AARMS-CMS Student Poster Session
Présentations par affiches des étudiants - AARMS-SMC

LIVIA ALAMINO CAETANO, Universidade Federal de São Carlos (UFSCar)
Fuzzy logic applied to the prediction of Attention Deficit Hyperactivity Disorder based on alterations in brain structures

The brain is the most complex organ of the human body, capable of making thousands of connections and controlling fundamental functions of the body. The Diagnostic and Statistical Manual of Mental Disorders (DSM) brings together the definition and classification of different mental disorders, including Attention Deficit Hyperactivity Disorder (ADHD). Although specific causes of the disorder have not been identified, there is evidence of anatomical differences in the brains of people with ADHD compared to those without the disorder. The goal of this scientific research was to analyze how different structural changes in the brain can contribute to the manifestation of ADHD For this, a Fuzzy Rule-Based System (FRBS) was built with input variables White Matter, Cerebral Cortex, Caudate Nucleus, and Total Brain Volume, all of them characterized with the linguistic terms appropriate, partially appropriate, and slightly appropriate. The output variable considered was the Structural Index, classified into significant variation, moderate variation, and low variation. The inference method used was Mamdani's, and defuzzification was carried out using the Center of Gravity method. Simulations of clinical scenarios of hypothetical patients were implemented in MatLab software and the results achieved show that the fuzzy model is capable of providing relevant information about ADHD diagnosis. The next steps in the research involve also considering functional variables, in a second model and combining both models. It should be emphasized that mathematics and fuzzy logic are suitable tools to assist in modeling real phenomena, including in medicine, and can contribute to decision-making in complex situations.

DANIEL FASSLER, Concordia University
Randomized Sketching for Large-Scale Spectral Recovery: The MAM^* Method and New Directions

The past decade has seen an explosion in the availability of experimental datasets and the rise in personal and professional computing power. For numerical simulations, this enables finer space resolution over longer time horizons, yielding data sets that are costly to store and process. This motivates techniques such as randomized sketching, which offers structure-preserving dimension reduction of data sets and can enable singe-pass or streaming data processing. In this poster, we first review the $MAM*$ framework, a recent development in randomized sketching for low-rank approximation and spectral recovery. This approach combines randomized linear measurements with compressed sensing techniques to recover sparse approximations of the leading eigenvectors of extremely large, approximately low-rank matrices. Building on these developments, we outline ongoing research directions aimed at extending randomized sketching techniques to the recovery of singular vectors and low-rank factors of large matrices and tensors.

WILLIAM DANIEL STEPHENSON, University of Ottawa
Solutions to the parabolic Anderson model on an open domain

The parabolic Anderson model is a stochastic partial differential equation that describes diffusion in a random environment. We consider the model on an open domain $\mathcal{D}$ with Dirichlet boundary conditions, and noise given by an isonormal Gaussian process that is fractional in time. We show that the existence of a mild solution on the full space implies existence to the corresponding equation on $\mathcal{D}$. Our approach relies on approximating the solution by random fields that admit a Feynman–Kac representation.

SOFIA MEDINA VARELA, University of Regina
Representations of Noncommutative Cubes and Prisms

Representations of the operator system determined by the canonical generators of the free product of two cyclic groups of order 2 and k, or d cyclic groups of order 2, are studied for the purpose of shedding light on the noncommutative geometry

of noncommutative d-cubes and k-prisms. By way of the duality of the categories NCConv and OpSys of noncommutative convex sets and operator systems, respectively, an analysis of noncommutative extreme points, exactness, the lifting property, automatic complete positivity, controlled completely positive extensions, tensor products, and operator system duality is undertaken. Of note is the pairing of two classical dilation theorems of Halmos and Mirman to give a complete description of the noncommutative triangular prism in terms of joint unitary dilations.

JINXIN WANG, University of Ottawa

A Functional Central Limit Theorem for the KPZ Equation with Narrow Wedge Initial Data

The Kardar–Parisi–Zhang (KPZ) equation is a fundamental model for surface growth. I will begin by introducing the equation and its connection with the stochastic heat equation via the Cole–Hopf transform. Building on a recent finite-dimensional convergence result, I will then present our proof of tightness, which yields a functional central limit theorem for spatial averages of the KPZ solution with narrow wedge initial data. The proof combines the Clark–Ocone formula, a common-ray change of spatial variables, and a Chapman–Kolmogorov relation to obtain uniform moment bounds for time increments on compact time intervals bounded away from zero. This is joint work with Raluca M. Balan and Le Chen.

SHUOYANG WANG, McMaster University

Stationary States on Periodic Metric Graphs with Nonzero Boundary Conditions

Stationary states of the nonlinear Schödinger (NLS) equation are considered on periodic metric graphs. Compared to the existing literature, we study stationary states with nonzero boundary conditions which model black solitons in optics. For a general graph with a single edge connecting compact cores symmetrically and periodically, we prove the existence of an energy minimizer pinned to the point of the edge symmetry. For the neckless graph example, we prove the coexistence of two energy minimizers pinned to two points of symmetry: one is in the middle of the link connected to two loops and the other one is in the middle of the loop connected to two links. In the semi-classical limit, which is equivalent to the limit of long edges, we prove that no other stationary states exist, whereas the link- pinned state is a local minimizer of energy and the loop-pinned state is a saddle point of energy without the pinning condition. We also prove that both are unstable in the time evolution of the NLS equation in such a way that the energy minimizer is strongly unstable with a real eigenvalue and the saddle point of energy is weakly unstable with a quadruplet of complex eigenvalues. The analytical results are illustrated away from the semi-classical limit by using numerical approximations.