YOUNG RESEARCHERS WORKSHOP

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BOOK of ABSTRACTS:

PLENARY SPEAKERS:

Mihai Cucuringu (University of Oxford, UK): « **Spectral methods for clustering signed and directed networks ».**

Abstract: We consider the problem of clustering in two important families of networks: signed and directed, both relatively less well explored compared to their unsigned and undirected counterparts. Both problems share an important common feature: they can be solved by exploiting the spectrum of certain graph Laplacian matrices or derivations thereof. In signed networks, the edge weights between the nodes may take either positive or negative values, encoding a measure of similarity or dissimilarity. We consider a generalized eigenvalue problem involving graph Laplacians, with performance guarantees under the setting of a signed stochastic block model. The second problem concerns directed graphs. Imagine a (social) network in which you spot two subsets of accounts, X and Y, for which the overwhelming majority of messages (or friend requests, endorsements, etc) flow from X to Y, and very few flow from Y to X; would you get suspicious? To this end, we also discuss a spectral clustering algorithm for directed graphs based on a complex-valued representation of the adjacency matrix, which is able to capture the underlying cluster structures, for which the information encoded in the direction of the edges is crucial. We evaluate the proposed algorithm in terms of a cut flow imbalance-based objective function, which, for a pair of given clusters, it captures the propensity of the edges to flow in a given direction. Experiments on a directed stochastic block model and real-world networks showcase the robustness and accuracy of the method, when compared to other state-of-the-art methods. Time permitting, we briefly discuss potential extensions to the sparse setting and regularization, applications to lead-lag detection in time series and ranking from pairwise comparisons.

Alexandra Neamtu (University of Konstanz, Germany): « **Dynamical systems for stochastic evolution equations with fractional noise** »

Abstract: We analyze stochastic partial differential equations (SPDEs) driven by an infinite-dimensional fractional Brownian motion using rough paths techniques. Since the breakthrough in the rough paths theory there has been a huge interest in investigating SPDEs with rough noise. We con-tribute to this aspect and develop a solution theory, which can further be applied to dynamical systems generated by such SPDEs. This talk is based on joint works with Robert Hesse (Friedrich Schiller University Jena) and Christian Kuehn (Technical University of Munich).

Vlad Margarint (University of New York at Shanghai): « **Schramm-Loewner Evolutions (SLE) and Rough Paths** »

Abstract: In this talk, I will give an overview of some work carried at the intersection of Rough Path Theory and Schramm-Loewner Evolutions (SLE) Theory. Specifically, I will cover a study of the Loewner Differential Equation using Rough Path techniques (and beyond). The Loewner Differential Equation describes the evolution of a family of conformal maps. We rephrase this in terms of (Singular) Rough Differential Equations. In this context, it is natural to study questions on the stability, and approximations of solutions of this equation. First, I will present a result on the continuity of the dynamics and related objects in a natural parameter that appears in the problem. The first approach will be based on Rough Path Theory, and a second approach will be based on a constructive method of independent interest: the square-root interpolation of the Brownian driver of the Loewner Differential Equation. In the second part, if time permits, I will present a result on the asymptotic radius of convergence of the Stochastic Taylor approximation of the Loewner Differential Equation and numerical simulations of the SLE trace using a novel numerical method: Ninomiya-Victoir (or Strang) splitting. The first part is based on joint work with Dmitry Belyaev, Terry Lyons, and the second part on a collaboration with James Foster.

PH.D. STUDENTS:

STEFANA ANITA (IMAR Bucharest, Romania): « **An optimal control problem related to a non-linear Fokker-Planck equation** »

Abstract: We discuss an optimal control problem with feedback inputs for a McKean-Vlasov equation. The problem is equivalent to a deterministic optimal control problem with open-loop controllers for a nonlinear Fokker-Planck equation. We prove the existence of an optimal control under additional hypotheses for this latest problem and we derive necessary optimality conditions for the deterministic problem. These results give a deeper insight into the initial stochastic optimal control problem. An example is also discussed.

AMEL BELHADJ (University of Saida, Algeria): « **Mixed fractional Brownian motion as a stochastic volatility model** »

Abstract: The purpose of this work is to use the mixed fractional Brownian motion as a modeling tool in financial mathematics, specifically in stochastic volatility modeling. We propose that the volatility follows a mixed fractional Ornstein-Uhlenbeck process with speediness k and a parameter $H<\frac{1}{2}$. This model is a modification of the fractional model studied in volatility is rough paper. We show that our model exhibits the long memory due to its common properties with the rough model and its adequacy with empirical financial series data observed in the markets.

