INSTITUTE OF MATHEMATICS AND INFORMATICS,
BULGARIAN ACADEMY OF SCIENCES

FACULTY OF MATHEMATICS AND INFORMATICS,
SOFIA UNIVERSITY "ST. KLIMENT OHRIDSKI"

RECENT DEVELOPMENTS IN STOCHASTIC PROCESSES

27-29 March 2023

Sofia, BULGARIA

PIKOM
ENHANCING THE RESEARCH CAPACITY IN MATHEMATICAL SCIENCES

SIMONS FOUNDATION

MINISTRY OF EDUCATION AND SCIENCE

Contents

General Information

Welcome message

The mini-conference ***Recent Developments in Stochastic Processes*** (RDSP 2023), which takes place from 27 to 29 March, 2023 in Sofia, Bulgaria, will bring together renowned experts and promising young researchers from different subfields of contemporary probability theory to present some of the latest trends in the study and application of stochastic processes. The event is part of the program of the ***International Centre for Mathematical Sciences*** (ICMS, `https://icms.bg`) at the Institute of Mathematics and Informatics of the Bulgarian Academy of Sciences and is supported by the Simons Foundation Grant to ICSM. RDSP 2023 is jointly organized by the Institute of Mathematics and Informatics at the Bulgarian Academy of Sciences and the Faculty of Mathematics and Informatics at Sofia University "St. Kliment Ohridski", with the assistance of the Bulgarian Statistical Society.

Programme Committee

Mladen Savov – Chair
Institute of Mathematics and Informatics, Bulgarian Academy of Sciences
Faculty of Mathematics and Informatics, Sofia University "St. Kliment Ohridski"

Martin Kolb
Universität Paderborn

Tsvetelin Zaevski
Institute of Mathematics and Informatics, Bulgarian Academy of Sciences

Organizing Committee

Mladen Savov – Chair
Institute of Mathematics and Informatics, Bulgarian Academy of Sciences
Faculty of Mathematics and Informatics, Sofia University "St. Kliment Ohridski"

Hristo Sariev
Institute of Mathematics and Informatics, Bulgarian Academy of Sciences

Martin Minchev
Faculty of Mathematics and Informatics, Sofia University "St. Kliment Ohridski"

Accommodation

Hotel: Invited speakers will be accommodated in Grand Hotel Sofia (1, "Gurko" Str., 1000 Sofia, see map), which is located less than 1 km from the conference venue.

Getting there: People flying to Sofia Airport Terminal 2 can take the underground and get off at "Serdika" metro station, where the hotel is 5-10 min. away on foot. People flying to Sofia Airport Terminal 1 can either take the shuttle bus to Terminal 2 and take the underground, or take bus E84 or E184 to the city centre and get off at the last stop ("Gurko Str."), which is 10 min. from the hotel.

Public transport: All public transport in Sofia has recently been equipped with wireless 'pay-as-you-go' ticket machines that accept debit/credit cards. A single-trip ticket costs 1.60 BGN (0.82 EUR). More information can be found here.

Venue information

Venue: The workshop will be held in person at "Prof. Marin Drinov" Hall in the main building of the Bulgarian Academy of Sciences (1, "15-ti Noemvri" Str., 1040 Sofia, see map).

Getting there: The main building of the Bulgarian Academy of Sciences is situated in the very centre of Sofia, next to the Parliament building and "St. Alexander Nevski" Cathedral. The nearest metro station is "Sofia University St. Kliment Ohridski" on the Red/M1 and Yellow/M4 Lines, which is 3-5 min. from the conference venue.

Talks: All presentations will be slides only, with no whiteboard option available in "Prof. Marin Drinov" Hall. Talks will be recorded as part of the agreement with the Simons Foundation and may be shared on online video sharing platforms at a later date with the speakers' explicit permission. Invited speakers will have 50 min. (+5 min. for questions) to deliver their talks, while contributed talks will last 20 min. (+5 min. for questions).

Organizational details

Registration: Registration will take place from 8 to 8:50am on 26 March. Those wishing to pay their registration fee in cash upon arrival may do so only at that time. Others, who have not been granted a fee waiver, must present proof of payment when registering. The fee covers the conference kit, attendance of the conference, social activities and coffee breaks.

