UNIVERSITY OF CALGARY

2021 Program for Undergraduate Research Experience (PURE)

Book of Abstracts

Investigating magnetic turbulence in spiral galaxies

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Studies done by CHANG-ES (Continuum Halos in Nearby Galaxies — an EVLA Survey) on 35 edge-on galaxies show that magnetic fields influence the motion of outflowing gas. This effect takes place on galactic scales, such as the evolution of a galaxy down to stellar evolution. The purpose of this study is to make a connection between the outflowing gas from intra-galactic objects (such as supernova remnants, black holes or star forming clouds), the gas in the halo of the galaxy, and turbulent magnetic fields in the disk of the galaxy. The data used was gathered by CHANG-ES survey using the NRAO Very Large Array (VLA) in the C and D configuration, on the Virgo cluster galaxies NGC 4192 and NGC 4388 in the C band (6GHz). The data was processed using a method developed at the University of Calgary for this purpose, in which the raw data is cleaned, deconvolved and averaged using the Clean algorithm from NRAO's CASA software. This process produces images with low noise which are then analyzed to get the total depolarization of the galaxy. The depolarization is then compared with other surveys or space mission to study the effects of the magnetic field on the polarization and Faraday rotation of out-flowing gas within the galaxy. The results indicate that the magnetic field of the galaxy is not constant throughout the galaxy, and therefore different parts of the galaxy will experience different degrees of polarization and Faraday rotation. Newer techniques, implications and potential for future research are discussed.

Security trend analysis with topic model

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This study analyses vulnerability entries from the Common Vulnerabilities and Exposures database and National Vulnerability Database. We applied topic modeling to determine the present vulnerability topics and determined trends of vulnerabilities between the years of 2011 to 2021. In our study of over 114, 647 vulnerabilities, we identify the following main trends:
Buffer overflow and out-of-bounds write is on a steady decline.
Cross-site scripting is on a slow incline.
SQL injection is on a slight decline.
Sensitive information exposure is on a steep incline.

Supporting the transition to a virtual world in the education and healthcare sectors

Ahmed Abdullah
Supervisor: Mohammad Moshirpour
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The transition to a virtual world and remote processes has had many challenges. This research project aims to identify and address the challenges of transitioning to a remote world in the education and healthcare sectors. This is done through collecting requirements for remote systems from people working in the healthcare and education sectors and then developing web and mobile applications that address those requirements. Feedback is received

weekly on the development progress from the users to identify challenges that were not counted for in the requirements and try to solve those challenges through software. These developed systems can have more advantages than their in-person alternatives like making services more accessible and reducing costs.

Infinite habitat - Customized gaming to engage diverse youth

Justin Acton
Supervisor: Beaumie Kim
Werklund School of Education

Computational modelling of atmospheric flow over complex environmental terrains

Nurgul Akhshatayeva
Supervisor: Artem Korobenko
Schulich School of Engineering

The purpose of this research project is to continue the ongoing research work, which applies variational multiscale framework using isogeometric analysis in order to predict the near-surface behavior of atmospheric flows over complex environmental terrains. The process of the research project involves using CAD (computer-aided design) data for a model build up that was conducted via a pre-processing tool ANSA and executed in an interactive

command language by a Linux operating system. The resulting large sequential program is then partitioned and run with the code using the Fortran programming language. The outcome is solved by a cluster (a single entity of computers), which supports computational simulations of the atmospheric flows around the turbines. The resulting data can be used to make predictions on the aerodynamic loading overcomplex terrain models, which has its main application in wind energy, particularly in the estimation of strength and direction of the wind that affect building structures, bridge designs, and planning studies. Moreover, this research project has its benefits in making precise predictions of wind power output, which lets lessen wind energy expenses and use of IT virtual machines for computing, as well as increase the deployment of wind power systems.

High-speed UAVS video motion analysis and propeller engine mathmatical modelling

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Unmanned Aircraft Vehicles- commonly known as UAV or drones- have been the center of attention of multiple industries and research institutions for very good reasons. Every day, a lot of effort is invested to integrate UAVs in numerous applications that usually involve urgency, efficiency, hazard vulnerability, lack of accessibility, or even customers' satisfaction - from firefighting to agricultural monitoring or even package delivery. Although they can be utilized in many fields, developing cheap, fast, and easy methods to manufacture and test such drones can prove to be challenging. Therefore, the purpose of this paper is to present some practicable techniques to aid in testing and evaluating such UAVs. We will be going over some methods to measure the experimental motion of the UAVs from a recorded video and present a mathematical model for predicting and investigating the performance of propulsion engines in UAVs. We used SIMBA, a supersonic UAV model, developed by the Aerospace and Compressible Flow Research (AERO-CORE) Group to investigate the methods and obtain results. The paper goes over how we developed a program that allows us to manually track the object by selecting a specific point on it in successive frames and then predicting the motion of an object by finding the change in position between the pixels the object traveled and the time the motion took. The paper also goes over how to experimentally find the thrust of an engine by measuring the deflection it causes on a system hanging from its weight. The paper further investigates how to obtain a mathematical model of the engine by trying to quantify the losses in energy of the flow. We also go over the source code developed to help us solve our model numerically. Lastly, we present a specific study of the relationship between thrust and intake holes. We found that our launching system can launch our UAV model with 20 m/s. We also measured our experimental thrust to be around 8.1 N and improved it. Lastly, we found that there is a positive relation between the area of air intake holes and thrust. These methods and their results can be extended to predict and study the behavior of other UAV models, specifically propeller thrusted, fixed-wing UAVs as this was the focus of our study. For instance, using our programs and models, a team can easily measure whether their UAV is cruising, taking off, or landing at the right velocity or whether their engine will produce enough thrust for different flight regimes. Providing such easy and cheap methods and assessing their credibility and practicality will promote the development and research of multipurpose UAVs across the world as they reduce cost, time, and complexity of the whole process.

Self-balancing unicycle

Mohamed Aly
Supervisor: Roes (Arief) Budiman
Schulich School of Engineering

Dr. Budiman, Alex Ens, and I worked on research aiming to find out how to make a self-balancing unicycle. We have 2 approaches to solve this problem. One is using a PID controller to control multiple motors and/or a flywheel to balance the unicycle. Two is to use 3D kinematics equations to control the motors based on the input from the sensors. Creating a self-balancing unicycle is the goal of the project. In addition to the short-term goal of making a personal assistant/helper unicycle robot, Dr. Budiman plans to use the unicycle robot as a platform to improve the safety of motorcycle riding. Motorcycles are a luxury in rich countries but in many other countries it is the only affordable means of transportation, and such technology can save thousands of lives. We used a MATLAB simulation to simulate how a PID controller will react to balance a unicycle. This helped us find out the amount and duration of torques needed, and the rate of change of angle in the XYZ directions. These results are going to be used to know the specifications of the hardware needed to build the unicycle prototype. The progress of the research this summer did not reach the initial target of building a prototype. The main reason is the slow interpretation of the simulation results due to the complexity of the variables involved in the 12 equations derived from the 3D kinematics equations of motion.

From following recipes to creating them: Enriching experiential learning in labs through a community of practice and systematic reflection

Eric Anklovitch
Supervisor: Cari Din
Faculty of Kinesiology

The goal of this 8-week PURE project, led by Dr. Cari Din, was describing and documenting the changes to labs that previously followed a cookie cutter template as they were transformed through a pedagogical redesign. My focus was the development of an informative and easily digestible guide that will provide practical inspiration and guidance for other instructors interested in implementing the changes outlined in this project. Previously, labs in this course focused on confirming known experimental results and writing long, format-focused lab reports which drew students' attention away from practicing the habits of mind and skills of a scientist. Key concepts such as inquiry, hypothesizing, procedural planning, and reflection were often brushed over or ignored completely in the old labs. My PURE work was part of a larger lab reform project rooted in the Scholarship of Teaching and Learning (SoTL) as well as educational leadership literature. Through adding some student inquiry and weekly reflections, Dr. Martin MacInnis successfully modified his graduate level course, "Integrative Exercise Physiology" (Kinesiology 773) over three years. In the new format, students are creating questions, hypotheses, and reflecting on what they are doing and learning. They are following the thread of topics they are interested in during specific learning activities in the revised course. The project was qualitative in nature, with the data being collected predominantly through interviews. Due to time restrictions and an unforeseen delay in securing the website portal, our instructional resource is incomplete. Development will restart in spring 2022! Overall, I discovered the graduate students, TAs and Dr. MacInnis all agreed the weekly reflections were the most beneficial addition to the updated laboratory-based course. Additionally, Dr. MacInnis believes that by encouraging students to participate in self-directed inquiry and to take educated risks, he was able to enable deeper learning of real-world applicable knowledge. This project

marks the beginning of, as Dr. MacInnis puts it, a shift away from pretending to do science towards doing science within the kinesiology laboratory environment

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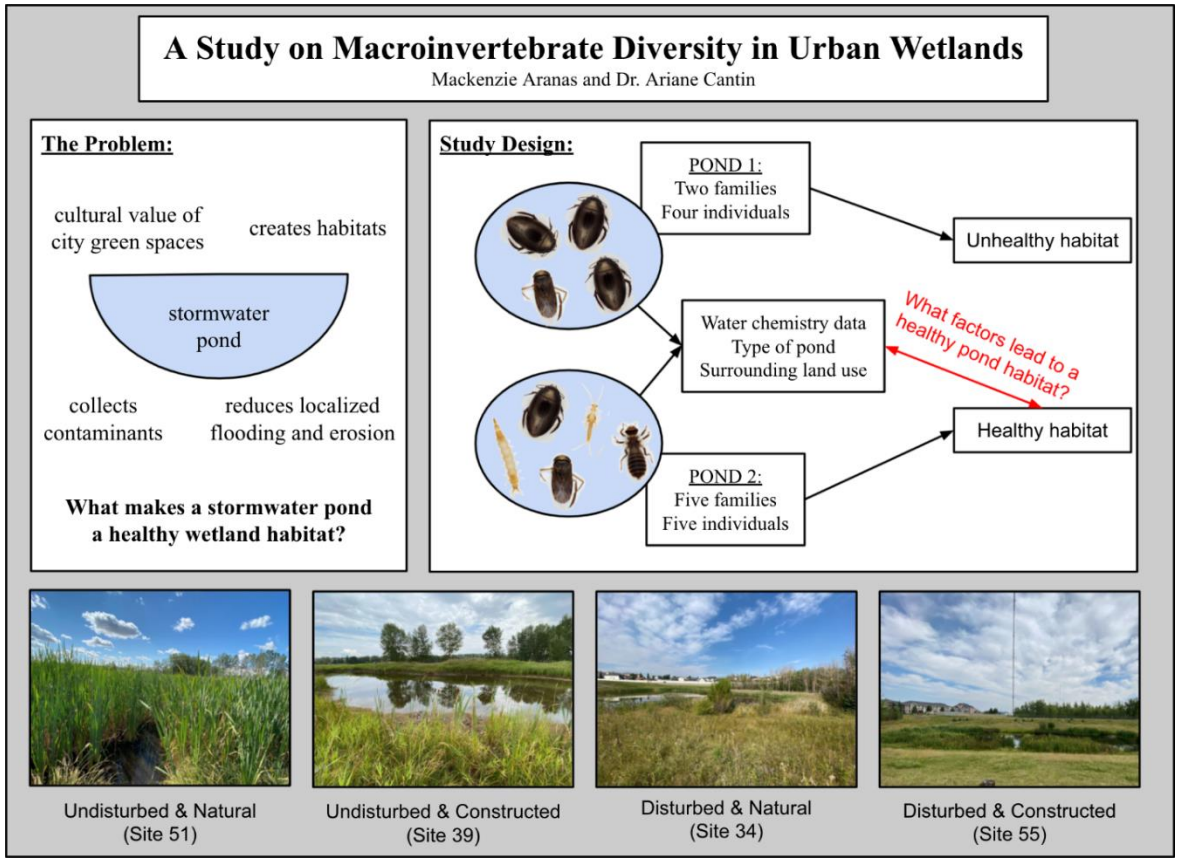
Programming a microcontroller to function as a lock-in amplifier

Ahmed Anwar
Supervisor: Kartikeya Murari
Schulich School of Engineering

The title of this research project is “Programming a Microcontroller to Function as a Lock-in Amplifier”. The basic functionality of a lock-in amplifier is that it is able to extract a weak signal which is embedded in a noisy signal and amplify it. The purpose of this project was to program a microcontroller to behave as a digital lock-in amplifier. The main reason to do this is that most lock-in amplifiers are large bench-top devices, and in several fields miniaturized, portable instrumentation can open up multiple new research opportunities. In this particular research, the miniaturized lock-in amplifier will be used in the biomedical field to allow researchers to record activity in awake, freely moving animal models like rodents. Since this project is coding oriented, the C programming language was used to program the microcontroller. The C code was written on a software called MPLABX, and by using a PIC kit that was connected to the computer, the software would get transferred to the circuit on the breadboard and program the microcontroller. In terms of findings, there were two coding languages that were considered for programming the microcontroller (C and Assembly). This term I used the C language because it was simpler, however I think overall the Assembly language would have been better as it gives a clearer view of instruction execution times, which was vital in this project.

A study on macroinvertebrate diversity in urban wetlands

Mackenzie Aranas
Supervisor: Ariane Cantin
Faculty of Science



Turning waste into carbon fiber

Ahmad Awan
Supervisor: Simon Park
Schulich School of Engineering

In a rapidly evolving world, the need for stronger lightweight materials continues to grow. At the same time, climate change creates the need for more eco-friendly methods and sources for these materials. Lignin is a waste product that comes from trees, and has successfully been used to produce carbon fiber. Traditionally, the carbon fiber process uses furnaces to stabilize and carbonize the spun fibers. With recent advances in technology, the use of alternative rapid thermal treatments have been explored as more eco-friendly alternatives to furnaces in these production methods. A Life-Cycle Analysis (LCA) was conducted in order to explore the quantitative differences in carbon dioxide emissions between traditional furnace-based carbon fiber production, and new alternative rapid thermal treatment techniques. This analysis directly showed a significant reduction in carbon dioxide emissions using these newer techniques. Electrospun lignin fibers were also treated with hydrogen peroxide before stabilization, afterwhich the effects on the mass yield and the stabilization itself were explored. A potential increase in post-carbonization yield was found, along with a potential improvement in the stabilization of the fibers. Another waste

product that can be used to produce carbon fiber is asphaltene. This material is derived from crude oil, and with proper treatment was successfully melt-spun into fibers.

Defining the dissemination of reproductive and sexual health information: An examination of Canadian medical reproductive and sexual health discourse

Margaret Ayriss
Supervisor: Maria Victoria Guglietti
Faculty of Arts

A Critical Discourse Analysis was conducted on the mainstream medical discourse of online sexual and reproductive heath content produced by/for the Canadian medical profession, focusing on vulnerable and underrepresented groups to expose implicit and explicit messages of inequality contained within framework of Canadians' options for contraceptive and reproductive healthcare. The research sought to understand the way that the asymmetrical relationship between medical professionals and patients reproduces a power/knowledge relationship within online sexual and reproductive health information, possibly affecting how Canadians regard their sexual and reproductive healthcare choices. Using purposive sampling, government sexual health websites from each of the Canadian provinces were selected. Three themes were identified that, to varying degrees, contain sexually repressive, hegemonic and patriarchal ideologies also found within our society. 1) Placing responsibility of sexual health and reproduction on women: 2) Underrepresentation of ethnic and sexual minorities: and 3) Reproducing rationality: valuation variances, biased representations of women who choose to parent their child and women who choose to terminate a pregnancy. The non-profit sexual health website, Action Canada.org, was also analyzed for the four themes. Compared to the data from the government websites, the non-profit sexual and reproductive health information was found to be free of gendered terminology and language, and inclusive with regard to males and LGBQT individuals, providing a complete picture of sexual and reproductive health that is representative of all Canadians. Creating a snapshot of Canadian sexual and reproductive healthcare information revealed inequalities for vulnerable and underrepresented groups, and the necessity of increasing sexual health representation to include males and the LGBTQ2A+ community.

From exploring factors influencing older adults' life satisfaction during COVID-19 to suggest recommendations

Jinyoung (Julie) Baek
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Faculty of Social Work

Purpose

The Covid-19 restrictions which have been put in place to protect general citizens has had negative impacts, such as, social isolation, especially for older adults. I investigated the patterns of contact for older adults, their physical/mental health, and the type of social activity they would want to engage in. Finally, I used the results of the survey to make recommendations that the provincial government and non-profit organizations in Alberta can use to improve life satisfaction of older adult clients.

Methods

An online survey was developed which included 30 questions about factors that could influence an older adults' life

satisfaction 'before' and 'during' the pandemic. The online survey on Qualtrics was posted on social media platforms: Nextdoor and Facebook.

Findings

In total, 43 participants completed the research survey. The frequency of contact with friends/families decreased during the Covid-19, but more people started to use virtual meeting to communicate. Only 23.3% of participants received social support from non-profit organizations during Covid-19. About 60% of participants would like to physically participate in social events such as social gatherings, volunteering, and sport activities.

Conclusions

Based on the responses, two main recommendations are for the government to put into place a regular physical/mental health check-up program for older adults, and to fund non-profit organizations that are educating older adults to set-up phone calls or video calls with their loved ones.

The stigma surrounding refugee/immigrant populations with COVID-19 status- scoping review

Grace Bailey
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Cumming School of Medicine

Purpose: Review evidence of stigma and discrimination experienced by vulnerable populations, specifically refugee and immigrant populations, relating to the COVID-19 pandemic.

Methods: MEDLINE, EMBASE, PSYCHINFO, Cochrane Control Trials and SOCINDEX were searched form from March 2020 to July 2021. Databases were searched for studies reflecting stigma in refugee or immigrant communities in regard to COVID-19 status. Inclusion criteria required studies to be interventional, observational or qualitative; any commentary or letter to editors was excluded.

Preliminary Findings: The search generated 222 articles, with duplicates removed. Two independent reviewers screened titles and abstracts removing anything that did not meet the inclusion criteria, disagreements were resolved using a third reviewer. This left 117 articles to undergo a full text review. After full text review, 7 articles were included in the scoping review. Currently two reviewers are extracting data to be included in the scoping review. Data abstraction, quality assessment and plan for potential meta-analysis are under way.

Conclusions: Results from the systematic review have reflected experiences of stigmatization and discrimination in refugee and immigrant populations during the COVID-19 pandemic. Understanding the experiences felt by vulnerable populations will have implications throughout public health sectors, refugee support networks, as well as implications for health care workers. It is critical to understand the experiences of discrimination during the pandemic as this understanding can translate into future strategies and policies that can safeguard vulnerable populations and reduce the impact of stress/isolation/financial challenges that these groups face.

Best practices for Alberta science teachers engaging with citizen science

Kristen Beechey
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Werklund School of Education

In Alberta, there is a growing effort to engage people in science and environmental monitoring through citizen science. Public participation in scientific research has the potential to further rigorous science, provide public science education, and increase motivation for environmental action. This project was interested in how citizen science projects might be taken up in school settings. Through employing an environmental science agency framework, local educational resources were scanned and assessed, a literature review of current scholarship was conducted, and educators who participated in citizen science professional development training were surveyed to understand the successes and challenges of implementing projects in practice. Findings suggest that, while barriers exist, ample opportunities and support are available for teachers who wish to engage citizen science experiences. A set of best practices for elementary and secondary science educators was developed and then applied to the specific context of a middle school science unit to outline how a project focusing on seasonal phenology might be taken up. As a preservice teacher, through this project, I learned that benefits of citizen science projects can be best achieved when participation is connected to student interests and experiences through meaningful preparation and guided reflection.

Analysis and correlation of substrate and slider behaviour in a two-dimensional spring-slider discrete element model

Noah Bensler
Supervisor: Joern Davidsen
Faculty of Science

The purpose of the research project is to study the internal kinetic energy events of the substrate in a two dimensional spring-slider experiment and to determine the degree of correlation between its properties and those of the slider. This will be done using a discrete element model developed by Nauman Hafeez Sultan, Kamran Karimi, and Joern Davidsen of the Complexity Science Group from the University of Calgary. The result of the analysis found that the internal kinetic energy avalanches follow an identifiable pattern, with a large rapid peak, followed by a gradual decay back to the baseline energy. Analysis showed that magnitude of the internal avalanche peaks followed a power-law distribution, that the event separation does not demonstrate any distinct behaviour, and that the event duration is not well correlated with the peak magnitude. Finally, the analysis showed a strong positive correlation between the internal kinetic energy and the slider velocity and a strong negative correlation with the derivative of the force on the slider. This correlation is maximal after a time delay, which indicates a causative link between the slider and internal avalanches. In conclusion, this research project has found that slip avalanches of the slider cause distinct and identifiable avalanches within the substrate.

Factors that influence the connection between engineering self-efficacy and life habits

Catherine Betancourt Lee, *Melissa Boyce, Kim Johnston, Brittany Lindsay, Mandeep Pandey*
Supervisor: Kim Johnston
Schulich School of Engineering

Research Question: What factors influence the connections between engineering self-efficacy and life habits?

First year engineering students begin their degree with pre-conceived notions of how the year will go, pertaining to their academics, social/spiritual lives, and their own expectations. These guidelines shape the framework for their first year but due to a loss of balance or adverse circumstances, instead give way to a loss of self-efficacy, associated with both engineering itself and their own persona. Previously, research has been performed on finding the stressors specific to first year engineering and how overall this affects the student's wellbeing (1) - although not specific to the motivational belief that is self-efficacy and the effect it has on their entire life. Using Inductive Thematic Analysis from previous responses written by students in their SSE Mental Wellness and Engineering Attributes course, (2) this research explores the factors that influence the connection between self-efficacy and an individual's personal growth (life habits). The purpose being, to establish the connections between self-efficacy and life habits when related to the learning and development of future engineers in a broader spectrum. The factors that were found to influence include - social/spiritual wellness in terms of a support system, a fixed academic mindset with a "all or nothing" behavior, the inability to cope with transitioning and adapting out of their previous institutions, harmful expectations, and the growth of finding a balance in their everyday lives. Given these findings, the connection between self-efficacy and life habits is prevalent both negatively and positively as behaviors that continue throughout their degree. They suggest that individuals in their first year are caught off guard by the difficulty, leading to a loss of self-efficacy and instead new negative learning strategies - until they discover how to succeed in engineering.

Vaccine evaluation against an emerging strain of avian coronavirus

Tithi Bhatt
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Faculty of Science

Infectious bronchitis virus (IBV) is a gammacoronavirus that causes a highly contagious disease in chickens, namely, infectious bronchitis (IB). IBV replicates in the respiratory, urinary, and reproductive tracts. The IBV DMV/1639 variant has been associated with egg production complications in layer flocks in Eastern Canada. Commercial IB vaccines are present in Canada, however, the protective ability of the current vaccinations against heterologous IBV strains is questioned. A group of 40 laying hens were divided equally into two groups: vaccinated and non-vaccinated. The vaccinated group received live attenuated IB vaccines followed by an inactivated vaccine before onset of laying. At 30 weeks of age,10 birds from each group were infected with $1x10^6EID_{50}$ of the strain and all birds were observed for 14 days post infection (dpi). Oropharyngeal and cloacal swabs were collected at 5 and 12 dpi and tissues including lung, trachea, kidney, ovary, and oviduct were also collected. RNA was extracted from swabs and tissues and then converted into cDNA using PCR. Quantification of the IBV genome loads within the four groups was performed by qPCR. The results were statistically analyzed to reach a conclusion. No IBV genome loads were quantifiable in non-infected groups. In the infected groups, the IBV genome loads from the vaccinated group were lower than those of the non-vaccinated group with a statistical significance detected only in the ovary ($P>0.05$).

Concluding data has not been obtained yet, however, the preliminary results suggest of partial protection against the variant infection in layers

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Viability of deep subsurface thermophilic endospores

Francesco Bisiach
Supervisor: Casey Hubert
Faculty of Science

Some bacteria can develop a resistant endospore that allows them to enter a dormant state when environmental conditions become harsh. These spores are extremely resistant to a variety of physical and chemical stresses such as temperature, desiccation, and pressure, and can remain viable for several thousands of years. Endospores of thermophilic bacteria are consistently found in cold marine sediments, particularly around natural oil seeps. It is theorized that these thermophilic endospores (thermospores) originate from deep petroleum reservoirs and are expelled from the subsurface through natural seeps. This study aims to find evidence that thermospores are part of a biogeochemical cycle: the thermospores would first be expelled from the subsurface into the deep sea, subsequently dispersed via marine currents, and finally sedimented back into the ocean crust, where new petroleum reservoirs may then originate. In this study, I recreated anaerobic ocean floor microcosms using both oil positive and oil negative sediments at different subsurface depths obtained from the Scotian Slope in the Atlantic Ocean. The microcosms were then incubated at 50°C for 56 days and subsampled regularly. 16S rRNA sequencing, paired with Ion Chromatography and HPLC, allowed us to monitor spore germination as well as the size and composition of the microbial communities. This study may allow us to create a list of hydrocarbon indicator species as well a test whether spores can stay viable during the long sedimentation step of the proposed cycle.

