**Memorial AI eSymposium – Friday October 2, 2020**

**Exploring the Technical, Heath and Societal Impacts of Artificial Intelligence**

Across Memorial University, there is a shared interest and desire to connect and advance work on artificial intelligence (AI) and machine learning. We – the Deans of the Faculty of Engineering and Applied Science (Dr. Greg Naterer), Faculty of Science (Dr. Travis Fridgen), Faculty of Humanities and Social Sciences (Dr. Jennifer Simpson), Faculty of Business (Dr. Isabelle Dostaler), and School of Music (Dr. Ian Sutherland) – have organized this eSymposium to do just that.

AI refers to computer systems that collect, interpret and learn from external data to achieve specific goals and tasks. It is having an increasingly significant impact on society, health care and the labour force. But questions have been raised about the ethics and social implications of AI in a growing number of areas. This eSymposium will explore these and other emerging issues of AI research and education.

The objectives of the eSymposium include: (i) forming a community of interested faculty members from across disciplines; (ii) increasing the knowledge and applications of AI at Memorial; (iii) raising the profile, visibility, and impacts of AI work at Memorial; and (iv) building interdisciplinary collaborations in technical and non-technical areas of AI - from pure research to applied projects and social and health impacts.

Themes of the event will include the history and past development of AI, as well as current progress in AI, and future directions of AI, including research, opportunities and threats. A total of nine sessions will cover topics of algorithms. A total of nine sessions will cover topics of algorithms; robotics; social and ethical implications; fisheries and aquaculture; business processes; healthcare; education; multidisciplinary applications; and earth science.

This event will highlight the multidisciplinary collaborations among researchers and leverage this expertise to apply AI to new areas. It aims to make Memorial a growing hub of activity for networking in emerging areas of AI. Thank you to all participants for contributing and hopefully you will find the event inspiring and enjoyable.

Sincerely,

Dr. Greg Naterer, Faculty of Engineering and Applied Science
Dr. Travis Fridgen, Faculty of Science
Dr. Jennifer Simpson, Faculty of Humanities and Social Sciences
Dr. Isabelle Dostaler, Faculty of Business
Dr. Ian Sutherland, School of Music

| | Memorial Artificial Intelligence (AI) eSymposium – Fri. Oct. 2, 2020 |
|---|---|
| 8:30 | **Welcoming Remarks** |
| 8:45 | **Keynote Speaker: Ahmed Abbasi (University of Notre Dame)**<br>**Developing a Research Program in Human-Centered AI** |
| 9:15 | **Overview of AI (David Churchill)** |
| 9:45 | **1: Algorithms (Yuanzhu Chen)**<br>Yuanzhu Chen (CS); Todd Wareham (CS); Anton Oleynik (Sociology) |
| 10:30 | **Break** |
| 10:45 | **2: Robotics (Vinicius Prado da Fonseca)**<br>Vinicius Prado da Fonseca (CS); Andrew Vardy (CS / Engineering) |
| 11:15 | **3: Social and Ethical Implications (Jennifer Simpson)**<br>Sean McGrath (Philosophy); Anton Oleynik (Sociology); Arthur Sullivan (Philosophy); Keif Godbout-Kinney (Sociology) |
| 12:15 | **4: Fisheries and Aquaculture (Jin Gao)**<br>Jin Gao (MI) |
| 12:30 | **Lunch** |
| 1:00 | **5: Business Processes (Isabelle Dostaler)**<br>Joerg Evermann (Business); Jeffrey Parsons (Business); Majid Eghbali-Zarch (Business) |
| 1:45 | **6: Healthcare (Michael Grant)**<br>Edward Randell (Medicine); Angus Hartery (Medicine) |
| 2:15 | **7: Education (Anne Burke)**<br>Sohaib Al-Asaaed (Medicine); Greg Naterer (Engineering) |
| 2:45 | **Break** |
| 3:00 | **8: Multidisciplinary Applications (Ian Sutherland)**<br>Syed Imtiaz (Engineering); Lourdes Pena-Castillo (CS / Biology); Pierre-Paul Bitton (Psychology); Oscar De Silva (Engineering) |
| 4:00 | **9: Earth Science (Travis Fridgen)**<br>Alison Malcolm (Earth Sciences); Colin Farquharson (Earth Sciences) |
| 4:30 | **Discussion** |
| 5:00 | **Closing Remarks** |

## Keynote Speakers

**Developing a Research Program in Human-Centered AI. Dr. Ahmed Abbasi, Professor, Department of IT, Analytics, and Operations, in the Mendoza College of Business, University of Notre Dame, Indiana.**

**Bio.** Dr. Ahmed Abbasi is the Joe and Jane Giovanini Endowed Chaired Professor in the Department of IT, Analytics, and Operations in the Mendoza College of Business at the University of Notre Dame. Dr. Abbasi received his Ph.D. in Information Systems from the University of Arizona, where he worked as a research scientist and project lead in the Artificial Intelligence (AI) Lab. He attained an M.B.A. and B.S. in Information Technology from Virginia Tech. Dr. Abbasi has over 20 years of experience pertaining to AI and predictive analytics, with applications in health, online fraud and security, text mining, and social media. Ahmed's research has been funded by over a dozen grants from the National Science Foundation and industry partners such as AWS, Microsoft, and Oracle. He has also received the IEEE Technical Achievement Award, INFORMS Design Science Award, and IBM Faculty Award for his work at the intersection of AI and Big Data. Ahmed has published nearly 100 articles in journals and conferences. He won best paper awards at MISQ and WITS. Dr. Abbasi's work has been featured in various media outlets, including the Wall Street Journal, Harvard Business Review, the Associated Press, WIRED, CBS, and Fox. Ahmed serves as Senior Editor for Information Systems Research (ISR) and Associate Editor (AE) for ACM TMIS and IEEE Intelligent Systems.