Coffee breaks: Refreshments will be served during the morning and afternoon breaks between sessions.

Welcome drink: All registered participants are welcome for a drink and networking at 18:30 on Monday (March 26) at the conference site.

Conference dinner: The conference dinner will be held on Tuesday (March 27) at 19:00 in Restaurant "Forest", which is located within Sports Hall "Sofia" in the "Borisova Garden" park (see map). The restaurant is 10 min. from "Fr. Joliot-Curie" metro station on the Red/M1 and Yellow/M4 Lines, or a 35 min. walk from the conference venue through the park. Food choices are flexible and people can opt for vegetarian/vegan options.

Wi-fi: Wi-fi is available on site.

General policies: All participants are expected to observe the usual code of conduct. People are advised to switch off their mobile phones during talks. Smoking on site is prohibited. Taking photos/recording video is not permitted.

The organizers will be available during the conference for assistance of any kind.

Resources

- Visit Sofia tour guide: `https://www.visitsofia.bg/en/`
- Metro map: `https://www.metropolitan.bg/en/scheme/operating-metro`

Program

	March 27, Monday	March 28, Tuesday	March 29, Wednesday
8:50 - 9:00	Welcome address		
9:00 - 9:55	D. Steinsaltz	G. Grimmett	K. Bogdan
10:00 - 10:55	O. Tough	I. Hartarsky	N. Yanev
11:00 - 11:30	Coffee break		
11:30 - 12:25	T. Hurth	L. Lichev	B. Racheva-Iotova
12:30 - 12:55			D. Nedeltchev
12:30 - 14:00	Break		
14:00 - 14:55	S. Johnston	V. Wachtel	
15:00 - 15:55	M. Lis	M. Kwaśnicki	
16:00 - 16:30	Coffee break		
16:30 - 16:55	D. Donchev	N. Neykov	
17:00 - 17:25	M. Slavtchova-Bojkova	P. Jordanova	
17:30 - 17:55	E. Sönmez	A. Tchorbadjieff	
18:00 - 18:25	A. Klump		
18:30 - 20:00	Wine reception		
19:00 - 21:00		Conference dinner	

Abstracts – Invited Talks

LIMITS IN STOCHASTIC SETTINGS WITH SCALING

29 Mar
09:00 -
09:55

Krzysztof Bogdan
Wrocław University of Science and Technology

Searching for a general perspective, we will discuss a number of intriguing cases when homogeneity semi-automatically yields limiting behaviour. We will focus on the setting of Green functions and heat kernels of Markov processes with scaling, for instance the isotropic stable Lévy processes in cones. The discussion will be based on papers:

Bañuelos, R. and K. Bogdan. Symmetric stable processes in cones. *Potential Analysis* 2004, 21:263—288.

Bogdan, K., Palmowski, Z., and L. Wang. Yaglom limit for stable processes in cones. *Electron. J. Probab.* 2018, 23:1–19.

Bogdan, K., Jakubowski, T., Kim, P., and D. Pilarczyk. Self-similar solution for Hardy operator. 2022. arXiv:2203.02039.

DYNAMIC EPIDEMICS

28 Mar
09:00 -
09:55

Geoffrey Grimmett
University of Cambridge

The stochastic epidemic is a classic example of probabilistic modelling dating back to work of Daniel Bernoulli in 1760, if not earlier. The problem becomes much harder when the model is "spatial" and the disease results in future immunity/death.

Inspired in part by a personal encounter with Covid-19, we consider two models for the spread of infection about a population of diffusing individuals in Euclidean space. The emphasis is upon the case of post-infection immunity. Partial results for the existence (or not) of a pandemic may sometimes be proved via comparisons with branching processes and percolation processes. The principal difficulties lie in the combination of movement and immunity.

The presentation will include summaries of the percolation and contact models, and an outline of their uses in epidemic theory. (Joint work with Zhongyang Li.)

