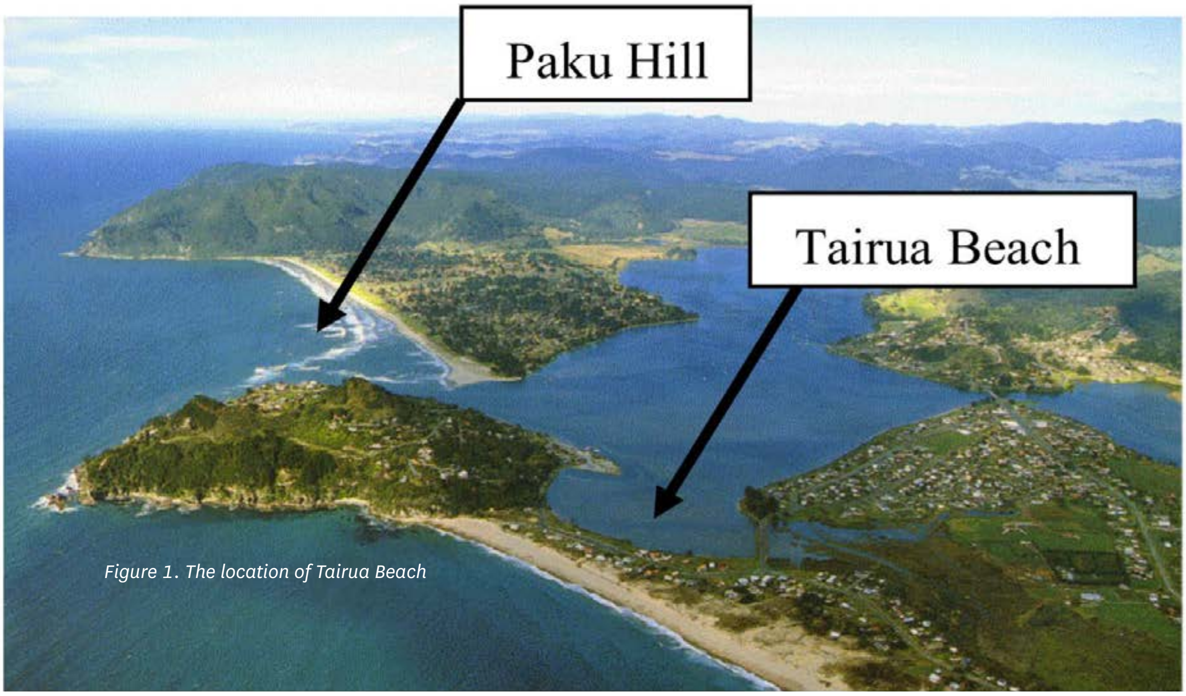

Figure 1. The location of Tairua Beach

Overview

The study of coastal processes is critical for the protection and development of beach amenities, infrastructure and properties. Many studies of beach evolution rely on data collected using remote sensing and show that beach evolution can be characterized by a finite number of "beach states". However, due to practical constraints, long-term data displaying all beach states are rare. Also, when the dataset is available, the accuracy of the classification is not entirely objective since it depends on the operator. To address this problem, we have collected hourly coastal images and corresponding tidal data for more than 20 years (Nov. 1998 - Aug. 2019). We classified the coastal images into 8 categories according to the classic beach state classification, defined as 1) reflective, 2) incident scaled bar, 3) non-rhythmic, attached bar, 4) attached rhythmic bar, 5) offshore rhythmic bar, 6) non-rhythmic, 3-D bar, 7) infragravity scaled 2-D bar, 8) dissipative. Classification models are usually based on convolutional neural networks. After image pre-processing with data enhancement, we have compared DenseNet, ResNet, ResNext and improved ResNext models. The improved ResNext obtained the best and most stable classification with an accuracy of 94.58% and good generalization ability. The classification results of the whole dataset are transformed into time series data. FP-Growth and MDLats algorithms are used to find frequent patterns and motifs which represent the pattern of coastal morphology changes within a certain period of time. Combining the pattern of coastal morphology change and the corresponding tidal data, we also analyzed the characteristics of beach morphology and the changes in morphological dynamics states.

Introduction

The change of beach shape is mainly controlled by interactions involving the coupling of hydrodynamics and morphodynamics. The study of waves and tides has important guiding significance for the protection and development of the beach. However, due to practical constraints, long-term data displaying all beach states are rare. To resolve this problem, we have collected hourly coastal images and corresponding tidal data for more than 20 years (Nov. 1998 - Aug. 2019). Moreover, the deep learning technologies are utilized to realize the classification of coastal images, and the pattern recognition methods are conducted to analyse the evolution process and transition rules of the beach.

Dataset

Tairua Beach is located on the east coast of the Coromandel Peninsula in the North Island of New Zealand, which is characterized by the typical "pocket beach" configuration[1]. Since 1998, a video monitoring station was installed on the extinct volcano at the south end of the beach. It collected images over a period of 20 minutes every hour. There are 103,660 images in this dataset during Nov. 1998 - Aug. 2019.

Lippmann and Holman[2] had proposed a typical classification method for sandbars. Considering nearshore morphology, the coastal images have been classified into 8 categories[2], defined as 1) reflective, 2) incident scaled bar, 3) non-rhythmic, attached bar, 4) attached rhythmic bar, 5) offshore rhythmic bar, 6) non-rhythmic, 3-D bar, 7) infragravity scaled 2-D bar, 8) dissipative. In our dataset, 3,744 images are labelled according to Lippmann and Holman's classification criteria.

Coastal image classification

For the coastal images classification, we have compared ResNet[3] and ResNext[4] models based on Convolutional Neural Networks. The network structures of ResNet50 and ResNext50 models are shown in Fig. 2.

stage	output	ResNet-50	ResNeXt-50 (32×4d)
conv1	112×112	7×7, 64, stride 2	7×7, 64, stride 2
conv2	56×56	3×3 max pool, stride 2 [1×1, 64; 3×3, 64; 1×1, 256] ×3	3×3 max pool, stride 2 [1×1, 128; 3×3, 128, C=32; 1×1, 256] ×3
conv3	28×28	[1×1, 128; 3×3, 128; 1×1, 512] ×4	[1×1, 256; 3×3, 256, C=32; 1×1, 512] ×4
conv4	14×14	[1×1, 256; 3×3, 256; 1×1, 1024] ×6	[1×1, 512; 3×3, 512, C=32; 1×1, 1024] ×6
conv5	7×7	[1×1, 512; 3×3, 512; 1×1, 2048] ×3	[1×1, 1024; 3×3, 1024, C=32; 1×1, 2048] ×3
	1×1	global average pool 1000-d fc, softmax	global average pool 1000-d fc, softmax
# params.		**25.5**×10^6	**25.0**×10^6
FLOPs		**4.1**×10^9	**4.2**×10^9

Figure 2. Network structure of ResNet50 and ResNext50

Tables 1-2 show the experimental results with regard to Top-1 Accuracy and F1-score. Comparing the accuracy of ResNet50 and ResNext50, it is clearly to find that Top-1 accuracy obtained by using Resnext50 can achieve higher accuracy than that obtained by ResNet50. Compared with the same network before and after using image enhancement, we can find that the accuracy of the two methods is improved by 4.7% and 3.1%, respectively.

Data processing	Algorithm	Top-1 Accuracy
No Image Enhancement	ResNet50	0.9028
	ResNext50	0.9588
Image Enhancement	ResNet50	0.9458
	ResNext50	0.9890

Table 1. Comparison of test results with different models

	A	B	C	D	F	G	H
ResNet50	0.9775	0.9166	0.9422	0.9500	0.8882	0.9908	0.9201
ResNext50	0.9942	0.9885	0.9909	0.9574	0.9288	0.9823	0.9867

Table 2. F1-score of different models in each category

Sequential pattern mining of classification results

Then, the classification results from A-H are then converted to numbers 0-7. We obtained a time series corresponding to the sandbar state in each hour. For sequential pattern mining, we have adopted three methods. 1) FP-Growth[5] is a typical association method, in which the database of frequent itemsets is compressed into a frequent schema tree to efficiently discover frequent itemsets. 2) PrefixSpan[6] is also an association algorithm for mining frequent sequential patterns, which projects the original data based on prefixes and constantly combines prefixes and outputs patterns that satisfy minimum support. 3) MDLats is a proposed motif discovery algorithm to mine frequent patterns from time series data.

Fig. 3 represents the variation of bar type and tidal height over a month. The red line stands for the hourly states, while the blue line stands for the tidal height. The blue square marked some similar patterns discovered.

Fig. 4 shows the transitions between morphologic bar types. X coordinate represents the initial type; Y represents the destination type after transition; Z represents the number of type transitions. From this figure, it can be seen that the transitions from type A to type H occur 1077 times.

Conclusions

In this study, the morphology in the coastal image is divided into 8 categories. The results of ResNet and ResNext are compared. ResNext achieved 98.9% of the best and most stable classification accuracy and the model had good generalization ability. The prediction classification results of the whole dataset are converted into time series. We have utilized FP-Growth, PrefixSpan and MDLats algorithms to discover frequent patterns and motifs that represent the regularity of coastal morphology change in a certain period. Combined with the variation of coastal morphology and the corresponding tidal data, the variation of beach morphology and morphological dynamics is analyzed and discussed.

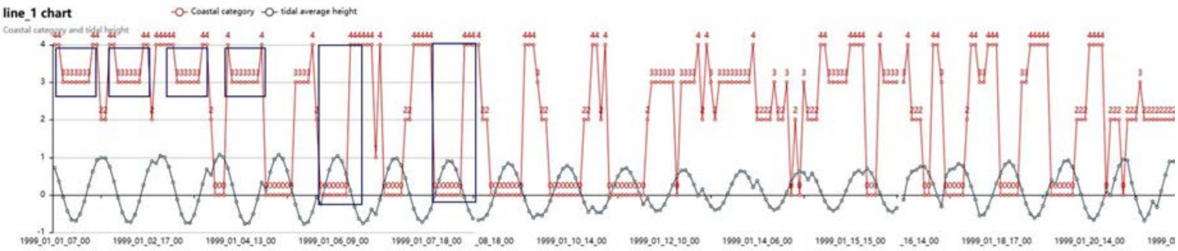

Figure 3. Variation of bar type and tidal height

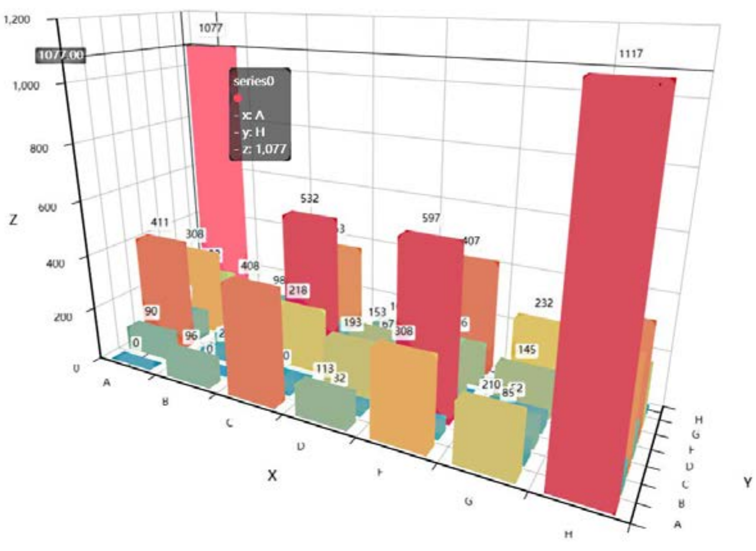

Figure 4. Transitions between morphologic bar types

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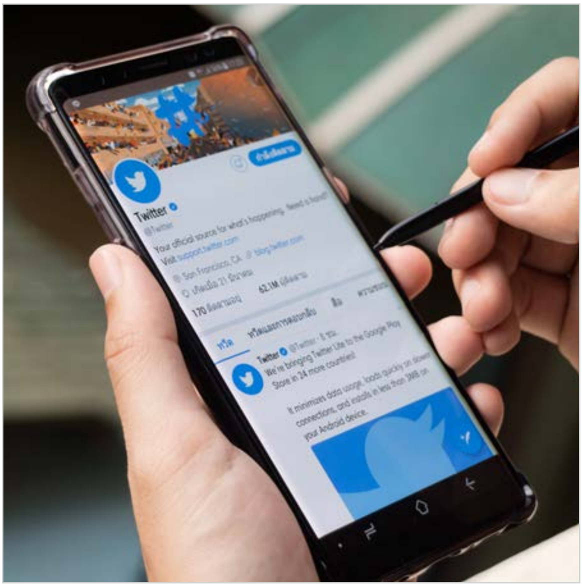
Exploring perceptions towards climate change over time on Twitter

Noel Zeng, Nick Young, Centre for eResearch; Assoc Prof Giovanni Coco, Dr Michael Martin, School of Environment.



Introduction

Anthropogenic climate change is one of the most urgent threats faced the world today, causing major, possibly irreversible disruptions to the biosphere that have already resulted in significant harm to ecosystems and the lives and livelihoods of people in vulnerable communities. Deliberation on the issue in the public sphere is a key part of the effort to counter disinformation, and create policies for adapting to the changing climate and mitigating further damage. One promising approach to investigating trends in deliberation on the issue is through collecting and analysing user generated content from social media networks such as Twitter.

Associate Professor Giovanni Coco and Dr Michael Martin wanted to explore the social media approach and worked with Nick Young and Noel Zeng from the Centre for eResearch on an initial data collection and analysis of Twitter microblog posts ("Tweets") about climate change from August 2019 to early 2020.

We collected 28.5 million Tweets that mentioned "climate change" and variants of the word from 2006 to 2019. We then analysed the emotional content of the Tweets using the sentiment analysis model VADER, as well as data analysis and visualisation tools pandas and Matplotlib. We found a steady decrease in mean sentiment in Tweets about climate change over time, as well as an increase in Tweets that use climate denial keywords since 2017. The results are an encouraging sign that analysing social media data can be a fruitful direction for investigation.

