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BOOK OF ABSTRACTS

StatMod

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Statistical Modeling with Applications 2024

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Book of Abstracts

Eds. Vlad Stefan Barbu & Bojana Milošević

Bernoulli Society
for Mathematical Statistics
and Probability

Republic of Serbia
MINISTRY OF SCIENCE,
TECHNOLOGICAL DEVELOPMENT AND INNOVATION

Preface

It is our great pleasure that to welcome you to *StatMod 2024*, the 5th edition of the International Conference on Statistical Modeling, which will take place in the historic and vibrant city of Belgrade, Serbia. This year's conference holds special significance as it is part of a celebratory year for the Faculty of Mathematics, University of Belgrade, which is commemorating 150 years of academic excellence.

The primary objective of *StatMod 2024* is to provide a platform for international experts to share their insights on both the theoretical and applied aspects of statistical modeling. This edition includes topics related to change-point analysis, demography, divergence measures and applications, financial mathematics, Markov and semi-Markov processes, reliability, model specification testing, statistics for dependent data, and many others. The presentations and discussions throughout the event will reflect the latest scientific advances, address significant current challenges, and explore the future directions of the field. More details about the *StatMod 2024* could be found at the website www.statmod2024.sciencesconf.org/.

We would like to extend our sincere thanks to all the speakers, contributors, and participants for their role in making this conference possible. Special appreciation goes to the organizing committee, sponsors, and partners who have played an essential part in the success of this event. We hope that *StatMod 2024* will spark new ideas and collaborations that will continue to advance the field of statistical modeling.

Welcome to Belgrade, and to *StatMod 2024*!

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Conference language: English

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Abstracts

Analysis of Demographic Groups in Relation to Employability and Digital Skills in the Romanian Labour Market

Laura Anghel, Mihaela Vlădescu, Mihaela Oprea, Alina Rădoi, Carmen Adriana Gheorghe

"V. Trebici" Center for Demographic Research, "Costin C. Kiritescu" National Institute of Economic Research of Romanian Academy, Romania

Abstract

In the context of rapid digital transformation, the dynamics of the labour market are increasingly shaped by the interplay between demographic factors and digital competencies. This paper presents an in-depth statistical investigation into how different demographic groups in Romania—characterized by variables such as age, education level, and geographic distribution—correlate with employability and the level of digital skills. Using clustering techniques and multivariate analysis, we aim to identify distinct patterns and groupings that reflect variations in job market outcomes and digital adaptation. The study employs data on workforce composition, unemployment rates, and the diffusion of digital skills across sectors. By exploring the relationships between these variables, we develop models that offer insights into both opportunities and vulnerabilities for different demographic segments in a digitalized economy. The findings provide a comprehensive view of the demographic challenges and opportunities Romania faces in aligning workforce capabilities with the demands of the digital era. These insights are crucial for policymakers, educators, and business leaders aiming to foster digital inclusion and optimize labour market participation through targeted interventions.

Demographic structures and economic development in small and medium-sized cities: a three-tiered analysis

Sorin Avram,[1,2] **Irina Onţel,**[3,1] **Luminiţa Chivu,**[1]

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[3] *Remote Sensing and Satellite Meteorology Laboratory, National Meteorological Administration, Bucharest, Romania*

Abstract

This research explores the relationship between demographic structures and economic development in small and medium-sized cities. It focuses on understanding their role in future urbanization scenarios influenced by climate change. The study categorizes urban areas with populations under 1,000,000 inhabitants into three tiers: cities with over 500,000 inhabitants, cities between 100,000 and 500,000, and cities with fewer than 100,000 inhabitants. As climate change drives depopulation in vulnerable regions, large cities are expected to face increasing pressure from population influxes. This research seeks to establish where small and medium-sized towns may fit into these demographic shifts and how they could alleviate the strain on megacities. Vital demographic factors such as migration patterns, population aging, and ethnic diversity are examined in economic performance metrics, including GDP per capita, employment rates, and infrastructure capacity. By analyzing potential growth opportunities and financial challenges for smaller urban centers, this study offers insights into how these cities can strategically absorb displaced populations and contribute to balanced regional development in a climate-impacted world.