Investigating the experiences of LBGTQ+ youth during the COVID-19 pandemic

Grace Bogowicz
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Werklund School of Education

LGBTQ+ (Lesbian, Gay, Bisexual, Transgender, Queer, and Questioning) people have historically been marginalized. The youth belonging to this group face even more vulnerability. The conditions that resulted from the COVID-19 pandemic revealed the plight of this group. As a future educator, it is incumbent upon me to be better informed and to be sensitive to the needs of LGBTQ+ youth. For this research, I used an interpretive research methodology to search for academic articles and media reports that described the unique situation of LGBTQ+ youth during the past 18 months. LGBTQ+ youth have indeed been affected in distinctive ways as compared to their non-LGBTQ+ peers. Most notably, youth were at risk of homelessness, abuse and rejection from families and peers, reduced access to supportive physical spaces where LGBTQ+ identities would normally thrive, were more susceptible to mental illness and substandard care with respect to physical well-being. Some of the strategies that LGBTQ+ youth used to cope with increased isolation, loneliness, and abuse were highly focused on Internet tools. Classroom teachers also hold enormous weight in providing safe environments for these youth. The message regarding the unique plight of LGBTQ+ students is important to disseminate to broad audiences and to help teachers become more aware of what actions they can take to help their students.

"KAPS" lock – A bold investigation of the role of KAP1 in mammary gland development

Maximillian Brant
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Faculty of Science

Mammary gland development is a complex, dynamic process governed by a diverse set of molecular factors. Kruppel-Associated Box Domain (KRAB)-associated protein-1 (KAP1) is a multifunctional transcriptional co-repressor, with roles in genomic regulation, cell differentiation, DNA damage repair, and cancer, and thus may have a critical role in mammary development. The goal for this investigation was to continue my pursuit of uncovering the role of KAP1 in mammary development. To examine this role, a mouse model was used where KAP1 is conditionally deleted from the mammary glands. Mammary tissue from KAP1 knockout and control mice was processed, stained, imaged, then analyzed for morphological discrepancies that will reflect KAP1's role at that developmental stage. Visualization of mammary tissue at successive stages of development revealed KAP1 is dispensable during some but not all stages of mammary gland development. We observed different phenotypes at two stages of mammary gland development in KAP1 knockout mice, suggestive of different functions for KAP1. These findings suggest KAP1 does play a role in mammary development, however, the significance of this role and molecular mechanism behind KAP1's mammary function remain to be elucidated. These results provide important insight to the intricate factors regulating normal mammary development providing the basis for understanding malignancies.

Applied research and learning; An evaluation of student partnerships with Indigenous-focused organizations and Indigenous communities

Jasleen Brar
Supervisor: Adela Kincaid
Cumming School of Medicine

BACKGROUND: This project built and evaluated a past CURE (INDG502) course that provided students with experiential learning opportunities to work with internal and external organizations to the University of Calgary that are Indigenous or serve Indigenous populations. The projects explored Indigenous, blended and applied research methods/protocols where ethical approaches to working with Indigenous peoples and organizations were emphasized. The purpose of each project was to help find practical solutions for organization/community issues by using CBPR.

PURPOSE: The overarching aims of this project were to: analyze and synthesize the research findings of the INDG502 student projects; hold discussions with project partners to evaluate how projects were conducted, to inform future projects, as well as how the results can be applied into practice; and to continue to develop relationships with Indigenous-focused organizations and Indigenous communities for future research. The identified future research areas will be foundational to continue experiential learning opportunities for University of Calgary students.

PROCESS: We achieved project aims by; culminating the INDG502 project research, disseminated the findings through various UCalgary avenues (including the U of C website and UToday), continue to build community partnerships, and developed strong, future experiential learning opportunities for Indigenous Studies students while simultaneously securing external funding to remove accessibility barriers for students.

RESULTS: This project identified three main findings. One, experiential learning opportunities are beneficial for students because they allow for increased networking, career exposure, and postgraduate job connections. Two, working with Indigenous organizations allows for community members to directly voice their needs and partner with institutions that have resources to mitigate barriers to their needs. Three, dissemination of CBPR with community is vital to develop and sustain partnerships and to allow the knowledge co-creation cycle to continue.

CONCLUSION: Experiential learning opportunities benefit all partners involved including students, academic institutions, organizations, and community members. It is vital to focus on community based experiential learning opportunities and integrate them into academic institutions to enrich the student experience and develop community based solutions.

Development of microsweat sweat collection and cortisol stress biosensor

Shehzaad Brar
Supervisor: Amir Nezhad
Schulich School of Engineering

My research project was on the development and testing of a microfluidic chip called Microsweat. The main professor in charge of the project was Dr. Amir Nezhad, and the development and testing of the chips were done by myself and another undergraduate student. The goal of Microsweat was to create a wearable biosensor that can detect and measure stress levels in individuals through the collection of sweat. The layers of the chip were created using CAD softwares and laser printing of materials. From this, each layer was attached to create a chip that would efficiently collect sweat from a human subject. Subjects would walk on a treadmill at a consistent speed over 60 minutes, or until the chip fibers were full of sweat. The chips were then taken off and fibers were removed and placed in vials. These vials were centrifuged to remove the sweat from the fibers. From here, an ELISA Cortisol Kit was used to test the levels of cortisol in the sweat from the vials. Through repeatability of the tests, it was found that the Microsweat chip was an accurate wearable biosensor that could determine cortisol levels through collection of sweat. The machine learning part was not completed yet, but the goal would be to predict which patients have higher stress levels and identify risk factors. In conclusion, the Microsweat chip was a precise way to measure the cortisol levels in human subjects.

Behavior-independent quantification of hippocampal theta phase precession

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Faculty of Science

Hippocampal place cells have been consistently observed to exhibit phase precession with respect to theta-range local field potential oscillations. That is, an active place cell spikes progressively earlier on each subsequent theta cycle as an organism traverses its corresponding place field. Furthermore, phase precession has been implicated as a putative mechanism for encoding sequences of events into memory. The problem is that conventional approaches for quantifying this effect rely on *a priori* knowledge of neural tuning so that spike timing with respect to local theta oscillations can be quantified as a function of the behavior to which the neuron is tuned. This curtails our ability to investigate phase precession as a general mechanism of temporal encoding since neuron-behavior tuning is typically not ~~knowable~~ beforehand. We sought to develop a behavior-independent quantification of hippocampal theta phase

precession and assess its sensitivity to biologically realistic variations in data. To investigate this, we first developed an algorithm to quantify hippocampal theta phase precession. Next, a neuron model was made to exhibit various known spike-phase relationships with a linear oscillator using dual-oscillator interference forcing. Finally, we used our candidate algorithm to quantify simulated spike-phase relationships and examine how their quantifications changed under variation of biologically relevant model parameters. Preliminary results suggest our algorithm is useful for quantifying theta phase precession, but further modeling with parameter adjustment will be required to quantify conditions which result in type I and type II errors. Only after this step could we potentially claim that the algorithm is robust to biologically plausible variations. After further testing, we hope our algorithm will become an indispensable tool for studying computational properties of phase precession within and beyond the hippocampus.

Determining lexical organization in children with a free association task

Rachel Burkinshaw-Zelko
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Faculty of Arts

During development, children learn vocabulary and concepts that will support future learning and academics. It is therefore very important to understand how children organize words and concepts in the mental lexicon. A free association task is one way to explore and measure children's understanding of early concepts. In a free association task, a participant is presented with a word and asked to say the first word that comes to mind after hearing that word. This allows for inferences to be made about the organization of words and concepts in the brain, and adds to our understanding of the mental lexicon through spreading activation.

In this study, a free association task was utilized to determine whether lexical properties of the word (i.e., concreteness, valence, frequency, and age of acquisition) influences the properties of the response and whether this changes with age. There is a claim that children initially give more syntagmatic responses (i.e., a word that may come next in a sentence, RED-CAR) then shift to more categorical or paradigmatic responses (RED-BLUE). This is called the syntagmatic/paradigmatic shift that has been observed between ages 6 and 8 years old. 120 words were chosen to determine associative structure during vocabulary acquisition. These have been taken from a previously validated list of words that have been rated for valence as well as concreteness and abstractness. The target words were age appropriate using well established age-of-acquisition norms. This study was adapted to an online format using a combination of online survey software, Zoom, and audio recording software to comply with physical distancing measures due to Covid-19.

Testing for this study is ongoing and therefore no findings or conclusions can yet be made with certainty.

Developing pedagogical tools for Dɛne Sųłiné

Tanna Butlin
Supervisor: Darin Flynn
Faculty of Arts

This research was a preliminary look into building a model of the structure of verbs in Dɛne Sųłiné, an Athabaskan language in Canada, and the development of language data elicitation methods. This research furthers the understanding of Dɛne Sųłiné verbs in the academic field as they are notoriously complex and there is little consensus

on how they work. Pervious papers were analyzed along with language data to create a rough model of how Dɛne Sųłiné verbs are formed. This model is a 3D puzzle that uses differently shaped connections to mimic how morphemes connect to the verb stem. Original elicitation material such as storyboards and animations were also drawn. These elicitation materials targeted aspects of Dɛne Sųłiné, predominantly perfective and imperfective tense. The cultural context was kept in mind when developing material to ensure the material remained culturally appropriate. Both of these projects have importance because their success in representing the verb and eliciting particular aspects could result in language learning materials that can be used by the Dɛne Sųłiné community to help teach young Dɛne people their native language that is endangered. These materials can be adapted by the community to fit their needs and interests in language teaching.

Life cycle assessment of a Canadian passive house: A case study

Linnaea Cartar
Supervisor: Joule Bergerson
Schulich School of Engineering

Buildings play a significant role in causing the global climate crisis, particularly the use stage. Methods exists to lower the operational energy of buildings, such as passive house design. Life Cycle Assessment (LCA) methodology is often used to determine the environmental impacts of building from cradle to grave, including material manufacturing, transportation, replacement, use, and end of life. This case study assessed if a passive house located in Calgary, Canada had lower environmental impacts – primarily Global Warming Potential (GWP) - over its 50-year building life than a house built to conventional standards. At the time of this study, passive house LCA's have not been conducted Alberta, which has an energy grid which uses more fossil fuels than most locations that residential LCAs have been conducted in.

Previous case studies have shown that the use stage of a building's life is responsible for the majority of GWP impacts. This study found that, though the case study house has greater impacts in all life cycle stages except utilization, it produces only 1.93% of the operational GWP the standard house produces. Over the building's life, the passive house design features resulted in the case study building producing 84.81% of standard house GWP. Two sensitivity analysis (SA) were carried out; the first assessed how changing the assumed building life from 50 to 100 years would affect the building's GWP while the second tested how much the impacts of the case study house would change is wood combustion was not considered carbon neutral. Overall, this study shows that passive building design has the potential to significantly reduce the environmental impacts of buildings, which could be a significant step to reducing the impact of climate change globally.

Extrasynaptic connections and edge analysis in the Caenorhabditis elegans connectome

Brandon Chau
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Faculty of Science

This project set out to investigate whether network control principles could elucidate properties of the multilayer aspects of the *C. elegans* connectome. We applied network control principles to cells that communicate via neurotransmitters in *C. elegans*. To determine the extent of their importance we looked at their role in locomotion in the organism since it is fundamental to many behaviors in *C. elegans* and maps neatly to a network control framework. The controllability of a muscle is directly related to the organism's ability to move in a healthy manner,

hence the results of interest were the probabilities of losing control of the muscles in *C. elegans*. We then analyze the control role of edges in the connectome. Edge classification was used to determine which connections in the neuronal network were critical for signal propagation. Edge removal was performed to tease out redundancies in the network. Overall, these findings began to uncover the fundamental pathways underlying locomotion in *C. elegans*, and the network redundancies that increase their resistance to failure.

Modelling Carbon fractionation in star forming regions

Ciara Chisholm
Supervisor: Rene Plume
Faculty of Science

Astrochemistry is an important tool in identifying the evolutionary stages of interstellar objects, and for answering many large questions such as “where did life originate”. The purpose of this project is to investigate the origins and evolution of complex carbon chain and complex organic molecules. This was done using a numerical model called pnautilus and was modified to include carbon 13 to better understand the dominant reactions that lead to the abundances we observe in different special environments. The model now contains many more ^{13}C reactions, which include a number of fractionation reactions as well as ^{13}C position specific molecules. We compared our model to the results from another model to test the accuracy of our model. We were able to show that the models produced the same trend in abundances and $C/^{13}C$, hence concluded that the model was working correctly. The model showed that the abundances of C and ^{13}C were similar, but not identical, with there being more CO frozen onto the dust grains than ^{13}CO. Our results also show that the dominant ^{13}C reactions are not the same as the dominant C reactions.

Exploring Src kinase activated Pannexin1 in regulating microglial phagocytosis

Andy Cho
Supervisor: Alex Lohman
Faculty of Science

Microglia are principal immune cells in the central nervous system (CNS). They play important roles in maintaining neural health by phagocytosing cellular debris in the brain and development by pruning excess dendritic spines (Paolicelli et al. 2011). However, signaling pathways regulating microglia phagocytosis remain largely unknown. ATP release from pannexin-1 (Panx1) channels has been implicated in microglia activation and phagocytosis (Burma et al. 2017). Furthermore, Src kinases are shown to activate Panx1 (Weilinger et al. 2016). Notably, P2X7 receptors on microglia have also been shown to activate Panx1 through Src kinase activation (Iglesias et al. 2008). I investigate here the understudied role of Src activated Panx1 in microglial phagocytosis. Microglial phagocytic capacity was first quantified using Arivis software and an in vitro model utilizing uptake of fluorescent nanospheres. To interrogate Panx1’s role in microglial phagocytosis, Panx1 siRNA knockdown was administered through magnetofection and lipofectamine. Furthermore, ATP was administered to cells to study effects of ATP release from Panx1 on amplifying P2X7R signaling and potentially phagocytosis. Src kinase activation of Panx1 was also studied using an ATP time experiment followed by Western Blots for phosphorylated Panx1 and Src. Overall, Panx1 siRNA knockdown was unsuccessful, requiring optimization before utilization in studying microglial dynamics. However, our microglial phagocytosis assay quantified microglial phagocytosis effectively. My results illustrate a tool for quantifying

microglial phagocytosis and needs for optimizing transfection of the BV2 cell line. Future projects aim to directly manipulate BV2 Panx1 and study the Panx1 Src kinase pathway in regulating synaptic pruning.

Analyzis, design, and prototype implementation of a social media based recommendation system

Zeeshan Chougle
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Schulich School of Engineering

In recent years, the development of recommendation systems especially content-based and collaborative-based systems has risen exponentially. However, the integration of context casts an additional dimension to the conventional recommendation systems which has received relatively less scrutiny. This implementation of context adds another layer of complexity to the recommendation process as certain parameters of an item may be matching with the user's query in a specific context only, which would be largely dependent on the application domain. The ability to recognize such contextual links would help generate more intelligent and accurate recommendations.

To take a step in this direction, we decided to develop a contextualized hybrid recommendation system in collaboration with a local startup. This system constituted both content and collaborative-based filtering techniques. Our system can generate highly personalized recommendations for the user by utilizing state-of-the-art semantic similarity analysis techniques to suggest items with the highest degree of contextual match. To achieve this goal, we researched numerous embeddings generating models like RoBERTa large, Specter, Wordnet etc. and semantic similarity approaches like cosine similarity, path-based approaches (Wu-Palmer, Euclidean, Manhattan distance etc.), and feature based approaches. In our quest to find the ideal approach for our system we provided numerous groups of contextually similar sentences and judged each systems ability to semantically rank those sentences in each group. After conducting our tests, we concluded that using Specter ML model with cosine similarity was the most ideal choice for our system. Finally, we evaluated our contextualized recommendation system by tuning it to provide research paper recommendations based on the input query provided by the users and submitted it to an international hackathon with 50+ participating teams held across North America, wherein our system ended up securing the 1st place in the competition.

Prevalence of meeting screen time guidelines in children under the age of 5: A systematic review and meta-analysis

Tashia Christie, *Brae Anne McArthur, Sheri Madigan*
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Background: Compliance with the current screen time recommendation for children under the age of five is low. The American Academy of Pediatrics (AAP) suggests children under two engage in no screen time and 2-5-year-olds limit use to one hour per day. In Canada, 20% of 2-year-olds and 5% of 3-year-olds are meeting the guidelines. Similar trends are evident globally. No meta-analysis has examined the prevalence rate of children 0-5 meeting screen time guidelines to date. There is a need to establish precise estimates of the proportion of children under age five who meet screen time guidelines to inform future screen time guidelines development and refinement. Through this meta-analysis, we examine the mean estimate of global prevalence of meeting screen time guidelines.

Method: Systematic searches were performed in MEDLINE, Embase, and PsycINFO, following the PRISMA guidelines. Sixty-three studies met inclusion criteria with over 90,000 participants. **Results:** Less than 25% of children under 2 and less than 40% of children 2 and 5 years old meet these guidelines. The proportion of children meeting the guidelines varied as a function of child age, screen device measurement, and year of data collection. **Conclusion:** Overall, results showed that a large proportion of children under five years do not meet screen time guidelines. Future research is needed to identify factors associated with adherence and to better understand parental beliefs and barriers to guideline adherence.

Screening for various mutant crosses from BZR1-D, XTH22, XTH23, CAAX, ERA-1, and COL in Arabidopsis thaliana

Julian Chua
Supervisor: Marcus Samuel
Faculty of Science

Early plant development and growth are important to ensure that the greatest yield can be obtained when a plant reaches maturity. The genetic modification of plants can assist in areas such as crop yield, disease resistance, and quality of product. Brassinosteroids (BR) are an important class of plant hormones that function in regulating proper development and growth. BRs bind to the BRI1 receptor which initiates a signal transduction pathway resulting in the regulation of gene expression (Reviewed in Planas-Riverola et al. 2019). BR-regulated processes include growth of root and stem cells, as well as adaptation to abiotic stresses such as drought. Gene mutations in the BR pathway result in defects in root and hypocotyl growth and drought tolerance. In this research project, I analyzed the phenotypes of *Arabidopsis thaliana* mutants of the BR pathway to better understand how these genes could be engineered to potentially increase crop yield. I investigated mutant lines of several BR genes including *bzr1, xth22, xth23* and *era1* for changes in hypocotyl and root lengths. These lines were crossed to obtain seeds and the mutant genotypes were confirmed by DNA sequencing. Seeds that showed the correct genotype were gas sterilized and transferred on germination plates to grow. Seedlings were then scanned and measured to identify possible differences between lines. The results revealed that the mutations resulted in varying hypocotyl and root length in comparison to the control Col-0 line. Future projects aim to analyze these mutations in later developmental stages of *A. thaliana.*

Novel cell culture model to analyze newly emerged camel prions

Seth Colby
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Prion diseases are fatal neurodegenerative diseases affecting a broad range of species and caused by the misfolding of cellular prion protein (PrPC) into the infectious scrapie prion protein isoform (PrPSc). Recently, a novel camel prion disease has been reported in Northern Africa with little known about its transmission potential, or robust models to use for the analysis of camel prion transmission. To establish such models, I explored the propagation potential of camel prions using a gene-edited cell line expressing bank vole (BV) PrPC; for its “universal acceptor of prions” feature. CAD5, mouse neuronal cells, knocked out for mouse PrPC followed by reconstitution to express BV-PrPC (CAD5-BV-PrPC), were challenged with either brain homogenate of a prion infected camel, mock brain (negative

control), or BV-adapted 22L or RML mouse prions (positive controls) followed by culturing of these cells for multiple passages. CAD5-BV-PrPC cells from passage 2, 4, and 6 were harvested for analysis of prion propagation with prion conversion assay (RT-QuIC) and immunoblotting for PrPSc. Interestingly, CAD5-BV-PrPC cells infected with camel prions at each analyzed passage appeared positive in RT-QuIC, indicating successful propagation, although negative in less sensitive immunoblotting. Non-reconstituted control cells were negative. Overall, this data indicates that CAD5-BV-PrPC cells can propagate new and old prions, and represents a novel cell culture model for analyzing prion infectivity, as well as underlying molecular mechanisms of various prions.

The sociocultural context of adolescent pain: The portrayal of teen pain in popular media

Allison Cormier
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By adolescence, approximately one in five youth will experience chronic pain (King et al., 2011). Additionally, research has consistently suggested that media consumption plays a vital role in socialization; including the socialization of painful experiences (Paek et al., 2011). Past research focusing on children's popular media has revealed maladaptive trends in media depictions of pain. Overall, children's media engaged in narrow and distorted depictions of pain which could contribute to pain-related stigmas (Mueri et al., 2021). Despite these findings in children's media, a gap in the literature remains when we consider the progression of pain depictions in adolescent media. The current study extracted a cross-section of popular adolescent media that was selected based on popularity, including ten movies and the first seasons of six television shows. Pain instances were coded using two established observational coding schemes assessing sufferer pain characteristics and observer responses. A total of 644 clips were coded and data analysis is ongoing.

Text entry in virtual reality

Seher Dawar
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Since the early days of virtual reality (VR), various text input interfaces have been developed and studied, targeting seamless and user-friendly typing in virtual environments. The methods of text entry that exist in VR games and development kits these days are tedious and time-consuming. There is always room for improvement in this field.

This research project aims to run a comparative study between different methods of text entry available in the market at the moment. Using a physical keyboard as a baseline, this study aims to test the effectiveness, accuracy, and limitations of physical keyboards, touch-typing based VR based keyboards and wearables. The project will also test the viability of these text entry methods in long and short form text entry and how useful they are while standing in the VR environment or sitting at a desk. A few of the variables to consider would be text-entry speed (in word-per-minute), error rate, back-tracking, and ease of use. The data generated from this study will be useful in directing future development of text-input methods for virtual and augmented reality environments.

The project will consist of researching relevant hardware, designing, and implementing a software to work with the keyboards and generate data, and then running a usability study.

Lactoferrin binding protein B: A potential vaccine antigen for *Moraxella catarrhalis*

Nimaya De Silva, *Dr. Jessica Duong, Dr. Anthony Schryvers*
Supervisor: Anthony Schryvers
Cumming School of Medicine

Background:
Moraxella catarrhalis causes otitis media in children and respiratory infections in some older patients; however no vaccine is currently available to protect from its infection. This bacteria expresses transferrin and lactoferrin receptors on its surface, which are shown to be essential for survival for a related bacterial pathogen, *Neisseria gonorrhoeae*, in humans, making them attractive targets for vaccines. However, the receptor proteins from *M. catarrhalis* are difficult to produce by conventional cytoplasmic expression systems.

Methods:
We provided further insight into using cytoplasmic expression as a production system for the LbpB protein by creating four mutants with various truncations of the anchor peptide region. Polymerase Chain Reaction (PCR) was used to first amplify the different forms of the LbpB protein. The mutants were digested and then ligated into a T7 vector. Following transformation into the ER2566 *Escherichia coli* cells and induction of protein expression, proteins were purified using Ni-NTA resin using an N-terminus polyhistidine tag. Small-scale expression was tested under induction conditions of differing temperatures, incubation times, and inducers.

Results:
The mutant LbpB with a 6 amino acid deletion in the anchor peptide region conveyed the greatest levels of protein expression when visualized using SDS-PAGE gels. However, the appearance of several smaller bands on the gel indicated potential protein degradation within the cytoplasm. Optimal protein expression conditions included culturing in autoinduction media at 37°C overnight, followed by culturing for 24 hours at 20°C with the additional introduction of 0.1% lactose to the cultures.

Conclusion:
M. catarrhalis, a pathogenic bacteria, has no vaccine to protect against its effects. LbpB offers a potential vaccine antigen candidate, but is difficult to produce using conventional methods. Our research expanded the current knowledge regarding the expression of LbpB by exploring different truncated forms of the protein. However, further optimization of expression conditions should be explored for increased confidence in its cytoplasmic expression.

Teaching and learning science in post-normal times: A scoping review

Abby Delisle
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We are living through a time when “facts are uncertain, values dispute, stakes high, and decisions urgent” (Funtowicz & Ravetz, 1993, p. 744). This is defined as post-normal times or post-normal science, and evidence of post-normal science can be seen in anti-science sentiments, distrust in science, misinformation, and public controversies including climate change. Critical reflection is a broadly accepted 21st Century skill and can be used to tackle post-normal science. It involves “developing awareness of values, assumptions, interests, and the power relations that

structure, inform, and frame scientific knowledge." (Blue & Weijs, 2021). The objective of this project was to review the concepts, ideas, strategies, methods, and tools that are discussed in the field of post-normal science and identify or link to critical reflection in science education. A scoping review of the literature was conducted, following PRISMA guidelines for screening. For this project, 13 journal articles from a larger data set were analyzed. The articles were categorized based on their scope (science education or the institution of science) and application (conceptual or practical methods). Authors identified collaboration and critical reflection as key themes that are overlooked in science education. Conceptual recommendations included considering values, context, engagement, and complexity in science. Given the urgency of post-normal times, thoughtful consideration of how to implement the authors' ideas at all levels of education may be appropriate.

Caring for others to care for myself: A qualitative inquiry on the experiences of multigenerational Filipino families during the COVID-19 pandemic

Rochelle Deloria
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Cumming School of Medicine

Filipino immigrants are rapidly growing in Canada with a large proportion recruited to work as caregivers and labourers as part of the secondary labour market. In Filipino culture, individual priority is often ascribed towards family, filial piety and care for one another. However, the responsibility attached to these values create lasting mental health impacts for its members, especially for Fil-Can children who are often tasked to uphold care as additional income providers and third parents for their siblings in multigenerational homes. Through an autoethnography of my own perspectives as the eldest child and the daughter of a meat plant worker in a multigenerational home, I will outline the shifting responsibilities of care during COVID-19, and the impacts on my role in the family. This qualitative study on multigenerational dynamics will be informed through an autoethnography of my own experiences well as through 5 interviews with other Fil-Can young adult children (aged 18-25) with caregiving responsibilities in multigenerational homes. Through this study, I seek to outline these silent voices to understand their lived experiences during the pandemic.

Abilities in focus: How do healthcare providers influence physical activity participation in people with mobility impairments?