**Abstract.** AI affords exciting opportunities for university-wide interdisciplinary research programs. In this presentation, I will describe our on-going efforts to develop a research program in human-centered AI. Human-centered AI – the design, development, and application of advanced machine learning and user modeling methods to human generated content including structured, text, image, and sensor-based data – has garnered considerable attention due to its immense potential to improve the human condition. However, this value proposition also comes with a bevy of AI governance concerns, computational problems, and socio-technical design obstacles. Consequently, engaging in impactful AI-oriented research often necessitates a more holistic, interdisciplinary perspective. I will use projects related to health and law enforcement to illustrate our journey towards developing a broader interdisciplinary perspective on human-centered AI.

**Overview of AI. Dr. David Churchill, Associate Professor, Department of Computer Science, Memorial University.**

**Bio.** I'm an Associate Professor of Computer Science at Memorial University. I grew up in St. Philip's, Newfoundland, and did my undergraduate program in Pure Mathematics and Computer Science at MUN. In 2009, I completed my MSc in Computer Science at MUN, doing research into autonomous robotics and computer vision. In 2016, I completed my PhD in Computing Science on Artificial Intelligence for Starcraft at the University of Alberta, and have been actively involved in research in AI and Computer Games ever since. I love video games! I've logged way more hours than I choose to admit in games such as EverQuest, World of WarCraft, StarCraft, Tekken, Quake, Path of Exile, League of Legends, Final Fantasy, and Overwatch. I love teaching on the subject of video games, and have lectured on topics such as video game design and programming, artificial intelligence for video games, eSports, and gaming culture and history. My main research focus is on AI for Real-Time Strategy Games, such as StarCraft, however I am interested in any research related to video games and/or AI (especially heuristic search).

**<u>Session 1: Algorithms</u> (Chair: Dr. Y. Chen, Professor and Department Head of Computer Science)**

**Dr. Yuanzhu Chen, Professor and Department Head of Computer Science**

**Bio.** Dr. Yuanzhu Chen received the B.Sc. degree from Peking University, Beijing, China, and Ph.D. degree from Simon Fraser University, Burnaby, BC, in 1999 and 2004, respectively. He is a Professor and Departments Head of Computer Science. My research revolves around using computing technologies to foster human interactions and knowledge sharing in order to advance our civilizations. I have used graph theoretic tools and optimization methods to design networks where users can move freely without infrastructure of any kind. Since joining Memorial University, I explored innovative designs of computer network protocols to unleash potentials of wireless and mobile devices (network coding, opportunistic data forwarding, and delay-tolerant networking). I apply techniques of complex networks modeling, machine learning, semantic data mining, and evolutionary computation to investigate properties of techno-social networks in terms of their formation, capacity, and resilience.

**Abstract.** Complex systems are often backed with a complex wiring diagram. Such systems can be natural such as gene regulation, technological such as power grids and the Internet, social such as physical or online human interactions, or informational such as the World Wide Web, patent citation, and representation of knowledge. Studying entities in complex systems with explicit modeling of their interaction and relation facilitates a greater revelation of their properties than processing them in isolation. With the combination of greater availability of structured data, advancement in machine learning algorithm design, and faster computing hardware, artificial intelligence has been effective in helping us finding about structural weakness of networks, labeling nodes categorically and numerically, analyzing strength of interactions, recommending unseen linkage, finding communities, and predicting virality of spreading phenomena, such as contagious diseases and Internet memes.

**Dr. Todd Wareham, Professor of Computer Science**

**Bio.** Dr. Todd Wareham received B.Sc. (Honours) and M.Sc. degrees in Computer Science from Memorial University, in 1985 and 1993, respectively. He received a Ph.D. degree from the University of Victoria, Canada, in 1999. He is a Professor in the Department of Computer Science, Memorial University. His research involves applying various theories of computational complexity (NP-completeness, parameterized complexity, polynomial-time approximation) to the analysis of problems from various disciplines, both as an aid to characterizing the sources of intractability in these problems and designing the most efficient algorithms possible for these problems.

**Abstract.** To solve a computational problem, one ideally wants an algorithm that is both fast and produces the correct or best solution for every input. However, what does one do if (as is often the case in AI) one cannot find such an algorithm? There are a variety of types of algorithms that may still be acceptable. However, this raises another question – namely, which of these types exist for your problem? This question is answered using Computational Complexity Analysis (CCA), which can not only determine what types of algorithms do and do not exist for a given problem but also be of assistance in deriving the best possible algorithm of an existing type.

**<u>Session 2: Robotics</u> (Chair: Dr. V. P. da Fonseca, Associate Professor, Department of Computer Science)**

**Dr. Vinicius Prado da Fonseca, Associate Professor, Department of Computer Science**

**Bio.** Dr. da Fonseca received B.Sc. and M.Sc. degrees from the Federal University of Tocantins and Military Institute of Engineering, Brazil, in 2010 and 2013, respectively. He received a Ph.D. in Electrical and Computer Engineering, University of Ottawa, 2020. His research interests are Robotics, Tactile sensing, Robotic manipulation, Human-machine interaction, Human-robot interaction, Applied machine learning and AI.

**Abstract.** Modern robotic platforms are shifting from industries to unstructured environments where their current abilities may not be enough. A new approach to dexterous manipulation is required to perform tasks reliably, so the next generation of robots can interact with daily objects. My recent research focuses on borrow concepts from the human somatosensory system and develops counterparts for robotic manipulation. Using state-of-the-art bio-inspired tactile sensing and visual feedback, we manage to extract important tactile information for in-hand manipulation tasks.

