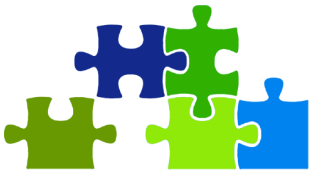
Science Atlantic
Computer Science
Mathematics & Statistics | Conference



Mathematics, Statistics, and Computer Science Conference

Université de Moncton

October 12th–14th, 2018

UNIVERSITÉ DE MONCTON
EDMUNDSTON MONCTON SHIPPAGAN

Atlantic Association for Research in the Mathematical Sciences

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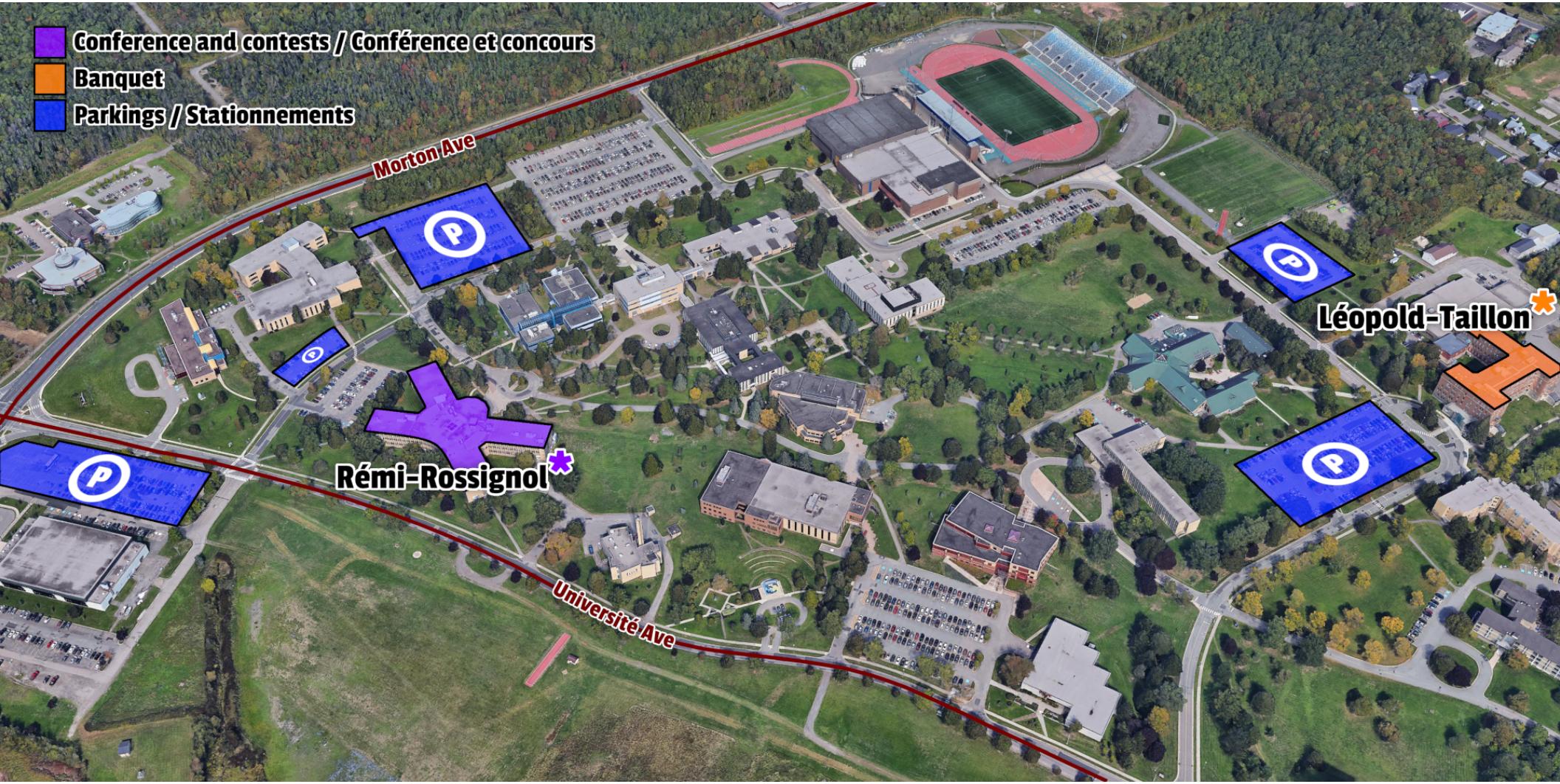
Conference and contests / Conférence et concours
Banquet
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Morton Ave
Rémi-Rossignol
Université Ave
Léopold-Taillon

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Welcome and General Information

On behalf of the Faculty of Science at Université de Moncton, it gives me an immense pleasure to welcome you all to the 2018 Science Atlantic meeting. This meeting that brings together the participants, especially the students of the fields of mathematics, statistics and computer science, is very important as the collective and individual advancements in these fields are leading to fantastic progress in science and technology. I am sure that the sharing of ideas through student presentations and the plenary talks by experts in these fields will be a very enriching experience to all the participants.