Kernel smoothing of the transition function for homogeneous continuous-time semi-Markov process

Chafiâa Ayhar

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Abstract

We consider a semi-Markov process with a finite state space. We use the classical kernel method to introduce nonparametric estimators of conditional sojourn times, continuous-time semi-Markov kernel, and the semi-Markov transition function. We also give asymptotic properties of the above estimators, such as the uniform strong consistency and the asymptotic normality. In addition, a numerical example illustrates the asymptotic properties of the transition function approximation in continuous time semi-Markov process

Modelling the Danish data set using three-spliced distributions

Adrian-Iulian Bâcă,[1] **Raluca Vernic**[2]

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[2]*Faculty of Mathematics and Informatics, Ovidius University of Constanta, Romania*

Abstract

When data exhibit high frequency of small to medium values and low frequency of extreme values, fitting a classical distribution might fail: a heavy tailed distribution will not be able to adequately model the small to medium values, while a less heavy-tail distribution will not capture well enough the extreme values. This is why spliced models defined from different distributions on distinct intervals were proposed in the literature. In this talk, we focus on three-spliced distributions, and to emphasize their ability to improve the modelling of extreme data, we consider the Danish fire losses, a popular insurance data set. To this data set we fitted several three-spliced distributions, with and without differentiability conditions at the two thresholds;

we also calculated some risk measures popular in insurance. Moreover, the results are compared to the best fitted two-spliced distributions from previous studies and with three three-spliced distributions from a recent paper.

Markov-type models and survival analysis

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[2] *"V. Trebici" Center for Demographic Research, "Costin C. Kiritescu" National Institute of Economic Research of Romanian Academy, Romania*

Abstract

The objective of this presentation is, first, to introduce various Markov-type models developed within our team: semi-Markov models, drifting Markov models and semi-Markov drifting models, along with their potential applications. We will also focus on developments related to survival analysis in connection with these models. These models have been the subject of several publications [1]-[6] and several software tools [7]-[10].

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A Bayesian self-starting hotelling (BSSH) T^2 for online multivariate outlier detection

Apostolos Batsidis,[1] **Konstantinos Bourazas,**[2] **Panagiotis Tsiamyrtzis**[3]

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[3] *Department of Mechanical Engineering, Politecnico di Milano, Milan, Italy*

Abstract

Control charts for online detection of multivariate outliers have been proposed, either under the classical "training and test" scheme or self-starting. In the former, the unknown process parameters are estimated via a phase I (calibration) stage, before online testing can be initiated in phase II. On the other hand, the latter methods have been developed when the process parameters are not known in advance or estimated via phase I. The aim of this work is to propose a Bayesian self-starting method for online multivariate outlier detection, henceforth named, Bayesian Self Starting Hotelling (BSSH) control chart. BSSH is the self-starting Bayesian analogue of the probably most widely used frequentist Hotelling's based control chart, which assumes multivariate normality with both the population mean vector and covariance matrix being unknown. Also, BSSH considers a conjugate power prior which incorporates different sources of prior information, if available. Some theoretical properties of BSSH, such as its power, are also determined, and we discuss regarding the post-alarm inference. Finally, a simulation study evaluates the performance of the proposed control chart, while a real data application demonstrates its practical use.

Nonparametric tests of Missing Completely At Random

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[2] *Univeristy of Cambridge, United Kindgdom*

Abstract

One of the most commonly-encountered discrepancies between real data sets and models hypothesised in theoretical work is that of missing data. When faced with incomplete data, the primary concern is to understand the relationship between the data-generating and missingness mechanisms. In the ideal situation, these two sources of randomness are independent, a setting known as Missing Completely At Random (MCAR), but this is often too restrictive in practice. In this talk I will discuss hypothesis tests of the MCAR assumption with material based on joint work with Richard Samworth (see [1]) and Alberto Bordino (see [2]). It turns out that there are deep connections between this problem and ideas from copula theory and convex optimisation. Our methods in the first work are based on using linear programming to test the compatibility of distributions. In the second we draw connections with the matrix completion literature and thus develop tests based on semidefinite programming. In both cases our methods are more widely applicable than existing methods and, in cases that existing methods are applicable, we see strong empirical performance with comparable power.

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Testing the independence among continuous random vectors based on L_1-norm

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[2] *Cadi Ayyad University, Morocco*

Abstract

We propose a novel statistical test to assess the mutual independence of multidimensional random vectors. Our approach is based on the L_1-distance between the joint density function and the product of the marginal densities associated with the presumed independent vectors. Under the null hypothesis, we employ Poissonization techniques to establish the asymptotic normal approximation of the corresponding test statistic, without imposing any regularity assumptions on the underlying Lebesgue density function, denoted as $f(\cdot)$. Remarkably, we observe that the limiting distribution of the L_1-based statistics remains unaffected by the specific form of $f(\cdot)$. This unexpected result contributes to the robustness and versatility of our method. Moreover, our tests exhibit nontrivial local power against a subset of local alternatives, which converge to the null hypothesis at a rate of $n^{-1/2}h_n^{-d/4}$, $d \geq 2$, where n represents the sample size and h_n denotes the bandwidth.