**Dr. Andrew Vardy, Professor, Computer Science / Electrical and Computer Engineering Departments**

**Bio.** Dr. Vardy completed a B.Eng. in Electrical Engineering from Memorial University in 1999, followed by an M.Sc. in evolutionary and adaptive systems from the University of Sussex in Brighton, UK. He continued his studies with a PhD in Computer Science from Carleton University, Ottawa. Dr. Vardy's main research interests are swarm robotics and biologically inspired robotics. He teaches courses in autonomous robotics, computer programming, software design and control systems.

**Abstract.** Andrew Vardy is a Professor jointly appointed with the Departments of Computer Science, and the Electrical and Computer Engineering. He has worked in diverse fields including wearable computing, evolutionary computing, game AI, robot navigation, and swarm robotics. Swarm robotics focuses on the quest to combine the abilities of simple robots to solve a problem that individual robots would not be able to solve independently. He runs the Bio-Inspired Robotics Lab (BOTS) which is focused on designing swarms of robots to modify their environment and shift it towards a desired state.

**<u>Session 3: Social and Ethical Implications</u> (Chair: Dr. J. Simpson, Dean and Professor, Faculty of Humanities and Social Sciences)**

**Dr. Sean McGrath, Professor, Department of Philosophy**

**Bio.** Sean J. McGrath researches and teaches in the areas of metaphysics, classical German philosophy (Kant to Heidegger), phenomenology and hermeneutics, and psychoanalysis. After graduate work at the University of Toronto in both theology and philosophy, he graduated in 2002 with a dissertation in philosophy supervised by Graeme Nicholson, later published as The Early Heidegger and Medieval Philosophy: Phenomenology for the Godforsaken (Catholic University of America Press, 2006, reprinted 2013).

In 2008 he published a second book, Heidegger: A (Very) Critical Introduction (Eerdmans), which was commissioned by the Centre for Theology and Philosophy at the University of Nottingham. That same year he was awarded a Humboldt Fellowship for two years of research in Germany on the topic of the historical and systematic connections between psychoanalysis and German Idealism. The fruit of that research was published in 2012 as The Dark Ground of Spirit: Schelling and the Unconscious (Routledge). He is the co-editor of A Companion to Heidegger's Phenomenology of Religious Life (Rodopi, 2010) and the editor of Analecta Hermeneutica, an annual journal on philosophical hermeneutics and related fields. He serves as the co-chair of the North American Schelling Society (which he founded with Jason Wirth in 2011) and a member of the executive committee of the Canadian Society for Continental Philosophy.

**Abstract.** I have been part of an international, interdisciplinary working group on Artificial Intelligence, based in Augsburg, Germany, for the past year. The group is composed of scholars working in fields as diverse as philosophy, computer science, ecology, psychology, and religious studies. As a philosopher and theologian, my interest in AI focusses on the notion of intelligence and some of the historical approaches to the issue from the history of philosophy and theology. In my recent book, Thinking Nature: An Essay in Negative Ecology (Edinburgh University Press, 2019), I revived an old theme in the history of the philosophy of mind, the theme of symbolic thinking, and the difference between the way all animals use signs, and the human animal, alone it appears, uses symbols. The distinction between signs and symbols could have some bearing on the production of Artificial General Intelligence because symbolic thought, according to many philosophers, is the necessary condition for self-consciousness. We have been debating the pros and cons of artificial general intelligence for some time, even if AGI or strong AI is a recent coinage. Are we so sure we know what intelligence is, at least human, natural intelligence? Would we not need to be clear on that first before we concluded that we have been doubled, perfected, and replaced? There is no great consensus on natural intelligence, but, on the contrary a long and ongoing debate that is as old as the Greeks and as recent as Thomas Nagel's Mind and Cosmos (Oxford 2012). Is a human intelligence essentially an information processor? Or is it rather a care-driven evaluator of what is relevant to its interests and therefore, a deliberator and chooser, rather than a data processor, an agent intellect as Aristotle put it, an actor, not primarily a processor? Since the human difference is a central question of the theological and idealist traditions, a central preoccupation of medieval theologians of differing faiths, it only makes sense that AI researchers who take seriously their quest for AGI, look to these tradition for clues as to what seems to have eluded mainstream science and eliminative philosophies of mind. AI researchers need to both widen and deepen their investigation of the human difference, and this offers an unprecedented opportunity for collaboration between the hard sciences, computer scientists, psychologists, and philosophers and theologians.

**Dr. Anton Oleynik, Associate Professor, Department of Sociology**

**Bio.** Associate Professor (Ph.D. in sociology, Ecole des Hautes Etudes en Sciences Sociales, Paris; Ph.D. in political economy, Moscow State Lomonossov University). Dr. Oleynik's research is focused on catch-up modernization in post-Soviet states seen from a comparative perspective and the role played in this process by power elites. His work has appeared widely in Russian, French and English, including in publications such as Journal of Economic Issues; Crime, Law and Social Change; Problems of Economic Transition; Cultures and Conflicts. Dr. Oleynik coordinates an international network of specialists on the issues of administrative reform in post-Soviet countries (AdmReformNet). At Memorial University he teaches courses on economic sociology, terrorism, the sociology of modernization, and research methods.