Kirinpreet Dhillon
Supervisor: Ranita Manocha
Faculty of Kinesiology

One in ten Canadians live with impaired mobility. Physical activity (PA) has been shown to reduce the incidence of all-cause mortality, hypertension, and type 2 diabetes in people with mobility impairment (PMI). PA also offers psychosocial benefits such as improved community integration, quality of life, mental health, and body image. Despite this, PMI are half as likely to be physically active as their able-bodied counterparts. Social support for PA has been shown to enhance PA levels in able-bodied populations. However, there is little research into specific behaviors from healthcare providers that influence PA participation among PMI. Our qualitative study asked, "How do PMI perceive their medical encounters about PA?" We aimed to identify: a) the barriers PMI perceived towards PA; b) how PMI believed their healthcare providers influenced their PA levels; and c) suggestions from PMI for healthcare

providers on encouraging PA in PMI. Six physically active adults (mean±SD age: 31±8 years) took photographs answering the question, "What does PA mean to me?" Participants then engaged in a semi-structured interview guided by the photographs. Researchers analyzed interviews using Interpretive Phenomenological Analysis, an inductive approach where the researcher interprets the participant's perception of a lived experience. Preliminary findings suggested that PMI felt that healthcare providers should: a) “Explore their own biases about disability”; b) “Understand the unique interests and goals of their patients”, and c) “Be aware of local adapted physical activity opportunities”. We will be recruiting more participants for this study and will present the results to primary care and specialist physicians in the coming year.

Establishing novel MAD7 nuclease gene-editing technique in plants

Shakshi Dutt
Supervisor: Marcus Samuel
Faculty of Science

In our study, we aimed to show that MAD7 nuclease-based gene editing approach is applicable to plants. We chose to use MAD7 as it is free of IP issues that we face when dealing with CRISPR and it is a royalty free endonuclease system making it cheaper and more accessible. Unlike CRISPR, previous research has yet to show MAD7 gene editing technique working in plants. We cloned MAD7 in an IPTG-inducible system and transformed the construct into BL21 (D3) competent cells; this showed no expression. We then transformed the construct into Arctic Express cells and ran an SDS-PAGE gel that showed the expression of MAD7 expression post-induction in Arctic Express cells. When purifying MAD7 protein from the cells, the His-tagged protein did not elute off the beads to completion when using the regular protein purification protocol. Changing the calibration buffer and the elution buffer resulted in complete elution of MAD7. An in-vitro digest was conducted which illustrated MAD7 making the expected cuts on target DNA. Now that we have purified MAD7 and showed it can make cuts, we will work towards cloning MAD7 into a vector that can be used in plants to demonstrate that the MAD7 endonuclease system can work just as well as CRISPR in plants.

Kinetics of titin domain refolding

Wejdaan Faridi
Supervisor: Walter Herzog
Faculty of Kinesiology

Titin is a structural protein in sarcomeres that connects the Z disc to myosin filaments. Recent evidence suggests that titin contributes to mechanical work in shortening muscle by a quick refolding of immunoglobulin domains (IGDs) that were unfolded when muscles are stretched[1]. However, such quick refolding of IGDs has never been observed in sarcomeres[2,3] The purpose of this study was to test if quick refolding of titin IGDs is possible in sarcomeres. We hypothesized that quick refolding of IGDs is possible, thereby supporting the idea that titin contributes to mechanical work when muscles contract. Skeletal myofibrils (n=6) were isolated from rabbit psoas and placed in a test chamber on an inverted microscope, as described previously (e.g.,[4]). A fast stretch was performed to lengthen myofibrils from an average sarcomere length of 2.4µm to lengths between 3.8 and 5.2µm to allow for unfolding of IGDs. Then, the myofibrils were returned to their original length, and refolding of IGDs was determined by the rate of shortening of the sarcomeres. Double exponential best fit approximations of the data were performed to obtain two characteristic time constants for IGD refolding. The rate constants for fast IGD

refolding were between -0.32 and -0.76um/s. This result suggests that the rate of IGD refolding is quick enough to produce useful mechanical work in physiologically relevant muscle shortening conditions. The primary finding of this study is that the fast component of IGD refolding is quick enough for titin to produce mechanical work in physiologically relevant situations. A limitation of this work is that IGD refolding is assessed indirectly through the rate of sarcomere shortening, but simulations suggest that this assumption is likely valid[5]

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Solving partial differential equations in a new way by using deep learning techniques

Joshua Felce Gonzalez
Supervisor: Wenyuan Liao
Faculty of Science

As stated above the title of this research project is “Solving Partial Differential Equations in a new way by using Deep Learning Techniques.” Essentially, this project was all about solving Partial Differential Equations through the use of computer programming. A Partial Differential Equation (PDE) is an equation that has at least two independent variables, an unknown function that depends on these variables and the partial derivatives of this unknown function with respect to the independent variables all related to each other via the equation. A solution to a PDE is a function that satisfies the equation. The reason for studying PDEs is that they show up all over the place in Math, Science and Engineering. So, solving them is of great importance to each of these fields. One way of solving them is analytically using pen and paper. Another way of solving them is numerically using computers. There are multiple ways of solving PDEs via computers, however. One way is called the Finite Difference Method. Which is a relatively older numerical method. Another way is via Deep Learning. The question we wish to answer is which method is better. The Process will be to pick a PDE (I chose the time-independent wave equation) and then write the code needed to solve the PDE using both methods. Then compare and contrast the two methods. Namely, compare and contrast the Convergence Order of each method. Convergence order refers to the accuracy of the solution obtained. The idea is to take a PDE (once again, we went with the time-independent wave equation) and solve it using both methods. Then hopefully, determine which method is the best for the PDE. That was the plan. Unfortunately, I didn’t end up answering this question as Deep Learning turned out to be far more complicated than I had anticipated. And as a result, most of my time ending being spent on learning about and trying to understand Deep Learning in the first place.

Modeling an entangled quantum sensor network working together with biologically-plausible neural networks

Emily Frede
Supervisor: Christoph Simon
Faculty of Science

This project aims to simulate the behavior of a variational quantum sensor network working in conjunction with a classical optimizer, in order to classify measurements with greater accuracy than could be achieved without the quantum advantage. It builds on the findings of another project wherein a classically-optimized entangled sensor network was proven to have higher classification accuracy. A support vector machine has been implemented as the classical processor; however, this project pushes the diversity of classical-quantum hybrid networks forward by considering the usage of different neural network models. The core motivation is to construct a model of how entanglement sustained in a quantum network could work together with a biologically plausible neural network, demonstrating the functionality of the proposal that quantum entanglement may be the physical mechanism for consciousness in the brain. In present work of this model, analytical methods are used to characterize the state of the quantum circuit, and computational methods are used to simulate this state so that it can interface with a neural network model. Quantum states of light in the circuit have been computationally simulated, and progress has been made to analyze the beam splitter component in the circuit. Present work also includes a literature search that has informed biologically relevant considerations for the neural network models.

Nurses' experiences working in Alberta harm reduction programs

Farida Gadimova
Supervisor: Jennifer Jackson
Faculty of Nursing

Research Question/Purpose: Injectable opioid agonist treatment (iOAT) programs implement ethical and moral decision-making frameworks established by the College and Association of Registered Nurses of Alberta (CARNA), as well as the harm reduction approach. This project explores the question "What are the experiences of nurses who work in harm reduction services for people who inject drugs in Alberta?".

Research methods/process: 16 interviews with Registered Nurses were analyzed using a thematic analysis approach.

Findings: Preliminary findings indicate that Registered Nurses find their work positively impactful and meaningful to their clients' daily lives and long-term well-being. Participants noted that flexibility in their approaches to harm reduction and individual patient care resulted in patient progress to healthier lifestyles. As the research progresses, we will explore nurses' views around ethical decision making and scope of practice.

Conclusion: Nurses report that working harm reduction services is fulfilling and enables them to support clients towards individualized recovery.

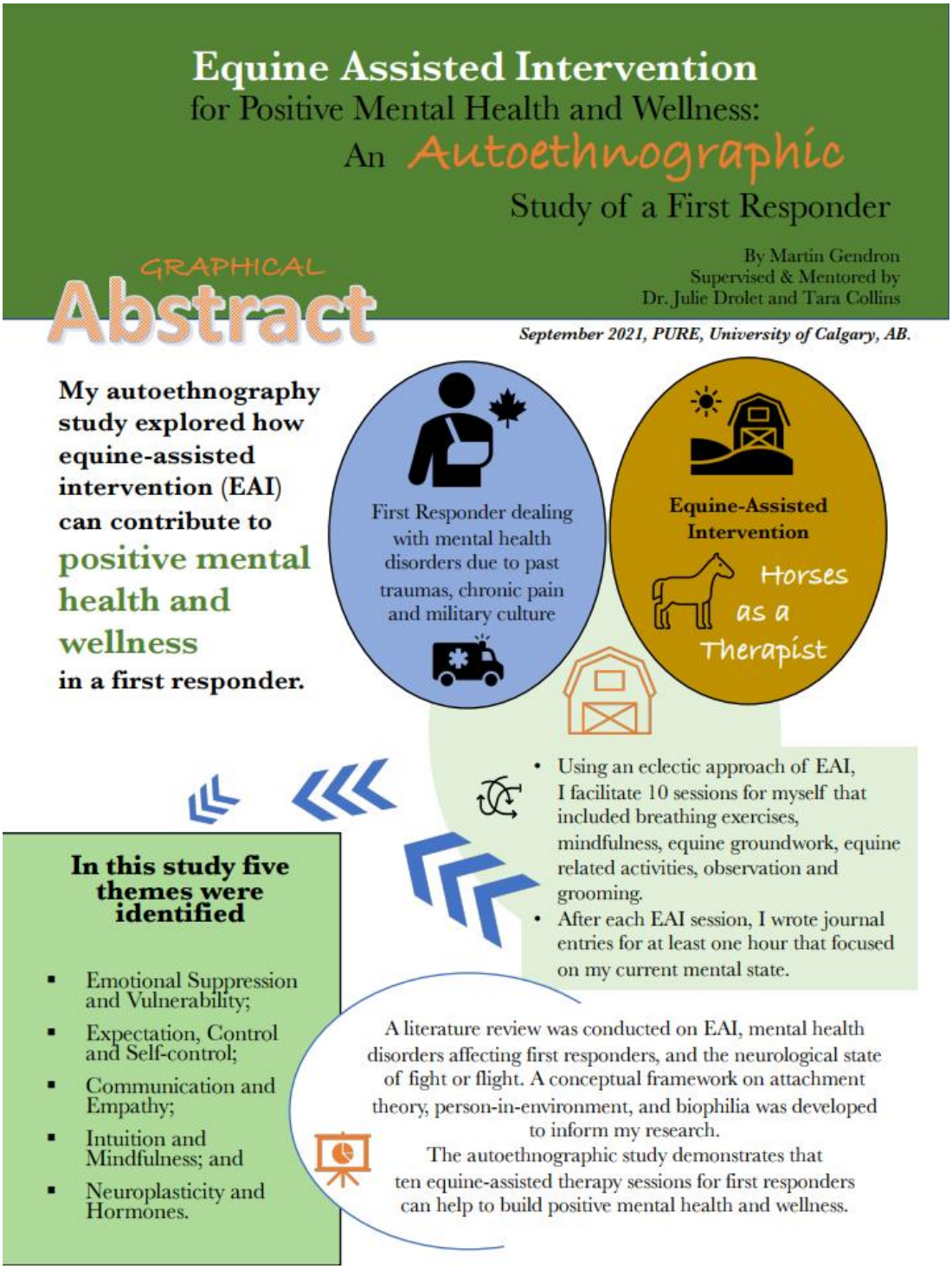
Integrating molecular techniques towards building a genomic based conservation strategy for the endangered Banff Springs snail

Bergen Galts
Supervisor: Sean Rogers
Faculty of Science

Conservation genomics is a tool that can be used to address conservation and management of threatened species (Supple and Shapiro 2018). *Physella johnsoni* is an endangered species of snail which could benefit from a well-informed management plan (COSEWIC 2018). Double digest restriction site-associated DNA sequencing was previously used to create a data set for 5 populations of *Physella johnsoni* and 3 populations of a more common snail *Physella gyrina.* However, there is no standardized analysis pipeline for RADseq data, and various methods used can greatly impact the inferences made (Shafer et al. 2017). This study attempted to optimize pipeline parameters via the -r 80 method (Paris et al. 2017). Initial results showed low numbers of shared loci and high polymorphism, which seemed inconsistent with what would be expected based on species biology. Changing software versions, nor running pipeline components independently, had any impact on the results. There was however an increase in shared loci and decreased polymorphism when low coverage samples were removed from analysis. Further analysis is still to be conducted on how and why the removal of the low coverage samples impacted the results in this manner, and whether it is appropriate to leave low coverage samples out when moving forward with analyses.

Equine assisted intervention for positive mental health and wellness: An autoethnographic study of a first responder

Martin Gendron
Supervisor: Julie Drolet
Faculty of Social Work



Yeísmo and ʎ/j distinction in Peru: An experimental study in the department of Arequipa

Andrés Giudice Grillo
Supervisor: Amanda Pounder
Faculty of Arts

Yeísmo is the merger of the sounds /ʎ/ (as in Italian *aglio*, less closely English *will you*, spelt <ll> in Spanish) and /j/ (as in *yell*, spelt <y> in Spanish) in the Spanish language. *Yeísmo* and the distinction between the two sounds have been considered important regional markers by dialectologists when dividing Spanish into geographical variants. While *yeísmo* is now a dominant trait in Spanish worldwide, there are regions of the Spanish-speaking world which conserve the distinction between /ʎ/ and /j/, and one of these regions is Peru, where the distinction between /ʎ/ and /j/ is now fluctuating toward *yeísmo*.

The research I have carried out is focused on Peruvian Spanish in the region of Arequipa. It consisted of two components: A literature search and an experiment. The goal was to discover the current state of the ʎ/j distinction in the Arequipa region from a geographical perspective, making use of audiovisual material found in the public domain on the Internet. The experiment consisted in gathering speech samples from speakers on videos associated to each district of each province of the Arequipa region, and compiling these items to produce average measurements of *yeísmo* respective to each province. The results reveal the following significant facts, among others: The ʎ/j distinction survives in the region, especially in the inland provinces, but it is competing with *yeísmo*; *yeísmo* does not radiate from the city of Arequipa, but from the coast by contact with regions where *yeísmo* is predominant; the province of Caravelí is where *yeísmo* is the most advanced. This research has taught me a lot about the process of *yeísmo* in Peru, and about the varieties of Spanish spoken in the Arequipa region. The model I designed for the sampling of speech will be useful for further research.

Charting tumor invasiveness using geographical analysis

Sean Grewal
Supervisor: Sorana Morrissy
Faculty of Science

A notable obstacle to successful therapy in cancer is the tumor microenvironment (TME). In glioblastoma (GBM), which the most common and fatal brain cancer in adults, the TME includes immune, vascular, neural, and glial cells. The prevalence and proximity of these cells form a life-support system for GBM cells as they grow and invade but remains to be studied in detail. Recent advances in spatial transcriptomics (ST) now enables expression profiling of spatially intact tissue sections on densely arrayed barcoded capture areas or spots. Depending on the size, diversity, and density of cells, each spot captures the transcriptome of 1-10 cells, and deconvolution is needed to infer the exact cellular composition. We combined a snRNA-seq cell type reference of the mouse brain with another containing cell types of a mouse tumor immune microenvironment, allowing us to generate a relevant cell type reference for our analysis. Using this reference with the tool cell2location, we deconvoluted an ST dataset of the mouse brain. This dataset contained 16 PDX samples that were generated from brain tumor initiating cells from patients with recurrent GBM. Non-negative matrix factorization (NMF) was then run on the deconvoluted data to identify groups of co-located cell types. Collectively these results show how multiple cell type references can be combined with manual review, how cell2location can be used to deconvolute ST data to gain information about the TME and how NMF can be used to identify which cell types co-locate to the invasive front of the tumor. These

approaches will allow us to have a better spatial understanding of the different cell types that contribute to tumor growth and invasiveness.

The effect of neuroprotectant NA1 on early infarct growth following endovascular therapy: The REPERFUSE-NA1 study

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BACKGROUND Unfavourable outcome despite successful endovascular therapy (EVT) recanalization may be caused by substantial infarct growth that occurs despite successful reperfusion. The REPERFUSE-NA1 study replicated the preclinical NA1 experiment by investigating the effect of NA1 on early DWI infarct growth in acute ischemic stroke patients receiving EVT.

METHODS The REPERFUSE-NA1 was sub-study of the randomized controlled trial ESCAPE-NA1 (ClinicalTrialGov NCT02930018). Patients received MRI within 5 hours and 24 hours of EVT. The primary outcome was early diffusion weighted (DWI) Infarct growth.

RESULTS A total of 71 patients was included, of whom 67 had sufficient MR imaging at 5h and 24h post-EVT. For patients who received NA1 compared to placebo, the median age (68.8 v 67.5), baseline NIHSS (15.5 v 16), time from symptom onset to reperfusion (161 v 167 minutes) and mTICI 2b-3 (94.4% v 94.3%) were statistically not different. Median DWI volumes post-EVT (5h) were 13.0 mL (IQR, 5.9-28.1) in NA1 and 13.3 mL (IQR, 3.1-27.0) in placebo. At 24h median DWI volumes increased to 22.6 mL (IQR, 11.2-63.4) in the NA1 group and 22.4 mL (IQR, 7.4-52.3) in the placebo group, equating to a 48.4% DWI volume growth in the NA1 group and a 66.0% growth in the placebo group. Median DWI volume growth was 55.1% for NA1 patients who received alteplase compared to 41.3% for NA1 patients who did not receive alteplase (p=0.65).

CONCLUSION The study did not show an effect of NA1 in reducing early DWI growth despite there being substantial DWI infarct growth in both NA1 and control groups.

Bioleaching of rare earth metals from neodymium alloy magnets using A. thiooxidans and G. oxydans

Allison Guthrie
Supervisor: Jinguang Hu
Faculty of Science

Despite being vital for hundreds of applications, rare earth elements (REEs) currently have no economically viable and widespread recycling methods. Current systems of REE recycling- such as pyrometallurgy and hydrometallurgy- cause detrimental environmental effects and are not practical or economical on a large scale. Due to their importance in electronics, green technology and other areas, it is essential to develop a method to recycle REEs from mixed metal material. One of the most promising streams for recycling is waste electronics, particularly hard drives, which contain large amounts of REEs.

Bioleaching is the use of acid-producing bacteria to create acidic solutions which can dissolve desirable metals in a low-cost and less environmentally-harmful way. For that reason, this research sought to compare and improve methods for the bioleaching of the REE neodymium from NdFeB magnets recovered from waste hard drives. The objective was to compare the rate of cell growth, magnet dissolution, and pH change of two species commonly used in bioleaching, *Acidothiobacillus thiooxidans* and *Gluconobacter oxydans.* These species will also be compared in two methods of bioleaching, wherein the cells may either be cultured in solution together with a magnet feedstock, or their growth solutions may be removed and used after peak cell density has been reached. Research planning and background was conducted online, with no results yet obtained and research ongoing. It is hoped that the results obtained will help future scientists and industry people to make informed decisions about which species and method best suits their needs.

Accumulation of genetic variation in primate populations with different mating systems

Sahiba Haji
Supervisor: Amanda Melin
Cumming School of Medicine

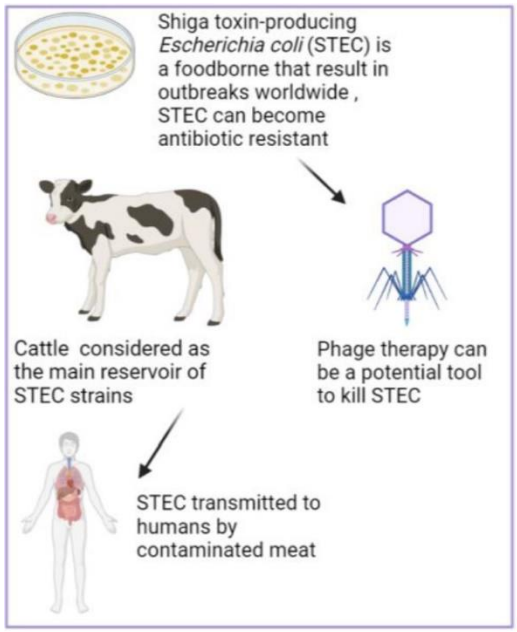
Robust models of primate mating systems were created through an intensive literature review of various primates. *Aotus nancymae* and *Nomascus leucogenys* were analyzed to create a monogamous mating model, *Gorilla gorilla gorilla* and *Theropithecus gelada* were analyzed to create a polygynous mating model, *Callithrix jaccus* and *Sanguinus imperator* were analyzed to create a polyandrous mating model, and *Cebus imitator* and *Macaca mulatta* were analyzed in order to create a polygynandrous mating model. Creating these modern mating models allows for an accurate prediction of the impacts of behavioural mating strategies on a population's genetic composition over multiple generations. In this paper, these models are proposed as pseudocode in SLiM (an evolutionary populations genetics simulation software) framework. Implementation of these models in SLiM will allow for further analysis of population genetics including how a population's level of polymorphism differs between primates of varying mating systems and how mating systems influence the rate of evolution on sex versus autosomal chromosomes. This can provide insight on the evolutionary future of primate populations.

Connected through creation: Lunaapeew perspectives on human-animal relationships in urban environments

Lucas Hale
Supervisor: Judy Anderson
Faculty of Arts

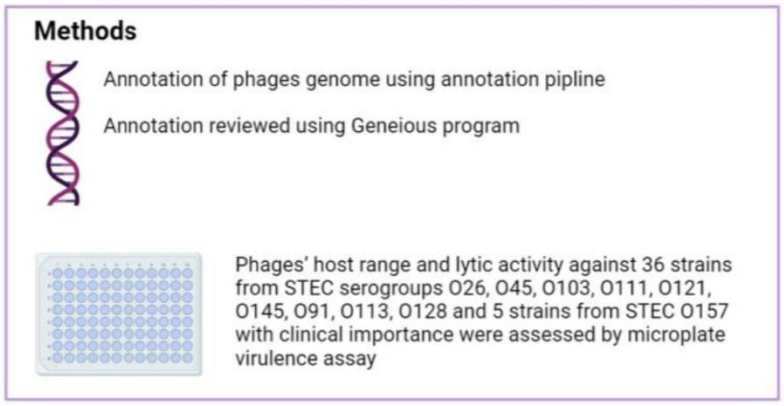
Genomic features and host range of Tequintavirus phages with infectivity against Shiga toxin-producing Escherichia coli

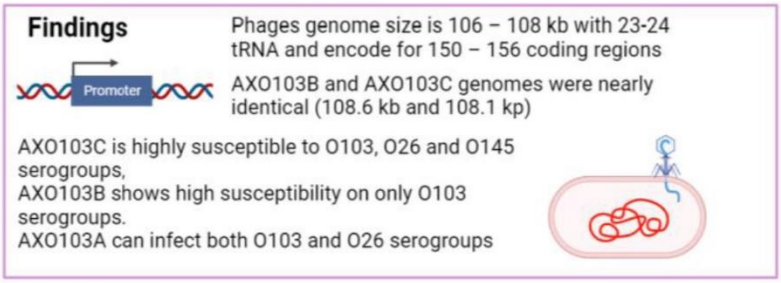
Rita Hannawayya
Supervisor: Dongyan Niu
Faculty of Science

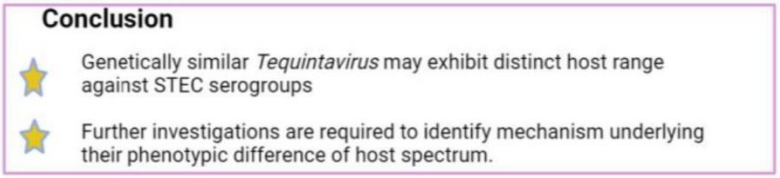


Hypothesis /research question : Phages with similar genomic feature can infect similar host range of STEC

Objectives :Determining the genomic chractertistics and host range of STEC O103-infecting *Tequintavirus* phages : AXO103A, AXO103B, AXO103C







Effectiveness of hackathons in software engineering education

Risat Haque
Supervisor: Laleh Behjat
Schulich School of Engineering

In the past decade, hackathons have become a growing part of Software Engineering (SE) education. Although the academic environment develops technical foundations, a hackathon can develop key competencies to hone lifelong learning. Skills such as interpersonal, entrepreneurial, and technical prepares SE students for a career after graduation and reinforces engineering-relevant skills such as problem-solving, teamwork, and management. This study examines students' abilities to transfer relevant course skills into the hackathon environment, specifically those related to best practices of SE design, SOLID principles and Object-Oriented Programming (OOP). Furthermore, through faculty-led hackathon prep sessions and workshops, students are trained to follow an adapted design-

thinking process, known as the Hackathon Design Thinking Process (HDTP). The study will examine a second-year SE undergraduate and a first-year SE masters cohort with data from participant perception surveys, judges and project submissions from two hackathons. Our results will confirm that participants believe hackathons have a positive impact on their education and that participants tend to sacrifice their planning time to implement their solution, often disobeying SE design principles and best practices due to the fast-paced nature of the hackathon.