Method

We used the Tweet scraping tool twitterscraper to collect Tweets which contained the keywords "climate change", "sea level rise", "global warming", as well as versions of the words without spaces. The tool worked by requesting the Twitter search page with our keywords as the query, then extracting Tweets from the resulting HTML page.

We came across limits placed by Twitter to mitigate against unreasonable network traffic volume. In response, we worked to stay within limits and ensure the robustness and transparency of the collection process. We split up the scraping task into separate requests, each request querying for one day's worth of Tweets. The requests were sent using Tor anonymisation network. And, finally, we kept a log file of the success or failure of each request.

After we finished collecting the Tweets, we used sentiment analysis to understand the emotional content and intensity of the Tweets. We tried to classify each Tweet based on emojis it used, using an emoji sentiment lexicon – a list of emojis and whether each conveyed a positive or negative sentiment. For example in the lexicon, a smiling face emoji was deemed to convey positive sentiment, while an angry face emoji was deemed to convey negative sentiment. While the approach yielded encouraging results, it only worked for Tweets that have emojis. We found VADER, a model with a human-curated sentiment lexicon attuned to social media texts, to be a superior approach. It analysed text based on the words used and assigned a decimal score between -1 and 1 to indicate sentiment orientation (negative, neutral or positive) and intensity. To classify the collected Tweets we used vaderSentiment, an implementation of the model built with the Python programming language. After classification, we manually read a sample of Tweets classified as having positive, neutral and negative sentiments, to verify the classifications were appropriate.

We then analysed the classified Tweets using pandas, a Python data analysis tool. We used the tool to label each Tweet as positive, neutral or negative based on their VADER sentiment score, and aggregated them by week and month. The dataset was also filtered for Tweets containing the words “fake”, “not real”, “isn’t real”, “doesn’t exist”, “hoax”, “propaganda” and “conspiracy”, to explore trends in Tweets that mentioned climate denial.

Finally, we used Matplotlib, a Python data visualisation tool, to create charts based on the analysis, in order to visualise trends in sentiment and mentions of climate denial.

Results

We collected 28,526,845 English language Tweets that mentioned “climate change” and its variants, sent during 2006 to 2019. (see example in Fig 1,2,3) Due to limitations of the scraping tool and the Twitter search page, nearly half of the Tweets in the dataset are from August 2019, when data collection took place. Tweets in the dataset sent before August 2019 will likely only be a subset of all sent Tweets during the time period.

Despite the limitations in data collection, we observed clear trends in changes to expressed sentiment over time. A steady decline of positive Tweets, coupled with an increase in neutral and negative Tweets can be observed until late 2017, when a noticeable decline in neutral Tweets can be seen. Overall, there was a steady decline in mean Tweet sentiment score over the time period, which may indicate Tweets that mentioned climate change had expressed more negative sentiment.

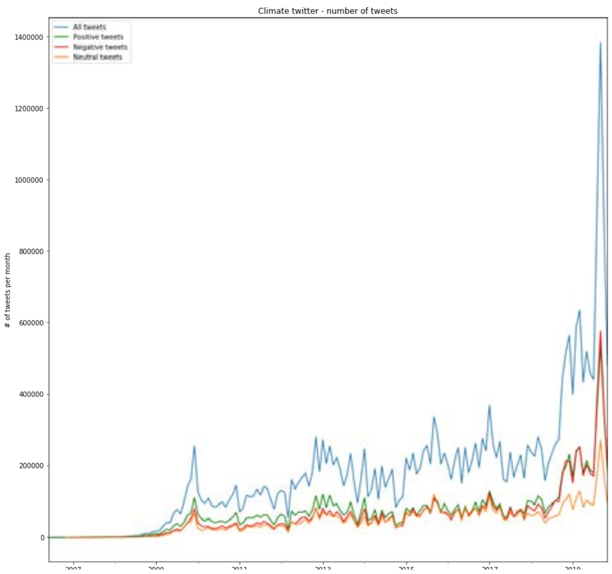
We found 778,166 Tweets within our data that included a climate denial keyword. There was a notable increase in the number of such Tweets since 2017, with notable spikes during certain months.

Next steps

We found clear trends in changes to sentiment and mentions of climate denial keywords over time. They indicate that analysing data from social media networks can be an effective way to investigate the deliberation on the issue of climate change in the public sphere. However, there are limitations of using social media data, one such as bots which are computer programs that can masquerade as humans to post or send messages on social media (see note[1]). Improving the data collection process, filtering out bot activities, identifying themes and communities in Tweets, as well as correlating trends with world events are potential directions for further investigation. We have published the analysis results and source code on *https://github.com/UoA-eResearch/twitter_analysis*, and we are hopeful of continuing this work.

Acknowledgement:
The authors wish to acknowledge the Centre for eResearch at the University of Auckland for their help in facilitating this research, and for providing research compute through the Nectar Research Cloud.

Note[1]: Researchers from Brown University examined 6.5m tweets posted in the days leading up to the month after Trump announced the US exit from the Paris accords on 1 June 2017 that a quarter of all tweets about climate crisis on an average day are produced by bots. It suggested that “substantial impact on mechanised bots in amplifying denialist messages” reported by The Guardian and BBC, see original news https://www.theguardian.com/technology/2020/feb/21/climate-tweets-twitter-bots-analysis, 21 Feb., 2020.



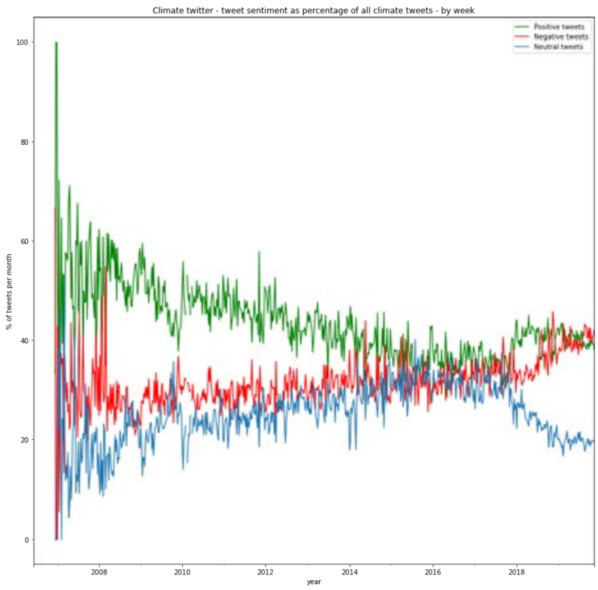
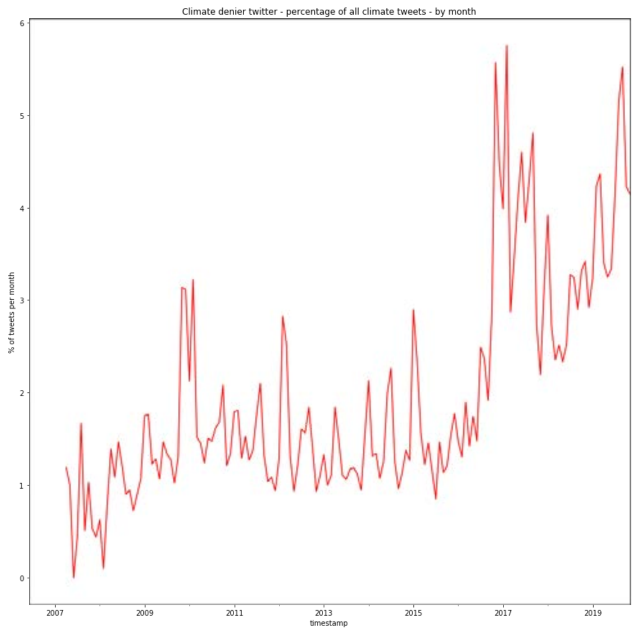


Fig 1.



Timestamp	Tweet text	VADER combined sentiment score
2009-12-31 18:22:08	Well folks, Happy New Year! Venturing out in snow to drive to NH to pick up family for New Year's Eve = gulp haha #tcot #rush #globalwarming	0.919
2017-01-20 22:14:03	2016 Was The Hottest Year Yet, Scientists Declare *http://n.pr/2iJSYwx #globalwarming #clientchange pic.twitter.com/gj5QJAO2VQ*	0
2019-08-23 01:01:58	Climate change is real. The world will not end but human beings starting with the poor Black and Brown ppl will suffer and die because of lack of water, food, shelter, displacement. This is more serious than you think. Please read up on it before making comments without the facts	-0.9527

A sample of Tweets that are classified as positive, neutral and negative by VADER.

Haka on the move: sport circuits and cultural performance

Dr Lisa Fa'anofo Uperesa, Senior Lecturer, Te Wānanga o Waipapa, Māori and Pacific Studies; Nick Young, Centre for eResearch.

Background

In Dr Uperesa's new book chapter "Entangled Histories and Transformative Futures: Indigenous Sport in the 21st Century", she provides a survey of several different Indigenous contexts to highlight longstanding historical and emergent engagements with sport forms to reveal complex genealogies and shifting meanings across time and space. Delving into colonial legacies and indigenous practices, she first explores surfing in the Pacific and lacrosse in Native North America as two customary sports with longstanding Indigenous traditions that have been transformed over time and are thriving today. These coexist with other Indigenous sport activities that have also been revived as part of resurgent efforts toward recognition and symbolic expressions of sovereignty. She then examines how Native communities engage some of the sport forms with colonial legacies, claiming them as their own, imbuing them with meaning, and in some cases transforming them. Finally, with attention to the shifting gender balance in sport participation broadly, she considers the relationship between (gendered) culture and (gendered) sport. This follows on her forthcoming book project that traces genealogies of football in Samoa and Samoans in American football, and offers critical assessments of media representation, labor, service, community belonging, risk and injury, and changing visions of the future.

Haka on the move

Indigenous people use sports as avenues toward recognition, opportunity, and as a way of narrating community identities and achievements to themselves and others, even as they navigate colonial, racist, and marginalizing social dynamics and institutional structures toward new futures.

Dr Uperesa is working on a project that focuses on the movement of haka through global sporting circuits outside of Aotearoa New Zealand, with an emphasis on how it appears in American football contexts. It includes local case studies of the use of haka in sporting and broader contexts in Aotearoa and the United States. The key focus is the movement and transformation of cultural forms in new contexts and the how the debates that emerge around protocol, ownership, and haka as cultural intellectual property intertwine with its importance as taonga in Aotearoa and valued performance of Polynesian identity in the U.S.

One of the approaches is to social media as a kind of digital malae/marae of public discussion and accountability, and involves collecting data to analyse how the discussion unfolds over time and space. For example, Dr Uperesa has been working with Nick Young from the Centre for eResearch to collect retweets and replies to a 2018 ESPN tweet about haka, to analyse any connections and reactions in Aotearoa New Zealand or the US. Nick used various tools to collect tweets, relationships between tweets, and geospatial tags to visualise them in a spatial context.

The original tweet posted by ESPN used the term "LSU Haka". It created numerous responses around the US, see figure 1 below. It was then re-tweeted by Beulah Koale* and went viral. (Figure 2)

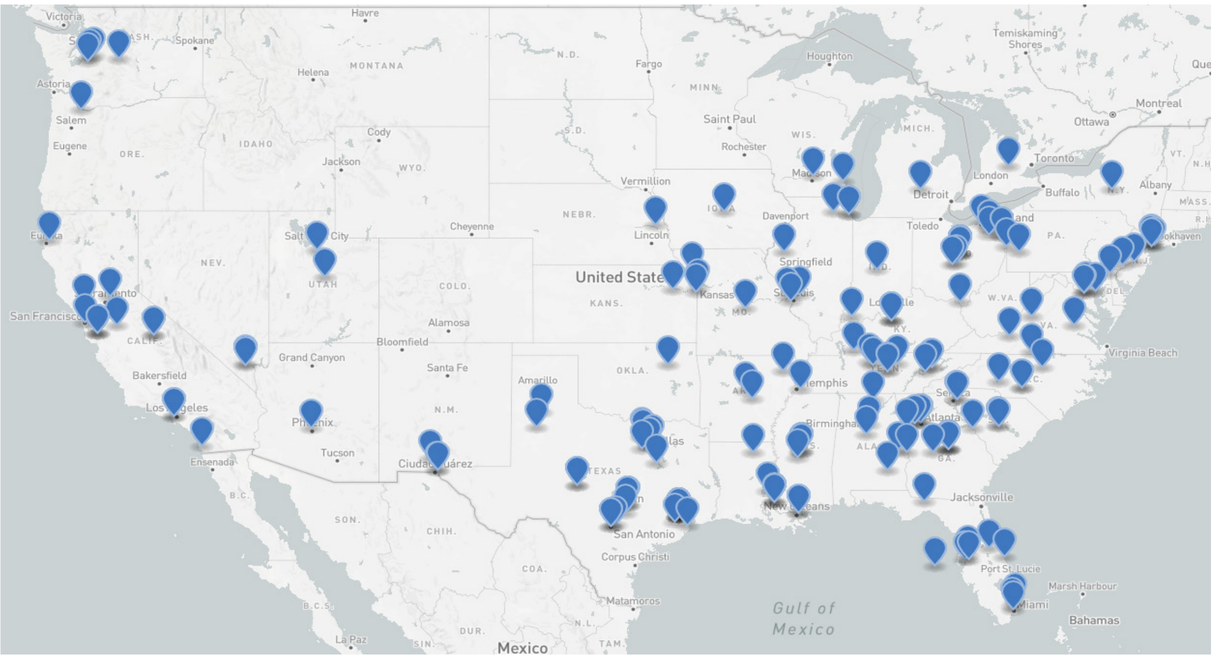


Figure 1. Geospatially tagged tweets in the US in response to the 2018 ESPN tweet

Figure 2. Beulah's reply
** Beulah Koale is a New Zealand-born actor of Samoan descent who portrayed Officer Junior Reigns in CBS reboot series Hawaii Five-0, and was formerly of Shortland Street and other NZ-based productions.*

To analyse tweets, Nick used a tool called twint to collect thousands of tweet ids, and a tool called twarc to fetch the geospatial information. Twarc was also used to see the connection between particular tweets, quote tweets, replies and re-tweets. Twarc was used to visualise data and create a network graph, see Figure 3.