**Abstract.** In its current form, information retrieval (IR), including web search, leaves little room for chance correction. A document can be retrieved in response to a search query either because it contains what the user intends to find or by chance only. For instance, PageRank allows 'random' visits of webpages through the procedure of teleportation. However, PageRank accounts for two sources of randomness out of four: not all webpages are indexed ('deep web') and not all web pages have in-links. Such pages can be discovered by browsing ('random surfing') only as opposed to web search. The two other sources of randomness, the contents of indexed documents (they can contain particular words by chance only) and users' interests (they may compose particular search queries by chance as well), are not accounted for. Our contribution offers an overview of four sources of randomness in information retrieval and introduces a number of chance-corrected measures of similarity initially developed in content analysis, a methodology for processing qualitative data (Krippendorff's α, Scott's π, Bennet et al.'s S, Cohen's κ). The relative performance of various measures of similarity is compared with the help of toy examples and simulation using ThinkMate.org, an online platform for content-analysis. Chance-corrected measures of similarity can be incorporated in algorithms for machine learning in IR.

**Dr. Arthus Sullivan, Professor, Department of Philosophy**

**Bio.** Arthur Sullivan is Professor of Philosophy at Memorial University's Department of Philosophy where he was also previously the Head of the Department. He works on the Phil sophy of Language, as well as in related areas of Philosophical Logic, Philosophy of Mind, Philosophy of Science, Epistemology, and Metaphysics. He has recently published papers in Synthese, Philosophical Studies, and Philosophers' Imprint, among other places. His book Reference and Structure came out with Routledge in 2013. His two most recent major research grants (SSHRCC SRGs) are "The Future of the Proposition" (2010-13) and "The Externalism/Individualism Debates" (2006-09).

**Abstract.** First, I give a brief survey of the conceptual and historical background (spanning from Homer to Alan Turing) of the notion of Artificial Intelligence. Second, I discuss the rapidly expanding subfield within Applied Ethics which is focused on issues raised by, or pertaining to, AI – which is sometimes evocatively called "Robot Ethics".

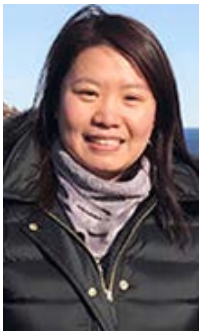
**Keif Godbout-Kinney, Department of Sociology**

**Bio.** I am a second-year PhD student in the Sociology Department at Memorial University. My areas of specialization are social and political theory and science and technology studies, and my specific area of research is the intersection of technology and society with a focus on medical and surgical robots and medical meaning creation. I have a Masters in Women and Gender Studies from Saint Mary's University and my research there focused on the intersection of sexuality and technology, specifically the advent of sex robots under capitalism. Finally, I have a Bachelor degree from St. Thomas University where I majored in Philosophy, specifically ethics and analytic philosophy, and did my honours in English with a focus on literary theory and criticism and genre.

**Abstract.** My research focuses on the intersection of technology and society, specifically the intersection of sexuality and technology examining the advent of sex robots. I examine the relevant literature detailing the current state of sex robots in the industry, problematic aspect vis-a-vis gender, and potential uses suggested for them. At this juncture, there is little empirical data measuring the actual effects of such

technologies, so it is largely a theoretical exercise, although there is significant research that has been done examining social isolation, gender, sex work, and potential therapeutic applications, so these can be extended and extrapolated for the application of sex robots.

**<u>Session 4: Fisheries and Aquaculture</u> (Chair: Dr. Jin Gao, Research Scientist, Marine Institute)**



**Dr. Jin Gao, Research Scientist, Marine Institute**

**Bio.** Jin Gao is a research scientist at CFER, and a junior Ocean Choice International (OCI) Industrial Research Chair in Fish Stock Assessment and Sustainable Harvest Advice for Northwest Atlantic Fisheries. She is a broadly trained quantitative ecologist who is particularly interested in fishery science. She develops and applies modern statistical methods to improve stock assessment. Her current work focuses on methods to improve abundance estimates by incorporating developments in spatio-temporal modeling and improve forecasting using equation-free nonlinear time series analysis. Jin did her second postdoctoral research at a joint position of the School of Aquatic and Fishery Sciences in the University of Washington and the Northwest Fisheries Science Center of NOAA. She did her first postdoctoral research at the Institute of Oceanography in the National Taiwan University. She obtained a PhD degree in Ecology and Evolution at the State University of New York at Stony Brook and a Bachelor's degree in Ecology at Shandong University, China

**Abstract.** Nonlinear dynamics is ubiquitous in fish time series. Understanding the potential for multiple stable states and transitions through them such as regime shift is critical for adaptive management. Complex population dynamics can arise from different processes such as interactions among species, interactions with physical environment, high intrinsic growth rates, stochastic process error, density-dependent dynamics and human intervention. The development in nonlinear forecasting framework significantly improves our understanding of complex dynamics. Empirical Dynamical Modeling (EDM) is based on the Takens' theorem stating that times series can be fully reconstructed using its own lagged variables as proxies. EDM has been a useful algorithm that takes advantage of the nonlinear behavior of time series and has successful applications in non-spatial settings a Pacific sardine, catch per unit effort time series in albacore and forecasting recruitment in sockeye salmon. Here I show the framework and some results in spatial sardine time series.

**<u>Session 5: Business Processes</u> (Chair: Dr. I. Dostaler, Dean and Professor, Faculty of Business Administration)**

**Dr. Joerg Evermann, Associate Professor, Faculty of Business Administration**

**Bio.** Joerg Evermann received his PhD from the University of British Columbia. Prior to joining Memorial, he was a lecturer in the School of Management at Victoria University of Wellington, New Zealand. Dr. Evermann's research interests include cognitive aspects of knowledge representation and knowledge integration. He also has active interests in statistical data analysis techniques and business process management. He has over 50 peer-reviewed publications in premier international journals and conferences.