Mind-wandering & executive functions in children

Fiza Hasan
Supervisor: Julia Kam & Susan Graham
Faculty of Arts

Fiza Hasan, under the supervision of Drs. Julia Kam and Susan Graham, conducted the study "Mind-Wandering and Executive Functions in Children." Mind-wandering (MW) is the shifting of attention from an ongoing task to task-unrelated thoughts. The executive failure theory of mind wandering proposed that executive functions (EF) regulate MW, so unwanted MW reflects the executive system's failure to prevent it. Since most MW and EF research have examined this relationship in adults, this study aimed to explore the MW-EF relationship in children. Accordingly, we aimed to determine whether children show different patterns of MW occurrence due to their developing EF and attention regulation capacity. Children (ages 8-12) will be asked to perform three tasks targeting three core EF and to report their attentional state as on-task or mind-wandering (if so, whether intentional or unintentional) at various timepoints during each task. Predictions show that MW frequency decreases with age, which corresponds to more developed EF. Further, controlling for age, children with better EF will report less MW. Therefore, lower EF capacities predict more frequent MW.

Computer generation of explicit formulas for jacobian arithmetic on hyperelliptic curves

Haiyang He
Supervisor: Michael John Jacobson Jr.
Faculty of Science

It is important to optimize the arithmetic (specifically divisor addition) on hyperelliptic curves for cryptographic applications that heavily rely on such arithmetic. Currently the fastest algorithms are expressed in terms of explicit formulas, which can be derived from state-of-the-art generic algorithm for divisor addition (NUCOMP). Thus we developed a software that can automatically convert NUCOMP to explicit formulas for ramified hyperelliptic curves with arbitrary genus and allowing the formulas to be converted into Magma code. This software is also extensible by design, allowing different operation optimizations to be added in the future. An extensive test suit will also be created to make sure the program and the formula it generated are correct. However, the software is only using school book techniques to convert polynomial arithmetic into explicit formulas, which means the generated formulas does not have the most optimal performance and there still room for future improvements.

Interrogating carceral social work in Alberta

Ashwini Hemmady
Supervisor: Yahya El-Lahib
Faculty of Social Work

As a future Alberta social worker, I am curious about the experience of micro-practice within unjust institutions and the tensions that emerge. For instance, there is the increasing overrepresentation of Indigenous persons in Canadian prisons. In January 2020, the Correctional Investigator of Canada called this phenomenon "disturbing" and called for "bold and urgent changes", while simultaneously acknowledging that "no government of any stripe has managed to reverse the trend". My research question is: how do social workers in Alberta navigate their roles in prisons? This study utilizes a qualitative research methodology with a focus on institutional practices called Institutional Ethnography (IE). The preliminary findings of this study cover the literature review as well as the process of research ethics board review. Due to the scope of this research project, I have elected to continue this research throughout the year and next summer under the guidance of my supervisor. Key objectives guiding this study are: a) to offer insight on the ways carceral social work functions as a settler-colonial institution; b) to investigate the ways that social workers negotiate and navigate their roles and responsibilities, while reconciling professional values of social justice and transformation; and c) to situate myself conscientiously as a future social worker.

Halogen bonding in diaryliodonium salts

Joy Idowu
Supervisor: Pierre Kennepohl
Faculty of Science

Halogen bonds (XBs) are weak interactions between the electron-deficient area of a halogen atom and an electron-rich Lewis base (LB). The prevailing theory behind the origin of XBs is the σ-hole theory. Still, increasing evidence has shown that chemical effects like charge transfer and Pauli repulsion also play a role in forming XBs. The purpose of this study was to investigate the nature of halogen bonding by studying diphenyliodonium (DPI) and diphenyleneiodonium (DPEI) salts. These iodonium cationic structures were studied with four different counterions. The anions used for this comparison were triflate (OTf^-), chloride (Cl^-), bromide (Br^-), and iodide (I^-). Anion exchanges were done to get the prospective anions. The powdered products were used to run Fourier-transform infrared (FT-IR) spectroscopy, NMR and X-Ray diffraction (XRD) analyses. FT-IR was done to see how the C-I bonds in these structures change under the influence of each anion. NMR analysis aimed to compare the different chemical environments in each structure series, while XRD analysis gave direct structural information of each sample. Results from XRD analysis showed that the DPI halogen bonding interactions were more linear than their DPEI counterparts. However, from the Density Functional Theory (DFT) analyses, the halogen bonding in DPEI appears to be stronger. X-ray absorption spectroscopy will be conducted in January of 2022 to observe how charge transfer plays a role in these interactions. Understanding halogen bonding in these structures will give valuable insights into how it can be applied for more practical purposes, such as crystal engineering, chemical catalysis, the pharmaceutical industry, and so on.

Methane transport from freshwater to marine systems in the Canadian high Arctic

Aaron Irving
Supervisor: Brent Else
Faculty of Arts

The Canadian high Arctic is an understudied and vulnerable environment experiencing rapid change imposed by rising atmospheric greenhouse gas (GHG) concentrations. As a strong GHG, methane is a significant contributor to these Arctic changes. Limited research has observed the transport of dissolved methane from Arctic-lake headwaters to the marine environment in a discrete pulse. Over winter months, frozen lakes cause methane to accumulate under ice. Dissolved methane is suspected to suddenly move through rivers once flow is established.

Field research was conducted at eight high Arctic rivers surrounding Cambridge Bay, Nunavut to investigate the transport of dissolved methane (CH4) during spring ice-break up. This research studied the magnitude and timing of gaseous pulses to define the broader behaviour of methane in Arctic rivers.

Water samples were collected over 3 weeks with each river sampled five times 2-4 days apart. Filtered and unfiltered samples were collected as well as duplicates for a total of 164 samples. Samples were preserved to prevent biological uptake of dissolved gases. Field parameters of pH, temperature, dissolved oxygen, and conductivity were monitored to estimate pulse movement. Laboratory analyses were performed for total alkalinity, dissolved inorganic carbon, and water isotopes as well as gas chromatography for CH4.

Based on preliminary results, all eight studied rivers exhibited pulses of dissolved CH4. Peak concentrations ranged from 25 nM to 1600 nM, representing 10 to 100-fold increases from suspected river baselines. These data suggest that a spring methane pulse is common in Arctic rivers, but with significant variability in magnitude. Further analysis should offer better insight into what controls methane emissions from Canadian high Arctic rivers.

Extraction of DNA from wastewater biosolid microplastics in the search for antimicrobial resistance

Paige Jackson
Supervisor: Sean Rogers
Faculty of Science

The purpose of this study was to determine the amount of microplastics needed to be separated from municipal wastewater biosolids and their biofilms to obtain measurable DNA. The concentration and purity of DNA present in biofilms associated with microplastics versus biosolids alone were quantified and contrasted. First, a literature search and review was completed on microplastics DNA extraction in wastewater contexts. Second, training in molecular biology techniques to extract DNA and measure its purity and amount occurred. Twelve samples of microplastics only, biosolids only, and microplastics plus biosolids were manually separated with visualization under a dissecting microscope. DNA was extracted using the Qiagen AllPrep PowerViral DNA/RNA Kit and Qiagen QIAamp PowerFecal Pro DNA Kit. DNA was measured for concentration and purity with a NanoDrop One/Onec Microvolume UV-Vis Spectrophotometer. The microplastics only DNA concentrations ranged from 2.8-11.4 ng/µL, biosolids only concentration was 14.2 ng/µL and biosolids plus microplastics was 70.5 ng/µL. The A260/A280 purity values deviated from the “pure” value of 1.8 for most samples and the A260/A230 purity values deviated from the “pure” range of

2.0-2.2 for all samples. Significant findings include the confirmation that DNA was present and measurable on the surface of microplastics, which has implications for future research.

A cross-sectional, provincial survey of stroke survivor to investigate barriers to care for vision loss in stroke in Alberta

Jennis Jiang, *Dr. Kiran Pohar Manhas*
Supervisor: Kiran Jot Pohar Manhas
Cumming School of Medicine

Vision loss (VL) post-stroke has become an increasingly recognized complication among stroke survivors. Internationally, few studies indicate barriers to VL diagnosis, rehabilitation, and therapy among stroke survivors; none of these are based in Alberta. The study's purpose is to clarify stroke survivors' experiences of VL diagnosis and management in acute, tertiary, and community care settings; and understand provider perceptions of health services delivery and interprofessional collaboration in these settings. This study supports Phase 2 of the Burden of Vision Loss Study. In Phase 1, qualitative interviews informed the development and validation of a survivor survey. Phase 2 involved the provincial distribution and analysis of surveys across nine participating sites in acute, inpatient rehabilitation, and community care. Researchers administered the online surveys with consented eligible participants via email or by phone. Results were analyzed using appropriate descriptive statistics to clarify demographics, common experiences, and priority gaps. A scoping review on interprofessional collaboration (IPC) in vision care settings was conducted to further support this study. Forty-six stroke survivors with VL across Alberta completed the online surveys. Survivor perceptions of post-stroke care management varied across the care continuum. Provider perceptions of vision care and health services delivery stressed the need for IPC to improve care. Findings suggest that improvements must be made to the Albertan healthcare system. The findings are anticipated to inform Alberta Health Services about the current state of provincial programs and justify future policy changes to standardize vision care and rehabilitation for stroke survivors.

A11 region ablation and the effect on locomotor behaviours in mice

Rebecca John
Supervisor: Patrick Whelan
Faculty of Kinesiology

The A11 nucleus is a small dopaminergic nucleus found in the posterior hypothalamus that projects to the spinal cord and provides the primary source of spinal dopamine across several species. My work is expanding upon an observed locomotor role for the A11 nucleus. My project utilized a diphtheria neurotoxin virus combined with a transgenic mouse line, allowing for a precise ablation of the dopaminergic cells of the A11 nucleus. It was hypothesized that locomotor changes would be observed following A11 ablation, including in general locomotor patterns, anxiety-like and exploratory behaviours and in skilled locomotion. Experimental TH-IRES-Cre mice (n = 9, 7M, 2F) were injected with AAV-mCherry-FLEX-dtA, while control mice (n = 9, 7M, 2F) received AAV DJ-CaMKII-eYFP. Behavioural tests were completed prior to and at several time points following ablation. Interestingly, in male mice, divergent results were obtained. Preliminary work indicated a non-significant trend towards decreased locomotion following ablation. However, an additional cohort of both male and female mice displayed a non-significant trend towards increased locomotion. As well, females and males in the first cohort showed a trend towards decreased exploratory behaviours compared to controls, while additional work in male mice trended towards increased

exploratory activity in ablated mice. Initial post hoc analysis indicates differences in the cells ablated throughout the A11 nucleus and surrounding areas which may be responsible for the differences observed. Future work will require matching of the ablated cells to the behaviours observed to more fully understand the locomotor behaviours associated with these regions.

Positional analysis of radio sources in comparison to their host galaxies in infrared and optical wavelengths

Christian Keenan
Supervisor: Jeroen Stil
Faculty of Science

The study by Johnston et al. (2021) analyzed samples of radio sources varying in compactness and flux. Galactic radio sources are theorized to be powered from matter falling on the central supermassive black holes of certain galaxies. Such active galactic nuclei (AGNs) emit jets of relativistic particles travelling out of the galaxy and fanning into radio lobes. The relativistic particles emit linearly polarized radio wavelength radiation; however, as they move throughout the galaxy, they become depolarized. The position of the radio sources relative to their host galaxies are currently unknown. To understand the relationship between radio sources and their host galaxies better, this study aims to determine the position of the radio sources relative to their host galaxies. The study will be conducted primarily utilizing python scripts to manage optical, infrared, and radio wavelength data to statistically determine the number of galaxies with compact radio sources contained within them. The main findings concluded that most galaxies contained radio sources within them, due to the cut-off radius of 3.6 arcseconds being smaller than a typical galaxy. In addition, a table and plots of magnitude counts were successfully created for the infrared and optical image data. It was determined that the counts per magnitude bin of the optical data per sample were quite similar due to similar slopes in the plots being found. In contrast, infrared counts per magnitude bin were discovered to fluctuate quite largely.

Peripheral intravenous insertion and removal practices on inpatients units at the Alberta Children's Hospital

Larissa Kelly[1], *Krista Wollny[1,2,4,5], Lily Ragan[4], Laurie Lee[1,3,4,5]*
Supervisor: Laurie Lee & Krista Wollny
Faculty of Nursing

[1] University of Calgary, Faculty of Nursing, Calgary
[2] University of Calgary, Cumming School of Medicine, Department of Community Health Sciences
[3] University of Calgary, Cumming School of Medicine, Department of Pediatrics
[4] Alberta Children's Hospital, PICU, Calgary
[5] ACHRI

Background: Peripheral intravenous (PIV) insertions are common for hospitalized children. Needle pokes can create persistent traumatic memories, needle phobia, and heightened pain sensitivity. PIV insertions are more difficult due to smaller, less accessible veins and poor compliance due to developmental stages. Despite the frequency of needle pokes during pediatric hospitalization, there is minimal research or standardization of practice.

Objective: To describe the characteristics of PIV insertions, and removals among children admitted to the Alberta Children's Hospital (ACH).

Methods: Data were collected on Alberta Children's Hospital Units 1 to 4 from July 12th to August 27th 2021. Data collection forms were developed based on clinical observation and literature review and included: clinician characteristics, reason, result, dressing type, number of attempts, locations, cannula gauge, comfort measures, and reason for removal. Staff were educated through email, posters, and bedside education. Audits were performed every weekday through consultation with the charge nurses on each unit. Data was entered into REDcap and analyzed with descriptive statistics.

Results: Data was collected on 194 IV insertions and 152 IV removals. Half (50%) of encounters had 2 or more attempts. Insertion encounters were performed by Unit Nurses (46%), Transport Nurses (35%), and the other professions (19%). Of successful insertions 89% were secured with a dressing with a border. The most used cannula gauges were 24 (60%) and 22 (36%). Comfort measures were used in 203 (82%) of attempts with the most common being topical numbing cream (32%).

Conclusion: There a need to reduce the number of encounters requiring more than one attempt. The two groups most responsible for PIV insertions on Units 1-4 are Transport and Unit Nurses. There is room to increase the number of PIVs secured with border dressings and utilization of comfort measures.

Masculinity and help-seeking behaviour among adolescent boys

Jordan Keough, *Dr.Exner-Cortens*
Supervisor: Deinera Exner
Faculty of Arts

Research in adult male populations has demonstrated an association between stereotypical male gender role norm adherence and negative attitudes towards seeking mental health support. This relationship is thought to be driven in part by a conflict between Western male ideals which emphasize toughness and emotional restriction, and the expectations of vulnerability, dependence, and emotional expression commonly associated with help-seeking. However, little is known about the relationship between male gender role norm adherence and help-seeking intentions in adolescent populations. Investigating barriers to receiving mental health support for adolescents is crucial as many mental health disorders emerge during this period. Furthermore, the help-seeking pathways of adolescent boys are a particularly important area of research as suicide remains a leading cause of death for this group. Therefore, to address this research gap, the current study examined the relationship between adherence to male gender role norms and help-seeking intentions in a sample of cisgender, grade 9 boys in Western Canada (*n*=209). Using scores from the Male Role Norms Inventory-Adolescent-Revised (MRNI-A-r), Adolescent Masculinity Ideology in Relationships Scale (AMIRS), and General Help-Seeking Questionnaire (GHSQ), bivariate correlation analyses were conducted to assess this relationship. As hypothesized, preliminary analyses revealed that boys who adhered more strongly to male gender role norms were less likely to seek help from a mental health professional. This finding emphasizes the need for gender-informed mental healthcare for adolescents that challenges stereotypical male gender role norms.

Singlet oxygen production by Rose Bengal and Methylene Blue and their mixture with using 9,10-DMA as probe

Pooneh Khalilpoorkordi
Supervisor: Belinda Heyne
Faculty of Science

Since the discovery of penicillin, we have developed our society under the assumption that most bacterial infections can be treated. As such; when sustaining an injury, we do not fear the infections it can bring that killed so many people one hundred years ago. However, with the recent appearance of superbugs, our fragile peace can be broken. It means that antibiotic resistance amongst microbial pathogens is increasing rapidly and it is necessary to search for new antimicrobial techniques. Photodynamic therapy (PDT) is one such technique that takes advantage of the whole array of light to destroy a broad spectrum of pathogens.[1] PDT is the combination of photosensitizers (PS) and light to produce reactive oxygen species (ROS) that can kill cancer cells and infectious microorganisms.[1,2] This PURE project was focused on the investigation of Singlet Oxygen (SO) production using Rose Bengal (RB), Methylene Blue (MB), and their mixture as PS species in organic media.

Many variable parameters such as type of sensors, PSs, as well as its different concentrations, light source, excitation wavelength, reaction time, distance from light source, and nature of solvent were used. The degradation kinetics of the quenchers/sensors generated by SO species were determined by monitoring the photo-oxidation of the chemical quencher and measuring its disappearance by spectrophotometry in the presence of different PSs. In this project, we have used solution based methods for generating SO and have found that the proper concentration of the mixture of RB and MB influence the SO generation efficiency and this mixture can be considered as a potential PS in PDT.

Assessing network size and distribution as potential indicators of postsurgical outcome in patients with drug resistant epilepsy

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Supervisor: Paolo Federico
Faculty of Science

Background & Hypotheses

The success of epilepsy surgery relies on accurate localization of the seizure focus as well as the characterization of its broader surrounding network. In this retrospective study using resting-state fMRI, we hypothesized that individuals whose seizure focus possessed 1) more numerous, or 2) more bilateral functional connections were less likely to be seizure free after surgery.

Methods

Five subjects with mesial temporal lobe epilepsy underwent simultaneous intracranial EEG and functional MRI. For each patient, a mask of the clinically-defined seizure focus was generated. Functional connections between the mask and every other voxel were determined, and connections that significantly varied from the normal networks of 20 healthy controls were determined to be abnormal. Laterality index, an indicator of network distribution, was also computed. Both laterality index and number of abnormal connections were compared based on patients' post-surgical outcomes (seizure-free vs. seizure recurrence).

Results

In a preliminary analysis of five subjects, a greater number of abnormal functional connections were observed in patients who experienced post-surgical seizure recurrence compared to those who experienced seizure freedom. Both groups exhibited bilateral networks.

Conclusions

Patients whose seizure focus have a greater number of abnormal functional connections may be more likely to experience seizure recurrence following surgery.

Climate and riparian white spruce growth in a northern boreal environment

Sarah Knude, *Jared Connoy*
Supervisor: Steven Michael Vamosi
Faculty of Science

Northern environments have been experiencing climate change in an exacerbated fashion, with a national average of an increase in temperature of 1.7 ˚C, while northern Canada has increased by 2.3 ˚C. With the increase in temperature due to climate change, the growth rate of white spruce (*Picea glauca*) has increased in southwestern Yukon, Canada. Through using dendrochronology in central Yukon, this research project attempted to see the impact of climate on white spruce. Tree growth was measured by width of rings in 45-50 tree cores per site, with a total of 5 sites. Tree sites were taken in riparian zones, reducing the likelihood of moisture being a growth limiting factor in sites, a common limitation on white spruce growth in Yukon, Canada. Dependence on summer temperatures appears to be significant, but more data collection and analysis is necessary to come to any meaningful conclusion. In comparing climate and tree ring data there appears to be a correlation between increasing temperatures and increased tree growth, though there is no statistical significance. Further research may be done to understand the effect of increasing temperatures on other tree species in northern environments.

Sodium citrate sensitizes multidrug-resistant Pseudomonas aeruginosa to triclosan

Julie Huynh Le
Supervisor: Tao Dong
Cumming School of Medicine

Pseudomonas aeruginosa is a Gram-negative bacterium causing many types of opportunistic infections, notably contributing to mortality in cystic fibrosis patients. Additionally, *P. aeruginosa* is highly antibiotic resistant. Our lab previously observed that washing *P. aeruginosa* PAO1 in sodium citrate reduces its resistance to triclosan. My project aims to characterize this mechanism of citrate-induced triclosan sensitivity in PAO1. Overnight cultures of PAO1 were resuspended in salt solutions, then serially diluted and spotted on lysogeny broth (LB)-triclosan plates. Survival of cells subjected to wash treatments was quantified by colony forming units per milliliter. When citrate washes were supplemented with magnesium chloride ($MgCl_2$), PAO1 regained its resistance to triclosan. We predict that citrate chelates divalent cations (Mg^{2+}) from the lipopolysaccharide (LPS) layer of the outer membrane (OM), weakening its integrity and sensitizing PAO1 to triclosan. This is supported by ethylenediamine tetraacetic acid (EDTA), a chelator of divalent cations characterized to disrupt Gram-negative OM also sensitizing PAO1 to triclosan, a phenotype reversed by the addition of $MgCl_2$. Triclosan is present in surface cleaning products used in healthcare settings as well as in some medical equipment. However, it is ineffective against *P. aeruginosa* which is a

common nosocomial pathogen with intrinsic multidrug resistance. We have identified that *P. aeruginosa* exposed to sodium citrate is susceptible to triclosan suggesting that the addition of sodium citrate to medical cleaners and surfaces could help to limit *P. aeruginosa* nosocomial infections.

Synergistic induction of gene expression by acetylcholine and LABA's in lung epithelial cells

Nikko-Johan Lee
Supervisor: Mark A. Giembycz
Faculty of Science

Inflammation is a common characteristic of respiratory diseases, including chronic obstructive pulmonary disease (COPD), a progressive inflammatory disorder of the airways and lungs. There is no cure for COPD, but it is treatable with drugs that open-up the airways. Long-acting β2-agonists (LABAs) and long-acting muscarinic receptor antagonists (LAMAs) are drugs that can provide symptomatic relief from COPD and can reduce the likelihood that a patient will experience COPD exacerbation, a sudden worsening of lung inflammation. Thus, LABAs and LAMAs may have anti-inflammatory function. Interestingly, acetylcholine (ACh) activity is blocked by LAMAs, implying that ACh has pro-inflammatory potential. Since inflammation is regulated by changes in gene expression, my objective was to determine the effect of LABA treatment with or without activation of muscarinic Ach receptors, on gene expression in lung epithelial cells. As expected, I found that the LABA, indacaterol, induces gene expression in these cells. Interestingly, co-treatment with the ACh analogue, carbachol, enhances the indacaterol effect, indicating a synergistic effect of these drugs. Time-course analysis shows that synergistic induction of gene expression reaches a peak at 4 hours after combination treatment. Potentially, combined treatment with indacaterol and carbachol could more effectively reduce the occurrence of COPD exacerbation.

Design of a portable white-noise generator for riometer calibration

Marcelo Li Gonzales, *Dr. Emma Spanswick*
Supervisor: Emma Louise Spanwick
Schulich School of Engineering

With the development of a new generation of riometers, 30 MHz receivers for near-earth space weather research, a new portable white-noise generator is being designed to be used as a calibration and on-site testing device. This noise generator would have a flat frequency output from 0 MHz to at least 60MHz, as well as have the capability of outputting 6 different power levels of this noise that are within the range of the new riometers. The designs of this new noise generator were tested through a spectrogram and as input to the old generation of riometers. The designs included testing what noise source was the best for a flat-noise response (diodes or transistors), if an amplification stage was needed, how much and what kind of noise the battery introduced to the circuit, as well as what kind of resistor network would be the ideal to obtain 6 different power levels of noise. The data showed that a transistor-based non-amplified design was the best for the relatively low power levels that the riometer is sensitive to, and that the battery does not introduce notable noise to the output as long as the connector is not directly grounded to it. Going forward, the experience with testing and prototyping gained will speed up remaining work and be useful in future endeavors both in and outside this research project.

The history of the Spanish Bilingual Program in Calgary

Jeanne Liendo
Supervisor: Roswita Dressler
Werklund School of Education

The Spanish Bilingual Program in Calgary's public schools was established in 2001. The rapid increase in enrolment since the program's inception, made it the fastest growing alternative language program in the city. Although the program has existed for two decades, little is known about the context and key components that led to its creation and implementation. The purpose of this qualitative research study is to document the establishment of the Spanish Bilingual program in Calgary. It traces the path from creation to implementation of this new alternative program within a public education system. A descriptive, narrative design is used. I analyzed historical and legal documents and collected data by conducting in-depth interviews with key stakeholders who pioneered the implementation of this program.

The establishment of the Spanish Bilingual program was a complex process in which different and interrelated elements converged. For better understanding of this process, I discuss the historical, legal political, economic, societal and cultural contexts that preceded the initial discussion to establish the Spanish bilingual program. Then, I present the key components that needed to be in place before program implementation. The data shows that program was the first of its kind initiated by a collaborative effort between school boards, the Ministry of Education of Spain, and Alberta Education. The data also reveals that this institutional support, including funding and resources, along with curriculum development and program structure, selection of program site, material and human resources, and leadership support were foundational elements of the Spanish bilingual program. This study can inform future decision-makers about the key elements necessary to the establishment of new bilingual, second language or alternative program of choice.

Canadian nurses' exposure to potential psychologically traumatic events during the COVID-19 pandemic: Co-designing an online solution

Paul Linek
Supervisor: Linda Duffett-Leger
Faculty of Nursing

The COVID-19 pandemic has placed immense strain on the Canadian health care system. Nurses, the backbone of patient care, have faced various unique and noble challenges throughout the pandemic. Nurses prior to the COVID-19 pandemic regularly experienced potentially psychologically traumatic events (PPTEs), which occur when a nurse is exposed to actual or suggested sexual violence, injury, or death. During the COVID-19 pandemic nurses are at an increased risk of experiencing occupational stress, burnout, and social isolation. With the current COVID-19 pandemic potentially exacerbating Canadian Nurses' mental health issues, it is imperative that their psychological impacts are measured, and appropriate interventions are developed.