Next steps include a deeper dive into the kinds of issues raised in the discussion, with attention to how people in different places enter the conversation and the kinds of positions they take. This is one of several social media events to be analyzed as a component of the larger project that builds on and amplifies existing work by Maori scholars and practitioners on haka. It will include case studies and talk-story interviews or kōrero with people involved with haka in Aotearoa New Zealand and abroad, alongside performances in sport or other events like Te Matatini.

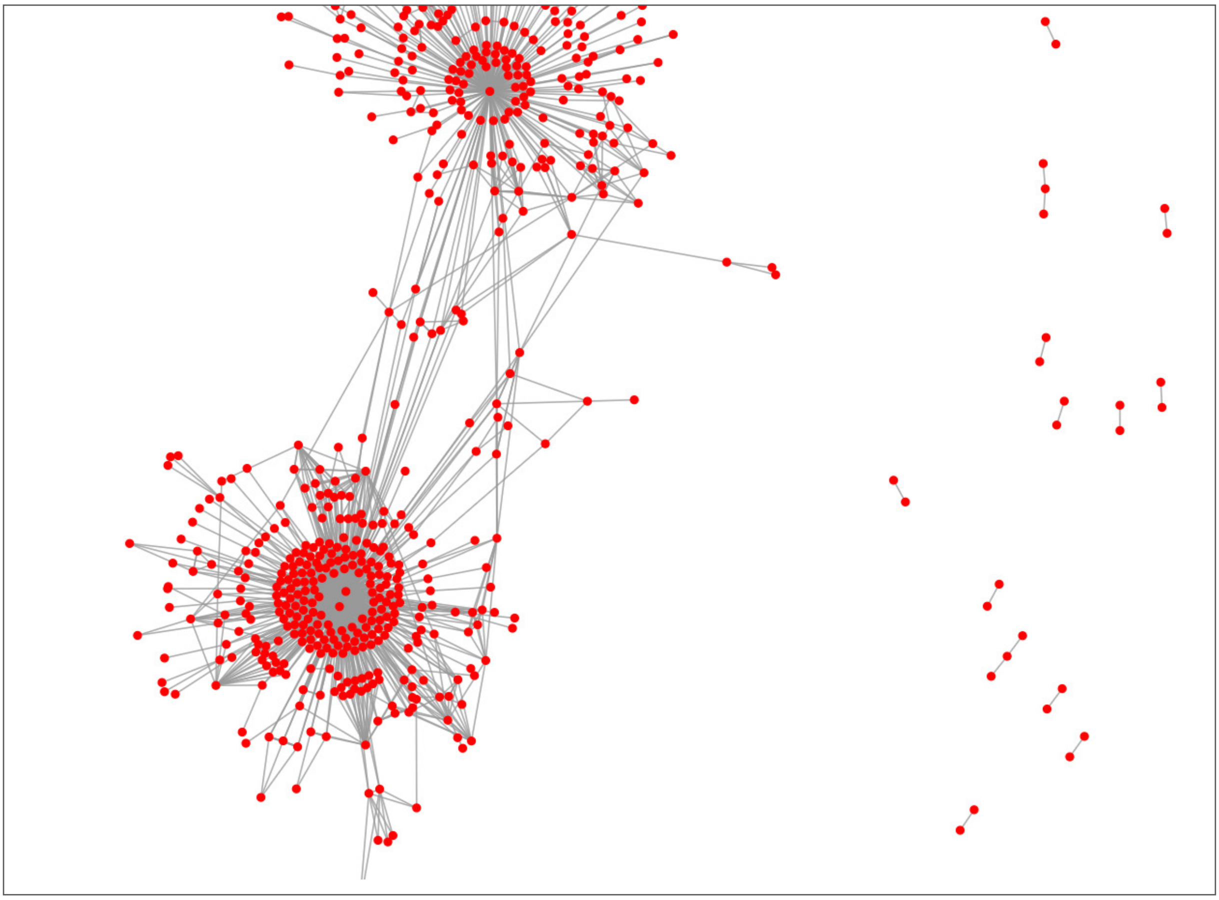


Figure 3. A network graph to show the relationship between the original ESPN reply tweet cluster (bottom) and the "beulahkoale" reply tweet cluster (top)

Data maturity project in High Value Nutrition-National Science Challenge

Dr Dharani Sontam, Yvette Wharton, Professor Mark Gahegan, Centre for eResearch; Dr Simmon Hofstetter, Operations Manager, Professor Richard Mithen, Liggins Institute and Joanne Todd, Challenge Director, High Value Nutrition, National Science Challenge.

About High Value Nutrition Ko Ngā Kai Whai Painga

High-Value Nutrition Ko Ngā Kai Whai Painga (HVN) is a New Zealand National Science Challenge with the vision to grow New Zealand food and beverage export revenue through international leadership in the science of food and health relationships. It is one of 11 national science challenges established in 2014 by the Ministry of Business, Innovation and Enterprise (MBIE) to tackle New Zealand's biggest issues and opportunities. *https://www.highvaluenutrition.co.nz/about-us/*

The Challenge's vision will be achieved through building multi-disciplinary teams to create new platforms, capability and collaborations. A fully integrated programme with a shared conceptual and practical approach is central to HVN's science strategy. In 2019, the Challenge entered its second phase, which is planned to run to 2024.

Drivers for data maturity

The success of HVN in Tranche two and beyond is reliant on an effective data management strategy. As such, HVN approached the Centre for eResearch (CeR) at the University of Auckland in May 2019 to run a data management planning and maturity modelling workshop for the extended science leadership team (SLT). The leadership team identified the need for improving the maturity level within HVN to fully enable the success of HVN strategy.

Following the workshop, the Challenge engaged CeR to support the development and implementation of a data management maturity analysis and prioritised roadmap. A dedicated data management consultant was recruited for the project.

Methodology

A situational analysis was undertaken of the existing data collection and management practices of the research teams and their host organisations for HVN. The situation analysis included a desktop review, data maturity survey, an online research data management survey and follow-up in-depth interviews with researchers and research support staff. Data gathered from the surveys and interviews was used to map the current maturity level within HVN using the data maturity model (DMM) framework.

Outcomes

We identified areas of opportunities that could be targeted to realise the level of data integration envisaged in the Challenge strategy documents. Our findings were presented to the directorate. Their feedback and data goals for the Challenge were incorporated into the design of three options – minimal, optimal and ambitious, that outline a series of steps to transform RDM practices in the Challenge. The options were designed to be incremental in scope with the "ambitious" option requiring the greatest time, effort and funding but also delivering the most comprehensive roadmap to achieve the desired data maturity.

We proposed that a balanced approach that keeps in mind the significant time and effort that an endeavor such as this requires, and at the same time delivers key Challenge data goals.

Next steps

We are streamlining RDM processes starting with one priority research programme (PRP) within HVN. This PRP will be utilised as a pilot group to introduce and standardise RDM. Successful processes will then be extended to other PRPs in an iterative manner. We also aim to outline further steps in HVN's research data management and the data maturity roadmap for the Challenge that enables it to achieve its data goals for tranche two.

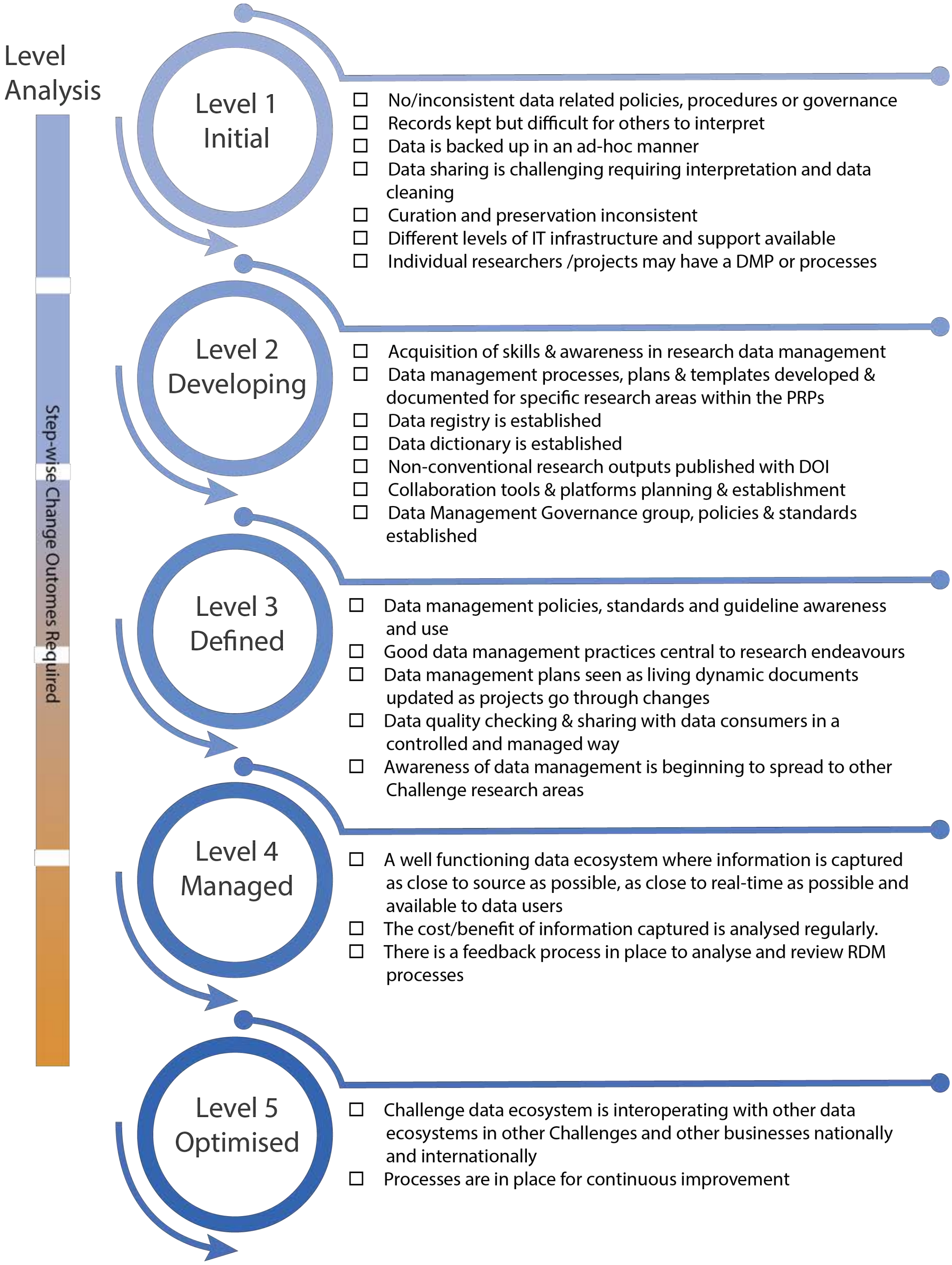


Figure 1: Step-wise changes required to achieve a higher level of data maturity

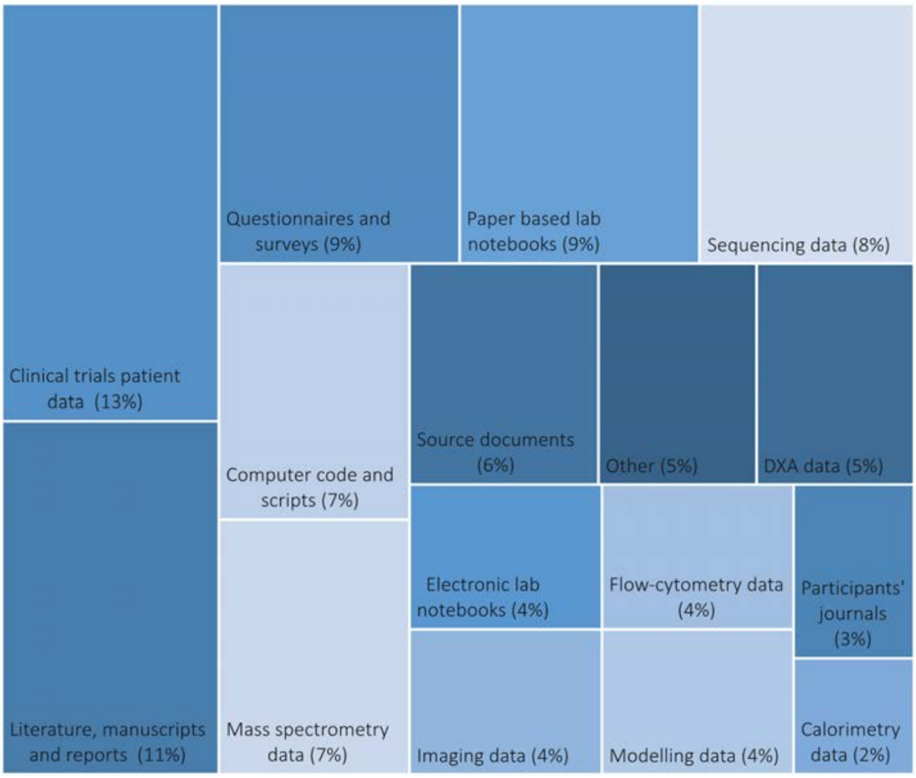


Figure 2 Diversity of data types in High Value Nutrition

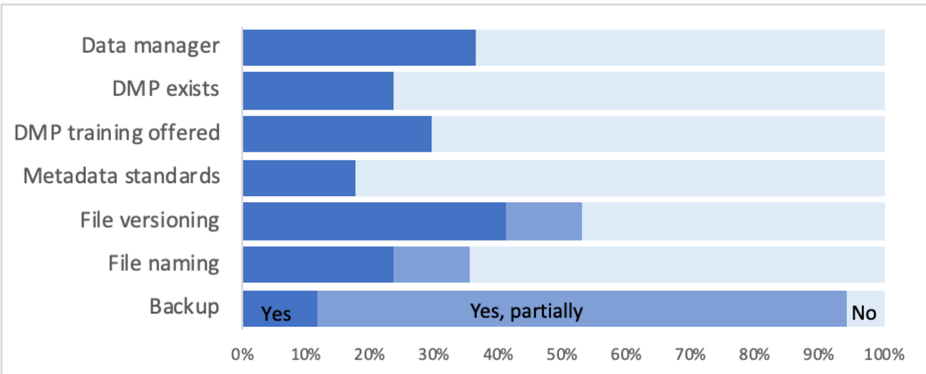


Figure 3 Survey responses that give an overview of current data management processes in High Value Nutrition