Matrix-valued factor model with time-varying main effects

Zetai Cen, Clifford Lam

London School of Economics, United Kingdom

Abstract

New proposal of the matrix-valued time-varying Main Effects Factor Model (MEFM). MEFM is a generalization to the traditional matrix-valued factor model (FM). Rigorous definitions of MEFM and its identifications are given, with estimators proposed for the time-varying grand mean, row and column main effects, and the row and column factor loading matrices for the common component. Rates of convergence for different estimators are spelt out, with asymptotic normality shown. The core rank estimator for the common component is also proposed, with consistency

of the estimators presented. A crucial test is proposed for testing if FM is sufficient against the alternative that MEFM is necessary, whose power is demonstrated by various simulation settings. The accuracy of our estimators is also demonstrated numerically in extended simulation experiments. A set of NYC Taxi traffic data is analysed and the proposed test suggests that MEFM is indeed necessary for analysing the data against a traditional FM.

Study on demographic dynamics through the entropy model

Elena Corina Cipu,[1,2,3] **Vasile Preda,**[4,1,5] **Carmen Adriana Gheorghe**[1]

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Abstract

Shannon entropy in demographic dynamics is a powerful tool for understanding the complexity of population structures. This can be interpreted as a parameter for the internal state of a system. The purpose of this paper is to determine entropy as a parameter for regional demographic dynamics in the Romanian population system. The obtained results are compared with those obtained in the case study of the population of Serbia. By analysing entropy over time and across regions, stakeholders can make informed decisions in areas such as urban planning, public health and social policy.

Numerical spectral analysis of Cauchy-type inverse problems: a probabilistic approach

Iulian Cîmpean,[1,2] **Andreea Grecu,**[3] **Liviu Marin**[1,3]

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Abstract

In this talk we consider a class of data completion problems that arise in many applications and are modelled by PDEs in a bounded Euclidean domain, subject to over-prescribed measurements at some accessible portion of the boundary and/or inside the domain; the goal is to reconstruct the entire solution from the partial measurements. It is well known that such inverse problems are severely unstable, and in spite of the huge amount of work that has been invested in this subject, several fundamental issues of both theoretical and numerical nature have remained open. The aim of this talk is to present a new framework in which such open issues can be efficiently analyzed with tools like elliptic measures, spectral representations and Monte Carlo approximations.
This presentation is based on the recent paper arXiv:2409.03686.

On independence testing: a randomly censored data perspective

Marija Cuparić, Bojana Milošević

University of Belgrade, Faculty of Mathematics, Serbia

Abstract

Here we consider the problem of testing independence in the presence of randomly censored data. In the first part, we focus on the recent adaptations of tests related to Kendall's τ, examining their asymptotic behavior and performance on small sample sizes (see [1]). The second part of the talk explores extensions of these tests within mixture cure models. We will also present some preliminary results and outline directions for future research.

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Reliability analysis of a K-out-of-N system with random rate of repair with application to wind park

Guglielmo D'Amico,[1] **Raina Raj**[2] **Selvamuthu Dharmaraja**[3]

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Abstract

This work studies the reliability function of K-out-of N systems with general repair time distribution and a single repair facility. It introduces a new repair mechanism using an effort function, described by a non-linear ordinary differential equation. Three theoretical results are obtained: regularity properties preventing simultaneous failures and repairs, derivation of a Kolmogorov forward system for micro-state and macro-state probabilities, and comparison of reliability functions of two K-out-of-N systems. Additional hypothesis on the model's parameters allows us to obtain an ordering relation between the reliability functions. An application to wind park management is described and demonstrates the model's practical usage and confirms the theoretical results.

A mixture transition distribution approach to portfolio optimization

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Abstract

In financial markets, understanding the interconnections among assets and their dynamic behaviors is pivotal for effective portfolio management. A way to assess the relationships among the financial assets is provided by the network theory. Many authors built the financial networks starting from the correlation matrix and applying some filter to reduce the network's density, e.g. the minimum spanning tree, the correlation threshold, etc. On the contrary, [3] proposed to build the financial network employing a multivariate Markov chain model based on the Mixture Transition Distribution (MTD) approach. As reported by the authors, the MTD based network allows to capture the nonlinear dependence among the stocks as opposed to the correlation networks which are unable to show the true relationships among the variables as they requires a filtering strategy to reduce the high density of the network. A recent strand of literature has been exploring the interconnections between the financial networks and the portfolio theory. In particular, the goal of these studies is to perform asset allocations for an optimal portfolio management [see, e.g., 4, 2, 1, 5]. In this study, we propose a new approach to portfolio selection starting from the MTD networks to capture the nonlinear dependence among the assets in order to execute the portfolio allocation. To this extent, we employ a measure of assortativity in order to identify the stock to include in (or exclude from) the portfolio. Finally, we apply the proposed strategy to a set of real-world financial data to assess the performance and compare them to the results of the classical mean-variance approach from the modern portfolio theory, as well as to the other correlation based networks.