My best wishes to you all for a memorable meeting and a pleasant stay in Moncton.

Au nom de la Faculté des sciences de l'Université de Moncton, j'ai l'immense plaisir de vous accueillir tous à la conférence Science Atlantique 2018. Cette conférence qui réunit parmi ses participants, en particulier des étudiantes et étudiants, dans les domaines des mathématiques, de la statistique et de l'informatique, revêt une très grande importance étant donné les avancements collectifs et individuels dans ces domaines qui mènent à des progrès formidables en science et technologie. Je suis sûr que le partage des idées à travers les présentations étudiantes et les conférences plénières par des experts dans leurs domaines respectifs sera une expérience très enrichissante pour tous les participants.

Je vous souhaite à tous une conférence mémorable et un agréable séjour à Moncton.

Dr. Pandurang V. Ashrit, Dean of Science

I am pleased to welcome all of you, teachers and students, to the 2018 Science Atlantic meeting at the University of Moncton. Computer Science, Mathematics and Statistic are very central fields in the 21st century sciences. The universe is mathematical and mathematical sciences are at the heart of the understanding of nature and of our capacity to develop new technologies. The solution to many problems of our time, facing global warming for instance, will not be found without computers and mathematics.

This conference is centered on students. Besides three plenary lectures given by experts in their respective fields, most of the activities of Science Atlantic revolve around the students. There are two student competitions and there are sessions of short talks presented by students from all corners of Atlantic Canada. Welcome to Moncton, enjoy and learn.

Je suis très heureux de vous accueillir, professeurs et étudiants, à la Conférence 2018 de Science Atlantique à l'Université de Moncton. L'informatique, les mathématiques et la statistique sont des disciplines centrales dans les sciences du 21e siècle. L'Univers est mathématique et les sciences mathématiques sont au cœur de la compréhension des lois de la nature et du développement des nouvelles technologies. Les solutions à plusieurs problèmes de notre époque, faire face aux changements climatiques par exemple, ne sauront être trouvées sans ordinateurs ou mathématiques. Cette conférence est centrée sur les étudiants. Outre trois conférences plénières, présentées par des experts dans leurs domaines respectifs, les activités de Science Atlantique tournent autour des étudiants. En plus de deux concours, il y a des sessions de communications présentées par des étudiants de partout au Canada Atlantique. Bienvenue à Moncton et profitez de votre expérience.

Dr. Paul Deguire, Directeur, Dépt. de mathématiques et de statistique

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Welcome to Science Atlantic 2018. We invite you to combine the pleasant and the useful by attending our expert lectures and student presentations, while enjoying your free time to explore the various charms of the city of Moncton. We wish you the best stay at Université de Moncton.

Bienvenue à Science Atlantique 2018. Nous vous invitons à joindre l'utile à l'agréable en assistant à nos conférences d'experts et à nos présentations étudiantes, tout en profitant de votre temps libre pour explorer les charmes variés qu'offre la ville de Moncton. Nous vous souhaitons le meilleur des séjours à l'Université de Moncton.

Dr. Eric Hervet, Directeur, Dépt. d'informatique

General Information

For **Saturday's banquet**, please make your way to the Taillon Building for 5:45pm, to be seated by 6pm.

Prize winners will be announced during the banquet.

Schedule At A Glance

Locations: With the exception of the Saturday evening banquet in the Taillon Building, all events on Friday, Saturday, and Sunday will be in the Rémi-Rossignol Building.

Friday

10:00–6:00	Check-in – Rotonde
11:30–12:00	Programming Competition Meeting – A031
12:00–5:00	Programming Competition – A031 & D213
2:00–5:00	Mathematics Competition – A102
2:45–3:45	Joint meeting – A002
4:00–5:00	Math meeting – A002
4:00–5:00	CS meeting – R113
5:30–7:00	Pizza Party – Rotonde
7:30–8:30	**Sedgwick Lecture (CS)** – R221: *A Connected World: Challenges and Opportunities in Overcoming the IoT Datastorm* – Soumaya Cherkaoui
8:30–10:00	Reception – Rotonde