The research project titled *Canadian Nurses' Exposure to Potential Psychologically Traumatic Events During the COVID-19 Pandemic: Co-Designing an Online Solution* aims to understand how Nurses have been impacted by the COVID-19 pandemic through a longitudinal survey and multiple focus groups. The three objectives of this project are to: (1) validate existing research that finds nurses at an increased risk of experiencing PPTEs during a pandemic, (2)

identify factors that increase nurses' mental health disorder symptoms during COVID-19, and (3) ask Canadian nurses how they would prefer to partake in an online mental health intervention.

Exploring animal-human relationships through Indigenous methodologies

Saskia-Mae Livingstone
Supervisor: Adela Kincaid
Faculty of Arts

Genes as biomarkers - An investigation into prognostication practices in prostate cancer research

Ronan Lopes
Supervisor: Tarek Bismar
Cumming School of Medicine

Prostate cancer is among the leading cancers in men in both Canada and the United State, however, prediction of disease progression is still unclear. There is a great need to develop and investigate biomarkers associated with disease progression. This project led by Dr. Bismar, and I was as investigation into prognostication practices in prostate cancer research. Bioinformatic tools coupled with literature examined top differentially expressed and coamplified genes in cancer. After initial screening, immunochemistry was used for outcome analysis to determine the presence and level of expression of various genes. Additionally, siRNA knockdown was used to further evaluate the role of specific genes in disease progression. Overall, the goal was to combine tissue-based data long with cell line data to illustrate how genes affect both disease progression and prognosis of prostate cancer patients. Extensive cell culture techniques were used to generate stable cell lines for protein estimation, western blotting, siRNA knockdown, transfection, and assessment of associated markers such as EMT pathways, invasion, proliferation etc. In conclusion, we added to the base of knowledge surrounding our selected genes through our diagnostic evaluations, however further work must be done to establish a deeper understanding of the roles.

Life cycle assessment of hydrogen and its many potential purposes as an energy carrier

JT Luterbach, *Dr. Joule Bergerson, Dr. Sylvia Sleep*
Supervisor: Joule Bergerson
Schulich School of Engineering

This research is focused on alternatives to fossil fuels, specifically hydrogen, and is trying to answer the research question: How do hydrogen-related technologies stack up against their incumbents from a life cycle perspective? Hydrogen is already an essential resource in many industries, but it also has the potential to compete with many other incumbent technologies in industries such as transportation, electricity storage, and heating. The purpose of this research is to compare the life cycle greenhouse gas emissions of various hydrogen technologies with the incumbents of each industry.

A comprehensive literature review of hydrogen-focused journal articles and federal reports was conducted to answer this research question. Data on the greenhouse gas emissions from each stage of hydrogen's life cycle was collected from these resources, averaged, and combined to produce estimates for the life cycle global warming potentials related to some of hydrogen's many purposes.

This research confirms that hydrogen-related technologies do have the potential to reduce greenhouse gas emissions in each of their respective industries. With that being said, the methods used for hydrogen production determine how much of a reduction, if any, is possible in each industry.

The most important thing to take away from this research is the value of life cycle assessment. Hydrogen, like electricity, does not result in the emission of greenhouse gases at the point of use, but upstream processes that are required to obtain that hydrogen can produce significant amounts of greenhouse gases. If the entire life cycle of a

product is not included in an environmental assessment, decision-makers may be given incorrect information which can lead to negative consequences.

When does the wolf takeover? An investigation on cooperation in wolfdog hybrids

Ridhampreet Madaan
Supervisor: Alexandra Twyman
Faculty of Arts

The intersectionality between social structure and genetics is a complicated interaction that holds significant implications in behavior. One way to investigate this interaction is through observations in animal behavior. This research article aims to investigate the tipping point between genetics and animal behavior, specifically in wolfdog hybrid animals. To investigate this, this research aimed to use findings from a previous study that suggests wolves cooperate better than dogs do with members of their own species (Marshall-Pescini, 2017). The researchers attributed a wolf's cooperation capacity to their need for cooperation in a social setting (i.e hunting together). This establishes that expectations of a social environment shape animal behavior. Yet, it's unclear how genetics then plays a role in shaping behavior. This research's central aim is to integrate an aspect of genetics into the discussion by replicating this study on wolfdogs with varying wolf content levels. Investigating the question: "At what genetic content level does a wolfdog begin to behave like a wolf?" To begin answering this question, a thorough literature review was conducted. In one study, low-content wolfdogs (25-30% wolf blood) exhibited wolflike tendencies like increased difficulty in training and abnormal attachment tendencies (Sommese et al. 2021). Additionally, two research articles analyzing wolfdog gazing behavior reported that even low-content wolfdogs deviate from typical dog behavior significantly, such that even domesticated wolfdogs looked at humans for help less often than dogs did (Maglieri et al. 2019). Interestingly, the wolfdog's wolf blood content level did not significantly correlate with wolfdog gazing behavior (Sommese et al. 2019). Which means just because an animal had less wolf content does not mean they displayed less wolf like behaviors (Sommese et al. 2019). All applicable wolfdog research suggests that wolf-genetics present in a wolfdog play a greater role in shaping behavior than initially anticipated. Future studies could use this knowledge to form hypotheses on anticipated wolfdog behaviors.

Bioretention for stormwater management

Farid Madanat
Supervisor: Jennifer He
Schulich School of Engineering

Bioretention system is a Low impact Development Technology (LID) in which a vegetated dip is created in the surface of the earth to allow for the control and management of stormwater runoff. It is regarded as a better alternative than its counterparts as they are often costly to build and maintain while bioretention system allows for the more efficient management of stormwater pollution in proximity to its source and is more sustainable. Another advantage of bioretention system is its dual benefits as it improves the quality of stormwater as well as attenuating the volume and peak flow of stormwater runoff. A bioretention basin often consists of ponding space, vegetation, a permeable growing media layer, a drainage layer, and an optional underdrain system from the top to bottom. Within the system, the media and vegetation are the most important components, as they are believed to largely determine the hydrologic and water quality performance of the system. Research on this subject is still not sufficient in terms of optimizing their design and thus their benefits.

To advance the understanding of the roles of the media, vegetation, as well as their interactions on bioretention systems, 24 testing beds located in the Town of Okotoks and 4 testing beds in Victoria were constructed with different media and planted with different vegetations are monitored. The effects of the hydrologic loading (quantity of stormwater runoff) and climate conditions would be examined. The data collected in multiple years will be used to evaluate the performance of bioretention systems, examine the roles of vegetation and media, and develop a practical modeling tool for designing bioretention systems in engineering practices.

Sociocultural perspectives on pain, injury, and fatigue amongst university contemporary dancers

Jenna Magrath
Supervisor: Sarah Kenny
Faculty of Kinesiology

Introduction: Contemporary dancers are at high risk for injury due to the high physical demands of the dance form. It has been demonstrated that a culture of "persevering through pain" exists in dance which may contribute to high rates of injuries. Research indicates that team culture and social systems can promote the normalization of pain and injury; this has been described in sport and ballet dancers, but little research has examined the perceptions of pain and injury of dancers enrolled in a contemporary based university dance program. **Method**: Three university dance students participated in semi-structured interviews to get an understanding of their perceptions of pain, injury, and fatigue. Interviews were transcribed and analysed using reflexive thematic analysis. **Results**: Analysis revealed four themes: *Perceived causes of injury, What is my best today?, Acceptable pain and injury pain,* and *External influences on injury perceptions and behaviours.* **Conclusion**: Dancers reported dancing through pain and injury, and not feeling always comfortable vocalizing their pain and injury. Additionally, they noted the importance of bodily check ins in noticing and preventing injuries. Furthermore, results highlight the role that dance instructors play in dancers' understandings of pain, injury, and fatigue, and influence whether or not they felt comfortable expressing their pain and injuries.

VessCo-opJ: An ImageJ plugin for automated measurement of cell-vessel contact and elongation over the course of vessel co-option

Mehr Malhotra
Supervisor: Lian Willetts
Cumming School of Medicine

Vessel co-option is an intricate, non-angiogenic process implemented by cancer cells to gain access to the body's pre-existing blood vessels and is regulated by motility associated microRNAs (miRNAs). Cancer metastasis, the spread of primary tumor cells to secondary sites, is also associated with vessel co-option, as successful entry and exit of blood vessels is required for successful metastasis. A potential therapeutic strategy to combat metastatic cancers, therefore, would be to interrupt the molecular regulatory pathways by dysregulating endogenous levels of specific motility associated miRNA candidates. Traditionally, it has been difficult to visualize the dynamic aspects and processes that define metastasis, including intravasation, extravasation, and vessel interaction. To gain insight into how specific miRNAs affect vessel co-option and cell motility *in vivo*, we use intravital imaging to visualize the cellular processes in real-time. Morphometric analysis of this manner can be labour intensive and prone to bias/errors. To generate a standardized platform to analyze visual aspects of vessel co-option, we developed VessCo-opJ, an ImageJ (NIH) plugin capable of measuring cell counts, cell to blood vessel overlap, and maximum cell length. VessCo-opJ is

currently undergoing further testing and development. With further development, we hope VessCo-opJ will be a powerful tool for rapid and accurate data collection/analysis in all studies measuring cell to vessel interactions.

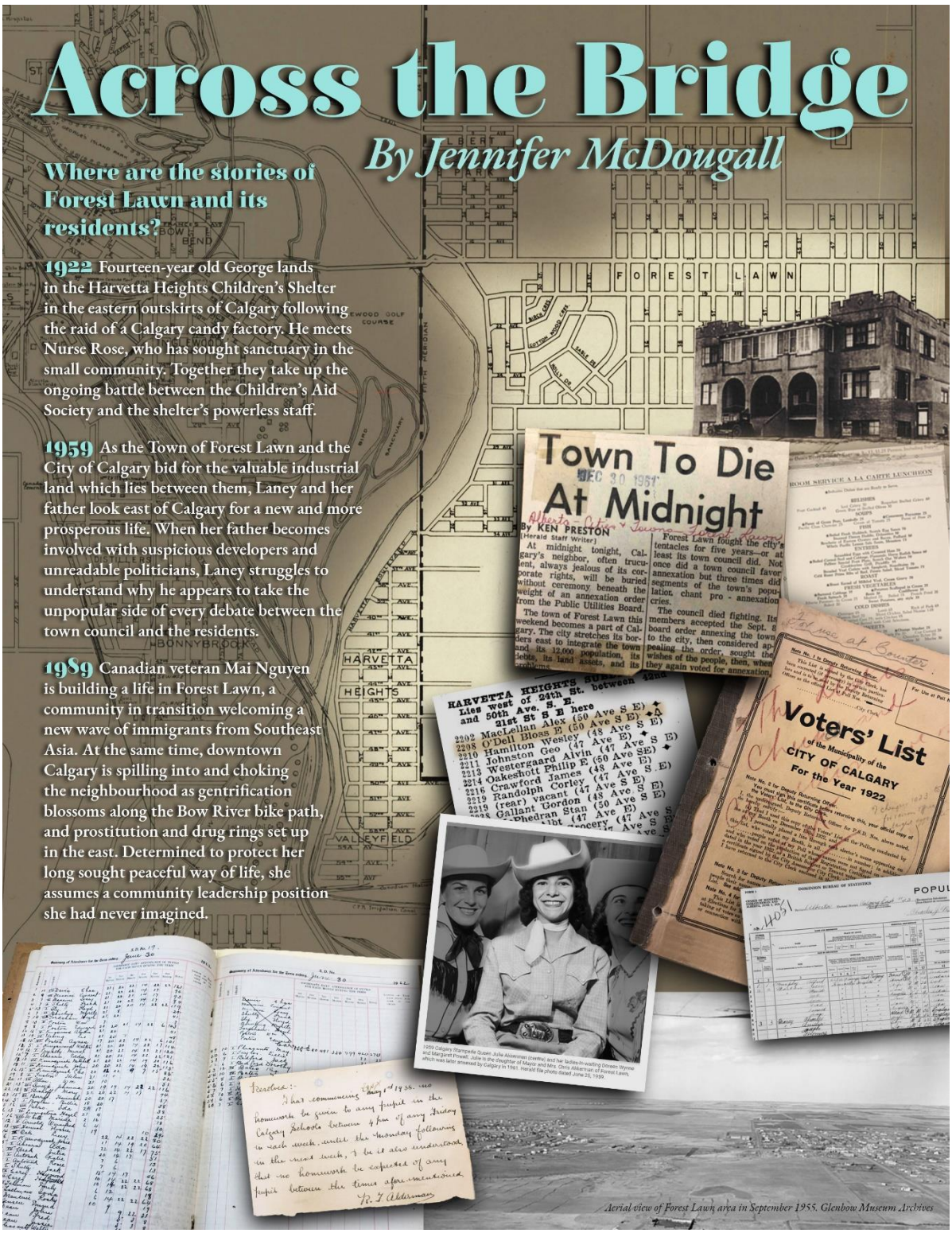
Cortical functional network assignment using template priors

Rylan Marianchuk
Supervisor: Signe Lauren Bray
Faculty of Science

Variance exists in the proclivities for humans to act. This is manifest by the disparate array of human endeavor and its specialization, from art, music, science, and physical sport. The trait-like behaviors that give rise to this diversity are known to have a biological basis which neuroscience looks to characterize. More specifically, this basis is thought to be found in the functional network organization of the human brain. To know precisely how these networks vary across or within subjects, there must be an assignment method that takes minimally preprocessed magnetic resonance images of the brain in vivo, where the human sits in the scanner, and derives a model of their brain that outlines the distribution of well known networks across their cortex. This report attempts to explicate the specific methodological steps required to achieve this using a previously proposed technique that matches individual functional connectivity with an externally provided template that contains network labeled regions of high group consensus. The task requires onerous computation, and was developed using Python along with a Cython binding to allow for C++ multithreading speedup. Code was made freely available on github for future use across the neuroimaging community.

Across the bridge: Tales of Forest Lawn

Jennifer McDougall
Supervisor: Suzette Mayr
Faculty of Arts



Machine learning and distributed acoustic sensing data for risk assessment: Gravity driven geotechnical hazards

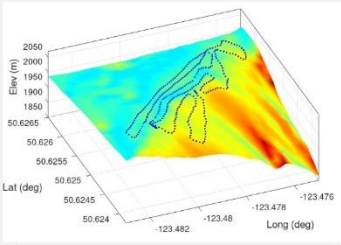
Jacob Mish
Supervisor: Robert Ferguson
Faculty of Science

MACHINE LEARNING AND DISTRIBUTED ACOUSTIC SENSING DATA FOR RISK ASSESSMENT: GRAVITY DRIVEN GEOTECHNICAL HAZARDS

Jacob Mish[1]
[1]Department of Geophysics, Research Mentors: Dr. Robert. J. Ferguson

Introduction

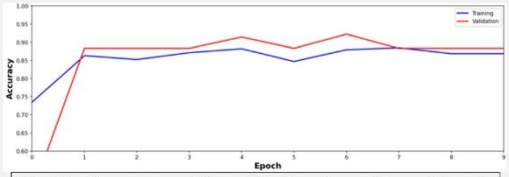
- Detect real-time rockfalls using machine learning
- Distributed Acoustic Sensing (DAS) data from fiber optic cables on Mt. Meager
- Monitor rockfalls near important workers and assets
  - Geothermal
  - Hydroelectric
  - Transport Infrastructure



DAS station map on Mt. Meager

Conclusions

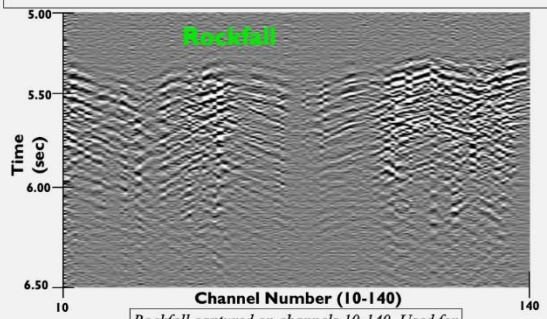
- Transfer learning: Fast & Effective Training
- Lines and Features: Easily Extracted and Identified
- Highly Successful: 80% accuracy for first model
- Real-time: Instantaneous classification



Classification accuracy of the machine learning model over 10 epochs

Methodology

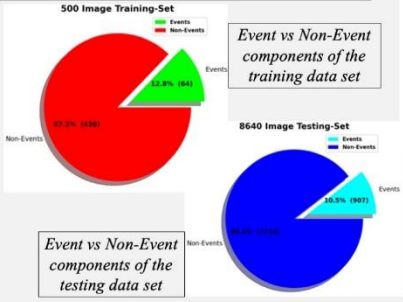
- Isolate microseismic band with the Generalized Window Transform: 10-40 Hz
- Train a convolutional neural network to classify images of energy events & non-events



Rockfall captured on channels 10-140. Used for training the predictive model

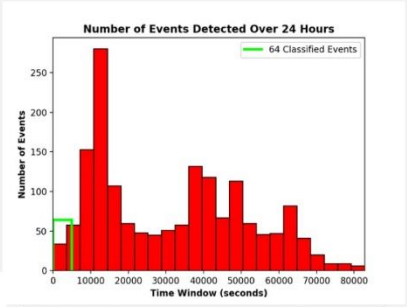
Examples

- Training Dataset: 64 Rockfalls in hour 1.5
- Testing Dataset: 907 Rockfalls in 24 hours



Event vs Non-Event components of the training data set

Event vs Non-Event components of the testing data set



Number of energy events detected by the neural network from 8640 frames over 24 hours on day 11

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M.E.D.A.L Lab

Abdullah A.D. Mohammad
Supervisor: Simon Park
Schulich School of Engineering

The question we are solving is regarding stratification, for this research we were tasked to construct a large testing apparatus due to the nature of fluid testing. The apparatus was designed to contain a pressure-sensitive control volume while also being modular to provide easy maneuverability for future location adjustments. The system was hooked up to various sensors and testing equipment modules, these methods will help provide critical data regarding the characterization of the apparatus. To ensure proper testing methods the system utilized hand-assembled piping and required pipe dope and bubble testing to ensure a leak-free system. For testing, we directed a laser through a long test pipe section which was then received at the wavefront sensor at the other end. The alignment for this process is critical due to the fine margins for optical-related equipment. The wavefront sensor was able to pick up on the individual fluid deflection properties, these are then computed to provide relevant contour plots that can be easily translated into workable data. The result for this testing cannot be shared at this point in our research. In conclusion, testing can have a lot of different test parameters which can lead to significant changes without much recognition. To ensure reliable testing, you must ensure organization and prioritize understanding the data before collecting useless data.

Investigating 4-HAP as a modulator of mitochondrial morphology via NMIIC

Armaan Mohan
Supervisor: Timothy Shutt
Cumming School of Medicine

Mitochondrial fission is a key cellular process that is balanced with mitochondrial fusion to meet the cell's needs. A dysfunction in this balance can lead to a variety of mitochondrial diseases, many of which, such as Charcot-Marie-Tooth syndrome, have an onset in childhood. Recently, we have demonstrated that the non-muscle myosin IIC (NMIIC) protein plays a crucial role in mitochondrial fission, mediating pre-constriction of the mitochondria via actin remodeling. 4-hydroxyacetophenone (4-HAP) is a small molecule activator of NMIIC, which locks the protein to the actin cytoskeleton, preventing its normal functions. Given 4-HAP's effect on NMIIC we sought to examine its effect on mitochondrial fission. In order to study mitochondrial fission, we employed imaging techniques to examine mitochondrial morphology following 4-HAP treatment. Imaging included immunofluorescence of cells treated overnight using antibodies against the mitochondrial outer membrane protein Tom20 as well as live-cell imaging using the MitoTracker Red dye following 4-HAP treatment. We found that 4-HAP had a dose-dependent effect on mitochondrial morphology with lower concentrations (2 µM) increasing the number of cells with fragmented mitochondria 1.8-fold ($p = 0.038$) while higher concentrations (20 µM) increased the number of cells with elongated mitochondria 1.8-fold ($p = 0.023$) In our live-cell imaging studies we observed hyperconnectivity of the mitochondrial network near the nucleus of 4-HAP treated cells. These findings suggest that low doses promote fission, while higher doses inhibit fission in a region-specific manner. Altogether our findings indicate that 4-HAP is a novel compound that can be used to modulate mitochondrial fission, whereby low doses fragment the mitochondrial network, high doses prevent fission, elongating the mitochondrial network. This study represents the early stages of further understanding NMIIC's role in mitochondrial fission as well as the potential of 4-HAP as a modulator of mitochondrial fission.

A novel biological-based approach for selective extraction of rare earth elements from industrial feedstocks

Arshia Mostoufi
Supervisor: Lisa Gieg
Faculty of Science

Rare earth elements (REEs) are a group of special elements with unique physical and chemical properties that make them essential to many modern industries. However, the current REE mining practices are energetically expensive and produce toxic products resulting in an unsustainable and volatile supply chain. Given that demand for these precious elements continues to grow, there is a need for a new sustainable method of REE extraction and purification. A biological method of REE extraction was proposed using a novel lanthanide (Ln) binding protein called lanmodulin (LanM) which portrays an extraordinary ability to selectively bind Lns in presence of a high concentration of impurities. In this system, LanM will be immobilized on cellulose beads using a LanM-Cellulose Binding Module (CBM) fusion protein. The cellulose beads are then packed into a column absorbed where LanM can extract Ln from highly contaminated sources. To develop this system, LanM genetic constructs were cloned into *E. coli* BL21 using restriction cloning. Positive colonies were successfully identified, using Polymerase Chain Reaction (PCR) and DNA sequencing. Future studies would focus on production and purification of the heterologous LanM proteins from the identified positive colonies.

Selective dry cow therapy practices on Canadian dairy farms

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Previously, on Canadian dairy farms, antimicrobial administration in all cows at drying off has been used to treat and prevent intramammary infections (IMI). Drying off is the beginning of the dry period, with cessation of milk production between one lactation cycle ending and giving birth to initiate a new cycle. However, blanket use of antimicrobials may no longer be necessary on all farms, as the incidence and prevalence of intramammary infection has decreased. Selective dry cow therapy (SDCT) aims to prevent and cure IMI by selecting cows for treatment based on several criteria, including a combination of milk culture results, somatic cell count, and clinical mastitis (CM) history. Therefore, SDCT can reduce on farm antimicrobial use (AMU), potentially contributing to antimicrobial resistance mitigation, and should be investigated further. To gain a deeper understanding regarding dry off AMU and selection methods, questionnaires answered by Canadian dairy producers during 2019 and 2020 were analyzed using R and R studio. Out of 140 participating Canadian dairy producers, 36% used SDCT. This highlights an increased adoption of SDCT, and higher numbers than previously reported (16%) in Canada. Median antimicrobial coverage on SDCT farms was 50% (ranging from 3-99%). The most important criterion considered when determining which cows to treat with antimicrobials at dry off was somatic cell count (70%), followed by CM history (64%), and milk culture (20%). SDCT can lead to AMU reductions and result in improved antimicrobial stewardship. The increase in SDCT shows progress in the Canadian dairy industry antimicrobial stewardship efforts.

FASTMAP: An open-source flexible atlas segmentation tool for multi-area processing of biological images

Daniela O Oboh, *Dylan J Terstege, Jonathan R Epp*
Supervisor: Jonathan Epp
Faculty of Science

Many biological systems have structure-function relationships as a fundamental principle. Studying the interactions between different brain regions is critical to better understand the brain. Examining these interactions requires a distinction between many brain regions in microscopic histological images. Traditionally, experimenters examine these interactions by manually charting regions based on pre-existing brain atlases. Some tools have made attempts to optimize this process, but these tools cannot accommodate diverse tissue types, tissue preparation or atlas orientations. In addition, fully automated tools often struggle to accurately register tissue when faced with common fixation or histology related artifacts such as tissue shrinkage and deformation or uneven background fluorescence. To address this, we developed FASTMAP*, a flexible atlas segmentation tool for multi-area processing.* To demonstrate FASTMAP flexibility, custom atlas plates delineating brain regions of interest were generated on the image analysis program, *ImageJ*, and applied to coronal, sagittal and horizontal mice brain tissue sections. Additionally, FASTMAP was used to map brain-wide c-*fos* expression during the recall of contextually conditioned memory to demonstrate atlas registration flexibility. FASTMAP meets the need for a flexible, easy use, efficient tool to investigate scientific questions using whole-tissue imaging.

The future of cultural humility training: Using virtual simulation to teach undergraduate nursing students cultural humility

Simon Paisley
Supervisor: Carla Ferreira & Heather Bensler
Faculty of Nursing

As registered nurses continue to provide care to a growing number of culturally diverse individuals and communities, there is an expanding awareness of the health inequities that exist among minority groups. Recently, the term cultural humility has been endorsed by nurse educators and researchers for undergraduate nursing students (UNS) to learn so that they may be better equipped to provide culturally congruent care to a diverse patient population. UNS are well-positioned to lead a reformed approach to providing culturally adapted care, however, methods to teach cultural humility remain sparse in the literature. To explore a burgeoning simulation-based educational modality to teach cultural humility and help nurse educators provide meaningful learning opportunities during the ongoing coronavirus disease 2019 (COVID-19) pandemic, this research will explore the effectiveness of using screen-based virtual simulation (VS) to teach UNS cultural humility. Using a qualitative study design, a synchronous unfolding case scenario followed by a theory-based facilitated debriefing were used to determine the efficacy of VS to teach UNS cultural humility. In this pilot study, preliminary findings suggested that VS is an effective method of teaching and learning about cultural humility.