Guillaume BRAUN (Inria Lille, France): « **Clustering graphs with side information** »

Abstract: In real life, networks often come with more information than the binary relationship between the agents of interest. This additional information can be used to improve the performance of clustering, especially when the clusters are not well separated by only one source of information. However, it is challenging to integrate different, and possibly heterogeneous, sources of information in the clustering process. We give an overview of different general strategies used to tackle this problem and illustrate them through application to multilayer graphs and graphs with nodal covariates.

Luigi-Ionut CATANA (University of Bucharest, Romania): « **The monotonicity of the moments of order k, survival function and the hazard rate as functions according to the parameters in the case of extremes order statistics using a multivariate Pareto distribution family** »

Abstract: In this presentation we analyze the monotonicity of the moments of order k, of the hazard rate as functions according to the parameters in the case of extremes order statistics when we use a multivariate Pareto distributions family

Julie GAMAIN (University of Lille, France): « **Random matrices and stochastic wave equation** «

Abstract: We consider a Wishart matrix $\mathcal{W}_{n,d}$ associated to $\mathcal{X}_{n,d}$, a $n\times d$ random matrix in which the entries are increments of the solution to the stochastic wave equation driven by a space-time white noise, $W^{(i)}$, where $W^{(i)}$, for $i=1,\cdots, n$ are independent white noises. In fact, the elements of the random matrix located on different rows are independent while on a same row, there is a correlation. This correlation is given by the spatial or temporal increments of the solution to the stochastic wave equation. The aim is to analyse the limit behavior of this Wishart matrix by using Malliavin calculus.

Thomas GKELSINIS (University of Rouen-Normandy, France): « **Inferential Techniques based on Statistical "Distances": The Weighted Case** »

Abstract: This work is dealing with two inferential techniques, a goodness of. Fit test and a test of homogeneity, based on a particular case of statistical « distances" called weighted divergence measures. Those measures calculate the "distance" between probability distributions by focusing on specific subsets of their support. The proposed tests are based on such a measure, called. Corrected Weighted Kullback-Leibler (CWKL) divergence. A brief presentation on the construction of the tests according with the essential asymptotic theory is placed. Finally, the performance of both tests according with useful comparisons with other, known, tests is concisely presented. Joint work with Alex Karagrigoriou and Vlad Stefan Barbu.

Adriana NISTOR (University of Bucharest, Romania): **Risk Measures**

Abstract: The focus of our presentation is to offer the audience a short walk through the fascinating world of risk measurement. Risk measurement is a topic with a wide range of applications, especially in finance. Currently, the risk of a portfolio is modelled using a random variable and the risk measure is essentially a function that associates to this random variable a real number. That number is the capital required to prevent company's default associated with the loss on the above-mentioned portfolio. Our proposal is to measure the risk with a function that maps the risk to a step function. Instead of mapping the risk to a single value, we are mapping it to multiple values that will indicate the risk regimes for the analyzed random variable.
The presentation will be structured in 3 parts. In the first part we will briefly introduce the technical details of the problem we are working on. In the second part, we will present the solution of the proposed problem for 3 particular random variables (Uniform distribution, Normal distribution and Laplace distribution), without stepping into the technical details. The last part of the talk is reserved for presenting the main steps of the solution for a class of distributions, covering the 3 particular cases above mentioned.

Marian PETRICA (University of Bucharest, Romania): « **A regime switching on Covid-19 analysis and prediction in Romania** »

Abstract: In this presentation we propose a regime separation for the analysis of Covid19 in Romania combined with mathematical models of SIR and SIRD. The main regimes we study are the free spread of the virus, the quarantine and partial relaxation and the last one is the relaxation regime. The main model we use is SIR which is a classical model, but because we can not fully trust the numbers of infected or recovered people we base our analysis on the number of deceased people which is more reliable. To actually deal with this we introduce a simple modification of the SIR model to account for the deceased separately. This in turn will be our base for fitting the parameters. We actually use the classical SIR model to detect the regime switching and in fact prove a proposition which shows that we can recover the parameters in a unique way from the daily observation of the number of infected and susceptible. This is the basis for guessing the main parameters in the model. The actual estimation of the parameters in our SIRD model is done in two steps. The first one consists in training a neural network based on SIR models to detect regime changes. Once this is done, we fit the main parameters of the SIRD model using a grid search near the values suggested by the neural network. At the end, we make some predictions on what the evolution will be in a timeframe of a month with the fitted parameters.