**Abstract.** Business processes are sequences of activities, events, and decisions carried out by human or technical resources in organizations. Prediction of the future behaviour of a currently running process instance is important. For example, a customer service agent needs to predict the time

to completion to respond to a customer query; a production manager needs to predict abnormal conditions to enable timely intervention. Over the last 5 years, prediction of running business processes has increasingly used deep-learning artificial neural networks and has been framed as classification and regression problems. This video reports on two published studies on this topic, discusses current work in the field, and challenges and open issues that need to be tackled in future work.

**Dr. Jeffrey Parsons, Professor, Faculty of Business Administration**

**Bio.** Jeffrey Parsons joined Memorial University in 1993, where he served as associate dean (research) from 2003-2007 and 2008-2012. Dr. Parsons earned an undergraduate degree in business from Memorial and a PhD in information systems from the University of British Columbia. His research interests focus on representing information in ways that better match how humans think about objects in their physical or social environment. His research has been published in journals such as Nature, Management Science, MIS Quarterly, Information Systems Research, Journal of the Association for Information Systems, Journal of Management Information Systems, Communications of the ACM, ACM Transactions on Database Systems, and IEEE Transactions on Software Engineering. He holds research grants from NSERC and SSHRC and has served on grant committees for both funding councils. Dr. Parsons has held editorial appointments at academic journals (including Information Systems Research and Journal of the Association for Information Systems). He has served as program chair of the AMCIS, ER and WITS conferences. His research interests focus on: classification in systems analysis and design; crowdsourcing; information quality; data management; design science; recommender systems; object-oriented systems and reuse; and electronic commerce.

**Abstract.** Driven by advances in machine learning that make it possible to extract useful information from large and diverse datasets, artificial intelligence has led to significant changes in how organizations use data. However, discrepancies between available data and knowledge about the domain described by the data can negatively affect machine learning outcomes. This research investigates challenges in preserving domain knowledge when preparing input data to use in training and testing machine learning models. We use conceptual modeling principles to develop a method for preparing data for machine learning, comprised of a process and eight guidelines for transforming data. We demonstrate the method's impact on machine learning outcomes in two ways. First, we show the method can improve model performance by applying it to data from a real-world foster care organization. We then conduct an applicability check with data scientists who assess the feasibility and potential usefulness of the method and its impact on process transparency. The results indicate the potential benefits of applying conceptual modeling to machine learning.

**Dr. Majid Eghbali-Zarch, Assistant Professor, Faculty of Business Administration**

**Bio.** Majid Eghbali-Zarch has received his PhD in general management from Ivey Business School at Western University. His main research areas are international business and global strategy. In particular, his current works are focused on: routines and capabilities of multinational enterprises (MNE) in resource allocation practices; and location and experience dynamics and the impact on MNEs' perceived distance from a target host country. Prof. Eghbali-Zarch has also published a case (Tavazo Co.) on the growth and internationalization of a family firm that has been re-printed in two books.

**Abstract.** The advancement in computational technologies, modelling techniques such as deep learning, and analytics as well as availability of large data has created an explosive growth in the deployment of Artificial Intelligence (AI). It is becoming incumbent on firms, small and medium size (SMEs) and large firms alike, to view adoption of AI in various aspects of their businesses strategically and devise a relationship between their overall business strategy and their AI strategy. This presentation will explore the dynamics and complexities of the interplay between automation (i.e. AI only approach) and an augmentation approach (i.e. AI and human agents complementing each other) may deserve further examination. Human agents are known for behavioral biases and the AI is also vulnerable to some biases, from existing data and algorithms. How can the augmentation approach minimize the behavioral biases of humans and the statistical biases of the AI? The adoption of AI in organizational processes and routines is another area of interest. How does the adoption of AI influence the stages of creation, maintenance, and modification of organizational routines and processes? Also, what structures and processes are needed to adapt and innovate using AI? Finally, governments and policy makers have a key role in stimulating and guiding the emergence of an AI economy. They have an important role in areas such as developing regulations, data policies, and privacy policies to prevent adverse ethical and societal consequences of large-scale AI adoption. They can also devise enabling mechanisms for AI-based SMEs (e.g. funding, data support, government AI procurements), as well as social programs targeted towards re-training of de-skilled workers as a result of AI adoption, and enhancing the work force's AI literacy.

**<u>Session 6: Healthcare</u> (Chair: Dr. M. Grant, Associate Dean and Professor, Faculty of Medicine)**

**Dr. Edward Randell, Professor, Faculty of Medicine**

**Bio.** Edward Randell is Chief of Clinical Biochemistry with Eastern Health and a Professor with the Faculty of Medicine in the Division of Laboratory Medicine. Dr. Randell received his B.Sc. and PhD in Science (Department of Biochemistry) at Memorial University. He received a Diploma in Clinical Chemistry from the University of Toronto and is a Certified Clinical Chemist and Fellow of the Canadian Academy for Clinical Biochemistry. He received his Six Sigma Black Belt (Process improvement) in August, 2017. He is actively involved in both national and international organizations focusing on laboratory medicine, including recent involvement as a full member of the International Federation of Clinical Chemistry and Laboratory Medicine Committee on Clinical Laboratory Management, since 2016. He has co-edited and co-chapter author on one book on leadership basics for clinical laboratory professionals (ISBN 978-88-87772-10-4), and has published over 100 articles in international peer-reviewed journals.