THE LARGEST AND SMALLEST FRAGMENT IN THE HALVING SELF-SIMILAR FRAGMENTATION PROCESS

27 Mar
14:00 -
14:55

Samuel Johnston
King's College

We study the simplest possible self-similar fragmentation process. The process starts at time zero with a single fragment of size 1, which has an $exp(1)$ lifetime before splitting into two fragments of size $1/2$. Thereafter, for a parameter $q < 1$, a fragment of size 2^{-n} has an $exp(q^n)$ lifetime before splitting into two fragments of sizes 2^{-n-1}. We find that at large times the sizes of the largest and smallest fragment in the system can be characterised with high probability to specific integer powers of $1/2$. Our approach draws on connections with branching random walks, point processes and q-combinatorics.

The talk is based on a joint work with Piotr Dyszewski, Nina Gantert, Joscha Prochno and Dominik Schmid.

TWO NEIGHBOUR BOOTSTRAP PERCOLATION AND FREDRICKSON-ANDERSEN MODEL

28 Mar
10:00 -
10:55

Ivailo Hartarsky
TU Wien

The Fredrickson-Andersen model of structural glass (FA) is a lattice spin system with constrained Glauber dynamics. It is closely related to the ubiquitous cellular automata known as bootstrap percolation. After introducing both models, we discuss the sharpest results available for the persistence time of a fixed spin for bootstrap percolation and for FA at equilibrium, as well as some of the techniques used to obtain them.

DIRECTED POLYMERS AND THE STOCHASTIC HEAT EQUATION

27 Mar
11:30 -
12:25

Tobias Hurth
Freie Universität Berlin

Consider random-walk paths on the d-dimensional integer lattice, so-called directed polymers, which are weighted by an i.i.d. random potential depending on time and space. If $d > 2$ and if the strength of the potential is small, the paths behave diffusively for large times. In an article published in 1995, Sinai derived this result by establishing a factorization formula for the point-to-point partition function of the polymer model, assuming that the distance between starting point and endpoint of the polymer grows at most as the square root of its length. In a joint work with Kostya Khanin, Beatriz Navarro Lameda, and Fedor Nazarov, we have extended the factorization formula to the sub-ballistic regime, where the distance between starting point and endpoint is allowed to grow as the polymer length raised to a power arbitrarily close to 1. Via the Feynman-Kac formula, this lets us prove that solutions to the semi-discrete stochastic heat equation with subexponentially growing initial data are attracted by a particular global solution.

NOVEL APPLICATIONS OF LÉVY PROCESSES FOR FINANCIAL PORTFOLIO MANAGEMENT WITH BEHAVIORAL AND SUSTAINABLE-INVESTING AWARENESS

29 Mar
11:30 -
12:25

Boryana Racheva-Iotova
FactSet Research Systems Inc.

It has been empirically proven that the Asset-allocation process is responsible for more than 50% of the financial risk-adjusted performance. Advanced Asset-allocation techniques necessitate two model ingredients: (1) generating possible paths for the future behavior of investment opportunities, a process typically called Economic Scenario Generation; and (2) multi-period optimization to maximize a properly selected utility function. We focus on the first component, where the Economic Scenario Generation is implemented based on Lévy Processes fundamentals, and discuss how that can be further extended to accommodate for two novel phenomena pertinent to the financial markets: Behavior preferences and Sustainable investing. We offer a general framework for modeling exogenous novel risk factors in an integrated framework via the notion of multi-subordinated Lévy processes. The approach introduces a unified framework for consistent integration of traditional and novel types of risk and can serve both risk budgeting and asset-allocation applications.

THE INTERPLAY BETWEEN SPECTRAL THEORY AND LÉVY PROCESSES

28 Mar
15:00 -
15:55

Mateusz Kwaśnicki
Wrocław University of Science and Technology

Spectral theory is an essential tool in the analysis of Markov processes. For example, the greatest eigenvalue of transition operators, and the corresponding eigenfunction, determine the long-time behaviour of the process. Also, various probabilistic quantities can be expressed by expanding them in terms of the eigenfunctions. On the other hand, many interesting operators in analysis can be identified with generators of Markov processes.

I will begin my talk with a short description of the connections mentioned above. Next, I will introduce a curious family of Markov processes, called *Lévy processes with completely monotone jumps*. These processes form a reasonably wide class, which includes all stable Lévy processes, but at the same time they have surprisingly nice analytical properties. In particular, using the methods of *fluctuation theory for Lévy processes*, one can study eigenfunction expansions of transition operators for processes stopped when they cross a fixed level. In the non-symmetric case, these operators fail to be normal operators, so standard spectral-theoretic tools do not apply.