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Eigenvalues approximation of integral covariance operators with applications to weighted L^2 statistics

Bruno Ebner,[1] **Maria Dolores Jiminéz-Gamero**,[2] **Bojana Milošević**[3]

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[3]*University of Belgrade, Faculty of Mathematics, Serbia*

Abstract

We review methods to estimate eigenvalues of covariance operators associated with limiting Gaussian processes. In particular, we introduce the Rayleigh-Ritz method for approximating the largest eigenvalue and, for the first time, apply it in the context of statistical goodness-of-fit testing. This application focuses on limit distributions of statistics of the weighted L^2 type, particularly in distribution-free or classical testing scenarios, such as testing for exponentiality or normality in both univariate and multivariate data. Lastly, we demonstrate the application of these methods across various contexts, illustrating how accurate eigenvalue estimation can lead to an approximation of the limit distribution using the Pearson system, and how this influences efficiency assessments of the asymptotic Bahadur type.

Applications of distance covariance in biostatistics

Dominic Edelmann

DKFZ (German Cancer Research Center), Germany

Abstract

Distance correlation is a powerful tool for measuring dependence between sets of random variables. Recently, Lyons and Sejdinovic, et al. generalized distance covariance to (semi-)metric spaces of negative type. In this talk, we present several innovative distance correlation methodologies tailored to challenges in biostatistics. In particular, we explore how distance covariance can be extended for testing independence for categorical data and survival analysis. Additionally we show how generalized distance covariance can be used to measure association in different kinds of omics data. Real data examples are provided to illustrate these applications.

Cell-wise robust and sparse principal component analysis

Peter Filzmoser, Pia Pfeiffer

Vienna University of Technology, Austria

Abstract

The estimation of principal components can be influenced by outlying observations, so-called row-wise outliers. For high-dimensional data, it becomes more and more likely that an observation contains outlying cells, which would lead to many row-wise outliers and to a breakdown of traditional robust methods. In this case, it is preferable to achieve protection against cell-wise outliers. We review approaches for principal component analysis that lead to row-wise and cell-wise robustness, and present a cell-wise method that is sparse, thus enforcing zeros in the loadings matrix to simplify the interpretation.

Parameter estimation for random graph models

Adrian Fischer,[1] **Gesine Reinert**,[1] **Wenkai Xu**[2]

[1] *University of Oxford, United Kingdom*
[2] *University of Tuebingen, Germany*

Abstract

We use Stein characterizations to obtain new moment-type estimators for the parameters of random graph models (for example the Bernoulli or exponential random graph model). These estimators are independent of the normalizing constant and usually of a simple form and therefore provide an interesting alternative to classical maximum likelihood methods. Competitive simulation studies are conducted in order to assess the quality of the new estimators.

Fixed values versus empirical quantiles as thresholds in excess distribution modelling

Daniel Gaigall,[1] **Julian Gerstenberg**[2]

[1] *FH Aachen - University of Applied Sciences, Germany*
[2] *Goethe University Frankfurt, Germany*

Abstract

Conditional excess distribution modelling is a widely used technique, in financial and insurance mathematics or survival analysis, for instance. Classical theory considers the thresholds as fixed values. In contrast, the use of empirical quantiles as thresholds offers advantages with respect to the design of the statistical experiment. Either way, the modeller is in a non-standard situation and runs in the risk of improper usage of statistical procedures. From both points of view, statistical planning and inference, a detailed discussion is requested. For this purpose, we treat both methods and demonstrate the necessity taking into account the characteristics of the approaches in practice. In detail, we derive general statements for empirical processes related to the conditional excess distribution in both situations. As examples, estimating the mean excess and the conditional Value-at-Risk are given. We apply our findings for the testing problems of goodness-of-fit and homogeneity for the conditional excess distribution and obtain new results of outstanding interest.