Electrokinetic control of viscous fingering in a Hele-Shaw cell

Anjali Patadia
Supervisor: Anne Benneker
Schulich School of Engineering

Viscous fingering (VF), an interfacial instability, is the finger-like patterns of a less viscous fluid formed during the displacement of a more viscous one in a medium. Interfacial instability control is of interest due to its effects in various processes including oil recovery, mixing in microfluidic systems, and CO_2 sequestration in saline pore fluids. These instabilities can be controlled by passive or active means. Passive means typically involve a change in the structure or geometry of the system, not feasible on a field scale. As active control methods that use an electric field can circumvent limitations of passive control, they are studied in this work. Active control methods that use an electric field involve the intentional enhancement or suppression of interfacial instability. An externally applied electric field induces a body force to the net charged electrical double layer formed when a fluid contacts solid surfaces. This body force causes an electro-osmotic flow with a flat velocity profile that eventually controls the parabolic flow profile typical of viscous fingering. Although this type of active control method has been previously studied for two immiscible electrolytes, this report shows that this method can still be used to control VF even with one non-conducting fluid. Experiments were conducted in a rectilinear Hele-Shaw cell with non-conducting mineral oil as the more viscous resident fluid and conducting less viscous NaCl brine as the displacing fluid. An electric field was applied in both the same and opposite direction of the pressure-driven. Four stability indices were used (fractal dimension, percentage swept area, interfacial length and non-dimensional interfacial velocity) to characterize the stability of the displacement. Our results show that applying the electric field in the opposite direction to flow destabilizes the interface as observed by lower fractal dimension and swept area values but higher interfacial length and non-dimensional interfacial velocity. Conversely, interface stabilization was observed when the electric field is applied in the same direction as the flow, where fractal dimension and swept area values are higher, with lower interfacial length and non-dimensional interfacial velocity.

Development of composite blade manufacturing techniques for small scale wind turbines

Deep Patel
Supervisor: David Wood
Schulich School of Engineering

The topic explored by Deep Patel through the funding provided by the PURE Research Award was the exploration of composite blade manufacturing techniques for small scale wind turbines. This project is proposed to tackle the challenge of developing a manufacturing process for the creation of symmetrical blades for a vertical axis wind turbine system. A focus is placed on investigating different methods for manufacturing composite blades to create a cost effective and reliable method for constructing blades of high quality and dimensional accuracy. Different materials and techniques for creating the blade mold were studied. These included additive manufacturing using 3D printing technology and subtractive manufacturing to make negative molds from MDF or foam. With the manufacturing capabilities available within the engineering department, creating negative molds through subtractive manufacturing was found to be the most effective method of creating blades due to the accuracy of the mold and the ability to reuse the mold. A successful blade half was created using the MDF mold created, and an effective process was found to cast fiberglass blades with minimal epoxy waste. The goal of this project was partially achieved as work remains to determine the dimensional accuracy of the casted blade half and the final completed full blade.

What controls the characteristics of compressive failure and accelerated seismic release?

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Externally stressed brittle rocks fail once the stress is sufficiently high. This failure is typically accompanied by a divergence of the total energy of acoustic emission (AE) events. Yet, other characteristics of approaching the failure point such as the presence or absence of variations in the AE size distribution and, similarly, whether the failure point can be interpreted as a critical point varies across experiments. Recent theoretical work suggests that the presence or absence of transient hardening might be responsible and that the presence of aftershocks during loading is indicative of such hardening. Here, we show that large-scale stress heterogeneities induced by a notch — which have been shown to lead to significant aftershock activity during loading — fundamentally change the characteristics of the failure point in triaxial compression experiments under a constant displacement rate on Westerly granite samples. Specifically, we observe accelerated seismic release without critical failure and no change in power-law exponent or b-value of the AE sizes. This is in contrast to intact samples, which exhibit a significant decrease in b-value. Our findings imply that the presence or absence of large-scale heterogeneities play a significant role in our ability to predict compressive failure in rock.

The effect of skeletal muscle glycogen content on oxidative capacity

Annie Pham
Supervisor: Martin MacInnis
Faculty of Kinesiology

Near-infrared spectroscopy (NIRS) is a non-invasive technique that allows for the measurement of muscle oxidative capacity. Glycogen, an important source of fuel for skeletal muscle can be derived from various sources of food and broken down. However, the relationship between various amounts of glycogen in the body and NIRS measured oxidative capacity of the muscle is unclear. The purpose of this study is to determine if different amounts of glycogen availability can influence the oxidative capacity of the muscle (vastus lateralis). Eight young healthy male and female participants were chosen for this study where they performed glycogen depletion rides in the glycogen depletion condition (GD) or did not exercise at all (Rest). Participants then consumed either a high carbohydrate drink (GD^{CHO} and $Rest^{CHO}$) or a placebo drink (GD^{PLA} or $Rest^{PLA}$) the night before completing an isometric kicking task. It is hypothesized that the GD^{CHO} condition will have a lower tau value. Raw data was then compiled into software and exported into a custom template followed by statistical analysis in Prism 9 for final analysis. Overall, there was no significant difference across the four conditions ($p > 0.05$). Findings may suggest that carbohydrate availability does not affect oxidative capacity as measured by NIRS and reported as tau (s).

Investigation of smart airfoils with trailing edge flaps and vortex generators to investigate mitigation of transient loads during pitch change

Keilan Pieper
Supervisor: David Wood
Schulich School of Engineering

The proposed project will consider reduction of transient loading of wind turbines during pitch adjustment. Ideally, wind turbines should maintain essentially constant or slowly varying aerodynamic forces to reduce fatigue and transient loading of the mechanical structures. However, such ideal circumstances do not exist. Wind gusts can generate excessive and fluctuating aerodynamic loads on turbine blades. This may cause damage or reduce the working lifespan due to cyclic fatigue. This will result in flow separation delay creating intense vortex structures that generate overshoot in the aerodynamic loads. The objective of this research is to use trailing edge flaps (TEF) to control the airfoil during dynamic stall conditions. By changing the lift coefficient of the turbine blade the aerodynamic load can be controlled. By using TEF the possibility to adjust the turbine and mitigate the variation of aerodynamic load on the turbine blade becomes dependent on the lift coefficient. Using Particle Image Velocimetry (PIV) we can document sudden deviations of the aerodynamic loads due to lift coefficient changes resulting from pitching of the blades by feathering operation of the turbine and then using TEF to reduce the amplitude of variation of those loads. We will also attempt to maximize the benefits of deploying TEF on airfoils as an actuating device to study unsteady lift scenarios.

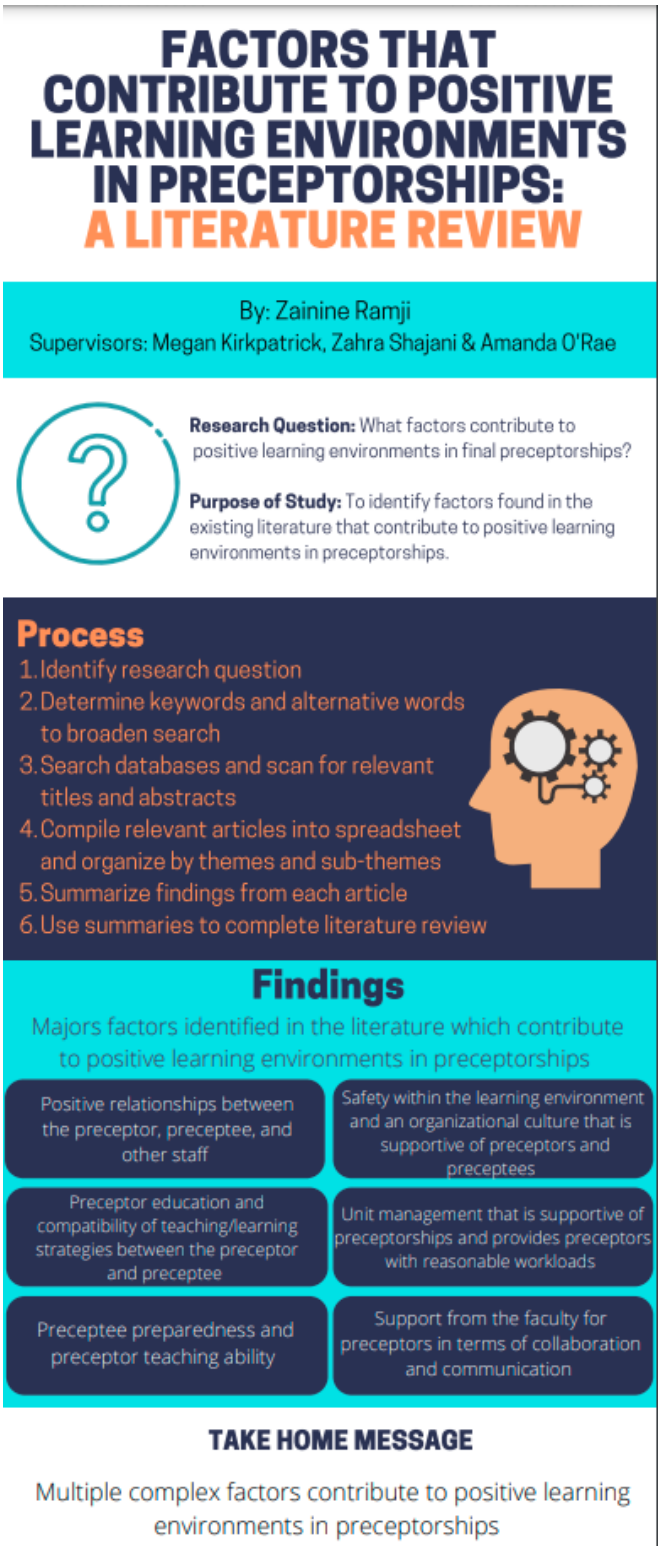
Vibration response of an elastically mounted circular cylinder near a Gao wall

Amy Pon
Supervisor: Chris Morton
Schulich School of Engineering

When a body is subjected to fluid flow, vortices will periodically shed around it resulting in vibration. This phenomenon is known as Vortex-Induced Vibrations (VIV). VIV has been extensively studied for the case of circular structures undergoing VIV in free stream flow and near a planar boundary. However, in real-life applications such as pipelines, structures often undergo VIV near a scoured boundary due to soil erosion at the seafloor. This project investigates the VIV response of a circular cylinder near two differed scour profiles (Gao walls) through the analysis of data from a laser displacement sensor. Different values for S^* (the distance between the cylinder and the wall) are tested to examine the effect proximity has on vibration response. From this data, the amplitude and frequency response plots of the cylinder are obtained and compared to past studies. The amplitude response data is consistent with past studies; however, the frequency response appears to differ when the cylinder is close to the wall. Overall, the results from this investigation show that VIV close to a Gao wall does influence the response of the cylinder depending on the proximity of the cylinder to the wall.

Factors that contribute to positive learning environments in preceptorships

Zainine Ramji
Supervisor: Megan Kirkpatrick
Faculty of Nursing



Localization of USP15 in the cell

Lisa Ru
Supervisor: Guang Yang
Faculty of Science

A cohort of patients with an unidentified neurodevelopmental disorder have all been found to possess differing mutations in the USP15 gene. These patients display symptoms such as underdeveloped organs, abnormally small cerebellums, and other symptoms concurrent with the abnormal generation of neurons from neural stem cells. During knockout experiments, USP15 was found to be expressed during the development of the mouse cerebral cortex and had increased expression in neural stem cells. This suggests that USP15 plays an important regulatory role in brain development and its loss of function results in the abnormal development seen in the cohort of patients. How the USP15 protein regulates neuronic development and the effect of mutations on this gene is largely unknown. In this study, the cellular localization of mutated USP15 protein is compared to that of wildtype USP15. HEK cells were first transfected with either the wildtype USP15 gene or a mutated version, then immunostained to target the localization of USP15 protein and the brightness in each location was then quantified using Fiji, an image processing software. A greater cytoplasmic/nuclear ratio of USP15 protein was found in the C289A mutated cells, indicating that the mutated USP15 is found with a greater concentration in the cytoplasm compared to the nucleus. This difference in mutated USP15 localization could be an indication of a disrupted cellular mechanism that manifests into improper development of neurons from neural stem cells. Elucidation of the mechanism and the precise role of USP15 is integral to determining useful treatment plans for patients with a mutated USP15 gene.

End of play: COVID 19 and theatre in Calgary, Alberta, Canada

Sebastian Rueda Montes
Supervisor: April Viczko
Faculty of Arts

The Coronavirus pandemic has had a major impact on the performing arts industry which typically relies on in-person events in order to generate revenue. Given the gathering restrictions imposed by the provincial government, theatre companies have had to cease their primary activities altogether. This research investigates how the business of theatre in Calgary, Alberta has changed and developed in response to the coronavirus between March 2020 and September 2021. This research is the result of conversations with theatre artists, attendance of theatrical performance, attendance of formal discussions on theatre in Canada, as well as the researcher's experience working for *Springboard Performance,* a performing arts company, as well as scholarly research. Among the changes experienced by theatre companies include arts administrators adopting the remote work environment, the introduction and subsequent rejection of the *zoom play*, the emergence of the *pay-what-you-can* model, and the emergence of alternative programming by theatre companies. Through the process of the research it became evident that theatre companies survived the coronavirus pandemic in large part due to the communities they were a part of. As the coronavirus situation continues to develop, special attention must be paid to how theatre companies cultivate, interact with, and respond to their local communities.

Implementing an efficient recommendation system for startup companies

Rishabh Ruhela
Supervisor: Guenther Ruhe
Schulich School of Engineering

Recommender systems are among the most visible success stories of AI in practice. Typically, the main task of such systems is to point users to potential items of interest, e.g., in the context of an e-commerce site. A great example of a recommendation system is already in place in all of the FANG companies. This system helps them boost their sales through their intelligent product recommendations based on either user's history or the items that they like. However, creating such an efficient and intelligent system becomes difficult when working with a startup company due to the lack of users and their subsequent features. User interaction and interest of the users is a significant factor. My goal as a student researcher is to find an effective and efficient way to optimize user interaction by creating a recommender system that aims to overcome these difficulties, creating a technologically advanced strategy through experimental studies and findings.

Quantum satellite ground station

Quinn Rupert
Supervisor: Daniel Oblak
Faculty of Science

As quantum computing technology continues to develop, the possibility of commercially available quantum computers may soon threaten the security of classical encryption methods. This necessitates the development of quantum encryption methods, specifically quantum key distribution, or QKD. The sending of quantum signals between users, including QKD, is generally done using polarized photons. While fibre-optic cables are useful for sending these quantum signals over shorter distances, in order for quantum communication to be feasible over longer distances it will likely be necessary for quantum signals to be sent over satellite links. Towards this end, a ground station was established at the University of Calgary in order to communicate with the existing Micius satellite and perform experiments in satellite-based QKD. The initial work in establishing this ground station involved the setup, calibration, and testing of ground station equipment in order to establish a link with Micius. Specifically, calibration of the telescope's direct-drive positioning system needed to be performed in order to achieve sufficient accuracy of the telescope's mount positioning such that the telescope was capable of tracking Micius as it passes over Calgary. Currently, initial efforts to establish this link have been successful, however more work will need to be done in order to ensure that the link is operating at optimum efficiency. Once this has been completed, the pathway will be opened for future experiments in satellite-based QKD.

Investigating the role of HES1 gene expression in regulating porcine iPS cell self-renewal

Margaret Rusteika[1,2,3], *Li-Fang (Jack) Chu*[2,3]
Supervisor: Li-Fang (Jack) Chu
Cumming School of Medicine

Affiliations: 1. O'Brien Centre for the Bachelor of Health Sciences, Cumming School of Medicine, University of Calgary; 2. Department of Comparative Biology and Experimental Medicine, Faculty of Veterinary Medicine,

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Induced pluripotent stem cells (iPS) can proliferate indefinitely in vitro while retaining the capacity to differentiate into all cell types present in an adult body, creating an unlimited source of material for cell-based therapies. The similarity to humans in organ size, physiology, and anatomy, makes pigs the prime model organism to test the safety and efficacy of cell therapies before human use. The Chu lab is currently working on understanding the role of the HES1 gene in maintaining pig iPS cells (PiPSCs), as HES1 oscillation has been shown to affect the switch between the pluripotent state and differentiation. We performed RNAseq analysis of PiPSC lines and pig fibroblasts and found that the HES1 gene was significantly upregulated in PiPSC. We hypothesize that HES1 expression dynamics are critical to maintain pluripotency. To further analyze HES1 we began generating a gene reporter to allow the investigation of gene oscillation. To generate the reporter, we used PCR amplification and molecular biology methods to clone homology arms into a vector backbone containing fluorescence reporters. These homology arms are expected to allow the homologous recombination of the gene targeting vector to knockin the reporter into the pig genome. In addition to the homology arms, we generated reporter-specific guide RNA to be used for CRISPR Cas-9 gene editing. Future work on this experiment will focus on the use of CRISPR Cas-9 to knockin the reporter into PiPSCs to monitor endogenous HES1 expression and its response to perturbations using signaling chemical inhibitors, siRNA gene-knockdown, and gene-editing approaches.

Exploring student assessments in an online learning environment: Challenges and opportunities in the new normal

Samantha Ruud
Supervisor: Kim Koh
Werklund School of Education

The unprecedented COVID-19 pandemic has led to a dramatic shift to online learning across the world. Many teachers are left to adjust their lesson plans and assessments without much support. With the rise of online learning, a recurring question is how student learning can be assessed accurately. This study aimed to address a prominent issue facing K−12 teachers today regarding the design, selection, and use of online assessments to facilitate student learning in an online or blended learning environment. Specifically, this study includes a systematic review of the literature on online assessments in K−12 learning environments to determine alternative methods of assessing students' learning and competencies (e.g., critical thinking, complex problem solving, communication, and collaboration). These competencies cut across all the subjects in the curriculum not only in Alberta, but also in other high-performing education systems. In an online environment, assessment of students' learning outcomes and competencies may pose a variety of challenges including inaccuracy in assessment results, cheating, technological issues, lack of instructional support and formative feedback, and heightened test anxiety for students. Finding the proper tools can greatly enhance students' positivity towards assessment. Using Covidence for searching and screening a large body of literature on online assessments, this knowledge synthesis project presents assessment methods and their affordances and challenges in assessing students' learning outcomes and competencies in an online environment.

University of Calgary anti-racist engagement: How students recognize racism and engage in anti-racist practices

Jenna Salem
Supervisor: Tanvir Turin Chowdhury
Cumming School of Medicine

BACKGROUND: Racism is the oppression of people based on race in a society favoring people of another race. Racism exists on a spectrum and is expressed in many forms including beliefs, attitudes, and stereotypes, etc. The purpose of this study was to determine how the undergraduate students at the University of Calgary (UCalgary) act against racism.

METHODS: We conducted a survey using an Anti-Racism Action Scale (ARAS), an 18-item measure, containing three subscales: Interpersonal action, Communal Action, and Political Change, the first two being of focus. Participants (n=265) were recruited primarily through social media to complete the online survey. Descriptive analysis for students' knowledge, practices, and related variables was conducted.

RESULTS: Respondents were of diverse background, including 36.9% Asian/South Asian, 21.9% Arab/Middle Eastern, 16.0% White/European, and 4.2% Black. Among respondents, the majority were females (64.4%). More than 2/3^{rds} of participants reported practicing interpersonal anti-racism actions including talking with friends about issues of race, ethnicity, discrimination and/or segregation (78.7%), and challenging or checking oneself (72.5%), family members (67.6%), or friends (64.4%), when using a racial slur or making a racial joke. On the contrary, low participation was observed at the communal level action; roughly a 1/3rd of participants attended a meeting on an issue related to race, ethnicity, discrimination, and/or segregation (37.9%), and joined a club or group working on issues related to race, ethnicity, discrimination, and/or segregation (26.5%).

CONCLUSION: Overall, there were decent amounts of interpersonal action, but more communal level participation is needed to combat racism.

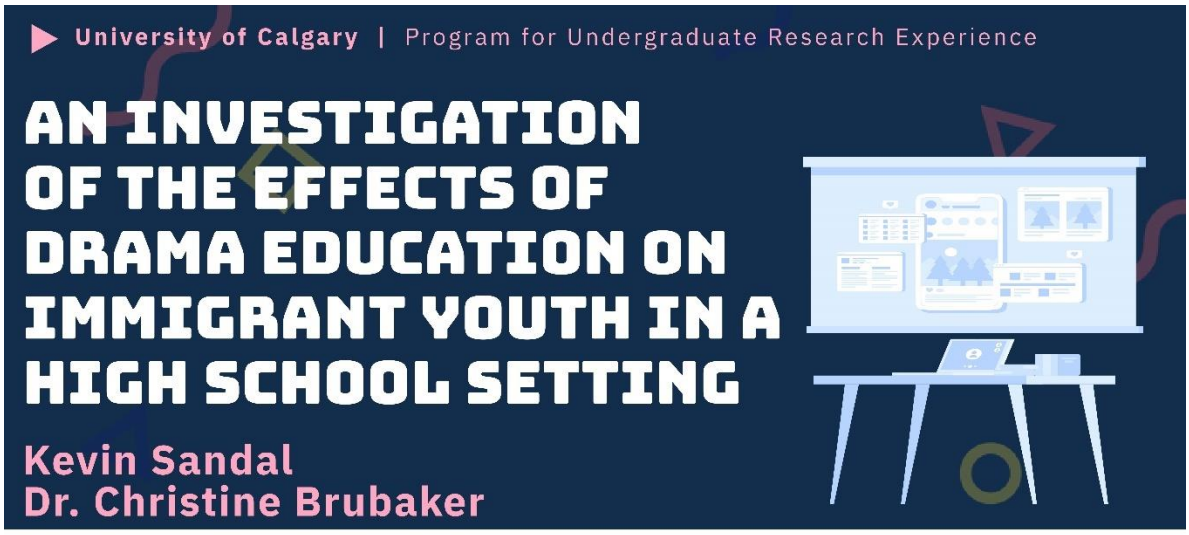
Network analysis of the human structural connectome including non-cortical structures

Salma Salhi
Supervisor: Christoph Simon
Faculty of Science

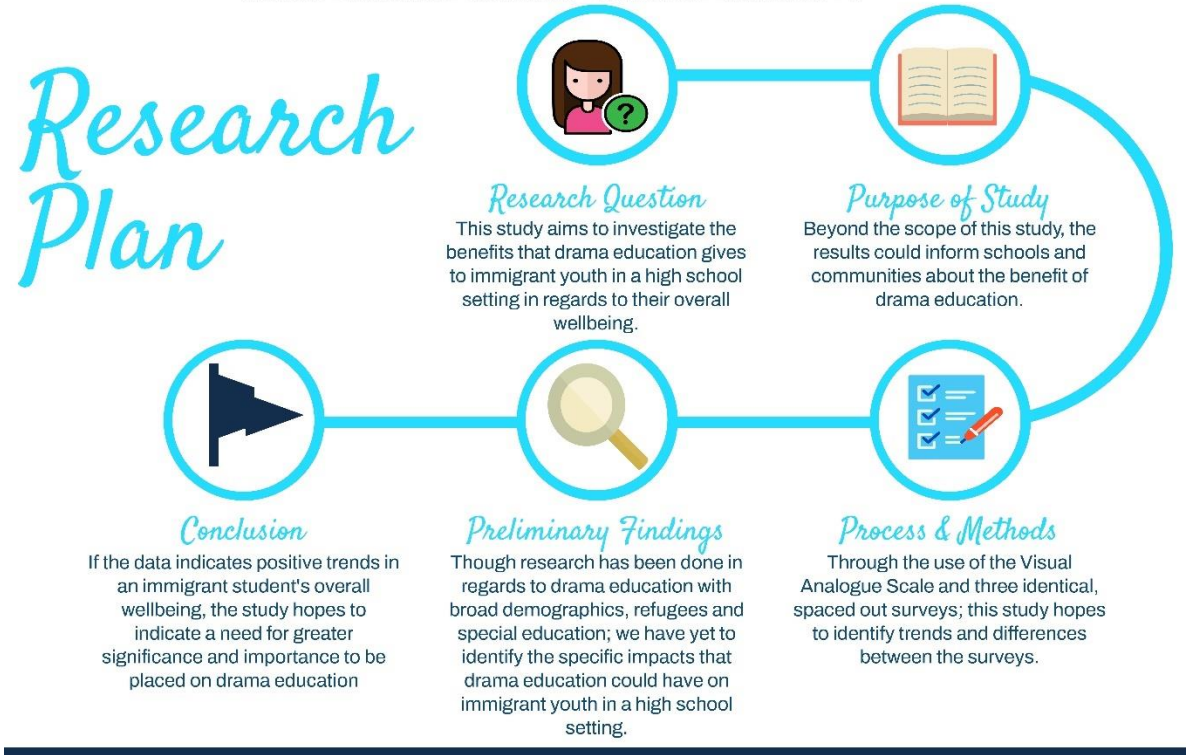
Over the past few decades, there has been growing interest in understanding the phenomenon of consciousness. While the cortex is a popular contender as the site of consciousness, other theories concerning subcortical structures have been put forward, including ideas that the thalamus and the brainstem are crucial for consciousness. To further analyze these subcortical theories, we investigated the structural connectome of 100 healthy adult human brains. We present some preliminary calculations for fibre connections between 104 regions in the brain, using the Python Dipy and Nibabel libraries to create a constrained spherical deconvolution model and apply probabilistic fibre tracking. A map of structural connections was then generated, representing 68 cortical structures and 36 non-cortical structures. We then used this data to identify several hubs and found that cortico-cortical connections are surprisingly sparse. We thus propose that subcortical structures have a more important role than generally accepted, and that current theories on the role of the subcortex in the subjective experience warrant further investigation. This research should serve as a steppingstone to the decades-long goal of mapping the human connectome, and as an insight into how the connectome can enhance our understanding of consciousness.