**Abstract.** The main currency of the clinical pathology laboratory is information. This information is mainly in the form of numeric data and in brief standardized and qualitative statements. This is used by clinicians with other patient specific health care information about signs and symptoms of disease, treatments, comorbidities, and family and personal history to inform an action plan to address health concerns. Technological advances have resulted in highly reliable analytical processes. However, considerable opportunity exists for improvements at other phases of the testing process and at the stages of the clinician-patient encounter, by making use of information technologies and artificial intelligence. The post-analytical phase presents the last opportunity for corrective action on any anomalous or unusual findings before release into the electronic health record and action by clinicians. The traditional and standard practice for test result validation has involved manual review of test results by laboratory staff prior to release. This is a time-consuming, labor intensive and subjective process vulnerable to human error, and inadequate in detecting many anomalies hidden within the complex relationships that exists

between different test results and patient demographics. In recent years, the use of computer technologies to facilitate identification for action unusual test results and result combinations have become more common. This has led to improvement in error identification and correction, and in timely alerting of clinicians to emergent and rapidly evolving health concerns for individual patients, both lowering risk for harm and improving outcomes. The automated process of test review is called autoverification. Our facilities have been leaders in adoption of these technologies. Our areas of interest involve further improving our autoverification algorithms by making use of artificial intelligence and machine learning technologies. And towards the goals of providing safer, faster, and more cost-effective laboratory service. Our interests also extend to exploring opportunities to facilitate personalized approaches to test selection and ordering towards the goals of providing rapid, timely, and effective use of laboratory services.

**Dr. Angus Hartery, Associate Professor, Faculty of Medicine**

**Bio.** Angus Hartery, MD, FRCPC, is a staff radiologist and associate professor in the Discipline Of Radiology at Memorial University. Dr. Hartery completed an abdominal imaging fellowship at University Health Network, Toronto, Ontario in 2011. He has just finished a 7 year term serving as postgraduate radiology residency program director. During his term he received the regional mentor of the Year award from the Royal College of Physicians and Surgeons of Canada. His interests are post graduate and undergraduate medical education, online education with interactivity to promote engagement, and online assessment with immediate feedback and statistical analysis.

**Abstract.** Radiologists are no strangers to adapting to digital change. They were among the first physicians to adopt computer science. In the past, disrupting technologies (e.g. non-x-ray-based modalities, such as ultrasound and MRI) that seemed to go beyond radiology were embraced by radiologists. Electronic systems for reporting and viewing images were primarily created to optimize radiologist productivity. The radiologist's duties also include communication of diagnosis, consideration of patients' values and preferences, medical judgment, quality assurance, education, policy-making, interventional procedures, and many other tasks that, so far, cannot be performed by computer programs alone. While AI may help with diagnosis and prediction, current AI cannot independently demonstrate action and recommendation without a radiologist supervising. If the time needed for image interpretation were shortened, radiologists would be allowed to perform more value-added tasks, such as integrating patients' clinical and imaging information, having more professional interactions, becoming more visible to patients and playing a vital role in integrated clinical teams. Physicians (i.e., radiologists) remain essential for medical practice. However, AI could already be used to accomplish tasks with a positive, immediate impact, most of them already described in literature: 1. Prioritization of reporting: automatic selection of findings deserving faster action. 2. Comparison of current and previous examinations, especially in oncologic follow-up: saving significant time for radiologists who normally count and measure many of the nodules on livers and lungs. 3. Quick identification of negative studies. Finding the normal studies and leaving abnormal ones for radiologists. 4. Accessing complicated and cumbersome electronic medical records allowing radiologists to adapt protocols or interpret exams in the full context. 5. Automatic recall and rescheduling of patients. 6. Helping ordering physicians with a clinical decision support system for deciding if imaging is needed and what imaging is needed. 7. Data mining regarding relevant issues, including radiation dose.

**<u>Session 7: Education</u> (Chair: Dr. A. Burke, Professor, Faculty of Education)**

**Dr. Sohaib Al-Asaaed, Assistant Professor, Faculty of Medicine**

**Bio.** Sohaib Al-Asaaed received in 2017 a Masters Health Professions Education, Maastricht University, Maastricht, Netherlands, in 2013 a Clinical Fellowship in Genitourinary Medical Oncology, Western University London, ON, and in 2011, a Residency In Medical Oncology, Western University, London. In 2009 he held a Residency in Internal Medicine, Memorial University, and in 2006, and MD, Dalhousie University, Halifax. He is currently assistant professor in the faculty of Medicine, Memorial University, Canada.

**Abstract.** Medical education is evolving at a rapid pace. With the introduction of competency based medical education, decision regarding competence is moving away from time based approaches to requiring evidence in support of promotion. Training programs across the country are beginning to feel the weight of a significant amount of data that is now required as part of the process of decision making. This model of education is spreading within the continent and beyond. Data is now being collected in electronic portfolios. This data is raw, with significant 'noise' and it is left up to groups of individuals (usually physicians) to dig through the noise to find a pattern that can inform their important decision to promote and entrust with patient care, or remediate and support. These humans understandably bring significant wealth of knowledge and context but may also be prone to conscious and unconscious biases. While mitigating inherent biases is always important, the application of artificial intelligence is even more profound when we examine its role in building predictive modeling of future performance based on current data. Some of this work is already taking place at universities in the United States, but it is in its early days. We aim to leverage the power of artificial intelligence and apply it to our already significant number of data points to build some of these models to assist in the decision making processes.