Saturday

9:00–11:00	Check-in – Rotonde
9:00–10:30	Contributed talks – A002 (CS), A102 (Math), A202 (Stats)
10:30–11:00	Break – R215
11:00–12:00	**Blundon lecture (Math)** – R221: *An Introduction to Mathematical Modeling: From Academic to Industrial Problems* – André Fortin
12:00–2:00	Lunch Break
2:00–3:30	Contributed talks – A002 (CS), A102 (Math), A202 (Stats)
3:30–3:45	Break – R215
3:45–4:45	**Fields lecture (Stats)** – R221: *Bayesian Statistics in theory and in practice* – François Perron
6:00-9:00	Banquet & Awards – Taillon

Sunday

AARMS Workshop – A031

9:00–10:00	*Introduction to Markov Chain Monte-Carlo sampling* – Salah El Adlouni
10:00–10:15	Coffee Break (R215)
10:15–11:00	MCMC Programming Workshop
11:00–12:00	*Constrained Multiple Taxicab Correspondence Analysis of Multivariate Binary Data with Rare Categories* – Vartan Choulakian & Jacques Allard

Keynote Speakers

Soumaya Cherkaoui – *Université de Sherbrooke*

A Connected World: Challenges and Opportunities in Overcoming the IoT Datastorm

Abstract: Internet of Things (IoT) systems use communication to interact with a variety of "things", at home, in industry, and on the road. In last few year, IoT has progressed from a being a cutting edge technology, to a pervasive, common one. In fact, specialists estimate that IoT growth is now gathering a massive momentum, with an estimated number of 50 billion connected "things" by 2020. In the quest to interact more efficiently with this world of things around us, a sea of data is being produced, thus prompting significant challenges. First, the sheer volume of data points generated by IoT systems are encumbering communications networks. Second, cybersecurity is becoming a major concern with surveys showing that users and consumers lack confidence in the security of IoT devices and systems. Third, there are many legal and regulatory questions that revolve around the IoT that need to be addressed including property of data, privacy, and liability when data is accessed. In this talk we will discuss all these challenges, while also presenting some new solutions to address these challenges and showcasing some of the most promising opportunities that IoT bring for a smarter world.

Bio: Pr. Soumaya Cherkaoui, P.Eng, Ph.D., is a Full Professor at Department of Electrical and Computer Engineering of Université de Sherbrooke, Canada which she joined in 1999. She is also the Director of INTERLAB, a research Laboratory which conducts research funded both by government and industry. Before joining U. Sherbrooke as a faculty member, Pr. Cherkaoui worked for industry as a project leader on projects targeted at the Aerospace Industry. Pr. Cherkaoui avails of a long research experience in the wireless networking, particularly machine-to-machine communications, IoT, cyberphysical systems, and vehicular communications. She has more than 200 publications in reputable journals, conferences and workshops in the area. She has led, as principal investigator, several Canadian and Quebec projects on wireless communications technologies supported by NSERC, NCEs and FRQNT along with several industrials. The work of Pr. Cherkaoui resulted in technology transfer to Canadian companies and to patented technology. She regularly acts as an expert in the field of wireless networks, having been on evaluation panels and committees of national and international funding agencies. She currently acts as vice-president of the Ad hoc and Sensor Networks Committee of IEEE Communication Society.

André Fortin – *Université Laval*

An Introduction to Mathematical Modeling: From Academic to Industrial Problems

Abstract: In this presentation, I will show how ordinary and partial differential equations can be used to provide mathematical models describing various phenomena encountered in nature. Starting from these simple academic models, mathematicians can build more complex systems of differential equations models that can be used in real applications. These equations are often extremely difficult to solve and numerical solutions are therefore necessary using sophisticated methods on supercomputers. I will show examples such as the propagation of infectious diseases, the design of new tires and of personalized orthopedic prosthesis.

Bio: Pr. André Fortin obtained his Ph.D. from Université Laval in 1984. He has been a Professor at École Polytechnique de Montréal from 1984 to 2000, and a Professor at Université Laval since 2000. He is also the Director of GIREF, and of the NSERC industrial chair on Mathematical Modeling and Multiphysics Numerical Simulations in partnerships with Michelin, Hydro-Québec and Bodycad.

François Perron – *Université de Montréal*

Bayesian Statistics in theory and in practice.

Abstract: In this presentation, we introduce the basic ideas of bayesian statistics starting from the beginning with Bayes and Laplace. We show that bayesian statistics are useful with simple examples and we explain why it is important for the theoretical aspects. We give real life examples where it has been used. Finally, we give the viewpoints of some of the leaders in statistics about bayesian statistics. This talk is mostly based on the following books, Ten great ideas about chance by Persi Diaconis and Brian Skyrms, (2018) The theory that would not die by Sharon Bertsch McGrayne, (2011).

Bio: François Perron est professeur titulaire au département de mathématiques et de statistique de l'Université de Montréal. Il a obtenu son PhD à Montréal en 1987. Ses intérêts de recherche portent essentiellement sur les aspects théoriques de la statistique. Cela comprend la théorie de la décision, l'approche bayésienne, les statistiques multidimensionnelles et plus spécifiquement les méthodes de simulations plus connues sous le terme MCMC (simulation de Monte Carlo par chaînes de Markov).