The impacts of drama education on immigrant youth in a high school setting

Kevin Sandal
Supervisor: Christine Brubaker
Faculty of Arts



Abstract



Patterns of prenatal cannabis consumption and second-hand cannabis exposure in Alberta: A secondary cross-sectional analysis

Sanam Sekandary[7], *Carly McMorris PhD[3,4], Amy Metcalfe PhD[1-3], Catherine Ringham PhD, Stephen Wood MD[1], Deborah McNeil PhD[2,5], Sheila McDonald PhD[2,6], Kathleen Chaput PhD[1-3]*

Supervisor: Kathleen Helen Chaput

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Background: Since cannabis legalization in Canada, growing evidence suggests that prenatal cannabis consumption is on the rise and associated with increased risk of preterm birth, low birthweight, and NICU admissions. The majority of published evidence dates back to the 1970s-1980s, and patterns of prenatal cannabis consumption in Alberta post-legalization remain unknown.

Objective: Our study aimed to describe the patterns of prenatal cannabis consumption and second-hand cannabis exposure in Alberta, which are critical for targeted health intervention and future prospective perinatal research.

Methods: We conducted a secondary analysis of data from the cross-sectional Cannabis Exposure in Pregnancy Tool (CEPT) development and validation study, conducted from 2019-2020 with 153 pregnant Albertans. We calculated proportions and 95% confidence intervals (CIs) to summarize the frequency, trimester(s), modes, and reasons for prenatal cannabis consumption and second-hand cannabis smoke/vapour exposure.

Results: Among the 86 participants who consumed cannabis prenatally, 54.7% did so in all three trimesters, most commonly reporting first and second-trimester consumption (76.7%). Daily (36.1%) followed by multiple times per day (32.6%) were the most common frequencies of cannabis consumption. The most common modes of cannabis consumption were smoking (88.4%) and edible/oral (24.4%), and 46% reported consuming multiple forms of cannabis. Participants most commonly reported that they consumed cannabis prenatally to help with pregnancy-induced nausea and vomiting (77.9%), sleep (65.1%), or anxiety (60.5%). Only 3.5% of participants reported only non-medicinal reasons for prenatal consumption. A vast majority of participants (84.9%) reported second-hand cannabis exposure (at least 15 minutes in a shared room), most often during the second trimester (62.8%). For THC products, approximately half of consumers (50-55%) reported their dose per use as low (<30mg THC), and as moderate for CBD products (31-60mg CBD), with the exception of concentrates for which moderate to high (61->120mg THC), was reported by 86% of consumers.

Conclusions: Our results indicate marked changes in patterns of prenatal cannabis consumption compared to existing evidence, including predominant medicinal use, high proportions of second-hand exposure, and frequent consumption that is commonly sustained throughout pregnancy. Findings can inform targeted public health intervention, harm-reduction strategies, and ultimately contribute to improved maternal and child health.

Empirical study of IoT security weaknesses in C/C++ code examples shared in stack exchange sites

Madhu Selvaraj
Supervisor: Gias Uddin
Schulich School of Engineering

Stack Exchange sites are widely used by software developers looking for programming solutions as many cover topics related to software engineering. The code examples found on these sites are frequently copied directly into real-world software systems, therefore it is crucial to understand the security of those snippets. Although there have been previous studies on the security of C/C++ snippets, none have been specifically focused on the security of *IoT* related C/C++ snippets. IoT is a rapidly growing field and understanding the security of code found online that could be potentially used in IoT devices is crucial as such devices often have unique security challenges. In this study, we analyzed the vulnerabilities found in IoT related C/C++ code snippets across six Stack Exchange sites. The specific characteristics explored are the types of code weakness present (CWE types) in the studied sites, the effect of code revisions on vulnerabilities, the characteristics of users who introduce vulnerable snippets, and the evolution of the vulnerabilities. We found that 28 out of 90 CWE types were detected with CWE-398 Indicator of Poor Code Quality being the most frequent. We also found that the vulnerabilities do not differ significantly among the different sites, revisions do not improve vulnerable snippets with the majority of vulnerabilities being introduced in the original version of the snippet, most vulnerabilities are introduced by a small group of users, and the most frequent CWE types detected have been increasing yearly. These findings signify that most vulnerable IoT snippets on Stack Exchange sites go unnoticed by the creators and have a high chance of being introduced to real-world software. Thus, users need to remain wary of copying the snippets found on these sites.

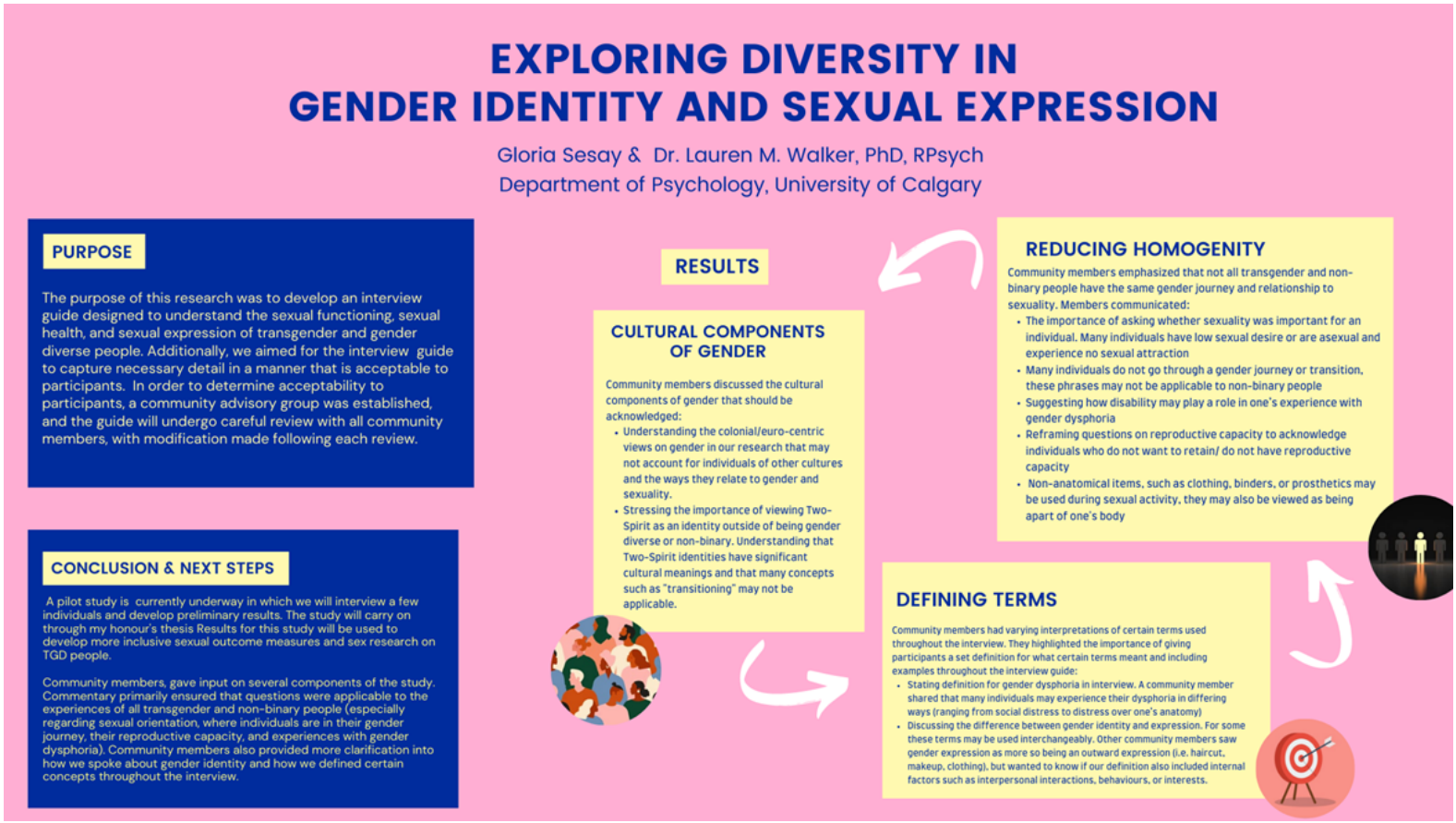
Stronger bounds of monogenic pure cubics

Jacob Serpico
Supervisor: Dang Khoa Nguyen
Faculty of Science

Let F be a finite field of order q and let g(t) be a non-constant square-free polynomial in F[t]. The current bounds for the number of square-free h(t) in F[t] such that deg(g) < N, gcd(h,g)=1, and the field F(t,h^{1/3}) is monogenic are >> q^{N/3} and << N^2 q^{N/3}. We aim to obtain both an explicit upper bound, not given by big O notation, and a stronger upper bound A(N)q^{N/3} where $A(N)$ is dominated by N^2. I will be utilizing both computational and theoretical methods to obtain results.

Exploring diversity in gender identity and sexual expression

Gloria Sesay
Supervisor: Lauren Walker & Barry Bultz
Faculty of Arts



Using machine learning models to predict the scaling behaviour of transcoding video segments

Ayman Shahriar
Supervisor: Mea Wang
Faculty of Science

With the popularity of video streaming steadily rising, the demand for efficiently converting video segments from one resolution or format to another (ie. transcoding) is increasing as well. In order for video transcoding to be efficient, the need for allocating the correct amount of computing resources is important, as overallocation can result in a waste of money, and underallocation can result in buffering and an unsatisfactory experience for the end user. The purpose of this study was to explore ways of using machine learning models to predict the CPU allocation and the transcoding time of video segments using the properties of each video segment. A dataset containing the properties of 597 video segments was created. Each video segment is 1 second in length, and various properties such as file size, bit rate, transcoding time, vmaf, psnr, and ssim were extracted from the segments and put into the dataset. A K-means clustering model was then created in order to divide the segments into groups based on similar transcoding times, but there seemed to be no correlation between the groups that the model produced and the transcoding times of segments within a group. A multiple linear regression model was then created to predict the CPU=2 transcoding time of a video segment when given the CPU=0.5, CPU=1 and CPU=1.5 transcoding times. The preliminary evaluation of this model indicates a correlation between the CPU=0.5, CPU=1, CPU=1.5 transcoding times and the CPU=2 transcoding time, however the evaluation of the accuracy of this model is still subject to ongoing research.

Android OS privacy evolution research

Austin Shawaga
Supervisor: Joel Reardon
Faculty of Science

The Android operating system has gone through several updates and changes since its first release in 2008; while changes to the various interfaces and functionality are easily seen by users, the operating system has also made several changes to its permission-based privacy model. The protection of private and personal data is becoming increasingly important to users and so companies are making changes to better protect privacy.

Through developer documentation, source code, publicly downloadable applications, and global news events, we study the evolving Android permission system across Android versions 5-11. We outline trends in permissions required to perform a variety of sensitive API calls, and we show that the evolution of permissions has gone towards securing the platform in a variety of ways.

We look at vulnerabilities found in historical Android versions and how the operating system has evolved to correct them. These updates are compared to real world application data and global events which provide motivation and effects for the changes. We built a website to systematize this information and to make it easy for researchers and developers to refer to where changes in the permission system occur.

The impact of artificial intelligence on management practice

Olga Shtepa, *Yongjian Bao, Oleksiy Osiyevskyy*
Supervisor: Oleksiy Osiyevskyy
Faculty of Arts

Artificial intelligence (AI) technologies (e.g., machine learning algorithms) portend a transformation of management practices across industries. Yet, this potential is still to be systemically linked with established theoretical perspectives in strategic management. Bridging the gap, we develop a conceptual framework examining the technological drivers of AI and its organizational implications. We proceed by drawing on literature from computer science and management information systems, managerial decision making, organizational economics, and organizational business models; then, we demonstrate the framework's application in real-life business cases. Our argument flows from the premise that AI technologies trained on big data minimize bounded rationality (i.e., humans' imperfect decision making due to a limited ability to process information inputs) (e.g., Simon, 1955). The alteration of this crucial micro-foundation of management enables firms to pursue automated and augmented rationality, moving from satisficing to next-best decision-making mode. Subsequently, firms can apply AI to formulate superior solutions in four decision problem domains: determination, design, deliberation, and discovery. Additionally, AI can increase cognitive synergy among an organization's members, allowing firms to use both synergies and divisions of cognition for enhanced performance. Relying on this framework, we describe the impact of AI on microeconomic mechanisms of value creation and capture, that is, organizational business models. Correspondingly, our work provides a basis for understanding the micro-foundations of digital strategy.

Affordances of children's nonfiction picturebooks on climate change

Madelyn Shuffler
Supervisor: Erin Spring
Werklund School of Education

Climate change is a highly relevant topic for children to explore and the topic of a wide range of children's texts. Nonfiction picturebooks, specifically, are a common format for children's environmental books, but offer a range of approaches. The purpose of this study was to explore the affordances of children's nonfiction picturebooks on climate change for environmental education appropriate for an elementary-level classroom context. A selection of 10 titles were found to approach the genre and topic in different ways and were assessed for their strengths and weaknesses. In my analysis, I argue that narrative-leaning books generally elicited engagement on the part of the reader and offered more opportunity for personal connection and/or exploration of social issues, but often over-simplified both causes and solutions. The more detail-orientated reference books offered a more robust and factual overview of the climate change crisis, with most following a similar outline by first describing what climate change is (causes), its effect on the world, and what is being done/should be done in response (solutions). The reference books struggled with accurately portraying some of these elements and many neglected some topics such as technologies or governmental roles. All of the books put significant responsibility on children for addressing climate change, and many inaccurately suggest that children's actions are a sufficient response by neglecting the role of adults - particularly governments and corporations - in addressing climate change.

Recovering reciprocity laws from the local and global Langlands correspondence

Kiera Sobolewski
Supervisor: Jerrod Smith
Faculty of Science

In Number Theory, there are theorems that tell us about the behaviour of primes in different number fields. These theorems are called reciprocity laws. The main reciprocity laws studied in this project were Quadratic Reciprocity, Hilbert Reciprocity, and Artin Reciprocity. In particular, what was studied was their proofs and how to recover Quadratic Reciprocity from Hilbert Reciprocity and Artin Reciprocity. The proofs of many other elementary reciprocity laws use Gauss sums. A Gauss sum is a weighted sum over the nonzero elements of a finite field evaluated at some character of the finite field. The latter half of this project was spent looking for an open problem relating to Gauss sums and Number Theory. This was achieved by reading various newly published papers, and finding open problems and conjectures. An open problem that is approachable to an undergraduate math student was found. Let $n = 11$, and χ_1 and χ_2 be regular characters of $\mathbb{F}_{p^n}^{\times}$. The conjecture states that if $G(\chi_1 \cdot \eta, \psi) = G(\chi_2 \cdot \eta, \psi)$ for all characters $\eta: \mathbb{F}_p \longrightarrow \mathbb{C}^{\times}$ then χ_1 and χ_2 are equivalent.

Mixture of regressions model with surrogate classifiers

Ge Song
Supervisor: Hua Shen
Faculty of Science

In statistical research, it often came across that only a pooled population is observed but the unobserved subpopulation identification is of interest. Mixture models can be developed to investigate the properties of the subpopulations and ascribe postulated subpopulation identities to individual observations through clustering procedures. The group identification procedure based on these measurements alone can be challenging and sometimes infeasible when the observed values have low capacity to differentiate. In such case, auxiliary classifiers subject to misclassification can improve the results. In this project we combine mixture of linear regression model with imperfect surrogate classifiers, obtain maximum likelihood estimation of model parameters using EM algorithm, and carry out simulations to compare the performance of the joint model with methods without the auxiliary information, model misspecification, and naive approaches.

Synthetically useful epoxidation catalysts based on novel redox reactions of chiral selenium compounds

Jessica Stadel
Supervisor: Thomas George Back
Faculty of Science

Enantiopure epoxides are important precursors of bioactive compounds that are used for both pharmaceutical and agricultural applications. The use of organoselenium compounds has become increasingly more popular for carrying out oxidation reactions as they function as oxidizing agents in the presence of H_2O_2 and only generate water as a by-product. The advantage to using selenium-based compounds is that they can exist as pure enantiomers which have proven to induce stereoselective outcomes in various reactions. However, almost no prior research exists for their use in asymmetric catalytic oxidation reactions. Thus, the goal here was to develop a novel chiral diselenide catalyst

that could be used for enantioselective epoxidation reactions. The synthesis and characterization of the chiral diselenide was successfully carried out. The active oxidant upon treatment of the catalyst with excess H_2O_2 was determined by ^{77}Se NMR spectroscopy to be a Se^{VI} species, as the major peak appeared at 1021.7 ppm, which is characteristic of selenonic acids. The catalytic epoxidation of 1-phenylcyclohexene and 1-methylcyclohexene with the novel chiral diselenide and H_2O_2 was efficacious. Overall, the results from this project could not only guide the design of a novel class of selenium-based compounds, but also new and efficient ways for achieving enantiopure epoxides.

Breathing rate measurements using thermal imaging

Pantelis Stefanakis
Supervisor: Svetlana Yanushkevich
Schulich School of Engineering

According to the World Health Organization (WHO), people with COVID-19 experience a wide variety of symptoms, which include fever, chills, shortness of breath and difficulty breathing. Thermal imaging systems have been used to accurately measure human skin surface temperature of individuals from a distance in places such as airports and hospitals. The U.S. Food and Drug Administration (FDA) has issued guidance for initial temperature assessment during a triage using thermal cameras to determine skin temperature from a distance.

The FDA approach has two areas that can improve on:

First, not all people infected with COVID-19 experience fever as a symptom. Alternatively, by acquiring an individual's breathing rate can help identify whether there is a difficulty of breathing, which is another of the COVID-19 symptoms. Thermography can be used to evaluate someone's breathing rate as thermal video indicates the variations of thermal image intensity during inhalation and exhalation.

Second, taking a video of each subject one by one can result in long lines in places such as airports and hospitals, which compromises social distancing and increases the risk of the subjects being screened to get infected. Tracking the breathing rate and skin temperature of multiple people at once can reduce lines and lower COVID-19 false negatives.

The purpose of this project was to develop an algorithm that can accurately detect in an image or frame which of the subjects are wearing a mask and which are not. For the subjects that are wearing a mask, the algorithm indicates the inhale or exhale breathing status. Once the breathing status is found for each subject wearing a mask, the respiration rate is calculated, and the subject's breathing is assessed.

The research was carried out over 16 weeks, which started with training in machine learning concepts. A literature review was conducted on breathing rate measurements using thermal imaging from five chosen recent papers to gather ideas. Then, an algorithm was developed that was used to generate a new data set of people wearing and not wearing masks in multiple backgrounds to train a machine learning network. This resulted to the development of a second algorithm which classified the subject in our testing images with great accuracy (over 90%).

An exploration of crisis nursery outcome evaluation tool usage, for the Children's Cottage Society

Raina Sunn
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Faculty of Nursing

Very few studies have been published that evaluate outcomes associated with crisis nurseries. In light of this information, the purpose of this study was to gather more research on what tools selected centre-based crisis nurseries use, how they are being used, and if they are providing meaningful outcomes, to inform the Children's Cottage Society and help them with updating their tools at the crisis nursery program. This project used a focused literature review and an environmental scan of crisis nurseries throughout North America. The literature review of 17 articles concluded that the tools being used for screening and outcome evaluation at the crisis nursery were valid and reliable, thus making them appropriate tools to continue using. An environmental scan of crisis nurseries found that there was a variety of tools and methods other nurseries used for their own evaluation purposes, which could possibly suggest that they develop their own tools or rely on outside experts to choose the most appropriate tools to use. Further research needs to be done and utilizing a larger sample of crisis nurseries to find more information on how they have developed their tools and how the tools are being used to assess their outcomes.

Distinguishing spin flips from ionizations for a direct measurement of antihydrogen's Lamb shift

Abbygale Swadling
Supervisor: Timothy Friesen
Faculty of Science

It is predicted that following the Big Bang equal amounts of matter and antimatter should have been created, however the universe is dominated by matter and there is much less of its counterpart. Antihydrogen is created and analyzed by the ALPHA (Antihydrogen Laser PHysics Apparatus) collaboration at CERN to look for asymmetries by comparing its spectra with hydrogen's. The Lamb shift is an important transition in hydrogen but has been only indirectly measured in antihydrogen from a combination of data from two separate laser spectroscopy experiments. ALPHA's goal is to make a more precise direct measurement of this transition that could lead to the discovery of a matter/antimatter difference. For this measurement to be made it is critical to distinguish signal from background or spin flip annihilations from photoionizations being picked up by the detector. This is done by examining positional data, in Z and phi, using both visual and statistical analysis. From this analysis the generally expected signal from a Lamb shift measurement is determined. In addition to this, due to the range of data sets examined, insight is gained as to the impact varying experimental parameters has on positional distributions. My project has provided insight as to the anticipated distributions from a future experiment and how they could potentially vary.

Building Indigenous identity through culturally responsive programming

Lindsay Swartz
Supervisor: Dustin Louie
Werklund School of Education

Culturally responsive programming is an integral part of building a cultural identity for Indigenous students. Research has shown that by building a solid Indigenous identity, students will feel a sense of belonging in school and experience greater academic success (Louie, Forthcoming). The purpose of this study was to examine how culturally responsive programming can initiate the discovery of Indigenous identity for Indigenous grade four students and how the curriculum can be designed through an Indigenous worldview. The course was combined with mentoring by an Indigenous role model to support Indigenous students on their journey of cultural identity reclamation. Preliminary findings from this project resulted in three innovations to the program design. First, to design a curriculum through an Indigenous worldview, interconnectedness is the underlying value that must guide the program design. Next, despite hesitation to teach the traumatic history of Indigenous people, it is necessary and can be guided by an approach of "celebrating survival" (Smith, L.T., 1999, p.166). Lastly, creating and delivering the program built a stronger sense of Indigenous identity for myself as a Cree/Métis person, modeling growth for the Indigenous students in the program. This program is the beginning phase of a larger project. Examining the impact of culturally responsive programming on Indigenous identity in elementary students is an ongoing project that will require constant innovation and renewal.

COVID-19 impact on current financial market – A multifactoral analysis

Muhammad Ali Tahir
Supervisor: Anup Srivastava
Haskayne School of Business

The purpose of this research was to examine how the pandemic has led to unprecedented instability in the financial markets. The S&P 500 index, which measures the performance of the Top 500 companies around the globe, in terms of market capitalization fell 33% from February to March 2020, which is the largest drop in the history of the S&P 500 within a month's time frame.

Over the summer, under the supervision of Dr. Anup, I did an in-depth quantitative and qualitative analysis on potential stock market corrections, investigated key metrics like financial ratios showing if a company is overvalued and if margin debt affected asset prices. Furthermore, I investigated the rise of retail traders and how they played a major role in stock market during the pandemic. I also did research on the increasing popularity of zero commission apps playing a role in financial markets. Lastly, I examined the appeal of cryptocurrency in today's world and the potential hindrances in the path of cryptocurrency becoming one of the mainstream assets.

Based on the research, I have found that markets are overvalued backed by the historical data indicating that S&P 500 P/E ratio is 45 compared to a mean of 15. Evidently, whenever the ratio is at an all-time high, a pullback occurs leading to an immediate return to the mean. Trading platforms like Robinhood and Weibull have benefited from this uptake of retail traders, wanting to enter the market for the first time because of them providing an easy user mobile interface and zero commission cost.

In conclusion, COVID-19 has led to a dynamic impact on financial markets through record fiscal spending by governments. The pandemic also accelerated the rise in popularity of crypto currencies as investors looked at it as

an inflation hedge due to record amounts of government spending. Lockdown implemented by COVID-19 has led to an uptake of retail investors using stock trading apps due to the convenience of trading at home and being able to save more because of the support from government through stimulus cheques. Speculative assets have thrived in the post pandemic markets because of social media groups highlighting the growth prospects of a company and beginner investors getting easily influenced by these posts trying to get involved in stock markets without proper due diligence.

The impact of Covid-19 on engineering education, the teaching methods adopted by the University of Calgary, its effectiveness and the possible incorporation of these methods in the course delivery long term

Amanda Tamakloe
Supervisor: Ivan Detchev
Schulich School of Engineering

Described by some as “the virus that shut down the world”, the coronavirus (Covid-19) significantly impacted many countries from challenging healthcare systems to greatly affecting educational systems. In a bid to curb the deadly virus, nationwide school closures were implemented which posed a challenge to institutions worldwide on their ability to adapt to the situation while maintaining the standards of pedagogy. Due to this huge challenge Covid-19 posed on educational institutions worldwide, the purpose of this study was to research into the impact of Covid-19 on engineering education, the teaching methods adopted by the University of Calgary and its effectiveness based on the feedback of students and faculty at the Schulich School of Engineering. This study involved literature reviews into the various educational changes made globally in response to the pandemic, surveys sent out to students and interviewing faculty at the Schulich School of Engineering. For this study, engineering education was divided into three main parts: lectures, laboratories, and assessments. Within this period - March 2020 to April 2021 - lectures, assessments and most laboratories were mainly held online in a synchronous or asynchronous format with assessments having a contingency plan to accommodate all setbacks. The study revealed that within this period, students faced challenges such as difficulty in building connections and staying focused, and difficulty in collaborating with peers because of online course delivery. On the side of professors, it also revealed a lack of students’ engagement during synchronous class activities and issues with academic integrity resulting from online assessments. Both students and professors experienced a deteriorating work-life balance. Additional impacts of Covid-19, the teaching methods adopted by the Schulich School of Engineering and the possible incorporation long-term are also discussed.

