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Women in Science & Engineering (WISE) Conference: 5MT Competition Abstract Collection

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Abstract
On Saturday January 25th, 2025, the 5 Minute Thesis (5MT) Competition took place at the 2025 Women in Science & Engineering (WISE) Conference. Participants from universities across Ontario presented their research in the form of 5-minute presentation with a singular slide. This abstract collection provides a summary of the amazing work being done by women in the fields of engineering, biology and chemistry. We come together to celebrate their achievements and continue to advocate and promote the presence of women in spaces of research.

Keywords: STEM; women; 5MT; engineering; health sciences; robotics; artificial intelligence; smart tech; biology; chemistry

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Conference Abstracts
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Designing Micro-scale Magnetic Soft Robots Using Evolutionary Algorithm

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Magnetically actuated soft microrobots can navigate down tortuous paths and perform previously infeasible operations as a result of their miniaturize size and flexible bodies. This results in a wide range of applications in engineering and healthcare. The design of these robots stems from a series of manual steps that primarily relies on a fundamental understanding of magnetism as well as trial and error. Automating this series of steps into a physics-based simulation that can be combined with an optimization tool helps to improve the design process. One promising avenue is the use of evolutionary algorithms

(EA) for improving the performance of robots through parameter optimization. In this study, an existing simulation environment based on a Material Point Method (MPM) is used to study the behaviour of the robot. This simulation environment is coupled with an evolutionary algorithm to optimize the magnetization profile of a crawling microrobot. The results show that a 39.5% increase in speed is achieved through this approach.
We hope to extrapolate this to other geometries and magnetization profiles.

Artificial Intelligence Model to Predict Footwear Slip Resistance

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The rapid aging of the global population is making falls a major global public health issue. Slips and falls pose significant injury risks to seniors, particularly during winter conditions. Slip prevention is crucial in reducing the burden of falls, decreasing the risk of morbidity and mortality, and enhancing independent living. The major factor for slipping is low friction between footwear and the surface. Although slip-resistant footwear can significantly reduce the risk of slips and falls, the current methods for measuring slip resistance, like mechanical tests, are not accessible to the average user. This highlights the need for accessible methods to assess the effectiveness of footwear in preventing slips and falls. Therefore, our goal is to develop and validate an AI model to estimate the slip resistance of footwear. Our model used foundation models and deep learning techniques to assess the footwear slip resistance based on images of the footwear outsole. To this goal, we first assessed the slip resistance quality of footwear by the gold standard measurement. This includes winter boots, indoor shoes, safety footwear, and also traditional Indigenous footwear, which incorporates cultural insights and unique design elements. Then, we extracted features from outsole images and developed artificial intelligence models to predict footwear slip resistance properties. Our model was trained using a diverse dataset to ensure it works across a wide range of footwear types and environments. This model achieved a high accuracy of 90%. Therefore, this solution will help the aging population prevent slips and falls by enabling them to wisely choose appropriate footwear from the market. It also will help footwear manufacturers optimize footwear designs in the early stages, reducing costs and improving product safety.

Transforming 5G: Empowering Global Connectivity for a Smarter, Connected World

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The rapid expansion of 5G networks is transforming how we connect and communi- cate, but it also introduces a critical challenge: handling the growing demand for band-width from billions of devices. Without smarter solutions, network congestion will lead to slower speeds, increased delays, and an inability to meet the needs of critical applications like smart cities, healthcare devices, and high-speed internet. This research tackles the problem of dynamic resource allocation by enabling 5G networks to adapt in real time. Using a combination of artificial intelligence and optimization techniques, this approach ensures that bandwidth is distributed efficiently, even under high demand. Key applications include the Internet of Things (IoT), which requires massive scalability for connected devices, and enhanced Mobile Broadband (eMBB), which powers high-speed, data-intensive activities like video streaming and virtual reality. Simulations will evaluate the system's ability to improve speed, reduce delays, and enhance Quality of Service (QoS), paving the way for a smarter, more connected future.

Planning for Enhancing the Resilience of Smart Grids Against Cyber Attacks

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Abstract – The evolution of power grids into complex and interconnected systems has increased their vulnerability to cyberattacks, particularly at the distribution level. This research investigates the resilience of smart grids against IoT-based cyber threats, focusing on load-altering attacks that exploit critical nodes in distribution systems. Using the IEEE 33-bus network as a testbed, the study replicates the MaDIoT 2.0 attack, which targets low-voltage nodes to destabilize the grid. The research evaluates the potential of distributed generation (DG) and microgrid integration to mitigate these vulnerabilities through optimized placement strategies. Initial findings demonstrate that targeted load-altering attacks significantly degrade voltage stability, causing voltage drops below operational thresholds. DGs, strategically placed using a custom particle swarm optimization (PSO) algorithm, are shown to enhance voltage stability and reduce power losses. This approach incorporates cybersecurity considerations by positioning DGs near critical nodes identified through voltage magnitude

analysis, further improving grid resilience. Future work includes comparing performance under various DG configurations and quantifying the improvement in system recovery and stability post-attack. By integrating advanced DG placement strategies with cyber threat mitigation, this research aims to provide actionable solutions for enhancing the security and resilience of modern smart grids.