Contributed Talks

Computer Science Session 1 – 9:00-10:30, A002

Relative visual localization for unmanned aerial vehicles – Andy Couturier, Department of Computer Science, UdeM (*Collaborators: Dr. Moulay Akhloufi*)

Abstract: Most of today's unmanned aerial vehicles (UAV) applications require autonomous navigation and depend on an accurate self-localization solution. The vast majority of UAVs board a global navigation satellite system (GNSS) sensor and an inertial measurement unit (IMU). IMU sensors are able to accurately estimate the pose of an UAV over a short period of time but tend to quickly accumulate error. GNSS are, however, more accurate over longer periods of time and have a bounded error. These sensors are combined through sensor fusion to retain the benefits of both while eliminating the effect of their individual weaknesses. However, this approach have a significant drawback due to GNSS being subject to signal unavailability and multiple type of interference. In such scenarios, the localization solution degrade very and put the integrity of the UAV in danger. The root cause of the problem resides in the use of radio communications. Therefore, we propose the use of local visual information to perform relative localization in unknown outdoor environments. We use feature point methods to extract salient points from a set of images pertaining to possible matches during the navigation. The extracted features are matched with available visual data stored during previous navigation or from aerial imagery. Multiple feature extraction techniques were compared empirically with data obtained from outdoor videos captured using a quadcopter. The results are promising and show the possibility of using relative visual data in GNSS-denied environments to improve the robustness of UAVs navigation.

Giving Neural Nets a Twist – Stephanie Cairns, School of Mathematical and Computational Sciences, UPEI (*Collaborators: Dr. Gordon MacDonald*)

Abstract: Neural networks have been part of the mathematical toolkit for decades, and in that time have evolved from simple function-approximating structures to deep networks capable of tackling immense data sets of increasing complexity. However, in using deeper and deeper networks, the famous vanishing gradient problem, a phenomenon that has plagued these constructions from the beginning, is magnified as well. Simply put, the gradients guide the network towards a solution but can become vanishingly small as more and more layers are added. Many work-arounds have been proposed, but vanishing gradients remain a key obstacle in modern machine learning. We offer a novel mathematical approach to this challenge: combining the norm-preserving properties of unitary matrices with a new hypervolume-preserving activation function in order to stabilize the gradients and avoid the vanishing gradient problem altogether.

Les réseaux des neurones font partie de la boîte à outils mathématique depuis des décennies et pendant ce temps ont évolué des simples structures dédiées à l'approximation des fonctions aux réseaux profonds capables de manipuler d'immenses ensembles de données de complexité croissante. Pourtant, en employant des réseaux de plus en plus profonds, le fameux problème des gradients disparaissant, un phénomène qui a embêté ces constructions dès le début, est aussi amplifié. Tout simplement, les gradients guident le réseau vers une solution, mais peuvent se rapetisser au point de disparation avec l'ajout de couches supplémentaires. Plusieurs solutions ont été proposées pour réduire l'impact de ce problème, mais il demeure un obstacle clé dans le domaine d'apprentissage automatique. Nous offrons une nouvelle approche mathématique pour s'attaquer à ce défi : en combinant les propriétés de préservation de la norme des matrices unitaires avec une nouvelle fonction d'activation capable de préserver ce même volume, nous prévoyons stabiliser les gradients et éviter dans son entier le problème des gradients disparaissant.

Human Movement Signal Decoding as an Unsupervised Learning Task – William Taylor-Melanson, School of Mathematical and Computational Sciences, UPEI (*Collaborators: Dr. Andrew Godbout*)

Abstract: This presentation will show the findings of a new strategy of human movement analysis using deep learning and artificial neural networks. Our strategy maps an incoming periodic signal, (t), from a human test subject using an encoder-decoder paradigm to an outgoing periodic signal, (t). This strategy uses the encoder as a linear mapping (t) representing the position of a time t relative to the waveform cycle of x. Once encoded, a decoder maps (t) back into a separate signal (t). This strategy opens the door to many possible applications, from time series prediction to physical therapy and interactive feedback. I will present a prototype system that uses our strategy to provide haptic (vibrational) feedback to stimulate muscles. This prototype takes as input an EMG (electromyography) signal from a test subject walking and when combined with our encoder-decoder paradigm allows one subject to 'feel' as they walk, the point in time (via haptic vibration) when the muscles of another subject would fire. Such a setup could be deployed in athletics and rehabilitation settings.