Survey of physicians, health care providers, and patients regarding their experience with virtual visits during the COVID-19 pandemic

Serra Thai, *Dr. Vikas Kuriachan, Dr. Stephen Wilton, Dr. Russel Quinn, Dr. Glen Sumner.*
Supervisor: Vikas P. Kuriachan
Cumming School of Medicine

This research study sought to determine the experiences of physicians, health care providers, and patients regarding their virtual visits during the COVID-19 Pandemic; specifically on visits regarding cardiology. The research study wanted to look at how these individuals felt about providing or participating in a medical visit virtually and see how

it compared to an in-person visit. Our research question thus was "What is the impact of virtual visits due to the COVID-19 Pandemic on individuals' cardiology health care experiences?". The research project was an online survey that was sent out to patients and physicians/healthcare providers. Each study group had a specific survey to accommodate for the differences in their experiences. In constructing the survey, many questions about which topics to address came up as research in the field of virtual visits is still needed. The questions ultimately decided upon were ones that used prior literature and experience. The questions attempt to accurately depict an individual's experience and address current concerns regarding virtual visits. While this research study is not fully complete, the questions and study have been approved by ethics and the survey will be sent out and results compiled within a few months.

Titin Isoform changes in Eccentrically trained Rabbit's quadricep muscles. (The TIER Muscle Pilot Study)

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Background: The coactivation of the synergistic muscles of the quadricep provide joint stability during exercise. Muscle morphology adaptations related to the sarcomere (smallest functional unit) are known to be influenced by eccentric loading. Titin stabilizes the lengthening of muscle and provides elastic recoil upon relaxation in an eccentrically contracted muscle. We investigated how eccentric training impacts titin abundance and isoform size in rabbit muscle following a loading intervention. **Methods:** Six rabbits underwent surgical intervention to implant a femoral nerve cuff electrode on the right hindlimb (experimental limb, EL). Rabbits completed 6 weeks of eccentric training on EL with the opposite left limb acting as a control (CL). After euthanization, the muscles of the quadricep (VL, VM, RF) were harvested. Titin abundance and isoforms were determined using 2.8% and 2.0% agarose strengthened acrylamide gels, respectively. **Results:** Titin abundance significantly decreased in the coactivated group of the CL compared to the EL which suggests the possible degradation of titin in response to the protocol. No significant changes in titin isoform size were found. **Conclusion:** The results of this pilot study show non-homogenous adaptations between the combined VL and VM group and RF. Differing intensities of eccentric training should be considered in future studies.

Measuring lanthanide concentrations using the protein lanmodulin

Thuy-Ann Tran, *Anika Zaman, Simran Sandhu, Dr. Mayi Arcellana-Panlilio*
Supervisor: Casey Hubert
Cumming School of Medicine

Lanthanides are becoming increasingly popular from the use of electronics. Therefore, the need to measure lanthanides in waste streams, tailings ponds, and electronic waste is important to recycle these elements. We designed three measurement systems to measure lanthanides in solution using the protein lanmodulin which selectively binds to these elements. Two of the measurement systems utilize a luminescent signal (using a BRET system or NanoBiT protein) and increases in light intensity will be measured when lanthanides bind to lanmodulin. The third measurement system utilizes an electrochemical system where redox potential changes will be measured when lanmodulin binds to the lanthanides in the sample. The process of designing the systems and their output involved dedicated literature review of different types of biosensor systems. In addition, DNA constructs had to be designed to make each of the customized lanmodulin-based sensors. Then, the measurement systems will be tested against a known concentration of lanthanides and potential interfering ions. Preliminary results include successful verification of the NanoBiT-lanmodulin coding sequence in the plasmid. After developing the measurement systems and discussing it thoroughly with multiple experts, there are different benefits to using each system which will be further parsed when the systems have been experimented with.

To create a lesson plan that celebrates a collaboration with Stoney Nakoda and Tsuut'ina Nation drumming and singing while realizing limitations and the imposition of Eurocentric music theory systems

Jason Valleau
Supervisor: Patricia Danyluk
Werklund School of Education

The initial purpose of this PURE research project was to create lesson plans respecting the Stoney Nakoda and Tsuut'ina Nation powwow drumming and singing to be taught in Indigenous and non-Indigenous high school music classes. After a music residency in Banff discussing cross cultural collaboration philosophies, a Stoney Nakoda language course, online music workshops with 2 Tsuut'ina Middle School classes, and several interactions with a key musician from the Stoney & Tsuut'ina community, this project was successful in certain aspects of sharing and discovery through a custom designed lesson plan. However, it also exposed sensitive areas of imposing European music theory, appropriation vs appreciation, protocols and privacy concerns that require critical reexamination. While it might be historically accepted, and in some ways easier to explore and share the findings of several other genres of music from around the world, the music, culture and traditions of the Indigenous Peoples, especially on local treaty lands, require different levels of access, respect, approach and communication. It was also discovered that perhaps using common globally recognized popular culture currently shared by most students provides an entry point to establish interest, trust and curiosity to then become comfortable exploring and analyzing music closer to home.

Quality analysis and assessment of raw GNSS observations from various android smartphones

Raymond Van
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Schulich School of Engineering

GNSS measurements logged by smartphones are widely known to have high measurement noise, multipath errors and suffer from inconsistencies like duty cycling often, which affect the possibilities for smartphones to achieve high precision positioning. This study aims to investigate and assess the quality of the raw smartphone GNSS measurements such as pseudo-range and carrier phase that are used to obtain positioning solutions. Quality assessment was done quantitatively through graphs plotted using the various GNSS observations logged by each smartphone. The analysis for satellite tracking found that both the Samsung S20 Ultra (S20) and the Xiaomi 8 (Mi 8) were able to both consistently track satellites from all GNSS constellations (G/R/E/C) with little gaps between epochs while the Google Pixel devices (4,4XL,5) were inconsistent and experienced large dips in total satellites per epoch. Both the S20 and Mi 8 also showed a pattern of tracking a slightly higher total of satellites for all constellations expect GLONASS. As for the signal quality the Google Pixel devices showed a consistent higher range of carrier-to-noise density ratio (C/N0) compared to the S20 and Mi 8 due to their poor masking capabilities. Results showed as well that for all devices code availability is near 100% for all tracked epochs although carrier phase availability varies between datasets and is seen to have a noticeably lower availability in high multipath areas like urban environments. Analysis and comparison on each smartphone's raw GNSS measurements showed advantages and disadvantages for different categories of assessment. Some flaws and areas for improvement are also revealed in this study which open avenues for further research around this topic.

Developing a data analysis workflow to optimize hard rock drilling for geothermal energy

Pooja Veedu
Supervisor: Roman Shor
Schulich School of Engineering

Geothermal energy, or heat derived within the sub-surface of the earth, is a renewable and environmentally friendly source of energy that can be used for electricity generation as well as for heating or cooling. Currently, geothermal energy usage is limited to niche geographies, however, deep drilling into hard rock would allow this energy to be accessed anywhere. The purpose of this research project is to develop a data analysis workflow to optimize hard rock drilling for geothermal energy. This was accomplished by implementing a performance model for rotary-percussive drilling to predict optimal drilling scenarios for different drill bits. This model was integrated within a web app that was built using Python to allow researchers to easily input data and obtain results. The model was then validated by comparing its predictions to previously obtained field data. This comparison showed that there is a relation between how well drilling occurs, based on the rate of penetration, and the different scenarios that the drill bits were used in, particularly the various RPM and hammer frequency combinations. By continuing to improve this model, drilling operations can be optimized and the high costs associated with geothermal energy can be reduced, allowing access to this sustainable energy source anywhere.

Insect pollinator diversity and native plant associations in the City of Calgary, Alberta

Sarah Vermaak, *Michaela Seal, Taylor Ford-Sahibzada, & Mindi Summers*
Supervisor: Mindi Summers
Faculty of Science

Insects pollinate roughly 75% of Earth's flowering plants**,** and while Calgary hosted a large number of diverse insect pollinators, its insect diversity and plant associations had not yet been catalogued. This study sought to document the diversity of Calgary's insect pollinators and determine which native plants support them.

We observed and combined observations of plant-pollinator relationships collected through iNaturalist (3168 observations) from 2008-2021, physical collections and observations from specific plants in 2020 (1840 observations), and observations of insects visiting flowers during transect (294 observations) and quadrat (225 observations) surveys in 2021. We compared the number and association type for 59 native plants, and nine major insect groups (flies, beetles, true bugs, wasps, solitary bees, butterflies, ants, bumble bees, and honey bees). We identified 63 families, 148 genera, and 194 species of insects. We found the greatest number of species and plant-pollinator associations for flies and solitary bees, followed by bumble bees and butterflies. We also identified ten native plants that were associated with the greatest number of major insect groups.

The results of this project will aid conservation and restoration efforts by providing guidance to city planners, landscape designers, and gardeners on which plants best support our city's pollinators.

Effect of altering electron density on phosphorescence of N

ZiQi Wei
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Faculty of Science

Phosphorescent materials are currently employed in many technologies, such as light-emitting diodes[1], bio-imaging nanoparticles[2], and solar cells[3]. The ability to use purely organic compounds holds many benefits such as decreased cost, decreased environmental impact, and ability for mass production[4]. The potential for purely organic molecules to exhibit room-temperature phosphorescence was once seen as impractical due to the inefficiencies of energy conversion between electron states, which create phosphorescence, when there are no heavy metal atoms to aid in electron state conversion[5]. N,9,9-trimethylacridan (TMA) has shown substantial room-temperature phosphorescence with times exceeding 1 s, where other molecules classified as 'ultralong room-temperature phosphorescence' have seen emission lifetimes barely exceeding 100 ms[5]. By adding bromine and cyano groups onto the para-positions of the aromatic carbon skeleton it was seen that the addition of both halogens and electron withdrawing groups, such as cyano groups, stopped the naked eye visible phosphorescence of the molecule completely. This was unexpected as generally the addition of halogens shortens but does not completely stop phospohrescence[6]. The effect of electron withdrawing cyano groups was unpredictable and the result shows that either extending the pi system or decreasing electron density reduces or stops phosphorescence. This study did not yield direct molecular frameworks but did raise questions with regards to why the heavy atom effect completely stopped phosphorescence in TMA as well as why decreased electron density in TMA seemingly decreases phosphorescence.

Hydrological patterns and changes of alpine lakes in the Canadian Rockies

Sarah Wensink
Supervisor: Cathryn Ryan
Faculty of Science

It is know that the changing climate effects the input sources of water into alpine lakes from their catchments such as snowmelt and glaciers. However, the extent to which these hydrological changes are affecting the chemical composition of lakes in the alpine is not yet understood, especially for lakes in the Canadian Rockies. Therefore, the purpose of this study was to quantify changes in the water chemistry of alpine and subalpine lakes that have occurred over the past 50 years, and to model the water sources and flow for specific lakes using water and chemical budgets, in order better understand how the two are related. From the lake water budgets it was determined that the quantity of summer precipitation greatly affects the flow volume into and out of alpine lakes, that a much larger component for water in alpine lakes comes from surface runoff, including snowmelt and glaciers, than from groundwater. Additionally, for the 12 lakes sampled it was found that the water of all 12 had increased (between 10% – 70%) in conductivity since the 1970's. This can be explained by increased contribution of groundwater into the lakes, which is higher in dissolved minerals than surface water, over time. This is relevant to the future of these lakes, and the watersheds that they feed, as glaciers and winter snowpack continue to recede, because this decreases the large surface water component of the water budget and proportionately increases the groundwater component, leading to continued changes in water chemistry.

Dual-functionail electron transport layers for organic photovoltaics

Sean Wilson
Supervisor: Gregory Welch
Faculty of Science

Organic photovoltaics (OPVs) offer an inexpensive, environmentally friendly alternative to inorganic photovoltaics. OPVs however face stability issues, and the active layer (component of OPV responsible for charge generation) is vulnerable to photodegradation induced by UV-light. To prevent this, a UV-blocking layer can be implemented before the active layer. In inverted architecture OPVs, only the electron transport layer (ETL) and cathode are between the photoactive layer and the substrate. This project aimed to develop a dual functional ETL for inverted OPV devices to facilitate efficient electron collection while preventing UV-light from reaching the photoactive layer. Several designs were proposed to complete this goal. The proposed designs faced many issues, including poor solvent resistance, weak UV-blocking, and poor device performance. Solvent resistance and UV-blocking were measured using UV-Visible spectroscopy, while OPV device performance was analyzed using a solar simulator. The produced OPV devices showed satisfactory UV-light blocking, however showed poor device performance (VOC: 0.209 V, PCE: 0.989%). The poor device performance meant that the electron transport layer material did not facilitate efficient electron collection, and thus was not successful as a dual functional ETL. Further investigation into the challenges involved in producing dual functional ETLs could result in new solutions to the photostability issues in OPV devices.

Examining the impact of neighbours on social isolation of older Chinese immigrants living alone: A case study

Ka Wai Wong
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With less technological engagement and the new norm of 'social distancing', older adults experienced increased social alienation and loneliness during the COVID-19 pandemic (Flint et al. 2020). In addition to the pandemic, racism against Asians intensified experiences of social isolation among older Chinese immigrants. These realities point to the importance of mental health support of older Chinese immigrants. However, there is a paucity of research that focuses on community-based interventions to improve their social ties during COVID in Canada. Drawing on the work of Mather (2017) who found that neighbourhood characteristics might influence the living conditions of older adults, this qualitative study examines the role that neighbours may play in decreasing loneliness and increasing resilience among older Chinese adults in Calgary. Eleven Chinese elders living in senior independent living buildings in Calgary Chinatown participated in a focus group and individual interviews. Findings indicated that neighbours have been crucial in supporting the seniors, especially for their inconspicuous daily tasks and social connection during the pandemic. Neighbourhood support is also an essential part of cultivating a more age-friendly community. Further discussions about ways to mobilize neighbours as valuable community resources are needed.

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The history of public housing: How policy, architectural design, and lived experience shaped Hong Kong public housing

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As urban populations continue to grow and housing affordability is becoming a global problem, public housing is a potential solution. However, in many Western countries such as the United States and Great Britain, public housing has been deemed a failure. The public housing programme in Hong Kong faced a different destiny, and it continues to house almost half the city's population. Because of the continued success of public housing in Hong Kong, the purpose of this study was to examine the history of the programme in light of architectural design and lived experience. The period covered spans from the 1950s to 1997 when public housing estates were built under the British colonial government. A comprehensive literature review on public housing developments in the United States, the United Kingdom, and Hong Kong suggests the economic and design challenges of public housing programmes. Yet, the architectural design of Hong Kong's public housing, such as structures without elevators, communal bathroom facilities, and multifunctional corridors, enhanced the cost-efficiency of public housing estates to house many families. In-depth interviews with nine former residents of different public housing estates in Hong Kong also revealed that the designs fostered neighbourly bonds. Many commented on friendships with neighbours

as their favourite part of public housing, indicating the importance of social relationships in influencing the lived experience. Implementing more communal facilities and amenities, such as wide corridors with communal spaces at the ends, playgrounds, gardens, and commercial amenities, ranging from local shops to shopping malls, allowing social interactions and activities may contribute to a positive living experience in public housing elsewhere on the globe.

Quantification of collateral status in colored multiphase CTA images of acute ischemic stroke patients

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Multi-phase CT angiography (mCTA) is a new tool for imaging collaterals of patients with acute ischemic stroke (AIS). The mCTA imaging also depicts whole-brain time-resolved images of arteries and veins beyond the blockage site of a blood vessel and informs on clot location/size. The objective is to obtain quantitative image features from the colored mCTA images to identify whether the patient has large vessel occlusion. This can also be used as a basis to develop an automated interpretation of mCTA images. Sixty AIS patients from the Prove-IT database were collected and separated into three groups: 20 with no occlusions, 22 with small occlusions and 20 with large vessel occlusions (LVO). The mCTA images were then processed using the ColorVizTM software (GE Healthcare) and separated into three phases to differentiate between the timing of when contrast dye was circulating in the brain. Afterwards, regions of interest were drawn manually on the middle cerebral artery for both sides of the brain to determine the blood volume and average Hounsfield unit (HU) of the enhanced vessel at different times. The results showed clear differences in volume between no/small occlusion and LVOs, thus leading to quantifiable characteristics between the groups. Volume of blood was shown to be a parameter that suggests a clear difference between LVO and no/small occlusions. This research can be used as the first steps to develop a quantitative approach to grade collateral status in the mCTA images of AIS patients.

Neuromuscular, cardiorespiratory and perceptual responses to blood flow occlusion superimposed on high intensity training in trained and untrained individuals

Matthew Yacoub*, Zachary McClean, Jenny Zhang, Saied Jalal Aboodarda*
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Exercise-induced fatigue and muscle pain transiently impair maximal voluntary force. Inhibitory neural feedback originating from activation of group III/IV muscle afferents during high intensity exercise could attenuate the voluntary motor output and reduce exercise performance. This study utilizes intermittent blood flow restriction (BFR) as an intervention to increase metabolic stress and simulate the sensation of pain induced by high intensity muscle contractions. Five healthy, recreationally trained subjects (n=5 [females=2]; mean: 28.4 years, 168.1 cm, 79.7 Kg) performed a cycling ramp incremental test to peak power output (PPO). In two experimental visits, a high-intensity interval training (HIIT) cycling exercise with 1:1min work:rest ratio at 90% PPO was performed with and without BFR (60% full occlusion) of the proximal thigh. Time to task failure, neuromuscular fatigue (assessed using interpolated twitch technique), rate of oxygen consumption, rating of perceived exertion and leg pain were

measured. BFR increased perceptions of pain and exertion ($p< 0.05$), decreased maximal voluntary force output ($p< 0.05$) and shortened cycling time to task failure ($p< 0.05$). BFR superimposed on HIIT cycling impairs time to task failure and modulates neuromuscular responses to exhaustive exercise. Delineating the acute effects of BFR during HIIT cycling assists in understanding the underlying mechanisms associated with reported chronic adaptations as a result of this training modality and may optimize the use of BFR in performance and clinical settings alike.

Metagenomic investigation of the role of bacterial tubersphere communities in preservation of starch granules used in ancient starch research

Daniel Yakimenka, *Peter Dunfield, Julio Mercader, Andriy Sheremet*
Supervisor: Julio Mercader Florin
Faculty of Science

Ancient starch research has seen extensive use in recent years as a way of understanding the dietary habits and economic botany of the first hominids that emerged 1.8 to 1.3 million years ago in present-day Tanzania. Though ancient starch research has seen success, it is still unknown why an easily biodegradable polysaccharide can be preserved in trace amounts for many millennia. The objective of this study is to find reasons for preservation of ancient starch hinging on the enzymatic makeup of the microbial communities that form around starchy tubers native to east African soils. We pose the question: is the microbial community of Olduvai Gorge soil enriched with *Ipomoea longituba* starch less adept at degrading starch than a potato starch enriched control? Real world starch degradation conditions were simulated using Olduvai Gorge soil enriched with the two types of starch, controlling for temperature, oxygen and moisture levels. Standard shotgun metagenomics workflow was applied to day 41 samples. Qualitative results indicate the presence of starch degrading microbes in both treatments. Quantitative results show that amylase genes are 4.6 times more abundant in the potato starch enriched community. We conclude that the ipomoea starch enriched community is much less adept at degrading starch than the potato starch enriched community.

Examining the effects of novel drug treatment on glioblastoma organoids

Lucy Yang
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Faculty of Nursing

Glioblastoma (GBM) is the most common type of malignant brain tumour and cancer of the central nervous system (Grech et al., 2020). Its incidence has increased in the last decade in most countries worldwide due to reasons including aging populations and air pollution (Grech et al., 2020). Cancer growth involves an increase in cell cycle progression and proliferative cellular pathways (Whittaker et al., 2017). This similarity between different cancer cell types could allow for the usage of drugs intended for other cancers on glioblastoma. This study aimed to determine whether drug treatment intended for various other types of cancers would be effective on glioblastoma organoids. Higher concentrations of palbociclib, disulfiram, and combinations of disulfiram with other drugs in the study resulted in decreased organoid sizes compared to control experiments. Therefore, drug treatments used on other types of cancer were associated with decreased glioblastoma organoid survival. Future studies should establish a connection between organoid size and viability. Also, cell viability assays should be completed to assess the status of cells within the organoids after drug treatment. As well, replications of the experiments and statistical testing

should be completed. If glioblastoma organoids are vulnerable to these types of treatment, organoids can be used in mouse models to continue drug testing.

The development of a suite of protein-based rare earth element measurement systems

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Supervisor: Mayi Arcellana-Panlilio
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Rare earth elements (REEs) are ubiquitous in modern society, playing major roles in the development of automobiles, personal electronic devices, and industrial technologies. Current REE extraction processes target metal ore, resulting in unsustainable and costly mining practices. As the demand for REEs increase, the need to look for an alternative source of REEs has become apparent in electronic waste (e-waste). Current e-waste recycling processes fail to target REEs, resulting in millions of dollars of precious metals being sent to the landfill. The recent discovery of lanmodulin (LanM), a novel lanthanide-ion binding protein, introduces a biological avenue for the recycling of e-waste. In order to appropriately address the efficacy of LanM-based recycling processes, we developed a suite of LanM-based lanthanide ion measurement systems. Three systems were tested, each of which consisted of a biological molecule attached to the LanM protein. The first system, BRET, was based on bioluminescence energy transfer (BRET) between protein reporters NanoLuc and mCherry. The second system, Lucifer, was based on LanM fused to the NanoBIT protein complementation reporter. The third system, Elektra, was an electrochemical system based on an $Ru(bpy)_2^{2+}$ nanoparticle immobilized to LanM, which would send a signal upon lanthanide-ion binding. With the use of software modelling, protein constructs were optimized. Previous research has indicated conformational changes in LanM, caused by lanthanide-binding, result in measurable fluorescence signals, which can then be used to determine lanthanide-ion concentration in solution.

Does bat consumption of insect pests result in a mutualist relationship between beef cattle and bats?

Derrick Zhang
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Insectivorous bats provide important ecosystem services in agricultural systems, including the consumption of insect pests. Bat consumption of blood-feeding insects which parasitize cattle may mitigate production loss caused by these insects, resulting in a mutualistic relationship. We investigated whether bat foraging behaviour is associated with the occurrence of cattle and blood-feeding insects on pastures across WA Ranches at UofC. To assess co-occurrence of bats and cattle, sixteen pastures with or without cattle were sampled using four monitoring stations composed of two trail cameras and one autonomous recording unit (ARU), rotated every 3-4 days between locations from May to August. This resulted in 6 sampling periods for each location. UV-light CO2-baited insect traps were concurrently deployed for 24 hours to determine the composition and relative abundance of insect populations. Logistic and negative binomial regression models were used to correlate bat presence/absence and call frequency, respectively, against cattle occurrence and other covariates. Based on our preliminary analysis on bat call data from the ARUs as

well as insect trap data, we found that there was no significant relationship between bat activity over pastures and cattle presence. Although bat activity and insect abundance were temporally correlated, there was no significant spatial relationship across pastures. Future analysis will explore the potential confounding effects of landscape heterogeneity, bat foraging activity, fine-scale cattle movement, and weather variables. Outcomes of this research have the potential to inform the surveillance of biting insects and arthropod-borne pathogens, as well as cattle production practices that support bat conservation.

Design of a bioaffinity-based system for rare earth recovery

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In the age of technological advancement, technology such as cell phones, laptops, tablets, and automobiles have become an indispensable part of our lives. Rare Earth Elements (REEs) play an essential role in the production and development of these technologies. This results to a growing global demand for REEs, with a projection for the overall consumption to double by 2035. While REEs are naturally found in ores, the mining practices are unsustainable and costly, and often not accessible for many countries. This leads to a dependency on imports, resulting in a monopolistic and volatile supply market. Recycling REEs from electronic waste (e-waste) proves to be a more sustainable stream of REE sourcing. However, the compositional complexity of e-waste as a feedstock proves to be a challenge for the selective separation of REEs from other metal ions, which is critical in REE recovery. Additionally, conventional methods like solvent extraction and precipitation are reagent-intensive and inefficient at low ion concentrations. Therefore, to produce a sustainable separation system with high throughput, we can use lanmodulin, a lanthanide-binding protein, which is immobilized on bacterial cellulose beads (BCBs) using a cellulose-binding domain (CBD). These BCBs are then packed into a fixed bed adsorber column, so the REEs can be extracted from the e-waste leachate. A preliminary modeling workflow was developed incorporating analytical models to determine the relative impact of the design parameters on the breakthrough behavior. The goal of the workflow is to determine working values to begin the development of a prototype and experiments needed to optimize the system for potential scale-up for industrial usage.

Parental sleep and child chronic pain outcomes

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Chronic pain is highly prevalent (affecting 25% of Canadian youth), costly (19 billion USD/year), and debilitating for families. Thus, understanding predictors of long-term outcomes in youth with chronic pain has never been more critical. Sleep is often noted as an important factor influencing chronic pain, however the relationship of how parental sleep impacts their child's chronic pain has not been examined. This novel study sought to analyze if parental distrubed sleep is linked to child pain outcomes, along with the relation to parent protective behaviours. Participants consisted of 80 parent-child dyads recruited through chronic pain programs at the Alberta Children's Hospital. Parental actigraphy and sleep survey data was analyzed correlationally alongside protective parenting survey data, and child quality of life and pain interference measures. Results of the anlysis found that there was no

significant correlation between disturbed sleep, protective parenting, and child pain outcomes. However, it was found that subjective parental sleep survey scores were strongly linked to child pain outcomes. These findings indicate that though protective behaviours may not be in relation to parental sleep and child pain, parental cognitive, emotional, and mental health factors may be an important mechanism. With evidence showing the impact of parental health on their child's pain, it is critical to examine how sleep may play a role, and how to develop interventions that can target these factors.