On Your Mark, Get Set, Glow: Using a Unique Electrochemically-controlled Method for Light Emission

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Electrochemiluminescence (ECL) is the emission of light produced from electrochemical reactions. In this setting, when electrochemical reactions occur, they produce short-lived, unstable species that can react to form excited-state species. As the excited-state species relax down to their ground state, they will release energy in the form of light, or ECL. The intensity of ECL produced and the timing of when it occurs is controlled by applied electrochemical potentials, enabling the precise tuning of ECL emission. ECL also offers the advantages of being highly sensitive with low background signal, making it useful for a variety of societal applications such as immunoassays, bioimaging, and biomolecule detection. The discovery of new, highly efficient ECL materials is crucial for the advancement of the many technologies which utilize ECL. The Ding Research Group at Western University is a leader in the field of ECL materials analysis. Through international collaboration with research groups from Jianghan University, China, who synthesize highly-luminescent materials, the Ding Research Group are able to use our expertise on ECL to analyze these novel materials. Here, we present our study on the ECL and photoluminescence (PL) properties of an organic compound (TDBA-Ac[3]) synthesized at Jianghan University, which featured bright luminescence and high efficiency, and provide insights into its unique ECL reaction pathways. Our work provides findings that could help to enhance the many technologies that utilize ECL in the fields of medical diagnostics and biology

Neuromelanin Concentration and Appetitive Conditioning Responses as a Measure of Reward Processing in Anorexia Nervosa

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Anorexia nervosa (AN) is a debilitating and potentially life-threatening eating disorder driven by an overwhelming fear of weight gain and a desire for thinness. Recent research exploring the neural mechanisms of AN pathology has noted abnormalities in dopaminergic reward processing, which manifests as diminished or aversive responses to hedonic cues such as food stimuli. Neuromelanin, a byproduct of dopamine synthesis, serves as a cumulative marker of dopamine activity in the midbrain that can reflect long-term changes in reward pathways. Investigating the relationship between neuromelanin concentrations and disruptions in appetitive conditioning responses can shed light on fundamental abnormalities in reward processing in AN. This study will build on a larger study of the neural, physiological, and subjective correlates of appetitive conditioning in individuals with AN. Participants are 12-22 year old females who meet current criteria for AN (underweight), weight-restored AN, or healthy controls. Participants undergo an appetitive (Pavlovian) conditioning paradigm during fMRI using the rewarding social stimuli of baby laughter. They also complete a neuromelanin-sensitive MRI (NM-MRI) scan, self-reported pleasantness ratings, and Behavioral Inhibition Scale/Behavioral Approach Scale questionnaires. This study will be among the first to examine both dopamine production and Pavlovian reward learning in individuals with AN. Results will help determine if there are abnormalities in dopamine synthesis and, if so, if they are linked to symptomatic behaviors and a diminished ability to experience pleasure and reward. This can lay the groundwork for future research into targeted interventions to address these deficits.

Aligning Higher Education With Industry Expectations: Bridging the Gap Between Students and the Workforce

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The transition from higher education to the professional workplace is a critical turning point for students. The alignment between higher education and industry needs can determine how students approach the transition from university to the workplace and whether they are equipped with the knowledge, skills, and values necessary to meet the demands of today's labour market. However, many employers have noted a gap between the skills that students develop through higher education and those required by the industry. This disconnect raises the question of whether higher education is aligned with industry needs, and more importantly, how this alignment might be improved. My research aims to determine how students' views on the biology curriculum, science industry requirements, and career preparation inform the alignment of higher education with industry needs. Existing literature has identified areas where students express a desire for improvement, including opportunities to develop communication skills, more interdisciplinary courses, and a stronger emphasis on real-world applications in their programs. I will present my findings from surveying biology students across Canadian institutions along with recommendations to improve the alignment between biology education and industry needs and ensure that future graduates are better prepared for their professional careers.

Enhancing Collaboration in Tangled Program Graphs With Shared Memory for Mujoco Continuous Control Tasks

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Tangled Program Graphs (TPGs) are a genetic programming framework designed to solve complex decision-making problems by evolving graphs of teams of programs. This research builds on prior findings to enhance TPGs for partially observable environments by introducing a shared memory mechanism. In contrast to global shared memory shared among all teams in previous work, this study employs separate shared memory for each team, accessible by all programs within that team. Shared memory cells are selected using a scaled normal distribution, balancing short- and long-term memory access within the memory range. The proposed approach is evaluated on MuJoCo continuous control tasks, including Inverted Double Pendulum and Hopper, which are modified to be partially observable by zeroing critical dimensions of the observation vector that impact performance. Results demonstrate that shared memory improves task performance, as shown by higher scores, and reduces solution complexity, defined as the average number of instructions executed per action. These findings highlight the potential of shared memory to enhance collaboration and decision-making in complex, partially observable environments. Future work focuses on scalability to multi-agent systems and applications in memory-intensive domains.

