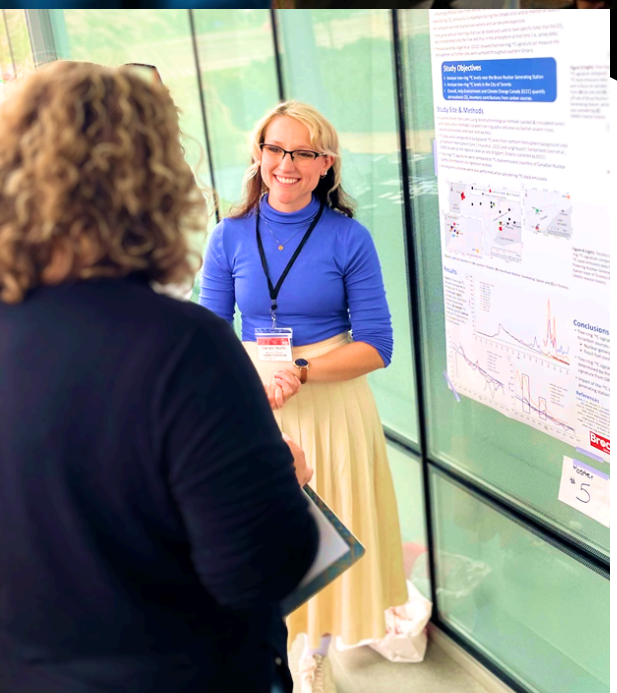
FMS GRaD Conference 2024



Presented by:

GRAMSS

Faculty of
Mathematics & Science

Brock University

FMS GRaD Conference 2024 Program

Friday, September 27th, 2024 & Saturday, September 28th, 2024
Brock University

Hosted by:
The Graduate of Mathematics and Science Students (GRAMSS) Society
Faculty of Mathematics & Science

Thank you to our funders:
Faculty of Mathematics & Science, Brock University
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X (formerly Twitter), Instagram, Threads, Facebook: @GRAMSSBrockU

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Welcome to the FMS GRaD Conference 2024!

Welcome to the third annual Faculty of Mathematics and Science Graduate Research Day: FMS GRaD Conference at Brock University! This event was established in 2022 to showcase the remarkable research being conducted by graduate students in the Faculty of Mathematics and Science (FMS), and beyond, while providing opportunities for students to network with professional researchers within the Brock University community. Furthermore, we want to celebrate students' academic achievements and encourage a sense of community among the FMS graduate students.

The FMS GRaD Conference will be held as a two-day event. Day 1 of the conference takes place on Friday, September 27th, which will consist of a Knowledge Mobilization workshop led by Jayne Morrish from Brock's Office of Research Services, and a keynote talk by Dr. Vaughn Mangal from the Department of Chemistry. Day 2 will take place on Saturday, September 28th, which will be full of research talks given by Brock's inquisitive graduate students, further highlighting the innovative research being conducted at Brock University.

The Graduate of Mathematics and Science Students (GRAMSS) Society would like to thank our funders, the Faculty of Mathematics and Science, the Faculty of Applied Health Sciences, and the Office of the Vice President of Research, at Brock University. Thank you to Norgen Biotek Corp for their continued sponsorship and providing the Norgen Rising Star Awards. Thank you to our first-time sponsor, Thermo Fisher Scientific, for their generosity and support. Lastly, thank you to various local sponsors for donating door prizes to our event, as well as Brock Dining and Fresh Food Company DeCew for their catering services.

Follow us on social media @GRAMSSBrockU on X (Twitter), Instagram, Threads, and Facebook! We encourage you to use #FMSGRaD2024 to share comments and interesting quotes you learned with your followers!

We hope you enjoy your experience at the FMS GRaD Conference 2024!

Location Information

Main gathering: Pond Inlet, 2nd floor of J-block in the Mackenzie Chown Complex

- All participants will visit this room for registration at the start of Day 1 and Day 2
- Opening/closing speeches, Jayne Morrish's workshop, Dr. Mangal's keynote talk, and social events will be held here

Oral presentations: Plaza Building, 4th floor

- Rooms: PLZ408, PLZ409, PLZ410, and PLZ411 (all located in the same hallway)
- Accessible through elevator or stairway
- Sitting area nearby

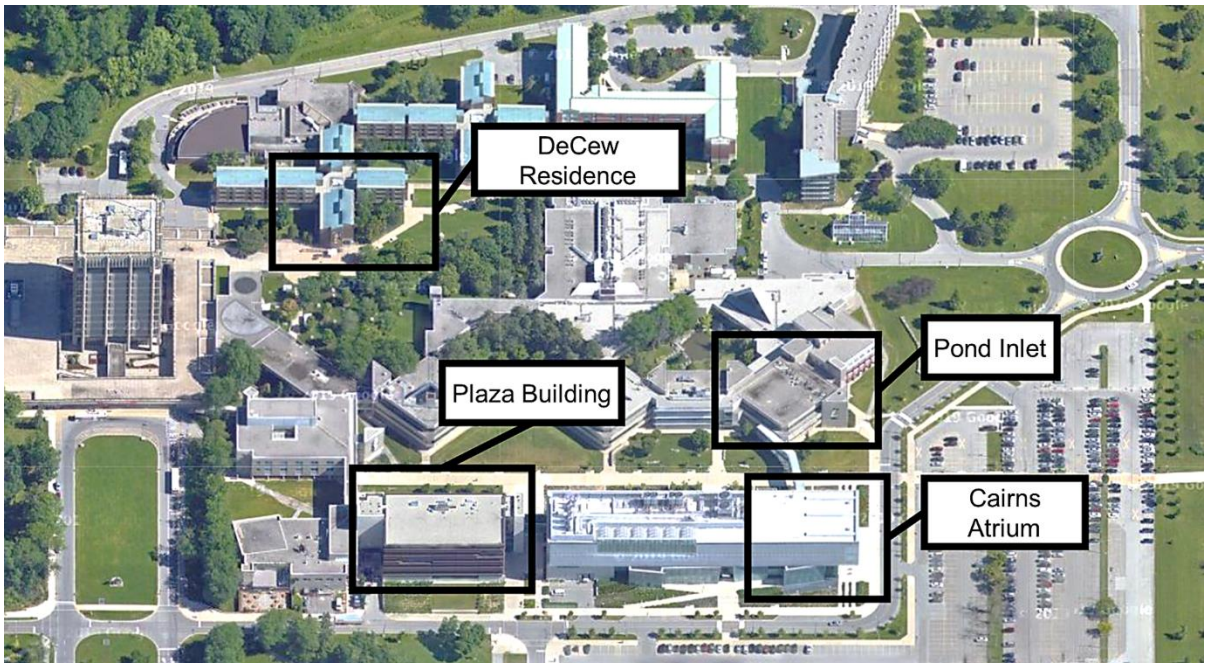
Poster presentations: Cairns Atrium, 2nd floor of the Cairns Building

- Sitting area nearby

Lunch: DeCew Residence (outside of H-block, Mackenzie Chown Complex)

- Lunch will be provided to attendees on **Saturday, September 28th ONLY**
- Participants must obtain a valid lunch voucher from the registration table, in Pond Inlet
- Buffet-style lunch

Map of locations



Remarks from the Faculty of Mathematics and Science Dean's Office

Dr. Peter Berg, Dean, Faculty of Mathematics and Science

Welcome to the 2024 GRAMMS Conference in the Faculty of Mathematics and Science (FMS). We are excited to have you join us for this special event, where we celebrate the innovative research and intellectual curiosity of our graduate students.

This conference is a unique opportunity to present research findings, engage with fellow researchers, and explore the vast landscape of mathematics and science. Whether you are here to share your latest progress or to discover new ideas, this event is all about collaboration, inspiration, and growth. Moving from learning what other researchers have discovered to discovering new findings yourself is a challenging and unique experience that can be tough and rewarding at the same time. It often ends up as the most memorable period in a researcher's life that only fellow researchers can relate to.

We have an exciting lineup of presenters that showcase the diverse range of research conducted within our faculty. These sessions are designed to foster discussions, challenge perspectives, and ignite new ideas. I encourage you to take full advantage of the chance to connect with your peers and explore new areas of interest.

Our faculty is committed to nurturing a supportive and dynamic academic environment, and this conference is a testament to that commitment. It is through your dedication and passion that we continue to push the boundaries of knowledge and make significant contributions to the world of mathematics and science. The research reputation of FMS rests in large part on the achievements of our graduate students.

I would like to extend my sincere thanks to everyone who has contributed to making this conference possible, including the organizers, presenters, and participants. Your hard work and enthusiasm are greatly appreciated.

Enjoy the conference, and I look forward to the discoveries and discussions that will unfold.

Warm regards,

Peter Berg
Dean, Faculty of Mathematics and Science

Dr. Melanie Pilkington, Associate Dean of Research and Graduate Studies, Faculty of Mathematics and Science

Welcome to the 2024 GRAMMS conference in the Faculty of Mathematics and Science (FMS) as we embark on this new academic year at Brock University. You are all here because of your talent, willingness to work hard, and commitment to your fields of research.

I would like to thank the organizers for providing a forum in which we can celebrate the academic achievements and groundbreaking research of graduate students and researchers within FMS. I encourage you all to take every advantage of this opportunity to come together, make new friends, network and share your research goals, findings and ideas. Being able to transfer existing skillsets from research into marketable skills is the key to communicating your skillsets to potential future employers.

I acknowledge that it can be overwhelming starting a new program, but the supportive graduate community within FMS means there is always someone on hand who has walked in your shoes, to offer help and support.

For those of you reaching the end of your studies, it is important to harness the motivation that comes with completing such a significant milestone. You will be the coming generation of researchers and innovators; and the mentors and instructors of our next generations of young people.

Enjoy this conference, and as you do so, take note that your graduate experience goes beyond academic growth to building a strong foundation for your personal and professional development.

Wishing you every success,

Melanie Pilkington
Associate Dean of Research and Graduate Studies, Faculty of Mathematics and Science

Conference Code of Conduct

The GRAMSS Society is committed to providing a safe and positive environment for all participants of the FMS GRaD Conference and other events. We strongly prohibit any form of harassment or discrimination. We request that all participants be respectful of the Inclusion, Diversity, Equity, and Accessibility values, and support a positive exchange of ideas during the event. Graduate and undergraduate students are also expected to abide by Brock University's Student Code of Conduct during the conference. Anyone that violates these rules will be requested to leave the event.

Expected Behaviour for All Participants

1. Treat everyone with respect, dignity, and consideration, valuing a diversity of views and opinions.
2. Be mindful of everyone's safety and considerate others' physical space.
3. Be professional, courteous, and collaborative.
4. Refrain from using any harassing, demeaning, or discriminatory behaviour or speech.
5. Refrain from interrupting or distracting presenters and audience members during the workshop, keynote talk, and graduate student talks.
6. Respect presenters' requests to refrain from sharing contents of their talk on social media or other public platforms. Presenters that wish to opt-out of media dissemination are encouraged to indicate their wishes verbally or by including a logo on their presentation or poster.
7. Respect and follow any instructions given by volunteers, GRAMSS executives, and Brock University staff to ensure everyone's safety.
8. Inform the volunteers, GRAMSS executives, and Brock University staff of any suspected inappropriate behaviours, dangerous situations, or persons in distress immediately.

Unacceptable Behaviour

1. Harassment involving any unwelcome or offensive comments, gestures, physical displays, or physical contact with any participant that would reasonably be considered offensive, humiliating, or intimidating to the other person.
2. Discriminatory conduct or comments based on race, gender identity or expression, sex, sexual orientation, disability, ethnicity, political affiliation, marital status, etc.
3. Behaving in a disruptive or unprofessional manner that puts the health, mental well-being, or safety of yourself or others at risk. This also includes making loud noises, talking over others, talking on your phone, etc., during presentation sessions, group activities, social events, and important announcements.

4. Failing to comply with the instructions of conference volunteers, GRAMSS executives, or Brock University staff.
5. Retaliation or threats directed against participants reporting any activity or situations reasonably considered to be in violation of this Code of Conduct.
6. Falsely reporting violations of this Code of Conduct in bad faith.

Rules for Presenters

To ensure a positive and cohesive experience, presenters of the FMS GRaD Conference are expected to:

1. Arrive prepared for your assigned presentation session at least 10 minutes in advance.
2. Refrain from exceeding your presentation time limit.
3. Refrain from switching between presentation rooms (or posters) during your assigned session.
4. Be respectful towards other presenters and audience members.
5. Respond to audience members' and judges' questions in a professional and courteous manner.

Reporting Unacceptable Behaviour

If you suspect someone is violating this Code of Conduct, please promptly report your concerns to the nearest conference volunteer or GRAMSS executive. If you are not comfortable reporting a complaint/concern to a volunteer or executive onsite, please reach out to us at gramss@brocku.ca or Alex Wilder at aw21sm@brocku.ca for an immediate response or immediate assistance onsite.

If you or someone else is in immediate danger, or if you would like to report an emergency, please contact Brock's Campus Security at 905-688-5550 x3200.