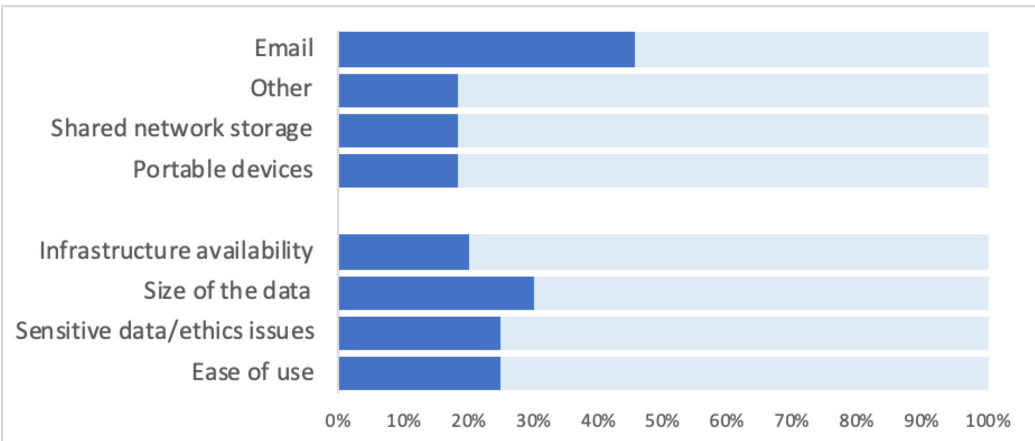


Figure 4 Responses for data sharing for (A) primary mechanisms for sharing and (B) main factors that affect the choice of mechanisms used to share data within High Value Nutrition

Proteins under a computational microscope: designing in-silico strategies to understand and develop molecular functionalities in Life Sciences and Engineering

Dr Davide Mercadante, Senior Lecturer, School of Chemical Sciences.

One word to spell the future out loud

Over the last century, Biology has seen a steady increase in the number of macromolecular structures being resolved by means of either X-ray crystallography, NMR or, more recently, cryo-electron microscopy (cryo-EM). However, even since the early days it appeared clear that structure alone wasn't the endpoint for investigating molecular behaviour. Antibody research in the 1930's showed there were limitations to fully explaining molecular function by solely looking at structure as in order to bind a large diversity of molecules, the molecular structure of antibodies needs to contain a certain degree of plasticity. This suggested that looking at an ensemble of molecular conformations interconverting over time, rather than a single structure, was probably the best way to understand how molecules function. In other words, *a key factor regulating molecular function is molecular dynamics*, which experimental techniques have historically struggled to define at high-resolution. This has on the other hand been successfully tackled by computational approaches that have evolved extremely fast through developments in both algorithms and hardware.

The rapid evolution of molecular hardware has probably been the major developmental factor of the field, with scientists continuously eager to simulate larger molecular complexes, for longer time.

If you were to ask a computational biophysicist like me, to describe the future in a single word, you would probably receive the answer in the acronym GPU. Graphical processing units (GPUs), thanks to their high core density, have revolutionised the computation of molecular dynamics. By looking back just a few years we can see an enormous increase in computational power, which combined with algorithm advancement has allowed scientists to push the boundaries in their understanding of molecular function and design.

Molecular dynamics spans timescales of several orders of magnitudes: from nanoseconds (a billionth of a second) to seconds and beyond. Before 2007, when nVidia introduced the first GPU cards, not only to accelerate graphical applications but also scientific simulations, few hundreds of nanoseconds would take several weeks to simulate. Today, in just a few days we can easily break the "wall of microseconds (μs)", which is where many biological processes occur. Now we can more easily study molecular processes, design drugs to block or enhance cellular targets or even design new molecules that would tackle challenging problems from food safety to biomedics.

My group, which is a recent addition to the research landscape of New Zealand, has been built to fit the purpose of understanding and designing molecular function starting from the simulation of molecular dynamics.

By taking advantage of the computational infrastructure currently available at the University of Auckland via Nectar, we were able to start and progress several projects targeting a variety of purposes: from the improvement of food safety and the reduction of food allergenicity, to the design of sweet proteins to substitute artificial sweeteners. Below, I provide a brief overview of some of the projects currently undertaken by means of molecular simulations strictly interfaced with experiments, all of which have made great use of the Nectar cloud.

Molecular simulations in the cloud – from protein understanding to design

Re-design proteins to make them resist high temperatures

Proteins are the workhorses of cells and perform a myriad of different functions: from providing structural integrity to the cell to constantly transforming metabolites in a highly efficient manner (enzymes). They have evolved over millions of years to fulfil their function, which over time has become optimal for their individual micro-environment. Nevertheless, such a micro-environment does not often match the micro-environment in which industry could make good use of a protein function. A multitude of industrial processes are indeed carried out at temperatures well in excess of the thermal stability of proteins, leading to their inactivation.

We are therefore developing and applying a series of algorithms that look at the sequences of a multitude of proteins to redesign and target their resistance to high temperatures. By aligning the sequences of proteins from common ancestors (homologues) and different species, we are able to identify the protein building blocks (amino-acids) that are important to the fitness of a protein structure. We then mutate these residues and perform molecular dynamics simulations at increasing temperatures to assess the stability of our designs. The best designs are then handed out to experimentalists for the ultimate testing. GPUs play a fundamental role in this as, thanks to the infrastructure in place, we are able to collect the large amount of data required to obtain statistical significance in the trends we observe. This is crucially important as having a high degree of confidence in our designs ensures that the experimental validation of the designed targets will be kept to a minimum of protein sequences. These sequences will therefore have a high likelihood to fit the purpose of the design, enormously reducing experimental costs by leaving the heavy lifting to the power of computational prediction.

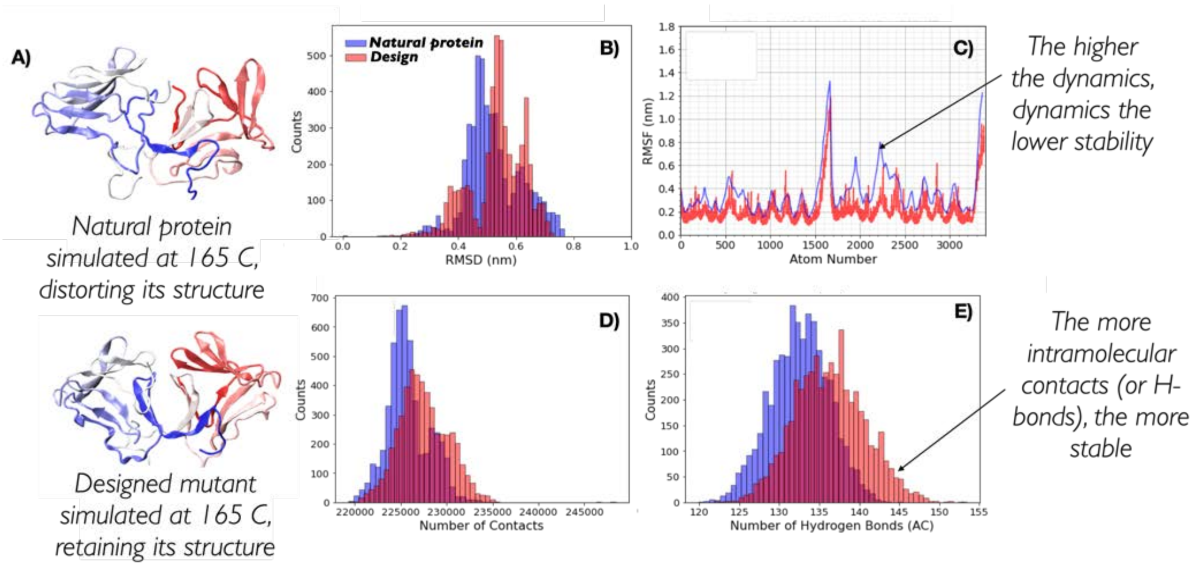


Figure 1. Development of more thermally stable sweet proteins for use in processed food. In panel (A) the wild-type natural protein partially loses its structure at high temperature (top panel, simulations at 166 degrees). The design (lower panel), on the other hand, keeps structural elements intact at the same simulated temperature. This is due to an increase of intramolecular contacts that, through the designed amino acidic substitutions, we can trigger. Overall the larger number of molecular contacts increase the stability makes it resist unfolding at high temperature.

Using pulsed electric fields to increase food safety

One of the largest problems in the New Zealand's food industry is to keep food safe from the effects of pathogens, in particular a strain of E. coli producing a protein called Shiga toxin. Little is known about inactivating the toxin by using non-conventional food processing methods and most of the attention is indeed devoted to prevent the infection of cattle or meat by conventional antibacterial means, which, in turn, means preventing E. coli's growth. We are focusing on an alternative strategy to inactivate toxins in food, by triggering the loss of a toxin's structure by applying pulsed electric fields (PEFs). Applying PEFs consist of exposing food samples to short but powerful electric fields. Nevertheless, nothing is known regarding the effects of PEFs on the stability of proteins. We are performing simulations in which the pentameric Shiga toxin produced by E. coli is exposed to pulsed electric fields featuring different electric field strengths, frequencies and/or exposure times. In our simulations we then monitor the disrupting effects of the applied field on the toxin's structure, which mediates its toxicity by binding receptors on the surface of human cells (Figure 2). Thus, by disrupting the toxin's structure, its ability to interact with human cells and trigger a toxic response would be hindered.

Overall, we thus plan to provide the industry with guidelines on what is required to inactivate the Shiga toxin, without affecting the organoleptic properties of meat. Interestingly, once this protocol is optimised for the Shiga toxin we will expand our study to other toxins, with the overarching goal of bringing the highly predictive potential of molecular simulations to service industry.

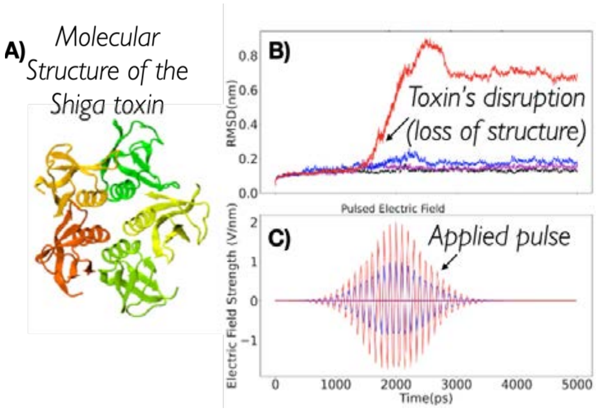


Figure 2 Investigation of the effects of pulsed electric fields on the stability of Shiga toxin. Shiga toxin is a pentamer with identical subunits engaging in a star-shaped structure (A). It Is majorly responsible for food poisoning especially from meat sources. In our simulations we simulate the effects of short pulsed electric fields on the structure of the Shiga toxin. Loss of its structure results in the loss of its infective potential as it would make it incapable of efficiently bind a receptor on the surface of host's cells. An example of the applied pulsed electric field can be found in (C), whereas the loss of structure over the simulated time can be simply followed as the divergence of the molecular structure when compared to the structure of the toxin at the start of the simulation (time = 0) (shown in (B)). With our simulations we aim to guide the industry to the best practices to inactivate this and other toxins.

Rational design of molecular motors to obtain carbohydrates with desired physical properties

Great attention in biology is given to so-called molecular motors. Molecular motors are proteins that can accomplish multiple chemical reactions on other molecules (their substrates) in a highly efficient way. They can perform several reaction cycles without having to dissociate and reassociate from their substrate (for a new reaction cycle). This makes molecular motors very efficient, at the point that they are involved in a large number of fundamental biological processes. In the past, we have discovered a particular class of molecular called Pectin methyl esterase enzymes (PMEs), as they work on pectin. Pectin is a polysaccharide that is extremely important to maintaining the integrity of the plant cell wall and equally crucial to the food industry for its jellifying properties in the presence of calcium. Interestingly, the jellification properties of pectin are strictly related to PMEs, as they control the number of negatively charged sugars that promote jellification by binding positively charged calcium ions.

With an ad-hoc computational workflow we are therefore trying to answer the following question: is it possible to design new PMEs so to have a selected amount and distribution of negatively charged sugars and control the jellification properties of pectin for targeted uses in the food industry? Our intent for this project is to design PME enzymes that are able to provide pectin with defined physico-chemical properties, by modulating the charge distribution of pectic polysaccharides upon the modifications promoted by specifically engineered PMEs (Figure 3). Besides PMEs, their natural inhibitors (called PME inhibitors or PMEIs) are of paramount importance for the food industry as, by stopping the activity of PMEs in fruit, they can control fruit juice clarification, often hindered by overly charged pectin in juice. By increasing the thermal stability of PMEIs we are designing new inhibitors that can be applied in high-temperature food processing processes of fruit juice manufacturing.