General results that I will present are not entirely explicit, but in some cases it is possible to give a closed-form expression. In the last part of my talk I will describe one particular example: the classical risk process, that is, a compound Poisson process, with exponentially distributed jumps, with a drift.

LABEL PROPAGATION ON BINOMIAL RANDOM GRAPHS

28 Mar
11:30 -
12:25

Lyuben Lichev
Université Jean Monnet and Institut Camille Jordan

In this talk, we will consider one instance of the popular class of unsupervised learning algorithms for finding communities in complex networks called *label propagation algorithms*. It is described as follows: we are given a network on n vertices carring labels $1, 2, \dots, n$. In each round of the algorithm, every vertex switches its label to the majority label in its neighborhood (including its own label). At the first round, ties are broken towards smaller labels, while at each of the next rounds, ties are broken uniformly at random.

We will focus on the action of the algorithm on the binomial random graph $G(n, p)$. More precisely, we will see that for all sufficiently large p, the algorithm typically terminates with a unique label as $n \to \infty$, and will try to understand how this label behaves as a function of p. In particular, we will try to justify why there is a phase transition around $p = n^{-1/3}$.

The talk is based on a joint work with Marcos Kiwi, Dieter Mitsche and Paweł Prałat.

ON THE DUALITY BETWEEN HEIGHT FUNCTIONS AND CONTINUOUS SPIN MODELS

27 Mar
15:00 -
15:55

Marcin Lis
TU Wien

We revisit the classical phenomenon of duality between random integer-valued height functions with positive definite potentials and abelian spin models with $O(2)$ symmetry. We use it to derive new results in quite high generality including: a universal upper bound on the variance of the height function in terms of the Green's function (a GFF bound) which among others implies localisation on transient graphs; monotonicity of said variance with respect to a natural temperature parameter; and the fact that delocalisation of the height function implies a BKT phase transition in planar models. This is joint work with Diederik van Engelenburg (University of Vienna)

QUASI-STATIONARY MONTE CARLO

27 Mar
09:00 -
09:55

David Steinsaltz
University of Oxford

The quasi-stationary behaviour of Markov processes – the asymptotic behaviour of the killed process, conditioned on long (but not infinite) survival – is a topic first investigated by Yaglom in the 1940s, but studied only sporadically until the 21st century. Interest first surged due to a range of applications in theoretical biology, driving the study of particular problems, particularly discrete models and one-dimensional diffusions. In the past few years quasistationary behaviour of a wider group of diffusion models that were previously neglected have come to be studied, due to the proposal by Pollock et al. that quasistationarity could offer a new paradigm for Bayesian computation, with conspicuous advantages over the convergence to stationarity that underlay traditional algorithms such as Gibbs sampler. In particular, they allow for exact calculation in a setting.

This talk will review some of the theory of quasistationary convergence of diffusions, and of Markov chain Monte Carlo algorithms, and explain some of the quasistationary Monte Carlo (QMC) algorithms that have been proposed, with some of their advantages and disadvantages. We will also describe what is known by way of theoretical bounds on the convergence rates of some QMC algorithms.

This is based on joint work with Andi Wang, Martin Kolb, Gareth Roberts, and Murray Pollock.

SYSTEMS WITH FAST RANDOM SWITCHING HAVE A SMOOTH STATIONARY DENSITY

27 Mar
10:00 -
10:55

Oliver Tough
Université de Neuchâtel

In this talk we consider the stationary distribution of systems obtained by randomly switching between different ODEs. In contrast to diffusions, the stationary distribution corresponds to a system of hyperbolic first-order PDEs, so PDE theory doesn't provide us with nice smoothness properties. For this reason, almost nothing was previously known about the smoothness of such stationary distributions in dimension greater than one. We establish, in any dimension, general (Hormander-type) conditions ensuring that, for any finite k, the stationary density is k-times continuously differentiable whenever the random switching is sufficiently fast. The fast switching requirement is necessary: we conversely obtain broad conditions ensuring that the stationary density possesses singularities (at which the density is infinite) whenever the jump rate is sufficiently slow. Moreover, we establish that the stationary density is lower semicontinuous regardless of the jump rate, under a general Hormander-type condition. The proof is probabilistic. This is joint work with Michel Benaïm.