Land Acknowledgement

Brock University acknowledges the land on which we gather is the traditional territory of the Haudenosaunee and Anishinaabe peoples, many of whom continue to live and work here today. This territory is covered by the Upper Canada Treaties and is within the land protected by the Dish with One Spoon Wampum Agreement.

Today this gathering place is home to many First Nations, Métis and Inuit peoples and acknowledging reminds us that our great standard of living is directly related to the resources and friendship of Indigenous people.

Conference Schedule

Day 1: Friday, September 27th, 2024
Location: Pond Inlet

Time	Description
10:00 AM	Registration
11:00 AM	Knowledge Mobilization Workshop with Jayne Morrish, Office of Research Services
12:00 PM	Collaborative Work Period ***Bring your own lunch*
3:00 PM	Opening Remarks with Dr. Peter Berg, Dean, Faculty of Mathematics and Science
4:00 PM	Keynote Talk with Dr. Vaughn Mangal, Department of Chemistry
5:00 PM	Social Event + Jackbox Tournament
8:00 PM	End of Day 1

Day 2: Saturday, September 28th, 2024
Location: Pond Inlet, Plaza Building, and Cairns Atrium

Time	Description	Location
8:00 AM	Registration	Pond Inlet
9:00 AM	Opening Remarks + Orientation	
9:30 AM	Oral Presentation Concurrent Sessions 1	Plaza Building
10:30 AM	Coffee Break	
11:00 AM	Oral Presentation Concurrent Sessions 2	
12:00 PM	Lunch	DeCew Residence
1:30 PM	Poster Presentation Session 1	Cairns Atrium
2:30 PM	Coffee Break	
3:00 PM	Poster Presentation Session 2	
4:00 PM	Awards Ceremony + Closing Remarks with Dr. Melanie Pilkington, Associate Dean, Faculty of Mathematics and Science	Pond Inlet
5:00 PM	Social Hour	
8:00 PM	End of Day 2	

Knowledge Mobilization Workshop: Jayne Morrish, Brock University

Friday, September 27th, 11:00 AM–12:00 PM, Pond Inlet

Knowledge Mobilization (KMb) refers to the process of transferring research knowledge to those who can use it to make informed decisions and further knowledge/research/practice. It is a critical component of the research impact process. KMb involves applying research knowledge to facilitate further scientific studies and achieving real-world impact on policy and society. This process not only enhances research uptake and informs decisions but also connects researchers with other researchers and knowledge users outside the university. In this workshop, Jayne Morrish, the Research Impact Manager at Brock University's Office of Research Services, will introduce you to KMb theory, strategies, and tools to support your academic work and prepare you for the annual GRAMSS GRaD conference. Jayne has received several awards for her work, including a Certificate of Academic Excellence from the Canadian Psychological Association, a 40 Under Forty Award, and Brock University's President's Distinguished Staff Service Award.

Collaborative Work Period

Friday, September 27th, 12:00 PM–2:00 PM, Pond Inlet

Pond Inlet will be open to all conference attendees from 12:00 PM to 2:00 PM. Presenters are welcome to work with peers to fix their coding errors, receive feedback on their presentation, or practice their talk. This is a great opportunity for graduate students to learn from each other! Participants are encouraged to bring their own lunch.

Keynote Speaker: Dr. Vaughn Mangal, Brock University

Friday, September 27th, 4:00 PM–5:00 PM, Pond Inlet

Dr. Vaughn Mangal is an assistant professor in the Department of Chemistry, associate director of science initiatives at the Brock-Niagara Validation Prototyping and Manufacturing Institute (VPMI), and head of the Brock University Biogeochemistry Lab (BUBL). Their research group investigates the relationship between carbon cycling and climate change in a wide range of terrestrial and aquatic environments. Dr. Mangal has collaborated with various academics, industries, and government organisations to understand how metal transport is affected by forest fires, forest harvesting, permafrost thaw, and agricultural land use. In partnership with Destiny Copper in Niagara, their research group is investigating sustainable methods for extracting copper from algae blooms in Lake Erie, to aid with the high demand for mining copper while reducing pollution in lakes. Read more about Dr. Mangal's work with Destiny Copper here.

JACKBOX TOURNAMENT

1. Choose your games

2. Score Points

3. Secure Victory

CHOOSE FROM

- Quiplash
- Trivia Murder Party
- Drawful
- Weapons Drawn
- Tee KO

REGISTRATION IS NOT MANDATORY BUT WALK IN PARTICIPATION IS NOT GUARANTEED

WIN TROPHIES AND BRAGGING RIGHTS

gramss@brocku.ca | brocku.ca/mathematics-science/gramss | @gramssbrocku

Oral Presentations Schedule

Session 1 (9:30 AM – 10:30 AM)				
Time	**Materials & Physics** PLZ408	**Ecology** PLZ409	**Behaviour & Neuroscience** PLZ410	**Human Physiology** PLZ411
9:30 AM	**Quantum Loops and Distortions of Transition Metal Dichalcogenides** Ashland Knowles	**Monitoring the Impact of Winter Cover Crops on Soil Nematode Communities using Metabarcoding Approach** Jerry Akanwari	**Exploring Risk-Taking and Health in Adolescent Immigrants to Canada: A Unique Focus on "The Healthy Immigrant Effect"** Youssef Nassar	**The Role of Neural and Vascular α2-adrenergic Mechanisms in the Sympathetic Baroreflex Control of Blood Pressure** Julia Spafford
9: 45 AM	**Collective Excitonic Modes in Benzene, Acenes, and Cyclacenes** Parisa Rouzbazar	**Prenatal Alcohol Exposure Alters Social Motivation in Early Adolescent Male and Female Sprague Dawley Rats** Andrew Sheehan	**Sex-Specific Effects of Adolescent Stress on Social Reward Motivation** Amanda Leonetti	**Validity of a Mobile Phone Application for the Assessment of Heat Stress in People Who Exercise** Georgia Charachousou
10:00 AM	**Development of novel Hybrid Bamboo/Timber Engineered Materials** Nima Jafarnia	**Sentinel Behaviour in Mammalian and Avian Species** Alex Popescu	**Exploring Sex and Age Differences in Aperiodic EEG Activity Among Children with ADHD** Sambavi Arulnandhy	**Ganglionic Blockade Modulates Sympathetic Neural Discharge and Neurocirculatory Regulation in Humans** Cameron Lynn
10:15 AM	**Electrochemical Activity of Two-Dimensional Titanium Carbide MXenes Synthesized using Milder Etching Route** Pritish Behura	**Ups and Downs of Living Underground: Behavioural Responses to Overwintering Emergence in the Spotted Salamander** Danilo Giacometti	**Impact of Prenatal Alcohol Exposure on Cognitive and Immune Signaling in Aging Male and Female Rats: A Longitudinal Study** Sunny Qureshi	**Investigating the Contribution of Forearm Vascular Compliance and Viscoelasticity During Exercise-Induced Hyperemia** Shamae Quinquito
Coffee Break (10:30 AM – 11:00 AM)				

Session 2 (11:00 AM–12:00 PM)				
Time	**Mathematics** PLZ408	**Cell Biology & Genetics** PLZ409	**Biochemistry** PLZ410	**Physics** PLZ411
11:00 AM	**Identifiability of The Linear Threshold Model** Anuththara Lekamalage	**Baseline Oxygen Level Affects the Response of Prostate Cancer Cells to Hypoxia** Ricardo Alva	**Use of *Saccharomyces uvarum* CN1 to Mitigate Negative Effects of Botrytis and Sour Rot in White Wine** Daniel Phillipow	**GNN-based Handover Management in 5G Vehicular Networks** Nazanin Mehregan
11:15 AM	**A Search for Integrable Evolution Equations with Lax Pairs Over the Octonions** Hin Ho (Philic) LAM	**The Hidden Genetic Legacy of Neanderthals and Denisovans in Modern Humans Through the Lens of Mobile Elements** Sultan Mussakhan	**Synthesis of Deuterated Nucleoside Derivatives for NMR and Mass Spectrometry Probes** Fiatan Binta Haque	**Nucleation of Wormholes and Topology Changes in Lorentzian Geometry** Alessandro Pisana
11:30 AM	**Optimal Design for Accelerated Life Tests with Progressive Stress Loading under Exponential Lifetime Distribution** Yujia Luo	**The Role of the Aldehyde Dehydrogenase Enzymes in Acetic Acid Production in Icewine** Nadine Ott-Peon	**Transcriptomic Evidence of Melatonin Agonism for Human 5-HT2A Receptor in HEK293 Cells** Wantao (Noah) Xiao	**mKdV Loop Travelling Waves and Interactions of Loop Solitons** Jaskaran Maan
11:45 AM	**End of Session**	**Insights into *Pantoea agglomerans* Genomic Diversity: Understanding the Drivers of Antimicrobial Resistance and Virulence Gene Acquisition** Muhammad Sulman	**Synthesis of Cyclic Azobenzene Bisammonium with Photo Switching Capabilities for Spatiotemporal Control of DNA and Cell Membranes** Stephanie Bedard	**End of Session**
12:00 PM		**Designing Simulated Cytoplasmic Fluids** Mariam El-Morched	**Synthesis and Mechanistic Study of Substituted 1,2-bisphenylhydrazones: An Unintended Discovery** Disha Patel	
Lunch (12:00 PM – 1:00 PM)				

Poster Presentations Schedule

Cairns Atrium	
Session 1 (1:30 PM–2:30 PM)	**Utilizing a Live CNS Organ Culture to Study Functional Retinoid Signaling** Alicia Piazza
	Examining Nerve Regeneration Using a Novel CNS Organ Culture Autumn Lif
	Beyond the Signal: Using Digitally-Coded Radiotransmitter Frequency to Predict Temperature Harry Kumbhani
	Pathway Interaction Identification using Canonical Correlation Analysis Marcus Villena
	Lighting the Way: Exploring Sex-Specific Responses to Light-Based Circadian Disruption in Degus Nico Zugo-Gadea
	Two-Dimensional Titanium Carbide MXene for Lithium-Ion Conductive Solid-State Electrolytes Hansima Keppetiyawa
	Sex-Specific Adolescent Development of Social Reward Motivation in Female and Male Octodon Degus Shealian Murray
	Comparing The Effects of Parental Experience on Cognition and Anxiety-Like Behaviour in Female and Male Degus Anton Dinh
	Sex-Dependent Alterations to the Gut Microbiota and Anxiety-Like Behavior in Rats Prenatally Exposed to Alcohol Kingston Wong
Coffee Break (2:30–3:00 PM)	
Session 2 (3:00 PM–4:00 PM)	**Transcriptional Alterations in HIF- and Redox-Related Pathways in Mitochondrial DNA-Depleted PC-3 Cells** Jacob Wiebe
	In-Vivo Analysis of Notch1 Cleavage by the Proteolytic Enzyme Nardilysin Chanille Ubias
	Using Whole Genome Sequencing for the Identification of Wild *V. riparia* Clones Robert Robinson
	Extending the Boundary of Multi-Objective Drug Design Karl Grantham
	Exploring Fast and Scalable Gradient-Free Evolutionary Optimization in Deep Learning Rasa Khosrowshahli
	Increases in Vascular Compliance Contribute to Rises in Skeletal Muscle Blood Flow Velocity at Exercise Onset Felicia Bouaban
	Preparation and Characterization of Vanadium Based Misfit Chalcogenides Imesha Samadhi Nanayakkara Hewawasam
	Fabrication and Structural Analysis of La(1-x)Ca(x)MnO3 Thin Films on SrTiO3 (100) Substrates Using Pulsed Laser Deposition Ankreet Kaur
	Synthesis and Structural Characterizations of Tantalum Zirconium Ta(1-x)Zrx Binary Alloys Teresa Dong

Oral Presentation Abstracts

Oral Presentation Session 1 (9:30 AM–10:30 AM)

Materials & Physics (PLZ408)

Quantum Loops and Distortions of Transition Metal Dichalcogenides

Ashland Knowles (Physics, MSc)

Abstract: Transition metal dichalcogenides (TMDs) are semiconducting materials of the form MX2 (for example, MoS2 and ReS2), where M represents a transition metal atom and X represents a chalcogen atom. A monolayer of a TMD is composed of three layers in the form X-M-X, where each layer ideally forms a regular triangular lattice. Some materials like LiVO2 have a structure that is similar to that of TMDs, but with an additional atom per transition metal atom. Both of these types of materials can exhibit distortions of the 1T structural phase. The objective of our research is to develop a quantum loop model that explains why such distortions occur. The loops represent covalent bonds between metal atoms on a triangular lattice. Loops can be formed in a large number of ways, leading to a resonating valence bond picture. In our model, valence electrons in a given transition metal atom never reside in the same orbitals, which leads to a local bending constraint. We first focus on systems in which two electrons (d2 systems) are shared from each metal atom to nearest neighbors, and then extend to three electrons (d3 systems). We construct an effective minimal quantum Hamiltonian that comprises a potential energy term, which is due to the proximity of covalent bonds, and a kinetic energy term, which is due to simple fluctuations of the locations of bonds. We then construct phase diagrams of the ground state of the Hamiltonian. The ground state in d2 systems has contributions from various loop geometries, but there are no simple fluctuations in d3 systems. The phase diagrams contain phases that resemble the 1T', the diamond-chain, and trimerization distortions of the 1T phase. We further propose that our model may be tested experimentally by doping the materials and observing the resulting structural phase.