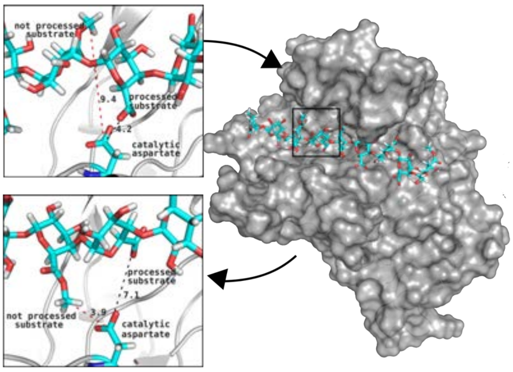
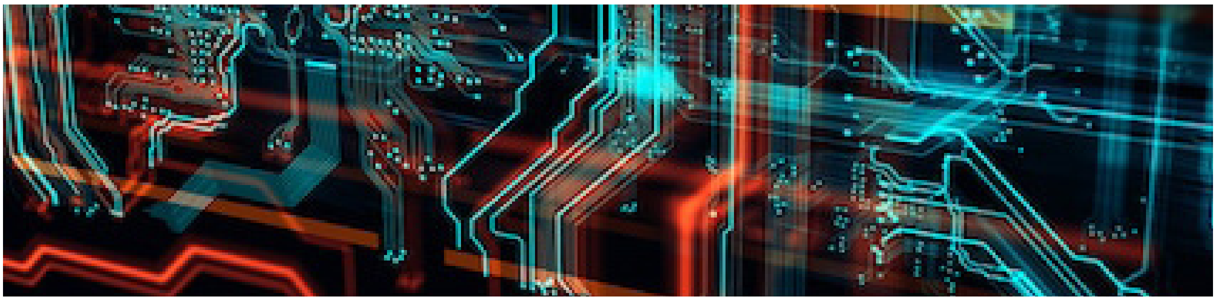


Figure 3 Design of enzymes for the controlled production of polysaccharides. Pectin methylesterase enzymes (PMEs) modify pectin by removing a methyl group and exposing a negative charge for each catalytic cycle. The amount and distribution of negative charges in a pectin polysaccharide controls its physico-chemical properties, its ability to jellify and ultimately its applicability in food applications. In their natural working environment, PMEs act on pectin in the plant cell wall controlling the softness of the wall, ultimately controlling plant growth and development. Bacterial and fungal PMEs, on the other hand, are heavily involved in plant parasitism, functioning as means to break down the plant cell wall by modifying pectin.



Molecular simulations in the cloud: from highly parallelized to highly replicated runs

Molecular simulations aiming to sample the dynamics of molecular systems, either through Monte Carlo methods or integrating equations of motion over time, are heavily stochastic. The conformational space of even small molecules is enormous and computational sampling of the functional space (let alone the whole conformational space of a molecule) is extremely challenging. For the simulation of larger molecular systems, scalability of molecular dynamics codes allows us to split the computation, in other words the molecular system, across a large number of computing nodes that work in parallel. Molecular dynamics simulations are "infamous" for being heavily parallelised. However, besides the need to simulate ever-growing molecular systems (composed of several hundred thousand to millions of atoms), statistical robustness is also required to achieve confidence for the claims of a scientific study. To obtain this, it is a must to perform several molecular dynamics simulation runs (replicates), starting from slightly different initial conditions (i.e. the initial velocities assigned to the particles to simulate) and to monitor the evolution of the simulation, finally obtaining population-averaged via time-averaged results.

Replicates are virtually independent from each other, and for smaller molecular systems do not need a heavy parallelisation scheme or multiple nodes. Moreover, especially considering the power of GPU computing, longer timescales, which are directly linked to the investigation of molecular function, can be accessed.

Overall, the need to simulate a large amount of replicated simulations, with small differences in the set of initial conditions, makes this problem highly suitable to be set up in a cloud-based infrastructure: with several replicates running on separate instances that do not communicate or work in parallel. With respect to these needs, Nectar instances are an invaluable resource for the understanding and design of molecular systems through molecular dynamics simulations.

What's next?

There have been two recent hirings in the School of Chemical Sciences at the University of Auckland: one in the field of computational biophysics and another in physical chemistry with a particular focus on computational research. These have undoubtedly increased the need of computational resources deployed towards the study of fundamental chemistry and the design of new molecules optimised for industrial applications.

Cloud-based systems can play a fundamental role in this, provided that they would be able to overcome hurdles that often characterise the setup of new workflows. These hurdles can be mostly identified in two immediate needs: (1) the need to have automated workflows that allow the ready setup of molecular simulations and (2) the necessity to have a critical amount of GPU-accelerated instances that can promote competitive research.

While the former can be quite easily addressed by directing expertise towards the development of configuration scripts that would make simulations run smoothly on different instances, the latter is a matter of an economic nature, requiring strategic investments and tactical planning. Initiatives directed towards the equipment of existing non-GPU accelerated instances with GPUs, the creation of hybrid infrastructures featuring both nVIDIA and AMD GPU instances and flexibility around the mainstream setups of data centres, are most likely key points to promote cost-effective but at the same time competitive research that can take enormous advantage from having a local GPU-enhanced computational infrastructure.

Annual Survey

Survey result

The Centre conducts an independent university-wide researcher survey each year. In order to capture as many research outputs as possible, we tied the 2020 annual survey with the year-end PBRF (Performance-Based Research Portfolio) reporting cycle to avoid multiple responses efforts.

We have recevied over 500 responses to the survey - the highest number of responses since 2017 and an increase of 54% over 2019. This annual survey is to understand how our service offerings are able to meet researchers' needs and demands, and their views on what are important eResearch services, and how we can make continuous improvements to these services.

Figure 1. below is to measures the scale of researchers satisfaction with our various services, including 1) if they receive adequate support, 2) whether the services meet their needs, and 3) if they feel comfortable recommending these services to colleagues.

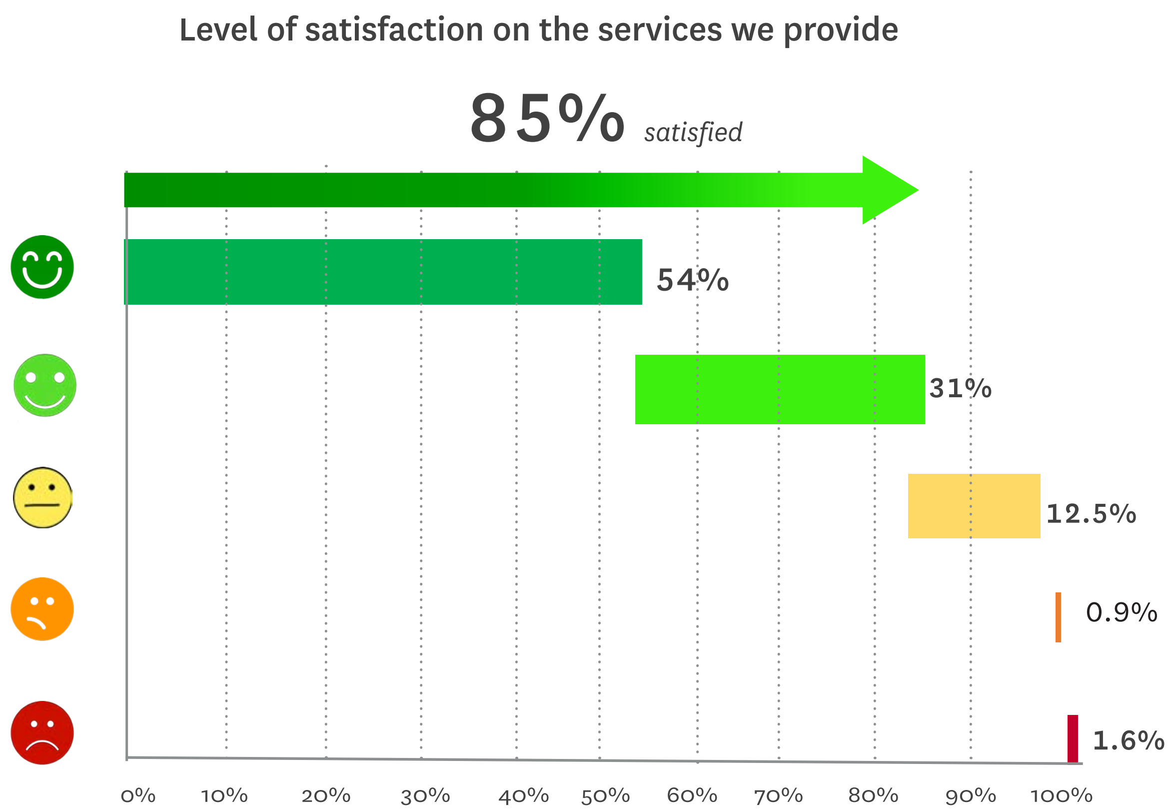


Figure 1 Percentage of respondents reported the level of satisfaction on CeR provided services in 2020

Researchers’ feedback

Thanks to the responses from our researchers, we have received largely positive comments about our services. Here are some of the feedback and constructive suggestions about our services and the improvements that we can make further.

My research group’s genomic and bioinformatic work in UoA would simply not have been possible with CeR’s advice and services. My group and I have been lucky enough in particular to have assistance from Yvette Wharton, who has been highly competent, imaginative in her solutions, friendly and tolerant as well as being a great communicator and having a can-do attitude. She has taken the trouble to get inside our pain points and help address them - she is a fantastic asset to CeR. We have also been lucky enough to work with Libby Li who has provided a significant boost to my group’s work in terms of bioinformatics software use and development - MyTardis development and Data Management Planning. A sincere thank you from us all!
- Medical Science, Molecular Medicine and Pathology

I think you are already doing everything really well. The VM I had fulfilled all my needs, and it was extremely useful in all aspects of my research.
- Civil and Environmental Engineering

I found the original RVM much easier to use than the Nectar RVM. It is very intuitive. I am about to do the Nectar tutorials that Martin sent me today so hopefully I find it easier after that. I have three papers under review relating to VM with the Centre for eResearch acknowledgement included, and some of those should be published soon. I appreciate the help given to me by eResearch in using the RVM services
- School of Environment

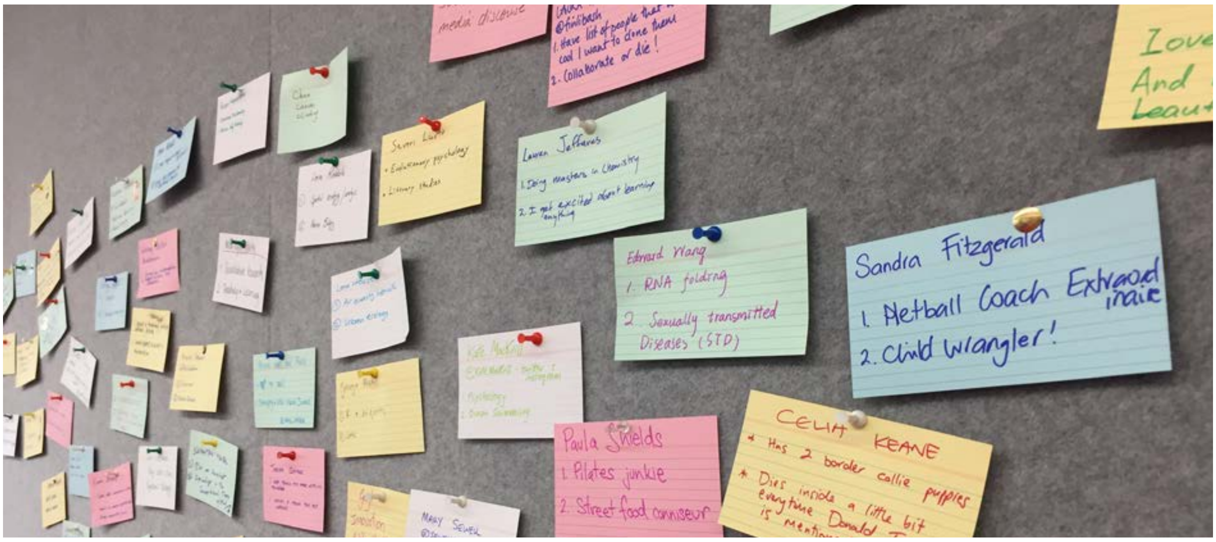
The CeR provide excellent services and help, but more training and support on how to store and use data effectively would be good.
- Biological Sciences

Your services are great! I had to have some delays in my research experimental part. I needed to validate my numerical modelling due to the COVID lockdowns and equipment failure, but I am doing my best to get things sorted and proceed with my numerical modelling as soon as possible. Thanks very much again for the service!
- Civil and Environmental Engineering

I have no issue recommending CeR to students and colleagues who seem to be able to get everything they need up and running efficiently with great support. We are slowly looking to migrate some existing services from in-house VMs to (most likely) Nectar. We have a student working on some natural language processing that might look to start using GPU capabilities, but would expect this to easily fit into existing eResearch infrastructures.
- Bioengineering Institute

Centre for eResearch has been very easy to work with and forth-coming with their services. My request was handled extremely quickly and the services themselves were organised and easy to work with. I am grateful to the leadership and organisation of Centre for eResearch for making it easy for researchers to use these resources.
- Bioengineering Institute

The Virtual Machine you provided has been really helpful, and is helping me get my first Journal and Conference papers ready. Support team who helped me set it up has been excellent, thanks everyone.
- Department of Electrical, Computer and Software Engineering



I am still collaborating with some overseas researchers and value having ad hoc access to this Virtual Machine allowing for data access / processing which I could not do otherwise. Many thanks.
- UniServices, Commercialisation