A family of toroidal diffusions with exact likelihood inference

Eduardo García-Portugués,[1] **Michael Sørensen**,[2]

[1] *Carlos III University of Madrid, Spain*
[2] *University of Copenhagen, Denmark*

Abstract

We provide a class of diffusion processes for continuous time-varying multivariate angular data with explicit transition probability densities, enabling exact likelihood inference. The presented diffusions are time-reversible and can be constructed for any pre-specified stationary distribution on the torus, including highly-multimodal mixtures. We give results on asymptotic likelihood theory allowing one-sample inference and tests of homogeneity of diffusions. The new family of diffusions is applied to test several homogeneity hypotheses on the movement of ants.

Detecting changes in production frontiers

Shakeel Gavioli-Akilagun, **Yining Chen**

Department of Statistics, London School of Economics, United Kingdom

Abstract

In this talk, we give a brief review of the nonparametric estimation problem of production frontier function, which concerns the maximum possible output given inputs. We then study in detail the problem of detecting and localizing changes in the frontier function, given a sequence of time ordered observations of inputs and outputs. We derive the global information-theoretic lower bounds for the change point problem, and present an algorithm which attains the bound up to log terms. If time permits, we discuss how confidence intervals for the change point locations can be constructed.

Beyond the demographic winter: spatial analysis of women's impact on Romania's economic and demographic revival

Carmen Adriana Gheorghe,[1] **Luminiţa Chivu,**[1] **Elena Corina Cipu,**[1,2,3] **Mihaela Vlădescu,**[1] **Mihaela Oprea,**[1] **Sorin Avram,**[1,4] **Alina Rădoi,**[1]

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Abstract

This presentation integrates a spatial analysis dimension to examine the regional variations in women's labor market participation and its effects on fertility rates across Romania. As the country navigates through the demographic challenges of declining birth rates and an aging population, it becomes imperative to scrutinize not just the national averages but also the regional disparities that influence these trends. By employing Geographic Information Systems (GIS) and spatial data analysis techniques, this study highlights how different regions within Romania exhibit unique patterns of female workforce participation and corresponding fertility responses. The analysis will also consider socioeconomic factors, access to childcare facilities, and regional employment opportunities, providing a comprehensive view of the spatial dynamics. Through detailed maps and spatial data visualizations, this presentation will offer policy recommendations tailored to specific regional needs, aiming to empower women's participation in the workforce while enhancing demographic sustainability. This approach not only addresses Romania's demographic winter but also showcases the potential of spatial analysis in crafting targeted and effective socio-economic policies.

Multicomponent stress-strength reliability: theory and practice

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Abstract

In this work we investigate the stress-strength reliability for a multicomponent system and for a general set of distributions which unifies under the same umbrella several of the classical distributions frequently encountered in reliability theory. The multicomponent stress-strength reliability is defined and evaluated for the case of the proposed unified set of distributions. Furthermore, we provide for the stress-strength reliability, inferential statistics including point and interval estimation, the relevant asymptotic theory and some properties for the special 1-out-of-k:G and the 2-out-of-k:G multicomponent systems for various k number of components. Examples and real case applications are provided for illustrative purposes.

Acknowledgement: This work has been partly supported by the University of Piraeus Research Center.

The Sarmanov family of distributions: extending the famous Dixon and Coles model for football

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Abstract

The Sarmanov family of distributions is an elegant way to construct a bivariate distribution based on two given marginals and some function(s) that introduce(s) dependence. It has a close connection to copula models but in the case of discrete distributions it offers some computational advantages. On the other hand there is a

famous and widely used model in football modelling the prevalent model by Dixon and Coles (1997) that extends the double Poisson model where two independent Poisson distributions model. In this talk I am going to show that this is a special case of a Sarmanov family. Based on this family, we create more suitable models and also investigate the properties of them. We apply the new models to women's football scores, which exhibit some characteristics different than that of men's football. Extensions outside the football literature will be also discussed

A Pareto tail plot and the principle of a single huge jump

Bernhard Klar

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Abstract

We propose a mean functional that exists for any probability distributions and characterizes the Pareto distribution within the set of distributions with finite left endpoint. This is in sharp contrast to the mean excess plot which is not meaningful for distributions without an existing mean and has a nonstandard behaviour if the mean is finite, but the second moment does not exist. The construction of the plot is based on the so-called principle of a single huge jump, which differentiates between distributions with moderately heavy and super heavy tails. We present an estimator of the tail function based on U-statistics and study its large sample properties. Several loss datasets illustrate the use of the new plot.