Development of Novel Hybrid Bamboo/Timber Engineered Materials

Nima Jafarnia (Physics, MSc)

Abstract: Bamboo is a fast-growing giant grass, that can reach 250–300 mm in diameter, with promising mechanical properties and has the potential to become a conventional material in modern construction. Not only are the mechanical properties of bamboo superior to those of most softwood timber, but also, bamboo’s global use in the construction industry will also decrease the risk of deforestation due to excessive use of timber. Bamboo can be harvested every three years without damaging the rhizomes of the bamboo plant, that obviates the need for replantation. However, until now bamboo has only been used in traditional engineering buildings in developing countries. The natural cylindrical shape of bamboo made it an undesirable choice for modern building contractors. One of the main reasons the cylindrical shape of raw bamboo has become an obstacle to it becoming a mainstream construction material is the complexity of connections in raw bamboo construction. Bamboo composite structural elements, however, can be produced in combination with a proper matrix. In this project, two

separate objectives will be pursued. Firstly, unprecedented bamboo-based composites using a stay-in-place cast made of timber will be fabricated and put to the test as an advanced load-bearing structural element. The wooden stay-in-place casts will provide the opportunity to fabricate the bamboo-based structural elements with orthogonal cross-sections that can be more desirable for construction purposes. The majority of the cross-section will be filled with strong bamboo strips while the timber casts will provide a desirable shape for the cross-section of the bamboo composite elements.

Collective Excitonic Modes in Benzene, Acenes, and Cyclacenes
Parisa Rouzbazar (Physics, MSc)
Abstract: We investigate collective electronic excitations of benzene, acenes (polyacenes), and cyclacenes. The materials studied share a common structural motif—a hexagonal ring of carbon atoms, or the benzene ring. When benzene rings connect in a one-dimensional edge-sharing arrangement, they form acenes. By joining the ends of an acene, a belt-like molecule called cyclacene is formed. In all these materials, electrons are shared in a coordinated fashion with resonance in the ground state. To understand electron behaviors, we first neglect interactions and employ a tight-binding description. After finding the energy states of the system, we then incorporate electron-electron interactions using the Hubbard model. We study excitonic behaviors using the Random Phase Approximation (RPA), where we consider susceptibility towards various fluctuation patterns. Interactions create internal fields that give rise to magnetic patterns, which can be interpreted as excitonic states. A notable finding is that, at some frequencies, the spins in benzene, polyacenes, and cyclacenes oscillate in unison, leading to the formation of antiferromagnetic excitons. Additionally, for all these materials, as the Hubbard interaction coefficient (U) increases, the frequency required for excitonic modes decreases. In polyacenes, as the number of benzene rings increases, the size of the band gaps, binding energy, and frequencies also decrease.

Electrochemical Activity of Two-Dimensional Titanium Carbide MXenes Synthesized using Milder Etching Route
British Behura (Physics, PhD)
Abstract: Since the discovery of MXenes in 2011, these compounds have become one of the largest and most versatile families of two-dimensional (2D) materials. 2D Titanium Carbide (Ti3C2Tx) MXenes are considered an excellent candidate for energy conversion and storage devices, sensors, optoelectronics, electromagnetic interference shielding, and biomedicine due to their unique physical-chemical properties. However, the etching process of MXene from its MAX phase uses hydrofluoric (HF) acid or concentrated acids as an etchant, which is highly corrosive, toxic to the environment, and restricted in labs. Here, we show a milder non-HF hydrothermal etching route that is environment friendly and produces good quality delaminated and thin MXene flakes in a shorter period of time using a lower concentration of a milder acid. The morphological characterization of MXenes was performed by X-ray diffraction, scanning electron microscopy, and atomic force microscopy which shows effective etching, excellent flake quality, and 2D nanostructure of Ti3C2-Tx MXenes. The electrochemical performance of Ti3C2-Tx/NF (Tx = F-, Cl-) for electrocatalytic water splitting is studied using a three-electrode setup in an alkaline medium. We have observed that even though 2D Ti3C2-

Tx MXenes have some desired properties, such as metallic-level electronic conductivity, rich surface chemistry, oxidation resistance, and durability, the electrocatalytic activity for alkaline water splitting is lower than the standards. So, we are working on improving the electrochemical performance of the alkaline water splitting reaction by inducing defects in the MXene flakes and hetero atom doping.

Ecology (PLZ409)

Sentinel Behaviour in Mammalian and Avian Species

Alex Popescu (Biological Sciences, MSc completed)

Abstract: Sentinel behaviour is a form of coordinated vigilance where individuals take turns ensuring constant vigilance over the group from exposed prominent positions. Foragers benefit from this behaviour by maximizing their foraging efficiency while maintaining vigilance for threats, seemingly at the expense of the sentinel. Initially thought to be an altruistic behaviour, recent studies have supported a selfish, state-dependent model for sentinel decision-making where individual energetic states and perceived risk play key roles. Studies across multiple taxa have revealed several intrinsic and extrinsic factors that can affect sentinel behaviour. The objective of our scoping review was to identify and compile these factors in mammal and avian species. We show that individual energetic states and perceived risk could be behind the effects of intrinsic and extrinsic factors, further supporting the selfish state-dependent model for sentinel behaviour. Our findings also show how these factors can interact and highlight the complex relationship between individual motivators and the environment. Understanding these relationships can help us better understand the underlying mechanisms behind social behavioural decision-making and predict how social behaviours could change in different environments. This is especially important in the ever-urbanizing world, where the effects of human-altered habitats can greatly affect a species' success.

Prenatal Alcohol Exposure Alters Social Motivation in Early Adolescent Male and Female Sprague Dawley Rats

Andrew Sheehan (Psychology, Neuroscience, MSc)

Abstract: Prenatal alcohol exposure (PAE) has detrimental consequences on cognitive, physiological, and social development. The crucial period of adolescence, characterized by several behavioural changes such as increased exploration, risk taking, and social interaction is a unique developmental stage that may exacerbate deficits in social behaviour observed following PAE. The current research investigated the extent to which PAE disrupts social behaviour, specifically social reward behaviour, using between subject operant conditioning considering sex and stages of development. PAE and control Sprague Dawley rats were tested using a social reward task that allowed for choice between a social, non-social, and neutral center port at different stages throughout adolescent development; postnatal day (P)30 (early adolescence), P40 (mid-adolescence), P50 (late adolescence), and P70 (early adulthood). All age groups show a clear social preference among both groups, however, compared to controls, male PAE rats display greater social preference at P30, P40, and P70 during training on

a fixed ratio. On a progressive ratio test at P30, PAE males poke less at the non-social side compared to controls, and at P40, PAE females and males spend more time on the social side than the non-social side. Across all ages, PAE females poked more than controls at the neutral center port during training, progressive ratio and extinction testing. PAE females show an increase in social nose-pokes in early adulthood during the progressive ratio test and the first extinction day. During extinction testing where control rats switch to preferring the non-social side, male PAE rats, at all ages, show less of a non-social preference continuing to poke more on the previously social side. Importantly, PAE males at P30 display a resistance to extinction on the first extinction day, where they continue to prefer the previously social side. These results suggest PAE differentially affects social motivation development, potentially having a greater effect in males. Further analysis will be conducted to observe potential dopamine receptor expression differences across several brain regions associated with reward behaviour.

Ups and Downs of Living Underground: Behavioural Responses to Overwintering Emergence in the Spotted Salamander

Danilo Giacometti (Biological Sciences, PhD)

Abstract: To decide whether to remain underground or to emerge from overwintering, fossorial ectotherms simultaneously process environmental, gravitational, and circannual migratory cues. Here, we provide an experimental framework to study the behaviour of fossorial ectotherms during soil temperature inversion—a phenomenon that marks the transition between winter and spring in the temperate zone—in light of three non-mutually exclusive hypotheses (i.e., thermoregulatory, negative geotaxis, and migration restlessness). Using a vertical thermal gradient mimicking a burrow, we evaluated how temperature selection (Tsel), activity, and vertical position selection differed under simulated soil temperature inversion (contrasting the active vs. overwintering thermal gradients) in the Spotted Salamander (*Ambystoma maculatum*). Salamanders had different Tsel and activity levels between gradients, but selected similar heights regardless of thermal gradient orientation. Our results suggest that negative geotaxis may explain responses to changes in vertical thermal gradient orientation, with a possible role for migratory restlessness contributing to differences in activity levels. Our work provides behavioural information in an ecologically relevant context, and will benefit those who aim to better understand the biology of fossorial ectotherms.

Monitoring the Impact of Winter Cover Crops on Soil Nematode Communities using Metabarcoding Approach

Jerry Akanwari (Biological Sciences, PhD)

Abstract: The integration of winter cover crops (WCCs) in corn-soybean production is expected to continue expanding across Ontario due numerous benefits. Nematodes, a crucial component of the soil microbiome, are influenced by WCCs, which can have varying impacts on both plant-parasitic and beneficial free-living nematodes (BFLN). Therefore, there is the need to access the impact of WCCs in corn-soybean rotations in Ontario. We conducted a two year study within the framework of Ontario Living lab project on long term agricultural sites that have integrated WCCs in soybean – corn

rotation. The goal of this research were to: (i) investigate the impact of WCCs on plant feeding nematodes and BFLN, and (ii) use BFLN to estimate the soil health conditions of WCCs. The study had four treatment: Fallow (no WCC); Winter rye, Mixture of winter rye and barley, and Mixture of winter rye and Oat. The study shows that mixture of cover crops had significantly higher nematode richness compared to winter fallow, with these systems dominated by diverse omnivores and predators (structure index >50%). Also, mixture of WCCs increased the abundance of plant feeding nematodes (>70%) relative to winter fallow. We also observed variable effect of each treatment on individual nematodes communities. The soil health conditions of winter fallow was between disturbed and depleted whereas the mixture of WCCs were between maturing and fertile, an indication of healthy soils. Our study provides insights on the variable effect of WCCs on nematode communities and that, the choice of a WCC as single or mixture has the potential to improve soil health conditions, suppress plant parasitic nematodes and promote free-living nematodes.

Housing History Matters: Preferences for Naturalistic or Standard Enclosures are Influenced by Experience in Bearded Dragons (*Pogona vitticeps*)
Melanie Denomme Stauder (Biological Sciences, PhD)
Abstract: To evaluate if animals value the enrichments provided to them, one may assess their behaviour when they are able to either interact with or ignore those enrichments. However, preferences for enrichment can be influenced by an animal's previous experiences; for example, animals may ignore enrichments unless the enrichment is familiar. In snakes, enclosures which mimic the animal's natural habitat are often preferred. In turtles, such preferences are observed even when turtles had never experienced naturalistic environments before. We assessed the preferences of bearded dragon lizards (*Pogona vitticeps*) for either naturalistic (NT) or standard (SD) style enclosures by recording the amount of time spent in each style when both were freely available. To consider the effects of experience with enclosure styles, preferences were assessed twice, once after lizards had been housed in either style for 200 days. Surprisingly, we found that the initial enclosure style significantly influenced preferences; lizards initially housed in SD enclosures preferred the style which matched the style of their home cages, but this was not the case for lizards initially housed in NT enclosures.

Behaviour & Neuroscience (PLZ410)

Sex-Specific Effects of Adolescent Stress on Social Reward Motivation
Amanda Leonetti (Biological Sciences, PhD)
Abstract: Adolescence is an important time of social learning such that experiences in adolescence can shape adult social behaviour. Here, we investigate the effect of adolescent social instability stress (SS; daily 1 hr isolation and pairing with a new cage partner from post-natal day 30-45) on social reward motivation using an operant chamber in which nose-pokes at one gate provided 5 sec of access to a novel peer (social reward) and nose-pokes at the other gate did not. Rats were tested either immediately after the SS procedure or several weeks later in adulthood. In the

progressive ratio test (with number of nose-pokes required increasing by increments of 5), SS female rats made fewer social gate openings than did controls (CTL; pair-housed and undisturbed until behavioural testing) when tested as adults and did not differ in adolescence, whereas SS and CTL males did not differ at either age. Only adult SS female rats did not show a preference for opening the social gate relative to the non-social gate, suggesting that SS reduces social reward motivation in female rats long-after stress exposure. Among CTL rats, females showed a higher preference for opening the social gate than males at both ages, indicating that female rats show greater motivation for the social reward. In an extinction test in which neither gate provided access to a peer, adolescent and adult female rats (CTL and SS) made more (previously) social gate openings than did males on both days of extinction, whereas male rats showed a higher preference for the non-social gate by the second day of extinction at both ages, suggesting that female rats are resistant to reward extinction. These findings provide evidence of sex differences in social reward motivation and extinction and indicate that adolescent social instability stress alters social reward motivation in a sex-specific manner.