The Dropbox team has been amazing and super helpful!
- Biological Sciences

I appreciate the assistance of eResearch, but because of the Coronavirus, there is not any research production now. Hope I can have more outputs before graduation.
- Civil and Environmental Engineering

More 'permanent' type allocations/images, so there is less time spend on setting things up. Some ideas include the ability to save 'images'. Another idea is to increase/decrease memory allocations more dynamically, such as a way for the system to recognise that my instance is running out of memory, allocate more, and claim it back once the task has completed/memory is no longer needed.
- Management and International Business

While your service is very useful, my project appears to be an unusual cross-over within the University between academic and professional, which means my technical needs have not always been well understood.
- Strategic Engagement, Alumni Relations and Development

This service is truly lifesaving. I feel carefree from the pain of storing data, sharing or having options for collaborative working. It is simply amazing and a MUST have for PhD researchers.
- Information Systems and Operations Management

Support has been great! made it easy for us to work as part of a team.
- Population Health, Social and Community Health

Some hands-on training or tutorial will help to enhance the knowledge of the user. The system often crashes for GUI. By enabling additional features and hand-outs will help researchers
- Liggins Institute

Thank you for all your support over the past year, once again.
- Medical Science, Molecular Medicine and Pathology

Thank you for a great service and support. In particular, the use of the UOA Dropbox was an enormous help for this shared project. We were only limited by the functionality of the software we used for analysis. At some point, it would be good to discuss with you how we could have managed that aspect better.
- Faculty of Science, Psychology

This is very important for collaborations in quantitative research.
- Faculty of Business and Economics, Property

Outputs from this year are still in prep. But it has also been used for testing different things for project proposals as listed in the recently awarded 'Grants' section. Future needs will fall within the current allowable VM constraints. The eResearch Slack workspace is really good - far faster and easier to sort out any issues than other tech support (raising tickets, back and forward emails etc.)
- Civil and Environmental Engineering

The Nectar services are fantastic, Sean in particular is great to work with. On the other hand, programming and long-term software support is something we really need that isn't provided for free. If we could develop something with the involvement of eResearch and have them provide some longer time support to the project (at least until we hit a certain milestone), it would be incredibly useful to us. This is make or break when it comes to publishing.
- Information Systems and Operations Management

I welcome automated deletion, but I would really like to have capacity to designate certain directories as excluded from the deletion rules without doing this on a case-by-case basis.
- Biological Sciences

eResearch support team has always gone above and beyond to make sure that these services are well managed, with proper support to the students that use them. I want to express high commendations for their continue efforts in bringing proper research data management to the University.
- Liggins Institute

The Centre for eResearch are extremely helpful in supporting my research needs and communicate clearly. Yvette made time to give me a phone call to explain the procedure required to set up a larger Dropbox capacity to support my work and Martin is always responsive and supportive when it comes to the VM we use.
- Psychology

The allocated CPUs are running at comparably lower speed (GHz) than regular desktop PC, which makes me hesitate to use the Virtual Machine as my first choice for running my codes. I am using Matlab, and the run-time is dependent on the CPU speed.
- Mechanical Engineering

The Dropbbox provides an incredibly important and fundamental service.
- Biological Sciences

Excellent service that enables critical data sharing amongst my group and enhances research productivity and outputs.
- Chemical Sciences

I have a lot of issues accessing my data over VPN. it takes 1-3 min to open a folder.
- Medical Science, Anatomy and Medical Imaging

My field involves oral health education in adults with disability. My only request is that universities talk to each other to share database and journal articles for students who try to bridge the gaps in science through our research.
- Faculty of Science, Psychology

The drive provided by eResearch has been an valuable asset for our lab. We are able to keep all of our sequencing data in one place.
- School of Medicine, Surgery

The Haka is so important to New Zealand yet its appreciation and understanding of it is left far behind. With eResearch support, this research definitely elevated my understanding of indigenous people and sport especially in a settler country.
- Maori and Pacific Studies

Excellent service and help from CeR. Currently, finding the limitation on VM storage is a bit of a pain: to move data, process and move off again to a research drive for storage. However, it is not terrible and is manageable. Also, one point of contact for well used VMs might be advantageous, so that CeR person knows the set-up, quirks and inter-dependencies and longer terms needs of a particular research/VM user group. But again that is a nice to have bonus and not essential for what is a great service already.
- Psychology

I've enjoyed using a Virtual Machine. Everybody was so professional and every problem I encountered was solved in a matter of hours and sometimes even minutes. I couldn't be more happier with the service I have been getting. Thank you!
- Mechanical Engineering

Martin and Bianca were more than helpful with any request I had. I can't thank you enough for giving me a chance to speed up my research.
- Mechanical Engineering

Great service! Especially during the lockdowns, we managed to be productive thanks to the VMs we had.
- Electrical, Computer and Software Engineering

Really happy. Especially with Nectar.
- Mechanical Engineering

I guess I don't know what is possible, but at the same time, have little time to find out what could be possible. That's not the fault of eResearch, as the Centre already provides plenty of opportunities for people to attend workshops/ HackyHours etc. It just is.
- Environment

Thank you for the ongoing, brilliant support!
- Psychology

World-class employees, service and equipment. Thank you for your help.
- Faculty of Medical and Health Sciences Administration

My work involves dealing with large image files and specialised software, often too demanding to run on standard work computers. Having access to more processing power would be very helpful.
- Biological Sciences

Clearer advise around vault vs archive storage and more information on available Virtual Machines would be good.
- Biological Sciences

An excellent service. I use the Dropbox service frequently. CeR has been very good to my research over the years.
- Mathematics

I find the service to be fantastic. I always get prompt and efficient responses when I need help. I would be slowed down in my work output if I didn't have access to this service. One thing I haven't asked is how I could have more storage to be able to store more data at once on the device. Currently, I have to transfer, process then delete data and I regularly need to transfer it again for subsequent steps in my analysis. A lot of the work I do produces spectrograms which seem to require a lot of graphics power. Sometimes Matlab crashes when I try to plot these data heavy figures, so improving the machine in that way would be very useful.
- Marine Science

I would like to thank for the excellent work of the support team. I will need more memory (at least 32 G) and also faster processing cores (if available) for my research in near future as the recent versions of Electronic Design Automation tools (which I use for the HW/SW co-design research) require more memory to use all their new features.
- Electrical, Computer and Software Engineering

The Research Drive has been useful in terms of storing video data for our research project. But I have a concern that two names listed in this project as the team members that I do not recognise. I sincerely hope they do not have access to this confidential data.
- Counselling, Human Services and Social Work

Very happy with the Research Drives that I have. I am anticipating using this service even more for future projects with the ability to host content online too.
- Bioengineering Institute

I find all of the provided resources meet all of my research needs.
- Psychology

Extremely useful services and staff who help assist you when needed.
- Civil and Environmental Engineering

It is great to use the eResearch service. Thanks for the help.
- School of Computer Science

The Dropbox service has been an invaluable resource for our work, enabling us to store, share and organise significant volumes of data.
- Medical Science, Molecular Medicine and Pathology

Easier accessibility to GPU would be awesome.
- School of Computer Science

Accessibility to GPU would be great to train Deep Neural Network.
- School of Computer Science

Not enough CPU and RAM allocated for extensive use.
- Computer and Software Engineering

I've included two publications that relate to the Knowledge-Rich School Project and can confirm that I signed a Book Contract with Routledge Publications last month for my book, 'Trans Acquisition Pedagogy for Academic Achievement in Bilingual and Immersion Education'. In respect to our research project entitled, 'Te Ao Tua Atu - The Next World for Te Reo and Tikanga Māori', Associate Professor Tony Trinick is writing the Literature Review and I am writing the Research Report for submission on December 18th to complete the project. I am looking to apply for further funding to continue my research which focuses on Virtual Technologies next year and would welcome any support that the Centre for eResearch can provide.
- Education and Social Work, Te Puna Wananga

I understand there was a talk of merging the Virtual Machine service (the one that I use now) with Nectar (which I registered a trial project for). But getting the Nectar set up (and getting more RAM?) was really hard and I didn't use it. If this happens, how do we make sure the data that is linked to the VM is not overseas? (Thinking about potential jurisdictional risk/data sovereignty issues.) A large part of the reason I like the VM service is the level of support offered (as in Nectar very much a 'self-service' - which is fine. But I would be dishonest if I didn't say this was a barrier to entry, at least for me personally). If there was some kind of merge, I would personally like to see a continuation of the kind of support offered for the VM service. I totally get that it's not all about me though, obviously, and that it's a large task ask!
- Medical Science

I received invaluable guidance and input from the Centre for eResearch after writing my first study protocol and obtaining ethics approval. This study gathers sensitive health information and required a robust and comprehensive plan for data sharing and storage. The Centre for eResearch assisted me in planning this and provided a template, guide, and links to appropriate documents to help me undertake this research with a high level of respect and care for the data. I now know about data management plans and have shared this information with my supervisory team (who didn't know about DMPs - this was disappointing). The Centre for eResearch has been invaluable at bringing this 1st year PhD student up to speed with current approaches, including ethics, of data management - thank you.
- Liggins Institute

I think that the UoA's staff already provided an excellent services which was very helpful to recognise my project needs. With the current popularity of TPUs, which seem to perform better than GPUs, it is necessary to provide this platform in the future. I also hope there is a tool to estimate GPU/TPU needs automatically by providing source code and sample data. With this tool, researcher can assure that the code can run error free and that GPU / TPU allocation can be done easily.
- Bioengineering Institute

It's been quite a lot of work for my former Post Doc who is now based overseas to get results from a previous project (now effectively closed) off your servers so that we can write the paper. I think this might have been partly our fault for letting the project close. And you guys have been working hard to help us. But its taken a long time, involving various issues with user accounts etc.
- Psychology

I have started using the Dropbox for other projects, it would be great if you captured this data, as the initial project I got access for is now on hold, but the Drobbox is still being used for other projects.
- Population Health

Center for eResearch is doing a good job.
- Information Systems and Operations Management

We were very impressed with the possibilities for using your services. However, we did not get the research funds, so were unable to advance our work in this area. However, since our meeting, we have shared the value that we think the Centre for eResearch can offer. I think we can do a lot more in the Pacific social science space.
- Social Sciences, Development Studies

The Dropbox is extremely useful to our group! We will have outputs coming out next year that we will be happy to link to the service, thanks!
- Pharmacy

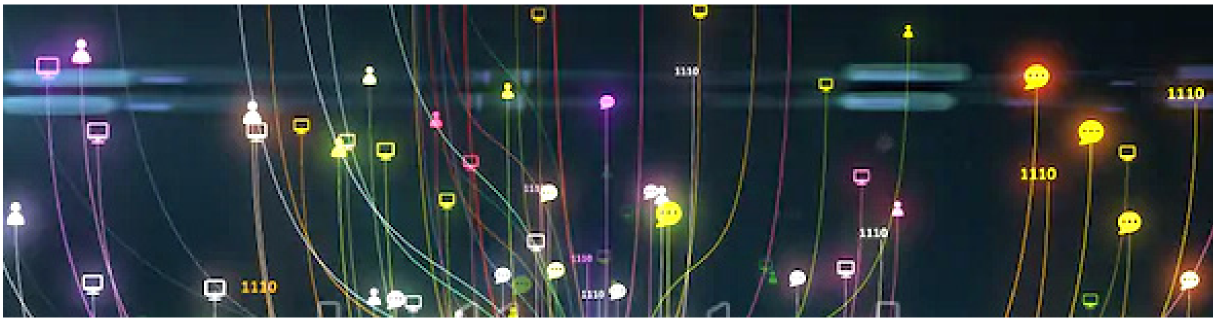
I actually didn't use your services to set up this research website. The biggest hassle was getting ethics approval. It appears there are no protocols or guidance to assist researchers using web-based data gathering. Fortunately, Elizabeth Visser was extraordinarily helpful in getting through the UoA 'cat-and-mouse' ethics approval process.
- Management and International Business

I think I have not just maximised the use of the service. It's been a pretty rough year.
- Social Sciences

The Dropbox shared drive has been extremely helpful for coordination across several members of the research group.
- Civil and Environmental Engineering

CeR Vis Suite space has been excellent to use, as have access to HoloLens, crucial for our AR project.
- Oncology

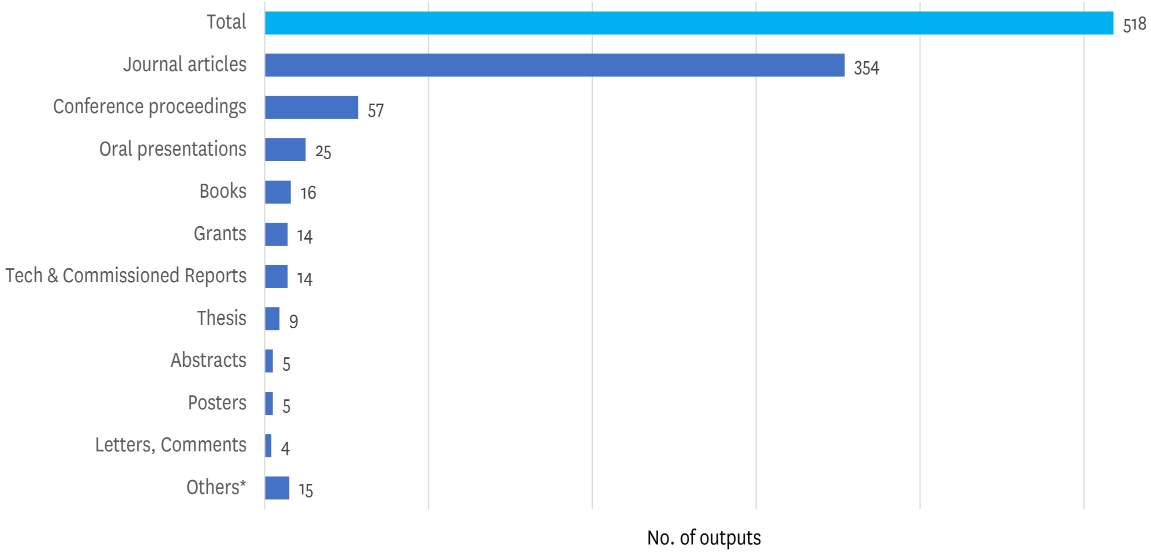
We value the accessibility of GPUs for graphics station uses with VM functionality and eResearch support.
- Bioengineering Institute



Research Outcomes

The following graph provides a summary of research outcomes by category. These outputs are based on the Centre's annual survey, and only represent those who responded to the survey, so it is likely that some research outcomes are not included. However, we have captured over 500 reported research outcomes that are related to the Centre's services and support - an increase of 24% over reported outcomes in 2019 . The most significant increase is in the Journal Articles with 82% more than 2019.