Utilizing Protein Language Models to Enhance Local Protein Sequence Alignment

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Protein molecules perform critical functions in living organisms. They are chains of amino acids that fold into specific three-dimensional shapes. The order and properties of the amino acids determine how the chain will fold, and the shape determines function. Each amino acid is represented by a single-letter code, allowing proteins to be shown as sequences of these letters. Protein sequence alignment is a computational method to assess similarity. Significant similarities often suggest shared ancestry and common functionality. Beyond tasks like database searching, sequence alignments also serve as key inputs for advanced models, such as protein structure prediction systems The alignment process can be visualized as arranging sequences so that they are stacked on top of one another, aligning identical or similar amino acids in the same columns, and introducing gaps where necessary to optimize the matches. There are two main types of alignment algorithms, global which aims to optimally align two protein sequences along their entity, and local, which aims to find the best matching region between two sequences. Local alignment, more widely used than global, is ideal for detecting evolutionary conservation, and functional domains, even when overall sequences differ significantly. Alignment algorithms traditionally rely on scoring matrices to assess how similar two amino acids are; however, these matrices are context independent meaning the similarity score for aligning two amino acids is always the same, regardless of the surrounding amino acids. This is an issue because the biological or structural context of a protein sequence can significantly influence the functional relationship between amino acids. This project aims to improve current local alignment methods by leveraging contextual information from protein embedding vectors, generated by deep protein language models. Using the cosine similarity between protein embedding vectors in place of static scoring matrices in the Smith-Waterman local alignment algorithm offers a more dynamic and

context-aware approach to sequence alignment, improving alignment accuracy. We believe that the application of embedding vectors to local alignment has not been effectively researched, mainly due to the lack of a comprehensive evaluation pipeline, and designing one is a key focus of this project. Our local alignment algorithm is compared against other contextually dependent alignment methods, providing a comprehensive analysis of local sequence alignment.

Auto-Safe: Trustworthy AI Drone Path Planning

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Human trust is an essential component within human-robot interaction, as it shapes user performance outcomes and system reliability. Thus, this research develops a trustworthy drone path planning tool — Auto-Safe. This tool integrates both environmental and user- based trust measures, employing the DBSCAN algorithm to evaluate obstacle density and classify safety zones. Auto-Safe adapts its behavior based on user interaction profiles from initial runs, categorizing users as cautious, risk-taking, or mixed, which aligns system responses with individual tendencies. Building on this framework, the current study focuses on using the results of these tools and trust analysis over the course of the game to examine how trust evolves during gameplay and identify ways to modify the simulator to help users calibrate their trust earlier. This approach aims to enhance safety and performance by systematically leveraging trust quantification for real-time trust calibration. Initial results demonstrate that this method enhances user performance and trust, leading to safer and more reliable human-autonomy interactions throughout the game. Future work will focus on integrating additional trust factors to further advance adaptability and user- centric operation in automated environments.

Understanding Osteoarthritis Patients' Perspectives on Gait Analysis: A Feasibility Study

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Osteoarthritis (OA) is a leading cause of pain and mobility loss, deeply affecting the quality of life for older adults and others with the disease (Loeser et al., 2012). In recent years, gait analysis—the detailed assessment of human walking patterns—has emerged as a valuable tool in clinical practice, enabling healthcare practitioners to monitor functional recovery and rehabilitation in patients (Klöpfer-Krämer et al., 2020). However, further research is essential to evaluate patients' willingness to adopt such innovations (Clermont et al., 2019). Thus, assessing OA patients' perceptions and experiences with biomechanical technology is critical for developing practical and effective clinical solutions (Clermont et al., 2019). This study aims to evaluate the feasibility of conducting gait and functional tests for patients undergoing treatment for hip or knee pain at St. Joseph's Hospital's Fracture and Orthopaedics Clinic. Additionally, the study examines how patients' perceptions of these methods vary based on their stage of care and the treatments they have received. Through focus-group discussions, it also explores how patients' perceptions compare to those of healthcare practitioners, such as orthopaedic surgeons and physiotherapists. To date, 357 individuals who have either previously undergone gait analysis or are current patients at St. Joseph's Fracture and Orthopaedics Clinic have participated in the quantitative survey portion of this study. The survey included 58 prompts spanning topics such as: past and anticipated treatments, willingness to undergo a walk test, perceived significance of various gait tasks, and preferred formats for receiving research-driven data reports. Participants rated these prompts using a 5-point Likert scale to quantify elements such as: the importance of functional tests for their clinical care (1 = not important, 5 = very important) and the impact of osteoarthritis on their daily lives (1 = minimally impacted, 5 = significantly impacted), to name a few. Interestingly, our results indicate that patients view gait assessments as a crucial aspect of their care (perceiving them as highly feasible), express little to no privacy concerns about camera-based motion capture, and are generally very willing to undergo these assessments. The next intriguing step is to integrate these perceptions into real-time discussions with healthcare practitioners in a focus-group setting to see how they compare

Conflicts of Interest
The author(s) declare that they have no conflict of interests.

Authors' Contributions
HS: served as the Competition Directors for the WISE conference, assisted authors with their abstract submissions, and gave final approval of the version to be published.
RS: served as the Competition Directors for the WISE conference, assisted authors with their abstract submissions, and gave final approval of the version to be published.

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