Exploring Sex and Age Differences in Aperiodic EEG Activity Among Children with ADHD

Sambavi Arulnandhy (Mathematics and Statistics, MSc)

Abstract: Attention-Deficit/Hyperactivity Disorder (ADHD) is a common neurodevelopmental condition in children, yet its neurophysiological causes remain incompletely understood, especially in girls who are often underdiagnosed and exhibit fewer behavioral issues in school. This study aims to fill this gap in the literature by comparing electroencephalogram (EEG) signals among boys and girls with and without ADHD. EEG signal, which is used to study brain activity, consists of periodic activity, involving rhythmic oscillations, and aperiodic activity, traditionally considered as noise. Recent studies have revealed that the aperiodic slope of the EEG signal flattens more with age in boys with ADHD, while less is known about this effect in girls. To address this, the study explores developmental differences in the aperiodic slope of resting-state EEG in girls with ADHD, compared to boys with ADHD and typically developing children. Using data from 1438 children ages 5-18 years from the Healthy Brain Network, EEG signals will be analyzed using Specparam algorithm to decompose the power spectral densities and extract aperiodic slopes. Significant differences in the aperiodic slope between boys and girls with ADHD are predicted, and a potential three-way interaction between age, biological sex, and ADHD diagnosis will be examined. The study also considers covariates such as parental education, medication status, and intellectual functioning. Conducted as a Registered Report, the initial research involves a two-stage peer review process. Stage 1 evaluates the study protocol, including research question/s, methods, and pilot data, with no primary analysis before “Acceptance In Principle”. The final manuscript is reviewed based on adherence to the approval protocol and the validity of conclusions, minimizing publications bias and emplacing methodological accuracy. The findings, whether positive or negative, will contribute to the literature, specifically addressing the gap in understanding ADHD in girls. Additionally, the results may guide more tailored approaches to ADHD diagnosis and treatment.

Impact of Prenatal Alcohol Exposure on Cognitive and Immune Signaling in Aging Male and Female Rats: A Longitudinal Study

Sunny Qureshi (Psychology, PhD)

Abstract: Prenatal alcohol exposure (PAE) can lead to long-lasting detrimental effects on the developing brain, resulting in cognitive deficits and alterations in immune function. However, the progression of these deficits with aging and their relationship to sex-specific changes remains understudied. To explore this, we utilized a PAE rat model to examine the relationship between immune function, cognitive performance, and sex differences in aging animals. Pregnant rats were randomly assigned to either an ad libitum PAE (liquid ethanol diet) or control (pelleted diet) group throughout gestation. Their offspring were tested on the Barnes Maze and Novel Object Recognition (NOR) tasks at 6 (6M) and 12 months (12M) of age. Blood was collected for circulating cytokine measurement and brains were collected for immunofluorescence of microglia (Iba-1). NOR analysis revealed that by 6M, PAE females exhibited recognition memory deficits which continued into 12M of age. However, PAE males only displayed these deficits at 12M of age. Barnes maze analysis showed no differences in spatial learning and memory, however, age-related improvements were observed with repeated testing. Cytokine data showed that PAE males had lower levels of IL-4 at both ages, while PAE females exhibited reduced IL-4 levels only at 12 months. Additionally, at 12M, PAE females displayed significantly lower levels of IL-10, IL-13, and IFN-γ compared to controls, suggesting sex-specific alterations in immune signaling. Furthermore, microglia analysis revealed an increased number of microglia in the hippocampus only in PAE females at 12M of age, indicating potential sex-dependent neuroinflammatory mechanisms contributing to cognitive decline.

Exploring Risk-Taking and Health in Adolescent Immigrants to Canada: A Unique Focus on "The Healthy Immigrant Effect"

Youssef Nassar (Applied Health Sciences, MSc)

Abstract: The healthy immigrant effect is when an immigrant comes to Canada healthy, and over time their health worsens because of different social and environmental influences. Risky behaviours such as smoking, drinking and drug use are important factors that could affect the health of young people. This study explores how such risky behaviours impact the health of teen immigrants in Canada. It looks at patterns across different generations of immigrants. We want to understand how taking risks affects the health of immigrant teens and see if there are differences across generations, comparing those born outside Canada, with those whose families have been here awhile. Adolescence is a critical stage of life, and health differences often emerge during this time period. Our goals are to figure out how taking risks affects the health of immigrant teens. We specifically want to understand the relationship between generation status and taking risks, and whether differences in risk account for something called the "health immigrant effect". We predict that there will be a pattern of increased taking risks and poorer health from 1st to 3rd generation immigrant teens. We will base the analysis on a 2022 national survey involving some 25,000 young Canadians. The analysis will provide critical findings on the health and well-being of teenagers in Canada, and it will provide new evidence to improve their health by guiding public health policy and prevention plans.

Human Physiology (PLZ411)

Ganglionic Blockade Modulates Sympathetic Neural Discharge and Neurocirculatory Regulation in Humans

Cameron Lynn (Biological Sciences, Neuroscience, MSc)

Abstract: his study investigated the impact of integrated muscle sympathetic nerve activity (MSNA) discharge patterns on human neurocirculatory regulation. In 24 healthy females (43 ± 16 years), the transduction of integrated MSNA (peroneal microneurography) into mean arterial pressure (MAP; arterial catheter) was studied during an intravenous infusion of a nicotinic ganglionic antagonist (trimethaphan camsylate, 1-7 mg/min). Neurovascular transduction (signal averaging) was studied based on the overall response, burst sequence (singlet, doublet, and triplet+), and burst amplitude (binned into tertials: small, medium, and large bursts). Data (mean ± SD) are reported for a 10-minute baseline (BSL), the one-minute period at the midpoint of the trimethaphan infusion with integrated MSNA bursts (TM-Mid), and the last minute of trimethaphan infusion with integrated MSNA bursts (TM-Last). During BSL, the MAP transduction responses were greatest for triplets+ (singlets: 0.2 ± 0.5mmHg, doublets: 1.3 ± 0.5mmHg, triplet+: 2.0 ± 0.8 mmHg; $P < 0.01$) and large bursts (small:0.8±1.0mmHg, medium: 1.3 ± 1.0 mmHg, large: 2.0 ± 1.2mmHg; $P < 0.01$). Young females exhibited greater transduction responses to all burst patterns and amplitudes than postmenopausal females ($P < 0.01$). Trimethaphan infusion reduced integrated MSNA burst frequency resulting in a greater proportion of singlets (BSL: 31 ± 23%, TM-Mid: 70 ± 29%, TM-Last:94 ± 19%; $P < 0.01$), a lower proportion of doublets, and a lower proportion of triplets+ (BSL: 45 ± 30%, TM-Mid: 10 ± 20%, TM-Last: 0 ± 0 %; $P < 0.01$). Trimethaphan infusion reduced integrated MSNA burst amplitude resulting in a greater proportion of small bursts (BSL: 41 ± 9%, TM-Mid: 32 ± 10%, TM-Last: 26 ± 7%; $P < 0.01$), a lower proportion of medium bursts, and a lower proportion of large bursts (BSL: 33 ± 1%,TM-Mid: 13 ± 23%, TM-Last: 2 ± 6%; $P < 0.01$). Trimethaphan-mediated changes in MSNA burst frequency and amplitude were associated with reduced overall MAP transduction responses (BSL: 1.6 ± 0.5mmHg, TM-Mid: 0.5 ± 0.2 mmHg, TM-Last: 0.3 ± 0.3 mmHg; $P < 0.01$). Linear regression analyses demonstrated that the trimethaphan-mediated reduction in the normalized burst amplitude ($\beta = 0.03 \pm 0.009$mmHg/%, $R2 = 0.15$, $P < 0.01$) more strongly affected sympathetic neurovascular transduction than reductions in the integrated burst frequency ($\beta = -0.009 \pm 0.009$ mmHg/%, $R2 = 0.01$, $P = 0.33$). These findings suggest that time-varying MSNA discharge patterns, particularly variations in burst amplitude, support human neurocirculatory regulation. This work was supported by the National Institutes of Health and the Natural Sciences and Engineering Research Council of Canada.

Validity of a Mobile Phone Application for the Assessment of Heat Stress in People Who Exercise

Georgia Charachousou (Applied Health Sciences, MA)

Abstract: Exposure to high temperatures has a significant health impact on people who exercise. In this study, we examined the validity of a mobile phone application

developed at the FAME Lab, an environmental physiology laboratory, to assess heat stress in people who exercise. In the first phase of the study, we tested the app's validity by taking measurements at 383 locations in Greece, comparing the wet bulb and black bulb temperature (WBGT) of the app (WBGTapp) with that of a portable weather station, known as Kestrel (WBGTKestrel). In the second phase of the study, we evaluated the validity of the Kestrel values by comparing the black-bulb (Tglobe), wet-bulb (Twb), air (Tair) and WBGT temperature values with those of the standard WBGT-heat-stress-monitor (WBGThsm). For all comparisons, a non-parametric T-test for dependent samples and Cohen's effect size analysis was performed. In the first phase of the study, a statistically significant difference ($p<0.01$) with a small effect size ($d=0.33$) was observed between WBGTapp (25.9±3.4°C) and WBGTKestrel (23.6±9.1°C). In the second phase of the study no statistically significant difference was observed between the two instruments in the parameters Tglobe (Kestrel:30.0±4.1°C, WBGThsm:30.0±4.2°C), Twb (Kestrel:19.9±1.8°C, WBGThsm:20.0±1.6°C), Tair (Kestrel:29.7±3.7°C, WBGThsm:29.6±3.7°C) ($p>0.05$). However, a statistically significant difference ($p<0.05$), with insignificant effect size ($d=0.19$), was observed between the two instruments on the parameter WBGT (Kestrel:23.5±2.5°C, WBGThsm:23.1±2.3°C). The values of WBGTapp and WBGTKestrel present deviation, but this seems to have a limited effect. Also, the Kestrel instrument provides an accurate measurement of the meteorological measurements. More research is needed to reduce the values deviation between the application and Kestrel.

The Role of Neural and Vascular α2-adrenergic Mechanisms in the Sympathetic Baroreflex Control of Blood Pressure

Julia Spafford (Applied Health Sciences, MA)

Abstract: This study tested the hypothesis that α2-adrenergic mechanisms contribute to sympathetic baroreflex regulation of blood pressure in humans. R-R interval (ECG), blood pressure (brachial arterial catheter), and muscle sympathetic nerve activity (MSNA; peroneal microneurography) were measured. Sympathetic action potentials (APs) were extracted from the filtered MSNA neurogram (continuous wavelet transform) in eight participants (5 females; 28±7 years) during a 5-minute baseline (BSL) and a dexmedetomidine (DEX) infusion consisting of a loading dose (10 minutes at 0.225µg/kg/hr) and maintenance dose (~0.1µg/kg/hr). Sympathetic AP baroreflex threshold gain was measured as the slope of the linear relationship between spontaneous AP discharge probability and diastolic blood pressure (DBP). Sympathetic neurovascular transduction was measured using a signal averaging approach to quantify the changes in DBP after integrated MSNA bursting and non-bursting segments. Mixed-effects analyses and post-hoc t-tests were performed. Data are reported as mean ± SD. DEX reset the baroreflex operating point for medium-sized APs to lower firing probabilities (i.e., cluster 4; BSL:20±7, DEX:6±5%; both $P<0.01$), to lower DBP (BSL:72±9, DEX:65±8mmHg; $p<0.01$), and reduced gain (i.e., AP cluster 4; BSL:-6.5±2.0, DEX:-1.9±1.6%/mmHg; $p<0.01$). DEX did not affect the firing probability or baroreflex gain of small-sized (i.e., AP cluster 1; BSL:-1.9±1.1, DEX:-1.6±1.6%/mmHg; $p=0.66$) and large-sized AP clusters (i.e., cluster 9; BSL:-0.8±0.4, DEX:-0.3±0.0%/mmHg; $p=0.42$). DEX reset the baroreflex operating point for AP cluster recruitment downwards to fewer AP clusters per burst (BSL:3.4±0.7, DEX:2.8±0.8

clusters/burst; p<0.01) but did not change gain (BSL:-0.02±0.05, DEX:-0.05±0.11%/mmHg; p=0.51). DEX reduced the DBP transduction response to integrated MSNA bursts (BSL:4.49±3.14, DEX:4.30±2.24mmHg; p=0.02) and increased time-to-peak transduction (BSL:6±1, DEX:10±3 cardiac cycles; p<0.01). DEX reduced the DBP transduction response to non-bursting MSNA segments (BSL:-0.68±0.35, DEX:-0.25±0.28mmHg; p<0.01). These data suggest that central α2-adrenergic mechanisms contribute to baroreflex regulation over sympathetic AP discharge and recruitment and these features are important for vasomotor regulation of blood pressure.