Research Outcomes by Category



** Including media release, webpapge, under review, award, preprint, paper accept yet published, paper in preparation, software release.*

Journal Articles

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35. *Montano, J., Coco, G., and 26 co-authors, Isolating time scales of drivers and shoreline response to predict shoreline changes, Ocean Sciences 2020, San Diego, USA (Online conference)*
36. *Morgan C, Dong Z, Lythgoe D, Tippett T, and Melzer T. (2020) Quantitative susceptibility and R2* mapping in mild cognitive impairment and early Alzheimer's disease. International Society of Magnetic Resonance in Medicine (ISMRM) Annual Conference*
37. *Osanlouy, M., Sanchez, M., Maso Talou, G., Babarenda Gamage, T., Nielsen, P., & Nash, M. (2020). Statistical shape analysis of the female pectoralis major muscle. In Virtual Physiological Human 2020. Paris (Online). Retrieved from https://vph2020.sciencesconf.org/*
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40. *Rasco, A., Chan, J., Peko, G., Sundaram, D. (2020). FinCraft: Immersive Personalised Persuasive Serious Games for Financial Literacy Among Young Decision-Makers. In Proceedings of the 53rd Hawaii International Conference on System Sciences (pp. 32-41). Manoa, Hawaii, USA: University of Hawai'i at Manoa.*
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47. *Shadi Esnaashari, Lesley Gardner, Tiru Arthanari, Michael Rehm, Olga Filippova, The Role of Motivation and Strategy Use in Predicting Students' Performance in a Blended Learning Environment. International Conference on Information Systems (ICIS), India (2020)*
48. *Sundaram, D., Sadovykh, V., Peko, G. (2020). Introduction to the Minitrack on Decision Making in Online Social Networks. In HICSS (pp. 1-2). ScholarSpace.*
49. *Thangavelu, S., Janczewski, L., Peko, G., Sundaram, D. (2020). Commercial Drones: Peeping Tom or Precision Operator? A Governance, Risk and Compliance Framework for a Secure Drone Eco-system. In AMCIS 2020 PROCEEDINGS (pp. 5 pages). ELECTR NETWORK: ASSOC INFORMATION SYSTEMS.*
50. *Vahid Zahiri Barsari; Duleepa J. Thrimawithana; Grant A. Covic; Seho Kim. A Switchable Inductively Coupled Connector for IPT Roadway Applications. IIEEE PELS WoW 2020*
51. *van Hal, V. H. J., Zhao, D., Gilbert, K., Gamage, T. P. B., Mauger, C., Doughty, R. N., . Nash, M. P. (2020). Comparison of 2D Echocardiography and Cardiac Cine MRI in the Assessment of Regional Left Ventricular Wall Thickness. In Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics) Vol. 12009 LNCS (pp. 52-62).*
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53. *Wei, S., Liu, J., Allan, G., Groutso, T., Chen, J. J. J., Taylor, M. (2020). Aluminium Smelter Crust - Phase Distribution and Structure Analysis of Top Zone Layer. In A. Tomsett (Ed.), Light Metals 2020 (pp. 644-652). San Diego, California, USA: Tms.*
54. *Xiaojie Liu, Ulrich Speidel. On an Alternative Approach to Congestion Detection in Ad Hoc Networks, accepted to proceedings of International Symposium on Information Theory and its Application (ISITA) 2020*
55. *Ye, X., & Manoharan, S. (2020). Marking Essays Automatically. In The 4th International Conference on E-Education, E-Business and E-Technology, June 2020 Pages 56–60, https://doi.org/10.1145/3404649.3404657*
56. *Ye, X., Zhang, M., & Liu, Z. (2020). A Natural Language-based Flight Searching System. 2020 5th International Conference on Computational Intelligence and Applications (ICCIA), Beijing, China, 2020, pp. 172-176, doi: 10.1109/ICCIA49625.2020.00040*
57. *Yiu, C.Y. (2020) Why The Housing Prices Of International Cities Suddenly Drop Together? An Intervention Test On Foreign Buyers' Impacts, PRRES Conference, Canberra.*

Oral Presentations

1. *Andrew J. Mason, Peter Keegan, Catherine Watson, Liam Morris, Pio Miguel de la Fuente, Rebecca Tonacao, "Linguistic Analytics: Using Network Models and Optimisation to Model the Adoption of English Words into Māori", presented at Informs Nov 2020.*
2. *ASSAB 2020 virtual Conference: first prize for best 3 minutes talk (1/54 candidates): " Individual vocal signature*

recognition using machine learning algorithms in an Aotearoa bird, the tititipounamu (rifleman, Acanthisitta chloris)"

3. *Bay, J.L. (2020) Adolescence and Lifelong Health: Getting it right before the first 1000 days. Liggins Institute Public Webinar, University of Auckland, 30 June, 2020, Auckland, New Zealand.*
4. *Bay, J.L. (2020) Intervening through education updates: COVID-19 through youth voices, Invited keynote. DOHaD ANZ Digital, 24 June 2020, Online, Australia*
5. *Chisholm, H., Howe, A., .Best, Emma, Petousis-Harris, H (2020). Using administrative data to investigate risk factors for pertussis vaccination failure. Department of Paediatrics: Child & Youth Health, 29 September 2020. Invited talk.*
6. *D'Silva, S., & McNeill, R. Inequalities in the Timeliness of Treatment of Cancer Patients in New Zealand. In 11th Health Services and Policy Research Conference. Auckland, New Zealand.*
7. *Ensing J.X., van Wijk, K., Sporli, K. B. (2020). A 3D shear speed model of the AVF crust, DEVORA Forum*
8. *G.R.P.Arachchige, E.B.Thorstensen, M.Coe, E.J.McKenzie, J.M.O'Sullivan, C.J.Pook. LC-MS/MS quantification of fat soluble vitamers – A systematic review. Analytical Biochemistry, Vol 613. https://doi.org/10.1016/j.ab.2020.113980.*
9. *Gavey, N. (2020). Beyond consent: Sexual violence prevention with young men. Winter Lecture Series, University of Auckland.*
10. *Hildreth, J.R., Vickers, M.H., Wall, C.R., Bay, J.L. (2020, November). First 1000 Days: New Zealand Mothers' Perceptions of Early-life Nutrition Resources. Presented by J Hildreth at DOHaD Australia and New Zealand Digital Trainee Conference, November 11, 2020.*
11. *Invited keynote. "Round about Machine Learning", International Conference on Coastal Engineering, September 2020, Sydney, Australia (online)*
12. *King VJ, Gunn AJ, Stone PR, Bennet L. Maternal sleep in late gestation pregnancy. Oral presentation, Medsci 2020.*
13. *McNeill, R., & D'Silva, S. Timeliness of Treatment for Different Cancer Types in New Zealand. In 11th Health Services and Policy Research Conference. Auckland, New Zealand.*
14. *Muthukaruppan A., Blenkiron C., Curran B.R., Fitzgerald S., Lois E.J., Shelling A.N., Bigby S.M. Investigating molecular changes in squamous cell carcinoma of the vulva. Thermo Fisher Scientific Seminar: One size does not fit all - Oncomine NGS Solutions, 13 October 2020 on Zoom*
15. *Peppy: A virtual reality environment for exploring the principles of polypeptide structure. Invited presentation (via Zoom) to Australian National University, Canberra, Australia, 03.09.2020*
16. *Peppy: A virtual reality environment for exploring the principles of polypeptide structure. Presentation to the Scholarship of Technology Enhanced Learning Symposium, 18-19.02.2020*
17. *Sethlans in the 21st Century: 3D applications to Etruscan bronze armour and modern reconstructions - Paper presented at The Computer Applications and Quantitative Methods in Archaeology (Australasia) Conference, 11-12 September 2020, Auckland, NZ.*
18. *Simpson, J., van Wijk, K., & Adam, L. (2020, October). Using laser ultrasonics for nonlinear rock physics. Dodd-Walls Centre for Photonic and Quantum Technologies Annual Symposium, Auckland, New Zealand. ESR seminar.*
19. *Talmage, A. (2020, July). Voices in Harmony: Researching community singing for adults with acquired neurogenic communication difficulties. International Society for Music Education (ISME) Community Music Assembly (CMA), online. https://www.youtube.com/watch?v=ZRONSyvDI*
20. *Talmage, A. (2020, November). Community singing for adults with neurogenic communication difficulties: A music therapy perspective on research and practice. Annual Conference of International Association of Music Librarians (New Zealand Branch). Auckland, NZ.*
21. *Talmage, A. (2020, November). Sing Up Rodney. Harbour Hospice POI Link Nurses Learning Lab, online.*
22. *Talmage, A. (2020, November). The CeleBRation Choir: A "neurological choir" in Aotearoa New Zealand [Presentation]. Asia Pacific Community Music Network Conference, online from Hong Kong.*
23. *Talmage, A. (2020, October). Voices in Harmony: Music therapy action research with adults living with a neurological condition. Graduate Women North Shore, Takapuna, NZ.*
24. *Tu'akoi S, Vickers MH, Tamarua-Herman N, Tairea K, Aung YYM, Bay JL. Taking DOHaD to the people of the Cook Islands, Invited plenary. DOHaD ANZ Digital, 2 September 2020, Online, Australia.*
25. *Victoria King. I dream of gg(plot2): visualising sleep in pregnancy in R. Invited lightning talk, SatRdays Feb 2020, Auckland.*

Book and Chapters

1. *Ahel Eroff, S., Polzar, J., Huang, H., Zhu, Z., Tomzik, D., Lu, Y., Xu, X. (2020). Smart manufacturing based on Digital Twin technologies. In C. Machado, J. P. Davim (Eds.), Industry 4.0. Challenges, Trends, and Solutions in Management and Engineering (1st Edition ed., pp. 46 pages). Boca Raton: Taylor Francis Group.*
2. *Armstrong, J., Fronda, M. P. Romans at War Soldiers, Citizens and Society in the Roman Republic. Routledge Monographs in Classical Studies.*
3. *Armstrong, J. S. (2020). Beyond the Pomerium: Expansion and Legislative Authority in Archaic Rome. In S. Bell, P. du Plessis (Eds.), Roman Law before the Twelve Tables: An Interdisciplinary Approach (pp. 133-152). Edinburgh University Press.*
4. *Armstrong, J. S. (2020). Organized Chaos: Manipuli, Socii, and the Roman army c. 300 BC. In J. Armstrong, M. Fronda (Eds.), Romans at War: Citizens, Soldiers, and Society in Republican Rome (pp. 76-98). Routledge.*
5. *Armstrong, J. S. (2020). Triumphal Transgressions. In M. Dillon, C. Matthew (Eds.), Religion and Classical Warfare. II: The Roman Republic (pp. 254-288). Barnsley: Pen Sword.*
6. *Armstrong, J. S., Fronda, M. (2020). Edited: Romans at War: Soldiers, Citizens and Society in Rome Republican (pp. 1-16). Routledge.*
7. *Collier, T. A., Piggot, T. J., Allison, J. R. (2020). Molecular Dynamics Simulation of Proteins. In MIMB (Vol. 2073, pp. 311-327).*
8. *Gavey, N. & Farley, N. (2020, in press). Reframing sexual violence as "sexual harm" in New Zealand policy: A critique. In Torres, M. G. & Yllö, K. (eds). Sexual Violence in Intimacy: Implications for Research and Policy in Global Health. Routledge. Pp. 229-237.*

9. *Hanif, M., Hartinger, C. G. (2020). From the hypothesis-driven development of organometallic anticancer drugs to new methods in mode of action studies. In P. J. Sadler, R. VanEldik (Eds.), Advances in Inorganic Chemistry (Vol. 75, pp. 339-359). Elsevier Academic Press Inc.*
10. *Henderson, M., Miles, A. (2020). Pediatric pharyngoesophageal trauma leading to phagophobia. In Laryngology: A case-based approach. San Diego, CA, USA: Plural Publishing.*
11. *Jennifer Curtin and Jill Sheppard (2020). The Independents. In A. Gauja, M. Sawer and M. Simms (eds). Morrison's Miracle. The Australian Federal Election. ANU Press DOI: http://doi.org/10.22459/MM.2020*
12. *Meredith, M., Fonua, S. M., Tatafu, A., McKay, Y. (2020). Why RPEIPP? Emerging/next generation Pacific academics, researchers, and educators. In S. Johansson-Fua, M. 'Otunuku, R. Toumu'a (Eds.), It takes an island and an ocean (pp. 113-125). 'Atele, Kingdom of Tonga: Institute of Education, The University of the South Pacific.*
13. *Miles, A., Allen, J. (2020). Vagal injury following ruptured carotid pseudoaneurysm. In Laryngology: A case-based approach. San Diego, CA, USA: Plural Publishing.*
14. *Mullen M, Johansson M, Niuia A, Johansson B, Revell-Sīo B, Savaiinaea C-M, Tofilau F, Folau L, Ahmad M, Johansson V. (2020). 'Opening doors, not filling boxes: Policy kinesis and youth performance with the Black Friars Theatre Company, Aotearoa New Zealand'. In The Applied Theatre Reader. Editors: Prentki T, Abraham N . Second. Routledge, London 2020*
15. *Richardson, S., Babarenda Gamage, T. P., Jackson, T., HajiRassouliha, A., Clark, A., Nash, M. P., . . . Nielsen, P. M. F. (2020). Pipeline for 3D Reconstruction of Lung Surfaces Using Intrinsic Features Under Pressure- Controlled Ventilation. In Computational Biomechanics for Medicine (pp. 123-134). doi:10.1007/978-3- 030-42428-2_8*
16. *Sharp, E. L. (2020). Free Fish Heads: A Case Study of Knowing and Practicing Seafood Differently. In E. Probyn, K. Johnston, N. Lee (Eds.), Sustaining Seas Oceanic Space and the Politics of Care (1 ed., pp. 125-138). London: Rowman Littlefield International Ltd.*