A versatile trivariate wrapped Cauchy copula with applications to toroidal and cylindrical data

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[2]*Institute of Statistical Mathematics*
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Abstract

In this talk, we propose a new flexible distribution for data on the three-dimensional torus which we call a trivariate wrapped Cauchy copula. Our trivariate copula has several attractive properties. It has a simple form of density and is unimodal. its parameters are interpretable and allow adjustable degree of dependence between every pair of variables and these can be easily estimated. The conditional distributions of the model are well studied bivariate wrapped Cauchy distributions. Furthermore, the distribution can be easily simulated. Parameter estimation via maximum likelihood for the distribution is given and we highlight the simple implementation procedure to obtain these estimates. We compare our model to its competitors for analysing trivariate data and provide some evidence of its advantages. Another interesting feature of this model is that it can be extended to cylindrical copula as we describe this new cylindrical copula and then gives its properties. We illustrate our trivariate wrapped Cauchy copula on data from Protein Bioinformatics of conformational angles, and our cylindrical copula using climate data related to buoy in the Adriatic Sea.

On some change-point tests based on the Laplace transform

Žikica Lukić, **Bojana Milošević**

University of Belgrade, Faculty of Mathematics, Serbia

Abstract

This talk comprises two parts. In the first part, we focus on the univariate case. Following the construction in [1], we present a novel class of tests for change-point detection based on the Laplace transform. These novel tests have favorable properties compared to the competitors in [1]. The asymptotic properties of the novel tests

are discussed, and they are applied to two datasets from the fields of meteorology and macroeconomics. The second part of the study is dedicated to change-point inference for symmetric positive definite random matrices. In [3], the change-point inference for random matrices orthogonally invariant in distribution was outlined. We modify the test in [2] to test for a change-point in distribution. We present the finite sample properties of the novel test. The talk concludes with some possible directions for further research.

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Infinitely stochastic model for risk reserving

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Abstract

The idea of our work is to propose an unconventional tool for a stochastic prediction of future losses based on individual (micro) developments of specific events. The aim lies in predicting future sub¬event flows based on a valid stochastic model. The modeling framework involves marked time-¬varying Hawkes processes with marks being again other time-¬varying Hawkes processes. The estimated parameters of an omnibus model are proved to be consistent and asymptotically normal under relatively simple and easily verifiable assumptions. The empirical properties and practical real-data based explorations are provided for illustrations.

Seismic hazard evaluation based on Poisson Hidden Markov Models

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Abstract

A study of earthquake seismicity is undertaken over the areas of Central and South America, the tectonics of which are of great interest. The whole territory is divided into 10 seismic zones based on some seismotectonic characteristics, as in previously published studies. The earthquakes used in the present study are extracted from the catalogs of the International Seismological Center, cover the period of 1900–2021, and are restricted to shallow depths ($\leq$60 km) and a magnitude $M \geq 4.5$. Fore- and aftershocks are removed according to Reasenberg's technique. The paper confines itself to the evaluation of earthquake occurrence probabilities in the seismic zones covering parts of Central and South America, and we implement the hidden Markov model (HMM) and apply the EM algorithm.

On the application of independence tests to variable selection problems

Bojana Milošević, Jelena Radojević

University of Belgrade, Faculty of Mathematics, Serbia

Abstract

We explore the potential of kernel-based generalizations of distance covariance for variable screening procedures. The flexibility of this association measure allows for the integration of models with spherical and hyperspherical data, which are commonly encountered in fields such as meteorology, geology, biology, and more. Through extensive empirical studies, we demonstrate the robustness and adaptability of our proposed method.

Optimal design and planning of observational studies: a combined approach using rule-mining and metaheuristics

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Abstract

Observational studies are crucial for understanding real-world phenomena in fields like social sciences, medicine, and economics. Unlike controlled experiments, they observe and analyze naturally occurring variations. Observational data often arise as the end product of a well-planned study, characterized by the units from which data are collected, the variables to be measured, and the times of measurement. We focus on controlling the first two dimensions. Data collection costs restrict scientific knowledge, so efficient planning is crucial. Smart decisions on study design maximize the precision of parameter estimates within a budget or minimize costs while meeting study goals. This paper investigates using Design of Experiments in observational studies to select informative observations and features for

classification. Optimal supersaturated plans are searched for in existing data, and based on these plans, the variables most relevant for classification are determined. An association rule algorithm is used to mine the potential relationship between the elements hidden in observational data. However, rule-mining algorithms may produce redundant results even when the support or confidence is high enough, hindering key information discovery. We propose a metaheuristic approach using a genetic algorithm to search for an optimal supersaturated plan constructed from the data. This plan allows identifying and selecting the most relevant factors. The L1-norm Support Vector Machines technique is used to evaluate the performance of the proposed method, providing promising results for the filed.