Investigating the Contribution of Forearm Vascular Compliance and Viscoelasticity During Exercise-Induced Hyperemia

Shamae Quinquito

Abstract: The regulation of blood flow to active skeletal muscle during physical exercise involves a complex interaction of circulatory mechanisms to satisfy oxygen and metabolic demands. Given the pulsatile nature of blood flow, it is primarily controlled by both (i) vascular resistance, which is largely influenced by the degree of vasodilation; and (ii) vascular compliance and viscoelasticity, which is influenced by the elasticity of the blood vessels. However, our current understanding of how changes in vascular compliance and viscoelasticity, which are critical to continuous skeletal muscle blood flow, contribute to blood flow responses during rhythmic exercise is limited. Thus, this study will test the hypothesis that vascular compliance and viscoelasticity will increase to facilitate blood flow to the active skeletal muscle during rhythmic exercise. To test this, heart rate (ECG), brachial artery blood flow velocity in the exercising arm (Doppler Ultrasound) and blood pressure (finger photoplethysmography) were continuously collected. Participants performed 5 minutes of baseline rest period followed by a 5-minute rhythmic handgrip (RHG) protocol and a recovery period (5 min) in supine position. The RHG protocol involved a 33% duty cycle of 1s/2s contraction/release schedule at 40% of participant's maximum voluntary contraction (MVC) performed at heart level. The beat-to-beat blood pressure and blood flow waveforms were analyzed using a four-element modified Windkessel model (Matlab) which quantifies vascular compliance, viscoelasticity, and vascular resistance per 1 cardiac cycle. Results suggest that vascular compliance and viscoelasticity increases with rhythmic handgrip exercise at 40% MVC to increase blood flow in the brachial artery of the forearm. In conclusion, this study will provide new insights regarding the contribution of vascular compliance and viscoelasticity in governing blood flow during physical exercise in humans.

Oral Presentation Session 2 (11:00 AM–12:00 PM)

Mathematics (PLZ408)

Identifiability of The Linear Threshold Model

Anuththara Lekamalage (Mathematics and Statistics, MSc)

Abstract: In the linear threshold model, each individual has a time-invariant threshold and initial action A or B. At each time step one or more individuals become active to revise their action depending on their own threshold and the population proportion of others taking one action. The resulting decision-making dynamics can be predicted and controlled, provided that the thresholds of individuals are known. In practice, however, the thresholds are unknown and often only the evolution of the total number of individuals who have chosen one action is known. The question then is whether the thresholds are identifiable given this quantity over time. We investigate the threshold identifiability of the linear threshold decision-making dynamics for synchronous and asynchronous updating and find necessary and sufficient conditions. The results open the door for reliable estimation of the thresholds and in turn prediction and control of the decision-making dynamics using real data.

A Search for Integrable Evolution Equations with Lax Pairs Over the Octonions

Hin Ho (Philic) LAM (Mathematics and Statistics, MSc)

Abstract: Lax pairs play a vital role in the integrability theory of evolution equations because they are used for the inverse scattering transformation to generate multi-soliton solutions. As an extension of integrable real evolution equations and their known Lax pair, this report focuses on the search for octonion evolution equations $u_t = F(u,u_x,u_{xx},u_{xxx})$ of KdV type and mKdV type that have a Lax pair, where $u(t,x)$ is an octonion variable. A Lax pair is defined as $L_t \psi = M(L \psi) - L(M \psi)$ with linear differential operators L and M whose coefficients depend on u and x-derivatives of u, where $\psi(t,x)$ is an auxiliary octonion function. These operators act on ψ by producing a linear polynomial in ψ and x-derivatives of ψ such that each term is a product involving u, u_x, $\ldots$, and (x-derivatives of) ψ in a given order. It is assumed that the evolution equation $u_t = F(u,u_x,u_{xx},u_{xxx})$ as well as both $L\psi$ and $M\psi$ are homogeneous under a scaling of t,x,u which is either the scaling associated to the KdV equation or the mKdV equation. This leads to an overdetermined system of algebraic equations for the (real-valued) coefficients of u and $x-$derivatives of u in F, $L\psi$ and $M\psi$. The formulation of the overdetermined system involves two important differences compared to the case of a real variable u. Firstly, since octonions are non-associative and non-commutative, F, $L\psi$ and $M\psi$ contain many more terms, with different orderings of products. In particular, ψ (and its x-derivatives) are allowed to appear on the left, in the middle, or on the right. Secondly, products of octonions obey certain algebraic identities, whereby terms that are equivalent modulo these identities must be eliminated. To solve the overdetermined system, Maple is used to do the splittings, and depending on the complexity of the system, 'rifsimp' in Maple or a package called 'Crack' in Reduce are used to solve it. As a main result, a single KdV octonion equation, three mKdV octonion

equations, and also a single potential-KdV octonion equation, each of which has more than one Lax pair, are obtained.

Optimal Design for Accelerated Life Tests with Progressive Stress Loading under Exponential Lifetime Distribution
Yujia Luo (Mathematics and Statistics, MSc)
Abstract: In life testing experiments, it is often challenging to collect lifetime data on highly reliable products with long lifespans, as very few observed failures may occur within a reasonable experimental time under normal use conditions. Accelerated Life Testing (ALT) can shorten the testing time by subjecting products to higher-than-normal stress conditions to obtain sufficient failure data. Censoring is another approach to reduce the experiment time. This paper addresses both ALT and censoring. One commonly used method to increase stress is the progressive stress loading scheme, which allows test units to undergo continuously increasing levels of stress. This paper presents optimal designs for ALT experiments under a progressive stress loading scheme, assuming the lifetime of the test units follows an exponential distribution. We discuss the methods to maximize test efficiency by optimizing the progressive stress loading rate according to various optimality criteria, including D-optimality, A-optimality, and a modified c-optimality. To illustrate our method, we present an example demonstrating three different censoring schemes, each with optimal choices of stress loading rate. Compared to the stress loading rates used in the literature, our optimal choices yield average efficiency gain of 41%, 66.2%, and 70.2% under D-, A-, and modified c-optimality, respectively. Additionally, we examine the impact of the planned failure proportion on optimal designs, suggesting that a failure proportion of around 60% can achieve the best experimental performance.

Cell Biology & Genetics (PLZ409)

Designing Simulated Cytoplasmic Fluids
Mariam El-Morched (Biotechnology, Chemistry, PhD)
Abstract: Cytoplasmic fluid was extracted from *E*. *coli* DE3 cells and studied on the basis of their viscosity, diffusion coefficient and their T2 relaxations times of water. It was concluded that a mixture of 7.5% (w/v) sucrose and 19% (w/v) PEG 10,000 closely mimicked the cytoplasmic fluid.

Insights into *Pantoea agglomerans* Genomic Diversity: Understanding the Drivers of Antimicrobial Resistance and Virulence Gene Acquisition
Muhammad Sulman (Biotechnology, MSc)
Abstract: *Pantoea agglomerans* is a versatile bacterium involved in plant infection pathogenesis, biocontrol, and industrial applications. Its functional diversity is largely due to its genetic adaptability, allowing it to acquire and lose genes that confer specific traits. This study explores the genetic mechanisms underlying the acquisition of antimicrobial resistance (AMR) and virulence genes within regions of genomic plasticity (RGPs), and their mechanisms of gene flow. We constructed the pangenome *P. agglomerans* using 165 strains. RGPs were found and classified as plasmidic, viral, or

both. RGPs were clustered by gene family content and phyloGLM modeling was used to trace origins and assess the impact of geographical factors. The study revealed that 83% of *P. agglomerans* proteins are highly conserved, while 17% of genes were variable, typically homologous to genes in *Pantoea* and *Erwinia* species. Only 25.4% of RGPs were plasmid-associated, with most being chromosomal. Clustering showed that no RGP group was exclusive to chromosomes, and nearly all RGPs contained significantly more viral genes ($p<0.05$). AMR genes were predominantly in chromosomes, while virulence genes were spread across both plasmids and chromosomes. AMR genes were typically not found within RGPs. Geographical factors did not significantly influence RGP distribution. Given that no RGP clusters were exclusive to plasmids or chromosomes indicates that gene flow between plasmid and chromosomal DNA is pervasive in *Pantoea agglomerans*. This may occur through phage insertion into both chromosomal and plasmidic DNA, as well as frequent recombination and transposition events. The observation that the Pantoea and Erwinia genera, which are phylogenetically closest to *P. agglomerans*, are the primary contributor to its genomic diversity suggests that horizontal gene transfer is most active between closely related species. The scarcity of AMR genes in plasmids and other RGPs suggests that AMR genes in *P. agglomerans* are likely inherited in a stable manner.

The Role of the Aldehyde Dehydrogenase Enzymes in Acetic Acid Production in Icewine

Nadine Ott-Peon (Biotechnology, MSc)

Abstract: Canada is known for Icewine which is fermented from grapes naturally frozen on the vine. Grapes are harvested below –8°C and pressed while frozen, trapping ice crystals inside the berries and releasing juice highly concentrated in sugars and acids. The high sugar juice environment (40°Brix) causes hyperosmotic stress for yeast, resulting in water loss, triggering glycerol production to act as an internal osmolyte to draw water back into the yeast cell, resulting in an NAD+ imbalance. Icewine has significantly higher acetic acid versus table wine, where acetic acid production may be used to reduce NAD+ to NADH via an NAD+-dependent aldehyde dehydrogenase (Aldp). Previous research identified the NAD+ redox imbalance during Icewine fermentation while gene expression patterns indicated a role of Ald3p encoded by ALD3 in elevating the acetic acid whereas in table wine, ALD6 expression dominated. The objective of this project is to remove each of the 5 ALD genes individually from the genome of a commercial wine yeast K1-V1116 using CRISPR-cas9 gene editing and then determine the roles of the aldehyde dehydrogenase proteins in acetic acid production in both Icewine and table wine using these commercial yeast deletion strains. All copies of ALD5 and ALD6 were successfully knocked out of K1-V1116. Ald6p was found responsible for the majority of acetic acid during table wine fermentation, but not all acetic acid. The ALD 6 and ALD 5 knockouts showed significant different in normalized acetic acid production in table wine, but only the ALD 6 knockout showed significant difference under Icewine conditions.

Baseline Oxygen Level Affects the Response of Prostate Cancer Cells to Hypoxia
Ricardo Alva (Biological Sciences, Research Assistant, MSc completed)
Abstract: The transcriptional response to hypoxia is largely regulated by the hypoxia-inducible factors (HIFs), which induce the expression of genes involved in glycolysis, angiogenesis, proliferation, and migration. While cell culture models have been invaluable tools to investigate biological phenomena at the cellular level, oxygen levels are not routinely regulated in standard cell culture practices. As such, cells are continuously exposed to 18–21% O2 during experimentation, which is hyperoxic compared with mammalian tissue microenvironments, where oxygen levels range from 2% to 9% O2 (physioxia). Thus, all in vitro hypoxia experiments in the literature have used near-atmospheric oxygen levels as the baseline for comparison with hypoxia. To determine how the baseline O2 level affects the subsequent response to hypoxia, we cultured PC-3 prostate cancer cells in either 18% or 5% O2 for 2 wk before exposing them to hypoxia (~1.1% O2) for 12–48 h. RNA sequencing revealed that the transcriptional response to hypoxia was highly dependent on the baseline O2 level. Cells grown in 18% O2 before hypoxia exposure showed an enhanced induction of HIF target genes, particularly genes involved in glucose metabolism, compared with cells grown in physioxia before hypoxia. Consistent with this, hypoxia significantly increased glucose consumption and metabolic activity only in cells previously cultured in 18% O2, but not in cells preadapted to 5% O2. Moreover, major HIF-mediated gene expression and metabolic activity were upregulated in cells grown in 5% O2 compared to 18% O2, suggesting that much of the cellular mechanisms associated with the response to hypoxia may be a consequence of adaptation to physioxia, which explains the seemingly mild response to hypoxia in cells previously grown in physioxia. We conclude that an inappropriately hyperoxic starting condition affects the transcriptional and metabolic responses of PC-3 cells to hypoxia, which may compromise experiments on cancer metabolism in vitro.