HARMONIC MEASURE IN A MULTIDIMENSIONAL GAMBLER'S PROBLEM

28 Mar
14:00 -
14:55

Vitali Wachtel
University of Bielefeld

We consider a random walk in a truncated cone K_N, which is obtained as a result of slicing cone K by a hyperplane at a growing level N. We study the asymptotic behaviour of the Green function of the walk killed at leaving K_N. Using these results we derive local asymptotics for the harmonic measure in K_N.

The obtained general results are applied to a gambler's ruin problem with many players studied in a recent paper by Diaconis and Ethier. In particular, we confirm their conjecture that the probability of eliminating players in a given order has the same exact asymptotic behaviour as for the Brownian motion analogue.

SOME GENERALIZATIONS OF KOLMOGOROV APPROXIMATION IN THE THEORY OF BRANCHING PROCESSES

29 Mar
10:00 -
10:55

Nikolay Yanev

Institute of Mathematics and Informatics, Bulgarian Academy of Sciences

Dedicated to the 120th Anniversary of A.N.Kolmogorov

Kolmogorov [1] considered a biological problem posed by Fisher (1930) about multiplication of a new gene in an unrestricted size population. In this case he also obtained the first asymptotic result in the theory of branching processes on the asymptotic approximation of the probability of non-extinction in a classical Bienaymé-Galton-Watson process.

In [2–5], we considered more general classes of branching processes including an immigration component generated by Poisson random measures with intensity $r(t)$. The reproduction process assumed in [2, 4] obeys the rules of a (non-Markovian) single-type Sevastyanov age-dependent branching process. In [3, 5], the reproduction process was generalized to that of a multitype Markov branching process. The probabilities of non-extinction were shown to exhibit a broad range of asymptotic behaviors essentially determined by the intensity $r(t)$. In some cases, these results are similar to Kolmogorov's, in other cases they differ. Different types of limit theorems are also obtained.

The talk is based on joint work with Maroussia Slavtchova-Bojkova, Kosto Mitov and Ollivier Hyrien.

References

[1] Kolmogorov, A.N. On the solution of one biological problem. *Proc. Inst. Math. Mech. Tomsk Univ.* 1938, 2 (1):7–12. (See also: A.N.Kolmogorov. Selected works, V.2. Theory of Probability and Mathematical Statistics, "Nauka", Moscow, 2005, 214-219). (In Russian).

[2] Mitov, K., and N. Yanev. Sevastyanov branching processes with non-homogeneous Poisson immigration. *Proc. Steklov Inst. Math.* 2013, 282:172–85.

[3] Mitov, K., N. Yanev, and O. Hyrien. Multitype Branching Processes with Non-Homogeneous Poisson Immigration. *Adv. Appl. Probab.* 2018, 35 (2):197–208.

[4] Slavtchova-Bojkova, M., and N. Yanev. Poisson random measures and critical Sevastyanov branching processes. *Stoch. Models* 2019, 35 (2):197–208.

[5] Slavtchova-Bojkova, M., O. Hyrien, and N. M. Yanev Poisson random measures and supercritical multitype Markov branching processes. *Stoch. Models.* 2022, Advance online publication. doi: 10.1080/15326349.2021.2016446.

Abstracts – Contributed Talks

ESCAPE FROM EXTINCTION WITH DECOMPOSABLE MULTITYPE SEVASTYANOV BRANCHING PROCESSES

27 Mar
17:00 -
17:25

Maroussia Slavtchova-Bojkova
Sofia University "St. Kliment Ohridski"

Dedicated to the 120th Anniversary of A.N.Kolmogorov

Biological populations under stress often face certain extinction unless they adapt towards unfavorable circumstances. In some scenarios such adaptation can assume the form of beneficial mutations within the genome of the population (e.g. cancer cells resisting drug treatment or chemotherapy, viruses developing resistance towards a vaccine), while in other scenarios it could assume the form of movement towards some physical location (e.g. spreading of cancer cells to parts of the organism unaffected by treatment, populations fleeing polluted areas or areas struck by disaster). Regardless of the particular situation, it is often the case that individuals with different levels of adaptation (which we may group into types) emerge among the individuals of a stressed population. In [2] a decomposable multi–type Sevastyanov branching processes (MSBP) (possibly with multiple supercritical types) for modeling relevant aspects of the dynamics of such populations, was proposed.