Quantum Maze – Chao Qian, School of Mathematical and Computational Sciences, UPEI (*Collaborators: Dr. Gordon MacDonald*)

Abstract: We talk about using quantum algorithms to analyze games. In particular, we consider the problem of escaping a maze, with n escape doors and a key with limited uses. We will reveal some "truth" in your life that no one has told you before, through a simple maze game!

Computer Science, Session 2 – 2:00-3:30, A002

Mathematical and Computational Applications of Magnetic Resonance Imaging in diagnosing ADHD – Cynthia Forgeron, Computer Science Department, StFX (*Collaborators: Dr. Jacob Levman*)

Abstract: Magnetic Resonance Imaging (MRI) and its application in diagnosis is one of the most significant innovations in healthcare engineering. Statistical analyses of volumetric MRI examinations are invaluable in neuroscience research as more and more anatomical biomarker measurements are acquired in a typical exam. MRIs of children (n=637, age range from 6 months to 21 years) with attention deficit hyperactivity disorder (ADHD) and 993 controls were acquired at Boston Children's Hospital. Statistical and computational methods were used to compare ADHD participants with neurotypical controls at a variety of developmental stages to assess any abnormal neurodevelopment associated with ADHD and to evaluate our ability to diagnose and characterize the condition from real-world clinical magnetic resonance imaging (MRI) examinations. Several anatomical differences were found, specifically in cortical regions that may be associated with known symptoms of ADHD. Future work involves the application of machine learning and pattern recognition technologies to help better understand the abnormal neurodevelopment associated with ADHD, as well as to assist in the creation of the next generation of diagnostic tests.

Machine Learning Applied to Medical Imaging as a Diagnostic Tool – Katie MacEachern, Computer Science Department, StFX (*Collaborators: Dr. Jacob Levman*)

Abstract: One of the most common applications of machine learning in medical imaging is in diagnostic testing. Diagnostic machine learning technologies are typically responsible for identifying a patient as healthy or having a particular pathological condition. Optimization of diagnostic testing involves tuning a test bias setting which makes the test more likely to predict a sample as either healthy or representing a given pathology. Traditional machine learning techniques such as the support vector machine (SVM) perform test biasing with a simple threshold that when modified causes a basic shift (translation) of the learned decision boundary in data space. An improvement to this popular technique in order to perform regression-based analysis is proposed based on a novel statistical learning formulation for which test biasing affects not only the position of the decision boundary but its shape as well. The proposed learning technique is explored and evaluated in several applications. The proposed tool is tested across many datasets and performance is compared to several standard supervised machine learning techniques using the performance metrics: overall accuracy and area under the receiver operating characteristic curve (AUC). All machine learning techniques under consideration are explored in a case study investigating their potential as diagnostic tools for autism by applying them to a large dataset of real-world clinical magnetic resonance imaging (MRI) examinations of children with autism and healthy patients.

Machine learning applied to medical diagnostics based on volumetric magnetic resonance imaging – Max Jennings, Computer Science Department, StFX (*Collaborators: Dr. Jacob Levman*)

Abstract: Machine learning is an active area of research in medical imaging-based diagnostics. Most machine learning algorithms applied to medical images are optimized for two-dimensional inputs, however, in magnetic resonance imaging (MRI) it is common to acquire three-dimensional volumetric images. This research involves the development of machine learning technologies optimized for medical diagnostics based on volumetric MRI examinations. In this analysis, we focus on a public Schizophrenia MRI dataset (Gollub et al., 2013). Classical diagnostic approaches to this problem would involve using an established feature extraction method, followed by the use of traditional statistical machine learning technologies. Alternatively, the use of convolutional neural networks (CNNs) has seen remarkable growth in recent years, a technology capable of learning the underlying features to be extracted from the examinations which form the basis of diagnostic prediction. This analysis attempts to pursue both classical approaches as well as those based on CNNs for volumetric MRI. The FreeSurferbrain imaging software package (Fischl, 2012) was used to extract measurements from the MRI image; these measurements were then used as input features to the traditional statistical machine learning algorithms investigated, including, the support vector machine, the random forest, the decision tree and the artificial neural network. We present results from our efforts to develop a wide variety of diagnostic technologies for this application. Work towards the development of CNN architectures for volumetric MRI is ongoing. Each of the diagnostic technologies evaluated are compared for accuracy using established methods. Methods for assessing sample size needs are also presented.