The Hidden Genetic Legacy of Neanderthals and Denisovans in Modern Humans Through the Lens of Mobile Elements
Sultan Mussakhan (Biological Sciences, PhD)
Abstract: The advent of next-generation DNA sequencing technologies, coupled with breakthroughs in working with ancient fossil DNA over the last few decades, has made it possible to sequence the whole genomes (WGS) of tens of thousands of present-day humans from diverse ethnic groups, along with hundreds to thousands of ancient genomes from modern and archaic human groups, including Neanderthals and Denisovans. The availability of such data has enabled us to start addressing long-standing questions regarding the relationship between archaic and modern humans. Among the many surprising findings from this research is the likely interbreeding between Neanderthals, Denisovans, and modern humans, which may have partially shaped the latter, contributing to local adaptations and survivability in various present-day human populations. These findings are intriguing and significantly advance our understanding of human evolution. Studies in this field have mainly utilized single nucleotide polymorphisms (SNPs) as genetic markers. Despite being the most abundant and easy-to-identify genetic markers, SNPs are identical-by-state (IBS) by nature, making them less ideal for analyzing certain complex questions, such as the fine

details of interbreeding and the later lineage-specific trajectories of modern humans. In this context, transposable elements (TEs), also known as mobile elements (MEs), are considered superior genetic markers to SNPs because they are identical-by-descent (IBD) and abundant in number. However, archaic and ancient WGS data are often highly degraded, with short, highly mutated single reads due to the high DNA degradation and modification level, limiting their use in ME polymorphism analysis with existing tools. To overcome these challenges, we developed a new SingleME tool to analyze archaic and ancient WGS datasets and identify ME polymorphisms. This tool was developed through a collaborative effort, reflecting the collective dedication of the scientific community to advancing our understanding of human evolution. Using SingleME, along with other tools, we have analyzed 48 Neanderthal genomes and 5 Denisovan genomes, along with approximately 900 representative modern human genomes from the 1KGP, HGDP, and SGDP projects. Using 40 WGS datasets from the Mbuti and Biaka groups, known to be non-admixed with Neanderthals and Denisovans, as a baseline, we identified a total of ~4,200 MEs (~3,750 Alus, ~370 L1s, and ~120 SVAs) as candidate introgressed MEs between modern humans and Neanderthals/Denisovans with high confidence. At the meeting, we will present detailed results from the analysis of these ME markers, addressing questions including the number of interbreeding events, their estimated timing, and new insights into the relationships between modern human populations.

Biochemistry (PLZ410)

Use of *Saccharomyces uvarum* CN1 to Mitigate Negative Effects of Botrytis and Sour Rot in White Wine

Daniel Phillipow (Bilogical Sciences, MSc)

Abstract: Sour rot and Botrytis infections pose significant challenges to grape growers and wineries, negatively impacting wine quality and thereby affecting industry financial sustainability. Infected fruit exhibits elevated concentrations of acetic acid, glycerol, acetaldehyde, and ethyl acetate, compounds known to unfavorably alter wine sensory characteristics. Wineries establish juice thresholds for the concentration of acetic acid as a measure of infection, which when surpassed, necessitates rejection of entire loads, resulting in financial losses and disrupted production schedules. A locally isolated yeast, *Saccharomyces uvarum* CN1, shows promise for grape growers and wineries in managing acetic acid. Previous research on red wine fermentations showed CN1 metabolized acetic acid while simultaneously increasing volatile aroma compounds (VOCs) compared to commercial *S. cerevisiae* strains. However, studies have not extended to aromatic white wine fermentations. In this study, fermentations utilizing Riesling grapes with various degrees of rot infection were conducted by inoculating must with either CN1 or commercial *S. cerevisiae* EC1118. Wines fermented using CN1 showed a significance decrease in acetic acid when compared with the values in juice. In comparing acetic acid in wines fermented between CN1 and EC1118, CN1 showed a 13-fold decrease in 0% rot infection, a 6-fold decrease in the 20%, and a 5-fold decrease in the 40% lowering the acetic acid in wine to only 0.05-0.02g/L. The ability of CN1 to ameliorate sour rot and Botrytis contamination in grape must holds promise for a

transformative opportunity for winemakers to produce quality wines from fruit previously deemed unusable.

Synthesis and Mechanistic Study of Substituted 1,2-bisphenylhydrazones: An Unintended Discovery

Disha Patel (Chemistry, PhD)

Abstract: This research investigates the synthesis of various substituted 1,2-bisphenylhydrazones. Initially, upon reacting a substituted phenylhydrazine with a keto amide to yield a hydrazone, an unexpected byproduct formed which we determined to be a 1,2-bisphenylhydrazone. We employed NMR spectroscopy to propose a mechanism of 1,2-bisphenylhydrazone formation from keto amides and phenylhydrazines. This study aims to optimize the synthetic procedure and determine the limitations of our method. We anticipate that this work will lead to a generalized synthesis of 1,2-bisphenylhydrazones.

Synthesis of Deuterated Nucleoside Derivatives for NMR and Mass Spectrometry Probes

Fiatan Binta Haque (Biotechnology, MSc)

Abstract: The objective of the project was to incorporate deuterium into the C-5 position of 2'-deoxycytidine (dC) for studying nucleic acid structures using the modified nucleoside as an NMR and mass spectrometry probe. Previously, fluorine was incorporated in C-5 position of dC to be used as an NMR probe for studying the B-Z DNA transition using 19F NMR spectroscopy. Since deuterium is an isotope of hydrogen and the bonding properties of carbon-hydrogen and carbon-deuterium are virtually identical, incorporating deuterium in nucleotides would be more suitable for studying hydrogen bonding properties of nucleobases involved in transition of B-Z DNA as it will have virtually no effect on the properties of hydrogen bonding of the surrounding atoms in the nucleotide unlike fluorine which is highly electronegative. Results of experiments carried out showed deuteration took place in the C-5 position of 5-Iodo-2'deoxycytidine using Pd(PPh3)4 in MeOD4 and D2O, further experiments with another palladium catalyst, Pd(DBA)2 gave results of deuteration in C-5 and C-6 position of deoxycytidine and the scope of these experiments on other pyrimidine based nucleosides is also being investigated.

Synthesis of Cyclic Azobenzene Bisammonium with Photo Switching Capabilities for Spatiotemporal Control of DNA and Cell Membranes

Stephanie Bedard (Biotechnology, Chemistry, MSc)

Abstract: Over the past few decades, cationic compounds called polyamines have been found to play a role in the natural condensation of DNA via non-covalent interactions. In more recent years, azobenzene derivatives, particularly cyclic, have been looked at with special interest for their ability to isomerize to the lesser thermodynamically stable trans isomeric state under specific visible light causing a conformational change. It had been hypothesized correctly by utilizing a cyclic azobenzene as a photo switch under specific light conditions that these conformational changes, when associated to an oligonucleotide either by covalent or non-covalent interactions, could influence the condensation or stability of the DNA duplex. This type

of control has also been seen in other biomolecules such as cell membranes. The spatiotemporal control of nucleic acids and cell membranes is of particular interest due to their invaluable roles in the biology of living things. This study aims to synthesize a polyamine-like azobenzene photo switch that uses its cationic ammonium termini to non-covalently interact with the backbone of DNA within the major or minor groove. The isomerization of the switch to the trans-form should destabilize the complex as the switch would now intercalate between the two backbone strands, allowing spatiotemporal control of the oligonucleotide via its condensation state. The same switch potentially derivatized can have applications in other biomolecules such as artificial cell membranes. The synthetic steps include beginning with commercial dinitrodibenzyl and subjecting it to reduction, bromination, oxidative cyclization, amination, condensation, and finally methylation. The specific wavelengths in which this compound isomerizes as well as the influence the switch has on the condensation state of the DNA duplex in both the trans- and cis- isomeric conformation can be characterized by devices such as NMR, UV/VIS spectrophotometry and circular dichroism.

Transcriptomic Evidence of Melatonin Agonism for Human 5-HT2A Receptor in HEK293 Cells

Wantao (Noah) Xiao (Biotechnology, PhD)

Abstract: The 5HT2A receptor, a key serotonin receptor, plays an essential role in various physiological processes, including mood regulation, cognition, and the modulation of sleep-wake cycles. While traditionally associated with serotonin as its primary ligand, emerging evidence suggests that melatonin, a hormone best known for its role in regulating circadian rhythms, may also interact with the 5HT2A receptor. This study explores the potential agonistic effects of melatonin on the 5HT2A receptor using a transgenic HEK293 cell line expressing human 5HT2A receptors. In this study, we utilized RNA sequencing to investigate transcriptomic changes in HEK293 cells treated with melatonin, comparing these results to various drug controls. Preliminary results from differential gene expression analysis indicate that melatonin treatment leads to significant upregulation of specific genes, similarly to serotonin treated counterparts, supporting the hypothesis of melatonin’s agonistic role at the 5HT2A receptor. We further validated these findings through quantitative PCR and performed pathway analysis to identify key biological processes influenced by melatonin-5HT2A interaction. Our study not only broadens the understanding of melatonin’s pharmacological profile but also provides insights into the complex signaling landscape of the 5HT2A receptor, particularly in relation to its role in circadian biology. These findings hold potential implications for therapeutic approaches targeting the 5HT2A receptor, particularly in disorders involving sleep, mood, and circadian rhythm disruptions. Future work will aim to further characterize the downstream signaling pathways activated by melatonin and explore its role in neuropsychiatric and sleep-related disorders.

Physics (PLZ411)

Nucleation of Wormholes and Topology Changes in Lorentzian Geometry

Alessandro Pisana (Physics, PhD)

Abstract: The possibility that the topology of space can change even at a classical level in General Relativity necessitates abandoning either the causality conditions or the equivalence principle. If the causal structure is regarded as fundamental, topology changes are possible by allowing singularities, degenerate tetrads, or gravitational instantons, i.e., Riemannian solutions of the Einstein equations with interesting geometrical and topological properties. Conversely, if the equivalence principle is considered fundamental, spacetime is described by an everywhere non-degenerate Lorentzian geometry, requiring the existence of closed time-like curves for topology transitions to occur. Specifically, the formation of a wormhole from a topologically trivial configuration of space is constrained in the Lorentzian case by topological invariants of the spacetime manifold, even allowing for causality violations. Such topological restrictions are kinematical, independent of the equations of motion, and arise only from global requirements on spacetime. In this session, these topological constraints are presented in the case where the transition occurs in a finite region of space and is mediated by a Lorentzian cobordism. Special emphasis will be given to the nucleation of a wormhole by 3-dimensional topological surgery and the maintenance of the Lorentzian structure by employing Misner's trick of taking connected sums with closed 4-manifolds.

mKdV Loop Travelling Waves and Interactions of Loop Solitons

Jaskaran Maan (Physics, MSc)

Abstract: The modified Korteweg-de Vries(mKdV) equation is an integrable nonlinear evolution equation which has applications in modeling various physical phenomena. It also describes the curvature of curve which undergoes a certain non-stretching geometrical evolution in the Euclidean plane. This curve motion finds applications in various areas, such as describing the dynamics of inelastic rope, modeling the evolution of the boundary of vortex patch(swirling region) in thin, sheet-like layer of incompressible fluid, and understanding the behavior of electrons quantized in thin-layered materials by studying the boundaries of electron cloud densities under strong electromagnetic fields. This study focuses on mKdV curve motions called loop solutions. One class arise from soliton, heavy-tail(rational), and periodic solutions of the mKdV equation. These loop solutions exhibit intriguing symmetrical shapes: the soliton and heavy-tail cases describe a single loop which is open, and asymptotically straight or circular, respectively; the periodic case describes both open and closed loops which can have multiple crossings. Additionally, a class of colliding loop solutions are obtained from the 2-soliton solution of the mKdV equation. The collisions show interesting interaction patterns. A summary of different types of patterns will be given by categorizing the various shapes that occur during the interaction, which depend on the speed ratio of the initial two loops. Analytical and numerical methods are employed to determine the loop solutions for both classes, as well as the conditions determining interaction type in the case of collision. These findings contribute to a deeper understanding of the mKdV equation and solitons.

GNN-based Handover Management in 5G Vehicular Networks

Nazanin Mehregan (Computer Science, MSc)

Abstract: The rapid evolution of 5G technology has significantly impacted vehicular networks, offering seamless connections characterized by high bandwidth, low latency, and improved data rates. This progress is essential for real-time operations in smart vehicles and cities, enhancing traffic safety and entertainment service quality. However, challenges persist within vehicular networks. The limited coverage range of 5G necessitates base station densification for reliable connectivity, while frequent handovers, known as the "ping-pong effect," disrupt network stability. Additionally, the susceptibility of 5G signals to obstructions and the inherent high mobility within vehicular settings exacerbate these issues, demanding proactive handover management methods. We need to minimize unnecessary handovers to prevent disruptions while simultaneously maintaining optimal levels of throughput and latency. Traditional models struggle to meet the multifaceted requirements of 5G networks, resulting in inefficiencies and compromised user experiences. To bridge this gap, we propose a novel approach called TH-GCN (Throughput-oriented Graph Convolutional Network), which integrates graph neural networks (GNNs) to optimize handover management in dense 5G vehicular networks. By constructing a dynamic graph with vehicles and towers as nodes with connections representing edges and incorporating features such as signal quality, vehicle mobility, throughput, and tower load, TH-GCN predicts optimal tower connections for handover decisions. In addition to optimizing handover frequency and reducing the "ping-pong effect," TH-GCN takes throughput as a key feature, ensuring that handover decisions not only minimize disruptions but also maximize data rates and improve network efficiency. By shifting from a purely user-centric to a combined user equipment and base station-centric approach, our method enhances the adaptability and effectiveness of handover decisions in real-time, ensuring improved network performance in high-density, high-mobility scenarios.