**Dr. Greg Naterer, Dean and Professor, Faculty of Engineering and Applied Science**

**Bio.** Greg Naterer is Dean of the Faculty of Engineering and Applied Science and a professor of mechanical engineering. He has led the Faculty to substantial growth in enrolments, infrastructure, research capacity and interdisciplinary initiatives. Nationally and internationally, he has served in leadership roles in education and research, such as Chair of the National Council of Deans of Engineering and Applied Science (NCDEAS) and the Discovery Grant Committee (Mechanical Engineering) of Canada's Natural Sciences and Engineering Research Council (NSERC). Dr. Naterer is an active community volunteer. He serves on the Board of Directors of the Dr. Jack Hand Legacy Foundation (a cancer care foundation), Rotary Club of St. John's East and the Gathering Place. He was born in Toronto, Ontario, and received his PhD in mechanical engineering from the University of Waterloo in 1995.

**Abstract.** This presentation discusses the important role of universities in preparing graduates for the rise of artificial intelligence in the workforce. The impact of AI on future jobs has been extensively reported but relatively few studies have examined the role of universities in preparing students for this forthcoming disruption in the workplace. Dr. Naterer's research investigates learning outcomes and competencies of university graduates that are most resilient to AI computerization. As AI systems become more capable in various areas over a range of disciplines, university graduates will benefit from the right skills and

competencies that add value beyond what AI can achieve. The research examines the most resilient skills in various occupations by correlating the probabilities of computerization to individual competencies of educational disciplines.

**Session 8: Multidisciplinary Applications (Chair: Dr. I. Sutherland, Dean and Professor, School of Music)**

**Dr. Syed Imtiaz, Professor and Department Head of Process Engineering**

**Bio.** I joined the Faculty of Engineering and Applied Science in 2010 as an assistant professor of process engineering. Prior to 2010, I worked in the Advanced Process Control group of Aspen Technology where I implemented advanced control solutions for a wide range of industries including different units (CDU, HDS, FCC) of refineries, ethylene / methanol plants and other petro-chemical plants. My research interests involve safety and control in processing industries. Currently I am using multivariate statistical tools and Bayesian belief networks for complex reasoning and online diagnosis of process faults. In an Imperial Oil funded project, I am working on modeling and simulation of hydrogen desulfurization processes. I am also applying advanced control theories to automate managed pressure drilling (MPD) systems. My research is motivated by practical problems and applications to two key areas relevant to this province: offshore oil and gas, and mineral processing. I have published more than 30 peer-reviewed journal papers and conference proceedings.

**Abstract.** Artificial neural networks (ANNs) are useful tools for fault detection and identification. However, application of ANN to process systems is often challenging due to the high number of monitored variables, which leads to considering many neurons to model the system. The problem is more acute when modelling dynamic processes, as the number of variables increases many fold due to inclusion of the lagged variables in the data set. Training of such a large scale network is time-consuming and provides poor performance with a high error rate. In this presentation, a principal component analysis (PCA) and dynamic PCA (DPCA) are combined with ANN to reduce the dimensions of the training data set. PCA or DPCA extract the main features of the measured variables. Instead of raw data, lower dimensional score vectors are used to train ANN, where ANN performs the classification for anomaly detection. Results show that the use of the scores instead of the raw data reduces the time to train ANN to a fraction and results in a greater accuracy in detection and classification. The proposed approach is successfully validated, considering several real-life like faults associated with an existing offshore process platform.

**Dr. Lourdes Pena-Castillo, Associate Professor, Department of Computer Science**

**Bio.** Peña-Castillo is an Associate Professor in the Departments of Biology and Computer Science (jointly appointed) at Memorial University. Her current main area of research is the application of statistical- and machine learning-based methods to decipher bacterial gene regulation. Throughout her academic career, she has developed and/or applied artificial intelligence or machine learning methods in various areas such as biomedical sciences, games, and augmented virtuality.

**Abstract.** In this presentation, I describe four projects done in my lab that involved the application of machine learning methods to biological problems. These projects are: 1) using feature selection and machine learning to discover potential disease biomarkers, 2) creating a classifier to distinguish bacterial small RNAs (sRNAs), 3) predicting transcriptome-wide sRNAs targets using a random forest classifier, and 4) detecting bacterial promoters from genomic sequences using machine learning.

**Dr. Pierre-Paul Bitton, Associate Professor, Department of Psychology**

**Bio.** Pierre-Paul Bitton is an associate professor in the department of psychology, Memorial University. The Visual Ecology group studies visual communication in birds, fish, and other critters. The research projects will range from the proximate mechanisms of perception (spatial frequency, contrast sensitivity function, flicker fusion frequency, spatial summation), to behaviours (social visual communication in large groups), and ultimate mechanisms (e.g., effect of photic environment to evolution of visual system on micro-evolutionary scale). We leverage the range of expertise available in the Psychology department to complement our research, and offer students an interdisciplinary learning environment.

**Abstract.** Atlantic puffins are highly social colonial seabirds. They display bright bills that are presented during interactions with mates, and other individuals. One of our main research goals is to determine if each bill has features that make them unique, thus allowing for individual recognition. To accomplish this, we take pictures of puffins in the visible wavelengths, and in the ultraviolet because puffins can see in this range of colours. We initially used image analysis algorithms such as the scale-invariant feature transform (SIFT) to determine if individuals could be identified; these attempts were not successful. We are now turning to machine learning to find informative features. A preliminary trial (only 41 individuals) with Siamese Networking using One-shot learning algorithm successfully identified 90% of the individuals. We now have many more pictures (~200) and will be implementing a much better model. We have high certainty of reaching 100% accuracy.