Energy Efficient Multicast Scheduling with Delay Constraints – Ismaïl Bagayoko, Computer Science Department, UdeM (*Collaborators: Dr. Elmahdi Driouch*)

Abstract: Over the last few years, the number of connected devices has increased dramatically which resulted in an exponential growth in mobile data traffic. Today's networks are no more able to satisfy the increasing users' service demand in terms of higher data rates and reduced delays. Moreover, the demand is no longer focusing on traditional communication services, such as calling and texting but rather shifted to more capacity hungry services such as video streaming and content sharing. Fortunately, in many cases, data demands tend to be more and more similar both geographically and in time. For example, we may have several users asking a cellular base station for the same video clip at the same time. Therefore, unicast transmissions used in traditional networks are no longer the optimal communication strategy. In this talk, we present the advantages of using multicast transmissions in next generation wireless networks. In fact, even if multicasting has been a well-studied networking subject for decades, its implementation at the edge of wireless networks is becoming more interesting recently thanks to advances in edge caching techniques. We also present

in this talk, three algorithmic solutions that seek to optimize energy consumption at the radio access network subject to quality of service requirements at the mobile users. À venir.

Mathematics, Session 1 – 9:00-10:30, A102

An analysis of phase structure and execution of Steve Reich's "Marimba Phase – Margaret Hopkins, Dept. of Mathematics and Statistics, Acadia (*Collaborators: Dr. Holger Teismann*)

Abstract: Steve Reich is one of the world's most successful composers of modern music. The piece of music that is the focus of this research, Reich's "Marimba Phase", uses a technique called gradual phasing. Gradual phasing is an example of "process music", or music that is completely determined by the process through which it is created, in this case phasing. The composer needs only to define the parameters and the process, and then observe the resulting musical effects. The concept of live musicians performing this type of music prompts questions about whether it is possible for performers to implement this process accurately, whether they are aware of the structure of the piece as they are performing, and how to tell whether a phase was executed properly. In this talk, I will share how I extracted data from recordings of "Marimba Phase" and used this data to model the structure of the phasing in the piece. I will also make connections between the observations I made using my models and musical observations taken from my interviews with the performer. I would like to acknowledge my supervisor, Dr. Teismann for his support of my project, as well as Mark Adam for creating recordings of "Marimba Phase" for me to analyze and providing musical insight into the piece.

Easy as 1–2–3 – Adam Lucas, Dept of Mathematics and Statistics, Dalhousie (*Collaborators: Dr. Jeannette Janssen*)

Abstract: The 1-2-3 conjecture states that any graph with no component isomorphic to K_2 can be properly coloured by a function from the vertices and edges into the natural numbers with the property that each vertex is mapped to the whole number which agrees with the sum of the function's values over every edge incident to that vertex and every edge is mapped to a positive value less than or equal to three. Such a function is a 3-edge weighting, proper 3-edge weighting if it properly colours the graph. We will consider the case where the edges are only mapped to the numbers one and two, a 2-edge weighting, which does not always produce a proper colouring. A generalized conjecture with multisets lets any two distinct elements denote a unique class of graphs that we will show properly contains the class of graphs with a proper 2-edge weighting. If time permits we will show that the hypercube graphs each have a 2-edge weighting by defining a sequence of functions f_n where f_n is sufficient for hypercube H_n.

Trace Equivalence in Three Dimensions – Alex Christie, Dept of Mathematics and Statistics, Dalhousie (*Collaborators: Dr. Julien Ross*)

Abstract: It is well-known that the trace is cyclic in any dimension: if two words u anv v are cyclic permutations of each other then $tr(u) = tr(v)$ when the letters in u and v are interpreted as square matrices of dimension n. We show conversely that if two words u and v have the same trace when interpreted as the product of matrices of dimension n for any n then u and v must be cyclic permutations of each other. It follows that the relation of cyclic equivalence characterizes the relation of trace equivalence in all dimensions. This characterization no longer holds, however, when the dimension n is fixed. We provide examples in dimension 2 of words that are not cyclic permutations of each other yet have the same trace when they are interpreted as the product of 2×2 square matrices. Finally, we report on progress towards finding similar counterexamples in dimension 3.

The Firebreak Problem – Brady Ryan, Dept of Mathematics and Statistics, Dalhousie MUN (*Collaborators: Dr. David A. Pike*)

Abstract: Given a connected, undirected graph G, integers k and t, and a special vertex v, where a fire will break out, can we save at least t vertices by deleting k other vertices? In this talk we will explore the complexity of this problem on various graph types such as split graphs, trees, and graphs of bounded treewidth. A naive algorithm is presented as well as a quick discussion on tree decompositions and treewidth. Finally, we will briefly discuss a result proving the problem is solvable in linear time on graphs of bounded treewidth.

Mathematics, Session 2 – 2:00-3:30, A102

The Power–Index Game – Charlie Gerrie, Dept of Mathematics and Statistics, Dalhousie (*Collaborators: Dr. Jeannette Janssen*)

Abstract: In 1954, Lloyd Shapley and Martin Shubik introduced the Shapley-Shubik power index as a perspective model of voting behavior. Richard Nowakowski recently applied this to game theory, developing the power-index game. We used simulations of the power-index on a torus to explore long-term behavior. We also investigated using Markov chains to predict proportions of large-scale structures. This presentation will discuss the results of this research.