Poster Presentation Abstracts

Poster Session 1 (1:30 PM–2:30 PM)

Utilizing a Live CNS Organ Culture to Study Functional Retinoid Signaling

Alicia Piazza (Biological Sciences, Neuroscience, PhD)

Abstract: Retinoids (derivatives of Vitamin A) are essential in many developmental processes such as cell differentiation, patterning and neurite outgrowth, but also play a critical role in nerve regeneration and synaptic function in the adult brain. Both retinoid receptors, the retinoid X receptor (RXR) and the retinoic acid receptor (RAR) are considered nuclear hormone receptors and contain a conserved DNA-binding domain and a relatively conserved ligand-binding domain. Many invertebrates possess RXRs, but the presence of functional RARs is not well studied. Some invertebrates, such as molluscs, possess RARs, but there is insufficient evidence to support retinoid binding. Retinoid-binding capabilities of non-chordate, invertebrate RARs are currently limited to annelids and priapulid worms. We have pharmacological evidence that the molluscan RAR in *Lymnaea stagnalis* (LymRAR) is functional during development, nerve regeneration, axon guidance and memory formation and now seek to provide evidence that this LymRAR can indeed bind retinoids. We have designed and expressed ligand sensor constructs in live CNS of *Drosophila melanogaster* (which do not express RARs or RXRs endogenously). Using the transgenic *Drosophila* which we generated, we first show ligand-induced transcriptional activation by various retinoid isomers, using the LymRXR construct. We now also examine the capacity of LymRAR to initiate ligand-induced transcriptional activity in response to retinoids. These results will be the first to provide evidence of retinoid-binding capability of any molluscan RAR.

Comparing The Effects of Parental Experience on Cognition and Anxiety-Like Behaviour in Female and Male Degus

Anton Dinh (Psychology, MA)

Abstract: The experience of being a parent leads to various neural, physiological, and behavioural adaptations. In rats, motherhood experience is associated with improved spatial learning and memory after the pups are weaned, while research is equivocal on anxiety. In particular, the late postpartum is characterized by enhanced performance on tasks that rely on spatial, reference, and working memory. Work in fathers (in biparental rodents) is limited but suggests an enhanced spatial learning. To date, studies have focused on maternal experience in monoparental species and paternal experience in biparental species. The objective of the current study is to directly compare the effects of parental experience on behaviour and mechanisms in the brain of both sexes in the same rodent species, the degu. Degus provide biparental care allowing us to examine parental experience in both sexes as well as differences between the motherhood experience of a biparental pair and single motherhood when the male is removed. Adult degus were randomly assigned to one of three groups: (1) breeding pairs (biparental group), (2) breeding with male partner removal (single mother group) or (3) non-breeding animals (naïve group). After weaning the pups, all adult degus were subjected to behavioural tests to measure spatial learning and memory (Barnes maze) and anxiety-like behaviours (elevated plus maze). Preliminary results suggest that

experienced mothers have enhanced spatial learning compared to naïve females, while fathers display impaired spatial memory and reduced anxiety-like behaviour compared to naïve males. This study suggests that parental experience differentially affects spatial learning and memory and anxiety in females and males. Future work will examine potential neural mechanisms regulating these behaviours and further provide insights on how such an important life experience remodels the adult brain.

Examining Nerve Regeneration Using a Novel CNS Organ Culture

Autumn Lif (Biological Sciences, MSc)

Abstract: In the nervous system, regeneration is important for re-establishing diminished or lost neural connections, often following nerve injury. Although adult neurons of the mammalian central nervous system (CNS) are unable to regenerate, adult neurons from *Lymnaea stagnalis*, an invertebrate mollusc, display regeneration both in vivo and in vitro. Our previous studies investigating neurite outgrowth from the *Lymnaea* CNS have utilized the culture of identified neurons, however we have now developed a novel CNS organ culture that provides a simple, cheap, yet effective way to examine neurite outgrowth. This organ culture involves removing the CNS from the adult animal and the generation of a “floating brain” which demonstrates extensive outgrowth within 72 hrs. Our goals are to utilize this CNS organ culture to examine the effects of aging on neurite outgrowth across the lifespan of the animal. Our initial results have characterized the regenerative capacity of individual nerves emanating from the CNS, and we have determined the optimal age-range for regeneration, with regenerative capacity declining across age-groups. Our long-term goal is to examine the effects of neuromodulators (such as retinoids and endocannabinoids) on regenerative capacity in these differently aged animals and elucidate potential key factors integral to maintaining regenerative capacity in aging animals.

Two-Dimensional Titanium Carbide MXene for Lithium-Ion Conductive Solid-State Electrolytes

Hansima Keppetiyawa (Physics, MSc)

Abstract: Developing clean and sustainable energy conversion and storage devices using high-performance advanced materials is essential due to the urgent demand for energy and climate change. Solid-state electrolytes (SSEs) have appeared as promising materials for safe and efficient electrochemical energy storage devices. However, there are challenges such as low ionic conductivity and poor durability in SSEs that need to be addressed for the efficient performance of electrochemical devices, such as batteries, supercapacitors and fuel cells. Novel two-dimensional (2D) materials including transition metal carbides, nitrides, and carbonitrides (known as MXene), have gained attention due to their exceptional properties such as high surface area, abundant functional groups, high electrical conductivity, and hydrophilicity which are beneficial for the preparation of functional derivatives for electrochemical energy systems. In this work, we have synthesized and utilized 2D titanium carbide MXene (Ti3C2Tx) nanoflakes as a nanofiller to fabricate polymer composite SSEs, with a focus on improving ionic conductivity and thermal stability, while ensuring superior physical, chemical and electrochemical stability for safe operation in an electrochemical cell arrangement. The structural properties of the synthesized 2D nanoflakes are confirmed

using X-ray diffraction, scanning electron microscopy, Fourier transform infrared spectroscopy, atomic force microscopy, and Raman spectroscopy. The temperature variation of in-plane and through-plane ionic conductivities of the membranes are tested using electrochemical impedance spectroscopy. Additionally, the thermal stability and phase transitions are studied using differential scanning calorimetry.

Beyond the Signal: Using Digitally-Coded Radiotransmitter Frequency to Predict Temperature

Harry Kumbhani (Biological Sciences, MSc)

Abstract: Digitally-coded radiotransmitters allow for the simultaneous tracking of multiple animals but don't explicitly report temperature data. The precise frequency of individual pulses deviates from their nominal frequency, recorded as frequency offset. I hypothesized that frequency offset of digitally-coded transmitters is correlated with temperature and could be used to document temperatures in free-living animals. I first conducted calibration experiments exposing transmitters to controlled temperatures resulting in a strong relationship between frequency offset and temperature. Next these transmitters were attached to free-living Silver-haired Bats (*Lasionycteris noctivagans*). Using only inferred temperature from frequency offset, torpor and homeothermy were observed under environmental conditions known to induce these strategies. However, predicted temperatures were inconsistent suggesting limitations for inferring exact temperature. Data from American Tree Sparrows (*Spizelloides arborea*) tagged with the same model of transmitter was explored with no evidence of heterothermy detected. Furthermore, the predicted temperatures were far below normal bird temperatures. My research indicates that digitally-coded transmitters can detect changes in temperature of free-living animals but is best used to document temperature patterns rather than measuring precise temperatures. Further studies should be conducted on known heterothermic birds to know if this method works for birds and can be used to detect heterothermy in new species.

Sex-Dependent Alterations to the Gut Microbiota and Anxiety-Like Behavior in Rats Prenatally Exposed to Alcohol

Kingston Wong (Psychology, PhD)

Abstract: Individuals with fetal alcohol spectrum disorder are more likely to experience mental health disorders such as anxiety compared to typically developing individuals. The gut microbiota is involved in mood and emotion regulation but also the development of brain regions involved in these processes. Therefore, alterations of the gut microbiota are a possible mechanism in which prenatal alcohol exposure (PAE) could induce anxiety-behaviors. The current study examines the long-term effects of PAE on anxiety-like behaviors and the gut microbiota. Pregnant dams were randomly assigned to: PAE – liquid ethanol diet ad libitum or Control – pelleted control diet ad libitum. Male and female rats were assessed for anxiety-like behavior using the open field and dark-light emergence test. Fecal samples were collected afterwards for 16s rRNA sequencing to assess the gut microbiota. PAE animals exhibited anxiety-like behavior in the open field as they entered the center less and spent less time in the center compared to control animals. There were striking sex differences in the dark-light emergence, as control males took longer to enter the light chamber than control females. However, these sex

differences were attenuated in PAE animals. PAE did not affect bacterial diversity or community structure of the gut microbiota. However, PAE increased and decreased abundance of specific bacteria across taxonomic levels. In males, PAE increased abundance of Bacteroidetes but reduced abundance Firmicutes at the phylum level. Also in males, PAE increased abundance of bacteria belonging to the *Alistepes* genus. In females, PAE increased abundance of bacteria belonging to the *Turicibacter*, *Bifidobacterium*, and *Prevotella* genus. In both sexes, PAE reduced the abundance of bacteria belonging to *Lachnospiraceae* NK4A136 group. Alterations to the abundance of several bacteria, which differs across sex, could be a mechanistic pathway by which PAE induces anxiety-like behaviors. Support: NIH/NIAAA R01 AA022460 and Azrieli Foundation to CR and TSB.

Pathway Interaction Identification using Canonical Correlation Analysis

Marcus Villena

Abstract: In precision medicine and biomedical research, conventional methods for biomarker identification often utilize differential expression analysis at the gene-wise level. However, due to the high dimensionality of genomics data, this often involves an abundance of potential biomarkers likely consisting of mostly passenger genes. This subsequently requires investigations of an overwhelming number of gene-gene associations. Interpretation of these associations is not intuitively integrated with any biological context or interaction data. In contrast, through the clustering of related genes, analyzing pathway interactions provides insights into the underlying biological mechanisms while simultaneously reducing dimensionality. Objectives: We propose a new approach for utilizing canonical correlation analysis (CCA) in pathway-level expression analysis. CCA allows for the measure of maximal correlation between two latent canonical variates, which represent sets of observed variables. Here, transcriptomic data within potentially interacting pathways are used by CCA to measure their canonical correlation as a measure of pathway interaction. Methods and Results: Gene expression data across normal and breast cancer samples were acquired from TCGA-BRCA through the GDC Data Portal, and pathways were defined by curated datasets (e.g., KEGG) through MSigDB. Pathway correlation with CCA was validated against both intersection across KEGG pathways, alongside maximum combined inter-pathway protein interaction score from StringDB. In both cases, CCA was able to provide consistent results against the validation datasets, while also providing novel correlations between pathways. Conclusively, CCA allows for using pathways in biomarker identification and precision medicine. Results from CCA are highly interpretable, providing needed functional context to expression analysis.

Lighting the Way: Exploring Sex-Specific Responses to Light-Based Circadian Disruption in Degus

Nico Zugno-Gadea (Neuroscience, PhD)

Abstract: The circadian system regulates a range of physiological and behavioural functions in living organisms. Disrupted circadian rhythm affects mood, learning, and memory. Yet, ramifications of circadian disruption are still not yet fully understood. Past studies have largely studied males of nocturnal species but both sexes of diurnal species may exhibit very different responses. Males of some diurnal rodents exhibit

deficits in memory and increased anxiety-like behaviour following exposure to disruptive light/dark (LD) cycles, but females' responses are sparsely reported. We investigated the effects of circadian disruption on anxiety-like behaviour and spatial memory in both sexes of degus, a diurnal and highly social rodent. Female and male adult degus were exposed to constant light (LL) or normal 12:12 photo period for 60 days. In the last 15 days, degus were tested for spatial memory (Barnes maze, novel object placement recognition), locomotor activity (open field), and anxiety-like behaviours (open field test, and elevated plus maze). Results indicate that LL males made fewer errors and had shorter latencies to reach the escape hole across all five learning days compared to controls. In contrast, LL females made more errors compared to controls, but were still faster to reach the escape hole, suggesting that circadian disruption might impact males and females differently. Analyses of other behaviours are ongoing. We expect this work will increase our understanding of sex-specific responses to circadian disruptions in species with different daily routines and life histories.

Sex-Specific Adolescent Development of Social Reward Motivation in Female and Male *Octodon degus*

Shealin Murray (Psychology, PhD)

Abstract: *Octodon degus* are a small desert rodent known for their unique social behaviour profiles, and protracted development relative to other laboratory models. We have previously demonstrated that motivation for social reward fluctuates across adolescence in Long-Evans rats, and thus investigated the role of puberty onset on social motivation in juvenile male and female degus. We utilized an operant conditioning apparatus in which degus could "nose-poke" into two ports that opened a gate to allow five seconds of access to either a social reward (sex and age matched cagemate) or an empty chamber. On a fixed ratio (one nose poke = one reward) prepubertal males (~7 weeks old) demonstrated a social preference in gate opening, whereas there was no difference in gate opening for postpubertal males (6-8 months), or either age of females tested. However, on a progressive ratio (increasing number of nose-pokes required to access reward), irrespective of sex, prepubertal degus opened the social gate more than the nonsocial gate and had more overall openings than postpubertal degus. Lastly, we tested the animals in an extinction trial wherein no social reward was provided but both gates could be opened on a fixed ratio. In extinction, irrespective of age, males continued to open the previously social gate more than the nonsocial gate, whereas there was no gate opening preference in females. Therefore, we have demonstrated that in adolescent degus motivation for social reward is present prior to puberty and declines with maturation, and this occurs to a greater extent in male than in female degus.