Robust portfolio optimization for financial markets with transaction costs under logarithmic utilities

Serguei Pergamenchtchikov,[1] **Sergei Egorov,**[2] **Alena Murzintseva,**[2] **Evgeny A. Pchelintsev**[2]

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Abstract

We consider optimal consumption and investment problems under logarithmic utilities for financial markets described by semi-martingales with jumps defined through Lévy processes. For this problem, we show the corresponding verification theorem and construct the optimal strategies in the explicit form. Then, we apply these strategies to markets with transaction costs. Through the Leland - Lepinette approach we construct the strategies based on the finite number of portfolio revisions for which the objective function tends to its optimal value uniformly over the market distributions when the number of portfolio revisions tends to infinity, i.e. the proposed strategies are robust and optimal in the asymptotic setting.

Testing the maximal rank of the volatility

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Abstract

In this talk we investigate statistical estimation of the maximal rank of the volatility process in the context of multivariate diffusion models. Stochastic volatility is one of the most important objects in continuous time finance. There exist several situations in economic applications, such as e.g. joint modelling of bond prices with different maturities or factor models, where the matrix-valued volatility does not exhibit the full rank. In this scenario the natural question arises: What is the maximal rank of the volatility? We provide a formal estimation and testing procedure given high-frequency observations of the multivariate diffusion. If time allows, we will briefly discuss the high-dimensional framework.

QKD modelling in RoNaQCI

Pantelimon George Popescu

Politehnica Bucharest Bucharest, Romania

Abstract

A presentation about QKD behaviour modelling with practical implementations in RoNaQCI, the largest terrestrial QKD network in EuroQCI.

Around tridiagonal random matrix models

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[2] *ENS, Paris, France*

Abstract

I will talk about some tridiagonal random matrix models, and how one can get limit distributions for the eigenvalues in the large limit. I will show that this can be done using combinatorics but also analytical tools.

Order determination for tensor-valued observations using data augmentation

Una Radojičić,[1] **Niko Lietzen**,[2] **Klaus Nordhause**,[3] **Joni Virta**[2]

[1] *Vienna University of Technology, Austria*
[2] *University of Turku, Finland*
[3] *University of Jyväskylä, Finland*

Abstract

Tensor-valued data benefits greatly from dimension reduction as the reduction in size is exponential in the number of modes. To achieve maximal reduction without loss in information, our objective in this work is to give an automated procedure for the optimal selection of the reduced dimensionality. Our approach combines a recently proposed data augmentation procedure with the higher-order singular value decomposition (HOSVD) in a tensorially natural way. We give theoretical guidelines on how to choose the tuning parameters and further inspect their influence in a simulation study. As our primary result, we show that the procedure consistently estimates the true latent dimensions under a noisy tensor model, both at the population and sample levels. Additionally, we propose a bootstrap-based alternative to the augmentation estimator. Simulations are used to demonstrate the estimation accuracy of the two methods under various settings.

Comparing the expected value of imprecise-valued random elements

Ana Belén Ramos-Guajardo, Gil González-Rodríguez

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Abstract

An imprecise-valued random element is a random set that takes as response values that are imprecise sets as, for instance, intervals, star-shaped sets, or fuzzy sets, to name but a few. The purpose of this work is to introduce various measurements that allow comparing two imprecise sets. In addition, some hypothesis tests are proposed to formalize the comparison of the expected values of two imprecise-valued random sets. The proposed methos will be applied on some real-life situations.

Discrete Tsallis, Kaniadakis and Varma entropies of orthogonal polynomials

Răzvan-Cornel Sfetcu,[1] **Sorina-Cezarina Sfetcu,**[1] **Vasile Preda**[2,3,1]

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[3] *"V. Trebici" Center for Demographic Research, "Costin C. Kiritescu" National Institute of Economic Research of Romanian Academy, Romania*

Abstract

We define the discrete Tsallis, Kaniadakis and Varma entropies of Chebyshev polynomials of the first kind and find asymptotic expansions for them. We also make some computations in the special case of quadratic entropies.

Numerical solution to the Neumann problem in a Lipschitz domain based on random walks

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Abstract

We deal with probabilistic numerical solutions for linear elliptic PDEs with Neumann boundary conditions in a Lipschitz domain by using a probabilistic numerical scheme introduced by Milstein and Tretyakov based on new numerical methods.