Strongly Connected Node Reliability – Emily Wright, Dept. of Mathematics, MSVU (*Collaborators: Dr. Danielle Cox*)

Abstract: Consider a digraph D on n vertices and m arcs where the vertices operate independently with probability p in $[0,1]$. The Strongly Connected Node Reliability of D, $SCNodeRel(D,p)$, is the probability that the operational vertices induce a strongly connected subdigraph of D. Results on the existence of optimal digraphs for this reliability model will be presented and compared to the results of the undirected model, the Node Reliability of a graph.

Une "jolie" démonstration du théorème de Cauchy – Sory Ibrahim Cissé, Dept. of Mathematics and Statistics, UdeM (*Collaborators: Dr. Donald Violette*)

Abstract: Nous allons donner une jolie démonstration du théorème de Cauchy en utilisant la notion d'homotopie. Contrairement à la démonstration classique que l'on voit habituellement dans les cours d'analyse complexe de niveau premier cycle, notre démonstration est plus élégante et repose sur les notions de chemins homotopes et rapprochés.

Zero forcing set and the minimum degree – Zhiyuan (Owen) Zhang, Dept of Mathematics and Statistics, Dalhousie (*Collaborators: Dr. Jeannette Janssen*)

Abstract: In 2007, Barioli et al. introduced a graph parameter in spectral graph theory, the zero forcing number, published in a paper with the AIM Minimum Rank- Special Graphs Work Group. The zero forcing number of a graph G, denoted ($\mathcal{G}$), is the minimum size of a vertex subset of $\mathcal{G}$ that, if initially coloured black, is able to force all vertices black by applying certain colour-change rules. The zero forcing number aims at providing a tight upper bound for the maximum nullity of a symmetric matrix, and as a result. The minimum degree of graph G, denoted ($\mathcal{G}$), is a lower bound of ($\mathcal{G}$) as trivial. In this talk, I am going to talk about a classification on the family of graphs that has the property of $(\mathcal{G}) = \delta(\mathcal{G})$. And the result relies on an observation of the restrictions on edges other than the "forcing chains" in the graph.

Quantum Speed Limits: Lower Time Bounds on Implementing a Target Unitary Transformation) – Coleman Hooper, Dept. of Mathematics and Statistics, Acadia (*Collaborators: Dr. Holger Teismann*)

Abstract: This presentation is about lower time bounds on implementing a target unitary transformation on a given quantum system. A lower time bound (developed in a paper by C. Arenz, B. Russell, D. Burgarth, and H. Rabitz) is used to compute lower bounds on the time T to implement a target unitary transformation on a two-level quantum system, as well as a finite-dimensional approximation of the quantum harmonic oscillator. The lower time bound for implementing a target unitary transformation on a two-level system is computed, and the unitary transform which maximizes this lower time bound is shown to correspond to a flip between the two poles on the Bloch sphere. The lower time bound for a finite-dimensional approximation of the quantum harmonic oscillator (from a paper by M. Mirrahimi and P. Rouchon) is then computed. Finally, it is shown that as the dimension of the approximation of the quantum harmonic oscillator is sent to infinity, the lower bound on the time T to implement a target unitary transformation goes to 0.

Statistics, Session 1 – 9:00-10:30, A202

Discrimination between two–parameter frequency models in hydrology – Babacar Bachir Dieng, Dept. of Mathematics and Statistics, UdeM (*Collaborators: Dr. Fahim Ashkar*)

Abstract: In the peak-over-threshold (POT) approach for the analysis of hydrological extremes, another important problem is the identification of a frequency model to fit to the data. A way to reach this identification is to use statistical discrimination between models. Among the models used in the POT approach are the generalized Pareto (GP), Kappa (KAP), gamma (GAM), Weibull (WEI), log logistic (LLOG) and lognormal (LN). To discriminate between these models, we will use the Anderson-Darling and a modified Shapiro-Wilk (SW) statistic. The ML method is used to fit the models to the data and to measure the differences between the empirical distribution function and the fitted distribution functions of each of the models given above. The results obtained show that the modified Shapiro-Wilk statistic gives better results.

Comparaison d'approches pour l'estimation du risque avec covariables – Mounada Gbadamassi, Dept. of Mathematics and Statistics, UdeM (*Collaborators: Dr. Salah El Adlouni, Dr. Fahim Ashkar*)

Abstract: On s'intéresse dans ce travail à la notion d'estimation du risque conditionnel en présence de covariables. Trois approches sont considérées : La Régression Quantile, la Régression expectile et les modèles multivariés avec des copules vines. L'objectif est de déterminer l'approche la plus adéquate pour l'estimation du risque dans le cas d'existence de valeurs extrêmes. La comparaison est faite en fonction des propriétés asymptotiques de la distribution de la variable d'intérêt et de la structure de dépendance. L'estimation des erreurs est faite par simulations de Monte Carlo et la comparaison est réalisée par validation croisée. Les simulations sont réalisées pour deux types de comportement asymptotiques, de type Sub-exponentielle et à variations régulières. Un cas d'étude est présenté pour illustrer les résultats obtenus.