Poster Session 2 (3:00 PM–4:00 PM)

Fabrication and Structural Analysis of La(1-x)Ca(x)MnO3 Thin Films on SrTiO3 (100) Substrates Using Pulsed Laser Deposition

Ankreet Kaur (Physics, MSc)

Abstract: Thin films of La(1-x) Ca(x)MnO3 (a perovskite manganite) characterized by general formula ABO3 doped with Ca resulting in La (0.8) Ca (0.2) MnO3, La (0.67) Ca (0.33) MnO3, La (0.5) Ca (0.5) MnO3 films were fabricated also known as LCMO thin films from a bulk sample of LCMO (orthorhombic at room temperature) using the pulsed laser deposition (PLD) technique. The thin films were deposited on SrTiO3 (100) substrates with a KrF excimer(248nm) high-energy pulsed laser beam at a very high temperature of around 720˚C. The deposition process involved 2000 and 10000 pulses resulting in the fabrication of thin films with approximate thickness of 20 nm and 100 nm, respectively. Various X-ray diffraction (XRD) techniques were employed to investigate the possibility of epitaxial growth and to measure the thickness of the thin films. The various techniques involved Parallel beam X-ray measurement (PB) to analyze the crystallographic structure of materials, X-ray reflectivity (XRR) to provide information about thickness, density and roughness of sample material and Rocking curve (RC) to provide crystal's mosaicity using FWHM values, strain, and defect density. The analysis exhibits epitaxial growth with minimized structural imperfections, leading to superior film uniformity with controlled thickness, enhanced crystallinity and enhanced material properties for specialized applications.

In-Vivo Analysis of Notch1 Cleavage by the Proteolytic Enzyme Nardilysin

Chanille Ubias (Biological Sciences, MSc)

Abstract: Human diseases arise from the dysregulation of cell signalling pathways that regulate communication between cells and tissues. The Notch signalling pathway, prominent in a wide range of human diseases, operates through direct cell-to-cell contact. This contact activates the expression of discrete sets of genes in a context-specific manner throughout development and homeostasis, serving as one of the central modes of communication disrupted in human diseases. Furthermore, the core feature that distinguishes the Notch pathway is the mechanism for its signal transduction. It is highly regulated by a series of proteases that cleave the Notch1 receptor, resulting in the release of the Notch1 intracellular domain (N1ICD), which activates gene expression. An analysis of the human Notch1 protein sequence using the eukaryotic linear motif (ELM) analysis server (www.elm.eu.org), and human mutant variation data across cancers identified Nardilysin (N-arginine dibasic convertase; NRDc). NRDc, a zinc peptidase of the metalloprotease M16 family, selectively cleaves arginine residues in dibasic pairs at the N-terminus, is a key potential regulator of Notch1 function in human cancers through proteolytic cleavage of Notch1. In support of its nuclear function, it has been demonstrated that it plays a role in chromatin regulation through its activity as a dimethyl-H3K4-binding protein. However, the role of NRDc in transcriptional regulation through Notch signalling, along with the importance and biological role of NRDc-mediated Notch cleavage, is currently unknown and remains poorly understood. The central aim of this study is to determine the sufficiency and necessity of NRDc in mediating proteolytic cleavage of Notch1, exploring its

coordination with Notch activation, nuclear translocation, and target gene activation through overexpression and Western blotting.

Increases in Vascular Compliance Contribute to Rises in Skeletal Muscle Blood Flow Velocity at Exercise Onset

Felicia Bouaban (Kinesiology, MA)

Abstract: This study tested the hypothesis that increased compliance of the skeletal muscle vascular bed contributes to rises in blood flow at exercise onset. Beat-by-beat brachial arterial bed blood flow velocity (Doppler ultrasound), brachial arterial blood pressure (Finometer), and heart rate (ECG) were measured during a 2-minute supine baseline condition, 2-seconds isometric handgrip exercise (IHG, handgrip dynamometer) and for 2-minutes post-IHG in 12 healthy individuals (4 females). This protocol was repeated for IHGs performed at 20%, 40%, 60%, and 80% of maximum IHG. Compliance and resistance were calculated using a four-element modified Windkessel model. All intensities of IHG elicited rapid rises in blood flow velocity (all $P < 0.019$). IHG-mediated rises in blood flow velocity were attributed to increases in compliance (BSL to post-IHG; 20%: 0.0018 ± 0.0005 to 0.0027 ± 0.0008 cm/s/mmHg, 40%: 0.0019 ± 0.0006 to 0.0033 ± 0.002 cm/s/mmHg, 60%: 0.0020 ± 0.0007 to 0.0030 ± 0.001 cm/s/mmHg, 80%: 0.0020 ± 0.0008 to 0.0037 ± 0.002 cm/s/mmHg, all $P < 0.013$). IHG also reduced vascular resistance (BSL to post-IHG; 20%: 15 ± 9 to 5 ± 1 mmHg/cm/s, 40%: 12 ± 5 to 3 ± 1 mmHg/cm/s, 60%: 13 ± 6 to 3 ± 1 mmHg/cm/s, 80%: 13 ± 7 to 4 ± 2 mmHg/cm/s). Changes in vascular compliance were independent of blood pressure which was not altered by any intensity IHG (all $P > 0.087$). These data suggest that rises in vascular compliance support increased blood flow at the onset of physical exercise in humans.

Preparation and Characterization of Vanadium Based Misfit Chalcogenides

Imesha Samadhi Nanayakkara Hewawasam (Physics, MSc)

Abstract: Misfit layer compounds [(MX)1+δ]m[(TX2)n] are a class of two-dimensional materials formed by the alternate stacking of two different types of layers: distorted rock-salt type structured layers (MX) and hexagonal structured, transition metal dichalcogenide layers (TX_2) where M can be elements such as Sn, Pb, Bi, or rare earth metals; X can be S or Se; and T can be Ti, V, Nb, Ta, or Cr. These layers exhibit a complex stacking arrangement and incommensurate lattice matching along at least one crystallographic axis. This study focuses on synthesizing single crystals of [(SnSe)1 + δ]m[(VSe2)n] and [(PbSe)1 + δ]m[(VSe2)n] using chemical vapor transport with anhydrous NH4Cl as the transport agent. Among the various by-products, mixed crystals containing areas of misfit compound [(SnSe)1 + δ]m[(VSe2)n] were successfully synthesized, displaying various stacking arrangements. Topographical and elemental analysis using Scanning Electron Microscopy (SEM) and Energy-Dispersive X-ray Spectroscopy (EDS) confirmed the layered topography and stoichiometry of the synthesized compounds respectively. Further, polarization-dependent vibrational modes of the parent compound (VSe2) and monolayered [(SnSe)1 + δ]m=1[(VSe2)n=1] were examined through optical Raman spectroscopy measurements.

Transcriptional Alterations in HIF- and Redox-Related Pathways in Mitochondrial DNA-Depleted PC-3 Cells

Jacob Wiebe (Biological Sciences, MSc)

Abstract: Rho0 (ρ0) cells are widely used as a tool to investigate how the absence of respiring mitochondria affects a variety of physiological and pathological processes. Prominently, ρ0 cells have been used to study the role of mitochondrial reactive oxygen species (mROS) production and/or mitochondrial respiration in the stabilization of the hypoxia-inducible factor (HIF) in hypoxia. In this study, we cultured ρ0 and WT PC-3 cells in 5% O2 (physioxia) and Plasmax medium for 2 weeks prior to transcriptomic and functional analyses. RNA-seq showed that ρ0 PC-3 cells have an impaired induction of HIF-regulated genes when exposed to hypoxia, compared to wild-type (WT) cells. Surprisingly, when comparing the transcriptomes ofrρ0 and WT cells in physioxia (5% O2), we found a strong presence of HIF-related gene signatures in ρ0 cells compared to WT. Among the HIF targets found to be upregulated in ρ0 cells were CA9, ANGPTL4, EGLN3, EPAS1, HK2, ENO2, and SLC2A1. Moreover, several Nrf2 targets were upregulated in r0 cells, including HMOX1, NQO1, GPX2, SLC7A11, and UGT1A1, in line with ρ0 cells showing a hydrogen peroxide efflux rate almost four times higher than WT. Given the alterations to HIF-dependent and Nrf2-dependent gene expression and basal ROS production observed in PC-3rρ0 cells, we conclude that caution should be taken when interpreting the results of experiments that focus on ROS production and HIF signaling using ρ0 cells as a model.

Extending the Boundary of Multi-Objective Drug Design

Karl Grantham (Computer Sciences, PhD)

Abstract: With multi-objective optimization, a large search space, and complex protein interactions, drug design is a difficult task. Because of this, new artificial intelligence (AI) approaches are required in order to reduce the costs of discovering new drugs. These methods seek to leverage large data sets of known drug-like compounds to provide a basis which can be intelligently improved upon over time. This complex task often requires extensive effort in training large machine learning (ML) models. This work advances the field of AI aided drug design by developing a Multi-Objective Evolutionary Algorithm for Target Specificity (MOEA-TS) which is a relatively simple approach but has the ability of efficiently evolving and generating new molecules in the million scale with high performance in a variety of design criteria. In this research, our approach is comprehensively investigated and compared with existing drug design approaches based on deep learning.

Exploring Fast and Scalable Gradient-Free Evolutionary Optimization in Deep Learning

Rasa Khosrowshahli (Computer Sciences, PhD)

Abstract: The revolution in deep learning has been driven by the development of modern libraries and advancements in hardware accelerators and compilers, enabling large-scale gradient descent-based (GD) optimization for training neural networks, known as universal approximation functions. The widespread use of cutting-edge libraries such as PyTorch and Keras, which offer ready-to-use GD-based methods, has created a comfort zone for industrial engineers. However, the limitations of GD-based

methods have led researchers to either abandon neural networks for some tasks that are not GD-friendly or to design complex single-objective differentiable loss functions that do not accurately represent the target. An alternative approach, gradient-free (GF) methods, liberates parameter updates from gradient descent, avoiding local optima traps. While GD-based optimization remains the standard for neural network training, GF-based methods, including evolutionary strategies (ES), effectively address challenges such as non-differentiable objectives, multi-objective optimization, and neural architecture search in machine learning. Here we contend that the huge computational capacity offered by GPUs and TPUs can also greatly aid evolutionary population-based computation to directly be executed on hardware accelerators and automatically vectorized or parallelized across devices with JAX library. This study examines two candidate methods—Stochastic Gradient Descent (SGD) and Covariance Matrix Adaptation Evolution Strategy (CMA-ES)—to compare GD and GF-based training of neural networks. We analyze the differences in resulting weights, output distribution, and performance on image classification benchmark problems.

Using Whole Genome Sequencing for the Identification of Wild *V. riparia* Clones
Robert Robinson
Abstract: From a collection of over 800 clones of wild *V*. *riparia* collected throughout southern Ontario, 11 selections were chosen for further rootstock testing. These 11 were also propagated to establish a mother garden for future use. Since these riparia clones were chosen for production potential (drought tolerance, salt tolerance, lime tolerance, robustness), ampelographic differences among them were few or very subtle. Whole genome sequencing (WGS) was proposed as a method of separating them by identifying genetic variants within each genome. Millions of variants were found even within the locally collected samples and sufficient variants may exist for differentiating different plants from the same selection. Selecting a set of variants unique to each clone for verification and for examining their contribution to clone-specific traits will be the next objective. This initial work presents WGS as a promising option for trueness-to-type testing of these riparia clones, as well as for the micro-propagated grapevine material prior to field planting.

Synthesis and Structural Characterizations of Tantalum Zirconium Ta(1-x)Zrx Binary Alloys
Teresa Dong (Physics, MSc)
Abstract: Binary superconductors Ta(1-x)Zrx (x = 0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 1), composed of transition metals tantalum (Ta) and zirconium (Zr), were synthesized using the arc melting method in an argon gas atmosphere. These alloys were analyzed using X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy dispersive spectroscopy (EDS) to explore their structural properties. These techniques were employed to analyze the microstructural properties, surface topographies, element compositions, and element distributions of the samples. XRD analysis indicated that as the Zr concentration increased, the lattice parameter expanded until it stabilized at 20% Zr, with an amorphous structure. SEM imaging showed changes in surface topographies, from amorphous structures at low Zr content to distinct island and grid-like formations at higher concentrations. EDS mapping further proved that Zr began to

separate into phases at compositions above 20%, where clumping and phase separation occurred, consistent with the spinodal decomposition patterns. These results confirm that varying Zr content induces significant structural changes in the Ta-Zr alloy system, allowing for a comprehensive comparison across different compositions.

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