**Dr. Oscar De Silva, Assistant Professor, Department of Mechanical Engineering**

**Bio.** Dr. Oscar De Silva received his B.Sc. degree in mechanical engineering from the University of Moratuwa, Sri Lanka, in 2009. He joined the intelligent systems lab of Memorial University in 2010 as a graduate researcher focused on sensor design, estimation, and control algorithms for robotic applications. After completing his PhD thesis in 2015, he worked as a research fellow for the American Bureau of Shipping-Harsh Environment Technology Centre (ABS HETC) developing a computer vision system for detection and tracking of pack ice. In May 2016 he joined as an assistant professor of mechanical engineering. His current research interests include design of sensors, state estimators, autonomous navigation, and machine learning.

**Abstract.** This presentation considers Artificial Intelligence (AI) prospects of two industrial operations, namely ice navigation of vessels and last-mile goods delivery logistical operations. Ships traversing in polar waters continuously maps and quantifies the ice threat posed for arctic ship operations. The state-of-the-art operations rely on satellite radar and opportunistic vessel reports to generate a daily snapshot of ice conditions of the arctic made available through the Canadian Ice service. Ice navigators record ice conditions using the Egg Code standard for reporting and use it in Polar Operational Limit Assessment Risk Index System (POLARIS) for operational safety assessment. Egg code captures the concentrations, stages of development, and form of ice, which helps with the task and furthermore serves other ships in the area through the Canadian ice service data center. With the advances in machine vision, this process has the potential to be automated to reduce the time required for the necessary documentation to be completed and serve as enhanced AI navigation assistance for safe navigation in the long term. Current research at MUN develops AI machine vision systems to classify the ice types and improve the standardized reporting practices. The research uses Nathaniel Palmer voyage image data feeds to train a vision-based AI system

intended to supplement a vessel's navigation suite. Also, we consider autonomy of Vertical Take-Off and Landing (VTOL) aircraft used for transporting goods to and from inaccessible areas. These systems can be enhanced and de-risked by increasing the autonomous capabilities of the vehicles. Canadian research thrusts aim to develop AI-powered multi-sensor based navigation solutions, which can be integrated into VTOL vehicles in real-time to improve its autonomous capabilities and to reduce pilot workload.

**<u>Session 9: Earth Sciences</u> (Dr. T. Fridgen, Acting Dean and Professor, Faculty of Science)**

**Dr. Alison Malcolm, Associate Professor, Department of Earth Sciences**

**Bio.** Alison Malcolm received the B.Sc. (Honours) from University of British Columbia, Canada, in 2000. She received a Ph.D. degree in Geophysics, with a Mathematics minor, at the Colorado School of Mines, in the Center for Wave Phenomena (advisor Prof. M.V. de Hoop, co-advisor Prof. J. A. Scales) in 2005. My research focuses on the understanding subsurface fractures and fluids, specifically how best to image the subsurface and how best to exploit small but coherent signals in the data. It aims to better understand how accurate our images and parameter estimates are and imaging of the distribution of the Earth's nonlinear wave properties to distinguish fluid types and fracture orientations and densities remotely.

**Abstract.** In Earth imaging, we are often trying to connect datasets that are collected on different scales and sample different physical properties. Through this process, we are trying to learn the extent of certain subsurface structures, their properties, and the underlying physics that governs the observed processes. I will present two examples that illustrate two different aspects of this problem. In the first example, we take some relatively standard semi-supervised learning techniques and adapt them to use them to match geophysical data to geological labels. This is an important application because the geological labels are expensive to collect and are thus collected at only a few locations. The geophysical data by contrast, can be collected at many more locations but is much more difficult to interpret and label. By using a semi-supervised approach, and by tuning and adapting the various parameters, we are able to correctly label geophysical data with geologically meaningful results, using only a very few labels. In the second example, we work on the idea that machine learning is not only for pattern recognition, but can also be used to improve our understanding of the physics underlying our datasets. For example, there is no single widely-accepted theory that explains earthquake generation, but there are many competing theories. We are working towards applying machine learning to help us determine which of these theories best describe the observed data. We present a preliminary experiment in which we try to fit data to different models to see if a classifier can do as well as a minimum misfit model at determining which model best fits the data.

**Dr. Colin Farquharson, Professor, Department of Earth Sciences**

**Bio.** Colin G. Farquharson is associate Professor Department of Earth Sciences at Memorial University. His research interest is the development of theory and algorithms for the forward-modelling and inversion of geophysical electromagnetic data.

**Abstract.** Self-organising maps (SOMs) are a type of unsupervised artificial neural networks clustering tool. SOMs are used to cluster large multi-variate datasets. They have the potential to identify patterns and trends in the geophysical maps of an area

and to generate proxy geology maps, a process known as remote predictive mapping. We applied SOMs to magnetic, radiometric and gravity datasets compiled from multiple modern and legacy data sources over the Baie Verte Peninsula, Newfoundland, Canada. The regional and local geological maps available for this area, as well as the knowledge from numerous geological studies, allowed for assessment of the accuracy of the SOM-based predictive mapping. Proxy geology maps generated by primary clustering directly from the SOMs as well as secondary clustering using a k-means approach reproduced many of the geological units identified by previous traditional geological mapping. Of the combinations of datasets tested, the combination of magnetic data, primary radiometric data and their ratios, and Bouguer gravity data gave the best results. We found that using reduced-to-the-pole residual intensity or analytic signal as the magnetic data were equally useful. The SOM process was unaffected by gaps in the coverage of some of the datasets. The SOM results could be used as input into k-means clustering, which requires that no gaps exist in the data. The subsequent k-means clustering resulted in more meaningful proxy geology maps than were created by the SOM alone. In regions where the geology is poorly known, these proxy maps can be useful in targeting where traditional, on-the-ground geological mapping would be most beneficial. This can be especially useful in parts of the world where access is difficult and expensive.