Technical, Commissioned Reports

1. *Ball, J., Fleming, T., Archer, D., Sutcliffe, K., Clark, T. C. (2020). Youth19: Vaping Fact Sheet. Wellington: The University of Auckland, Victoria University Wellington.*
2. *Brydon Burnett, Prestart Optimisation Model for America's Cup Match Races, Department of Engineering Science Honours Report, University of Auckland, October 2020*
3. *Daniel Exeter. A brief report and an advanced interactive map for NZ Index of Multiple Deprivation. https://imdmap.auckland.ac.nz/.*
4. *Emily Harvey, Oliver Maclaren, Dion O'Neale, Adrian Ortiz-Cervantes, Frankie Patten-Elliott, Steven Turnbull, Demival Vasques Filho, and David Wu (2020). Network-based simulations of re-emergence and spread of COVID-19 in Aotearoa New Zealand. Te Pūnaha Matatini Report*
5. *Fleming, T., Ball, J., Kang, K., Sutcliffe, K., Lambert, M., Peiris-John, R., Clark, T. C. (2020). Youth19: Youth Voice Brief. Wellington: Youth19 Resarch Group, The University of Auckland, Victoria University Wellington, Otago Unversity.*
6. *Fleming, T., Ball, J., Peiris-John, R., Crengle, S., Bavin, L., Tiatia-Seath, J.,Clark, T. C. (2020). Youth19 Rangatahi Smart Survey, Initial Findings: Substance Use. Wellington: Youth19 Research Group, The University of Auckland and Victoria University of Wellington.*
7. *Fleming, T., Peiris-John, R., Crengle, S., Archer, D., Sutcliffe, K., Lewycka, S., Clark, T. C. (2020). Youth19 Rangatahi Smart Survey, Initial Findings: Introduction and Methods.. Wellington: The Youth19 Research Group, The University of Auckland and Victoria University of Wellington.*
8. *Fleming, T., Tiatia-Seath, J., Sutcliffe, K., Archer, D., Bavin, L., Crengle, S., Clark, T. C. (2020). Youth19 Rangatahi Smart Survey, Initial Findings: Hauora Hinengaro / Emotional and Mental Health. Wellington: The Youth19 Research Group, The University of Auckland and Victoria University of Wellington, New Zealand.*
9. *Gerrard, Juliet (2020): Annual Report 2020: Mahi Tahi 2. The Office of the Prime Minister's Chief Science Advisor. Report. https://doi.org/10.17608/k6.OPMCSA.12592112.v4*
10. *Jordan Nottage, Dynamic Games for America's Cup Pre-start Strategies, Department of Engineering Science Honours Report, University of Auckland, October 2020*
11. *Lambie, Ian (2020): What were they thinking. A discussion paper on brain and behavior in relation to the justice system in New Zealand. The Office of the Prime Minister's Chief Science Advisor. Journal contribution. https://doi.org/10.17608/k6.OPMCSA.12279278.v1*
12. *McNaughton, Stuart (2020): The Literacy Landscape in Aotearoa New Zealand: What we know, what needs fixing, what we should prioritise. The Office of the Prime Minister's Chief Science Advisor. Report. https://doi.org/10.17608/k6.OPMCSA.12749321.v1*
13. *Peiris-John, R., Farrant, B., Fleming, T., Bavin, L., Archer, D., Crengle, S., Clark, T. C. (2020). Youth19 Rangatahi Smart Survey, Initial Findings: Access to Health Services. Wellington, New Zealand: The University of Auckland and Victoria University of Wellington.*
14. *Randall, I., Seymour, F., Mccann, C.M., Anderson, T., & Blackwell, S. (2020). Young witnesses in New Zealand's sexual violence pilot courts. Report for New Zealand Law Foundation.*

Grants

1. *Agnes Paykel PhD Scholarship (Grant), P. Lockyer, Peer-to-peer leadership: impacts on participation in physical activity by children.*
2. *Deep South National Science Challenge 'National Assessment of Critical Infrastructure Network Service Disruption from Future Coastal Flooding' $450,000 (shared across organisations: UoA, NIWA) (Grant)*
3. *Demarais, N. J., Grey, A. C., Donaldson, P. J., Guo, G. (2020) Crystallin stiffs the lens of H2O: Implications for presbyopia and cataract. Auckland Medical Research Foundation (Grant)*
4. *Donaldson, P. J., et al. (2020) Regulation of lens water transport: A strategy to treat presbyopia and cataract. HRC (Grant)*

5. Grey, A. C. (2020) Spatial oculomics with imaging mass spectrometry for drug delivery. HRC Consolidator. (Grant)
6. Grey, Wu, Donaldson, Rupenthal (2020). Anti-cataract nanovesicle development. Auckland Medical Research Foundation(Grant)
7. Health Research Council of New Zealand Consolidator Grant 2020 (Grey, Guo,Rupenthal, Donaldson) Spatial oculomics with imaging mass spectrometry for drug delivery - $596,120 2 years (Grant)
8. Health Research Council of New Zealand Programme Grant 2020 (Donaldson, Lim, Grey, Vaghefi) Regulation of lens water transport: A strategy to treat presbyopia and cataract - $ 4,936,998 5 years (Grant)
9. Holtkamp, H. (2020) Probing the biochemistry of skin with lasers, light scattering and molecular ionisation. AMRF Postdoctoral Fellow & AMRF Research Support (Grant)
10. Mass Spectrometry Hub SRIF Stage-gate application 2020 (Grey, Demarais, Pruijn) - 1 year $200,000 (Grant)
11. MBIE Endeavour Project 'Reducing flood inundation hazard and risk across Aotearoa/New Zealand' $15,355,360 (shared across organisations: NIWA, UoA, UWaikato, UCanterbury) Project will also use NeSI (Grant)
12. MSACL Trainee Educational Grant to attend the MSACL workshop in Salzburg, Austria (Grant).
13. Neti Herman, CoPIs Dr J Bay, Prof. M. Vickers. Health Research Council of New Zealand Pacific Project. Determinants of NCD risk and mental well-being in Cook Island adolescents., $1m (Grant, Ref 20/284,)
14. Nico Nibbering Student Travel Award covering the conference fees and accommodation. (Grant)

Thesis

1. Aerodynamic Response of a Two-Dimensional Cambered Wing at Low Reynolds Numbers in Steady-State Onset Turbulence https://researchspace.auckland.ac.nz/handle/2292/53391
2. Amrita Bains. PhD thesis titled Oxidative Stress: An Unutilised Mechanism For Whole-Cell Biocatalysis Of Emerging Wastewater Micropollutants. (2020)
3. Ensing, J. (2020). Multi-component Ambient Seismic Noise Tomography of the Auckland Volcanic Field.
4. Hendrikse, E. R. 2020. Exploring expression of CGRP and amylin receptors in the rat brain. Thesis submitted. University of Auckland, New Zealand.
5. Ma, X. (2020), A Masters thesis. Development of an educational tool to visualise the glycaemic index of foods using a smartphone colourimeter,.
6. Nicholas Kay. PhD thesis titled Inflammatory and microbial heterogeneity in chronic rhinosinusitis- Michael Hoggard (2020)-Best Doctoral thesis 2020
7. Tu'akoi, S. (2020). PhD initial submission. Oraanga Meitaki: Early-life health for lifelong and transgenerational wellbeing in the Cook Islands.
8. Willsen Wijaya. PhD thesis. Permeability of 2D Woven Composite Textile Reinforcements: Textile Geometry and Compaction, and Flow Modelling (2020)
9. ¬Sharma. Prachi. PhD thesis titled Understanding the protein complexes involved in the reception of the plant hormone Strigolactone. (2020)

Abstracts

1. Craig, J. P., Jones, L. W., Willcox, M., James, W., Muntz, A., Luensmann, D., Xue, A. L. (2020). Evaluating the therapeutic profiles of lipid and non-lipid based dry eye supplements. In Investigative Ophthalmology Visual Science. Vol. 61 (pp. 119). Investigative Ophthalmology & Visual Science June 2020, Vol.61, 119.
2. Preliminary Study of Applied Binary Neural Networks for Neural Cryptography. GECCO July 2020 pp 291-292 Abstract. ACM Digital Library https://doi.org/10.1145/3377929.3389933
3. Rahmanipour, S., Fanslow, J., Hashemi, L., Wiles, J. (2020). Psychometric evaluation of the Mental Health Continuum-Short Form (MHC-SF) in New Zealand Context – A Confirmatory Factor Analysis. In L. Hashemi (Ed.), Virtual conference: School of Population Health and School of Medicine. Virtual conference.
4. Rees, T., Gingell, J., Siow, A., Harris, P., Brimble, M., Hay, D., Walker, C. (2020). Differential internalisation of the CGRP and AMY(1) receptor. In FASEB JOURNAL Vol. 34 Meeting Abstract (pp. 2 pages). San Diego, CA: WILEY.
5. Tasma, Z., Hay, D., Walker, C. (2020). Pharmacological Characterisation of PACAP-responsive Receptors Reveals Signalling Bias and Probe-dependent Antagonism. In FASEB JOURNAL Vol. 34 (pp. 2 pages). San Diego, CA: WILEY.

Poster

1. Bastow, B. P., Sarmadi, B., Araújo, L. D., & Kilmartin, P. A. (2020). Effects of hyperoxygenation on white wine aromas and phenolics. Poster presented at the School of Chemical Sciences Innovation Showcase, The University of Auckland.
2. Bensemann, J., & Witbrock, M. (2020). What Possible Use Could Consciousness Be? Poster. Proceedings of the Eighth Annual Conference on Advances in Cognitive Systems.
3. Ines Moran. 2020 SBS Showcase: Titipounamu "Zip": Vocal signature recognition using machine learning algorithms
4. Nersesyan, J., Anil, A., Conroy, F., Demarais, N. J. (2020) Revealing the Molecular Makeup of Rationally Designed Heterooligomeric Assemblies of Stable Protein Asia Oceania Mass Spectrometry Conference, Macau, CN.
5. Talmage, A., Purdy, S., Rakena, T., & Rickson, D. (2020, May). "Choir online is better than no choir at all!" Responses of adults with neurological conditions to an e-choir initiative during covid-19 lockdown in New Zealand. Brain. Cognition. Emotion. Music. Conference (BCEM), University of Kent, UK, Online. https://osf.io/yctj7

Letters, Comments

1. Claessens, S., Kyritsis, T., Atkinson, Q. D. (2020). Revised analysis shows relational mobility predicts sacrificial behavior in Footbridge but not Switch or Loop trolley problems. Proceedings of the National Academy of Sciences of the United States of America, 117(24), 13203-13204.
2. Prebble, M., Anderson, A. J., Augustinus, P., Emmitt, J., Fallon, S. J., Furey, L. L., Porch, N. (2020). Reply to Barber: Marginal evidence for taro production in northern New

We wish to acknowledge the contributions made to the case studies from UoA researchers. We also like to thank our researchers who participated in our annual survey.

Zealand between 1200 and 1500 CE. Proceedings of the National Academy of Sciences of the United States of America, 117(3), 1259-1260.

3. *Walker, N., Parag, V., Verbiest, M., Laking, G., Laugesen, M., Bullen, C. (2020). Nicotine patches with e-cigarettes for smoking cessation: Twitter discussion from a respirology journal club - Authors' reply. The Lancet. Respiratory medicine, 8(3), e9.*
4. *Wang, M. T. M., Dean, S. J., Muntz, A., Craig, J. P. (2020). Evaluating the diagnostic utility of evaporative dry eye disease markers. Clinical experimental ophthalmology, 48(2), 267-270.Wang, M. T. M., Ormonde, S. E., Muntz, A., Craig, J. P. (2020). Diagnostic profile of tear osmolarity and inter-ocular variability for dry eye disease. Clinical experimental ophthalmology, 48(2), 255-257.*

Others

1. *Chalakkal, R. J., Hafiz, F., Abdulla, W., Swain, A. (2020). An Efficient Framework for Automated Screening of Clinically Significant Macular Edema: Arxiv (Preprint) (2001.07002v1).*
2. *Denis M. Nyaga1, Mark H. Vickers1, Craig Jefferies1,2, Tayaza Fadason1, Justin M. O'Sullivan1,3 (2020). Untangling the genetic link between type 1 and type 2 diabetes using functional genomics. (Under review; Scientific reports)*
3. *Ehsan Vaghefi, Song Yang, Li Xie. Theia Software Commercial release Theia Software Commerical release.*
4. *Ensing J.X., van Wijk, K., Sporli, K. B. Crustal 3D shear speed model of the Auckland volcanic field from multi-component ambient noise tomography. Unpublished manuscript.*
5. *Gokuladhas, S., Schierding, W., Cameron-Smith, D., Wake, M., Scotter, E., O'Sullivan, J. Shared regulatory pathways reveal novel genetic correlations between grip strength and neuromuscular disorders. Frontiers in Genetics, 24 Apr 2020, https://doi.org/10.3389/fgene.2020.00393 (preprint)*
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