Stein's method of moments on the sphere

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[2] *University of Oxford, United Kingdom*
[3] *University of Manchester, United Kingdom*

Abstract

We use Stein characterizations to obtain new moment-type estimators for the parameters of three classical spherical distributions (namely the Fisher-Bingham, the von Mises-Fisher, and the Watson distributions) in the i.i.d. case. This leads to explicit estimators which have good asymptotic properties (close to efficiency) and therefore lead to interesting alternatives to classical maximum likelihood methods or more recent score matching estimators. We perform competitive simulation studies to assess the quality of the new estimators.

Change region detection on d-dimensional spheres

Di Su, Tengyao Wang, Yining Chen

London School of Economics, United Kingdom

Abstract

Change point detection in time series data has been extensively studied, but little attention has been given to its generalization to higher dimensional spaces, where changes may occur in different regions with irregular boundaries, posing significant challenges. This talk introduces a method to locate changes in the mean function of a signal-plus-noise model on d-dimensional spheres. We find that the convergence rate depends on the VC dimension of the hypothesis class that characterizes the underlying change regions. Our results extend to data lying on manifolds, under the assumption of a single change region. Furthermore, we adapt the method to address scenarios with multiple change regions. Simulation studies confirm the consistency of our approach for both single and multiple change scenarios with varying mean values across regions.

Multidimensional Stein-Malliavin calculus and asymptotic independence for estimators

Ciprian Tudor

Université de Lille, France

Abstract

We develop an extension of the Stein-Malliavin calculus which allows to measure the Wasserstein distance between the probability distributions of (X, Y) and (Z, Y), where X, Y are arbitrary random vectors and $Z \sim N(0, \sigma^2)$ is independent of Y. We apply this method to study the asymptotic independence for sequences of random vectors with a particular focus on the case of some estimators for some parameters of SPDEs.

A real option approach for the investment valuation of renewable source and storage system in diverse energy communities

Salvatore Vergine, Riccardo De Blasis, Graziella Pacelli

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Abstract

The use of energy storage devices and renewable energy sources has evolved over the past few decades from an individual to a community concept, whereby the energy produced and stored is shared among network users. Having renewable sources (such as photovoltaic systems) in a common setting and sharing energy among different consumers is the base principle of the energy community, where members own and have control over the sources whose presence is fundamental for the existence of the community. Furthermore, the use of battery storage systems in the energy community allows users to store excess energy produced by renewable sources and to use it when it is more cost-comfortable. Given the necessity for managerial flexibility on the investment, there is the need to provide an investment strategy in order to decide whether and when to invest in a photovoltaic-storage system to cover the energy demand. A suitable method to consider the flexibility of a project in an uncertain environment consists of using the real options theory. In this study, we implement an optimization model and a real options valuation which aim to size the photovoltaic-storage system and to obtain the optimal investment strategy in diverse energy communities. We consider the following three sources of uncertainty: photovoltaic production, energy demand, and price of electricity. We study diverse energy communities which include residential buildings, offices, schools, and retail strip malls, thanks to which we associate consumption profiles with different characteristics in terms of variability and time synchronism. Results show that being part of an energy community guarantees savings in terms of total costs and battery capacity, together with a reduction in the investing time and an increase in the value of the option.

Non-parametric tests for spatial dependence

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Abstract

We analyze real-valued data occurring in a regular two-dimensional grid for spatial dependence by using spatial ordinal patterns (SOPs), which constitute a kind of discretization of the originally continuously distributed data. After having derived the asymptotic distribution of the SOP frequencies under the null hypothesis of spatial independence, in a first step, we investigate non-parametric dependence tests using statistics being based on the so-called type of a SOP, a concept that was recently proposed by [1]. Our simulation study in [2] shows that the non-parametric type-based dependence tests have good size properties and constitute an important and valuable complement to the spatial autocorrelation function. However, types imply a three-part partition of the set of all SOPs, and reducing a real-valued spatial data set to three types only, information might get lost for uncovering spatial dependencies. Thus, in a second step, three versions of refined types are proposed that always lead to six classes of SOPs, namely rotation types, direction types, and diagonal types. These refined types are used to derive novel non-parametric tests for spatial dependence relying on entropy-like statistics. For all considered test statistics, the respective asymptotic distribution under the null of spatial independence is derived, which enables a simple implementation of the non-parametric spatial-dependence tests in practice. The finite-sample performance of our tests is analyzed within an extensive simulation study, covering various unilateral and bilateral spatial processes. It is shown that the novel tests (relying either on types or refined types) have appealing power properties and help to recognize how spatial dependence propagates across the data. To illustrate possible applications in practice, two real-world data examples are analyzed, namely one from agricultural science and another one about population changes in a region of Finland.

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