Testing for a Change in Compositional Seal Diets – Hongchang Bao, Dept. of Mathematics and Statistics, UNBSJ (*Collaborators: Dr. Connie Stewart*)

Abstract: Our research problem was motivated by samples of real-life seal diet estimates collected over two seasons for a five year period. Of interest is whether or not the diets have changed over time. Since the data is compositional with essential zeros,

traditional approaches may not be used and, furthermore, many of the standard approaches for handling compositional data are not applicable. We analyzed the data using three methods and carried out simulations to assess the associated Type I and Type II error rates.

A Geometric Approach to Risk Management – Ali Raisolsadat, School of Mathematical and Computational Sciences, UPEI (*Collaborators: Dr. Alex Alvarez*)

Abstract: In this talk we will be presenting a new approach to financial risk measures. This approach primarily uses geometric properties of the space of possible asset price trajectories instead of relying exclusively on probabilistic structures. This will result in a more robust, coherent risk measure. We use numerical simulations to compare our approach with "Value at Risk" (VaR), which is a widely used risk measure in the financial industry. In these numerical simulations we assumed that asset prices follow a stochastic volatility model, and we illustrate our approach with two basic strategies: a buy-and-hold and a delta hedge portfolio. The numerical results confirm the nice properties of our approach; more specifically we obtain more conservative results than those obtained using VaR. This translates into a safer, more risk-averse risk measure.

Pre-pregnancy Polycyclic Aromatic Hydrocarbon Exposure and its Effects on Latent Breast Cancer Development – Grace Tompkins, Dept. of Mathematics and Statistics, StFx (*Collaborators: Dr. Derrick Lee*)

Abstract: Breast cancer is the most common cancer among Canadian women. There are several recognized risk factors; however, despite occupational studies providing evidence of elevated risk for various cancers, the risk of breast cancer from occupational exposures is vastly understudied. Polycyclic aromatic hydrocarbons (PAHs), a ubiquitous environmental exposure, is a common occupational exposure in various industries including manufacturing and food industry. Etiological evidence suggests that timing of exposure can have an impact of breast cancer risk, particularly in women prior to the time of first-pregnancy, when the breast is not fully differentiated. This talk addresses the relationship between pre-pregnancy exposure to carcinogens when women maybe at a period of increased susceptibility, and the risk latent breast cancer development.

AARMS Workshop

Sunday's workshop is about Monte Carlo Markov chain approaches and Multiple Taxicab correspondence analysis.

Contact Dr. Salah El Adlouni, Université de Moncton: Salah-eddine.el.adlouni@umoncton.ca

Introduction to Markov chain Monte Carlo Algorithms using Hamiltonian operator

Salah-Eddine El Adlouni, Dept. of Mathematics and Statistics, UdeM

Abstract: Markov Chain Monte Carlo (MCMC) is an increasingly popular method for obtaining information about distributions, especially for estimating posterior distributions in Bayesian inference. This workshop introduces MCMC algorithms sampling with simple illustrative examples. Highlighted some of the benefits and limitations of MCMC sampling, as well as different approaches to test the convergence to stationary distribution. We will recall the basics of Monte Carlo approaches and show how the Hamiltonian operator improves the speed of convergence and the mixture of MCMC algorithms. A demonstration using Matlab codes will be developed with the participants.

Constrained Multiple Taxicab Correspondence Analysis of Multivariate Binary Data with Rare Categories

Dr. Vartan Choulakian and Dr. Jacques Allard, Dept. of Mathematics and Statistics, UdeM

Abstract: We consider data sets where p homogenous binary items, such as true-false questions in an arithmetic test or items in health-related questionnaire, describe similar complementary aspects of an underlying latent unobserved variable. A popular way to visualize such data is by multiple correspondence analysis (MCA). This talk is a cautionary note on MCA of multivariate binary data with rare categories. A binary variable has a rare category if the relative frequency of a category is small. We show that for multivariate binary data with rare categories MCA maps are misleading, because correlation is not a good measure of association for two binary variables with rare categories. To visualize such data, we suggest its analysis by constrained multiple taxicab analysis, where often the interpretation of the first three principal factors produce two kinds of clustering of respondents based on the sum score, a proxy for size, characterized by the first factor, and on partitioning of items characterized by second and third contrast factors.

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