The branching process developed in [2] is a generalization of the decomposable multi-type age-dependent branching process with a single supercritical type considered in [1]. With respect to [1], additional, possibly supercritical, types into the interaction scheme between types are introduced. Further, possible dependence of the reproductive capabilities of cells/individuals from their age is incorporated. A system of integral equations for the probability generating functions of the process are obtained in [2] and accordingly previous results from [1] concerning probabilities of extinction, number of occurred mutations, waiting time to escape mutant, and immediate risk of escaping extinction are expanded. We also provide a general numerical scheme for calculating obtained systems of integral equations.

The talk is based on joint work with Kaloyan Vitanov.

References

[1] Slavtchova-Bojkova, M., and K. Vitanov. Multi-type age-dependent branching processes as models of metastasis evolution. *Stoch. Models* 2019, 35 (3):284–299.

[2] Vitanov, K., and M. Slavtchova-Bojkova. Modeling escape from extinction with decomposable multi-type Sevastyanov branching processes. *Stoch. Models* 2023, 39 (1):161–184.

THE DISORDER PROBLEM. A POMDP APPROACH

27 Mar
16:30 -
16:55

Doncho Donchev
Sofia University "St. Kliment Ohridski"

We revisit the discrete time disorder problem. The classical approach to it is based on optimal stopping rules and martingale techniques. We include it into the framework of Partially Observable Markov Decision Processes which improves the quality of detection, and allows, in some cases, to find solutions to Bellman's equation.

MIXED POISSON PROCESSES WITH STACY MIXING VARIABLE

28 Mar
17:00 -
17:25

Pavlina Jordanova
Shumen University "Konstantin Preslavski"

Stacy distribution was defined for the first time in 1961. It provides a flexible framework for modeling of a wide range of real-life behaviors. It appears under different names in the scientific literature and contains many useful particular cases. Homogeneous Poisson processes are appropriate apriori models for the number of renewals up to a given time $t > 0$. This talk mixes them and considers a Mixed Poisson process with Stacy mixing variable. The new process is called Poisson-Stacy process. The resulting counting process is one of the Generalised Negative Binomial processes, and the distribution of its time intersections are very-well investigated in the scientific literature. Here we define and investigate their joint probability distributions. Then, the corresponding mixed renewal process is investigated and Exp-Stacy and Erlang-Stacy distributions are defined and partially studied. Some plots of the simulated sample paths of the considered processes and probability density functions of the considered distributions show possible applications of these random elements.

THE INVERSE FIRST-PASSAGE TIME PROBLEM AS HYDRODYNAMIC LIMIT OF A PARTICLE SYSTEM

27 Mar
18:00 -
18:25

Alexander Klump
Institute of Mathematics and Informatics, Bulgarian Academy of Sciences

Given a probability distribution on the positive real numbers, the so-called inverse first-passage time problem for reflected Brownian motion consists of finding a time-varying boundary such that the first-passage time over that boundary by a reflected Brownian motion has the given distribution. In this talk we see that this problem can be rediscovered in the macroscopic behavior of a particle system which undergoes selection according to a given probability distribution on the positive real numbers. With the help of stochastic order methods which were used for proving uniqueness and ideas from the analysis of the so-called N-branching Brownian motion, the hydrodynamic limit of the particle system is identified as the distribution of a reflected Brownian motion conditioned to not having passed the solution of the inverse first-passage time problem.

APPLICATION OF STOCHASTIC PROCESSES TO MEASURE MARKET RISK VIA EXPECTILE

29 Mar
12:30 -
12:55

Dragomir Nedeltchev

Institute of Mathematics and Informatics, Bulgarian Academy of Sciences

The market risk profile and consequently the risk management depend on the risk measure applied. Hence, the risk measure must be chosen based on weighting pros vs cons of the available measures. The report presents the measurement of the market risk via the expectile and compares this relatively new measure with the traditional ones: the Value-at-Risk and the Expected Shortfall. The returns of the base asset are presented as driven by stochastic process and 5 models are applied: the Black-Scholes model, exponential tempered stable model, stochastic volatility models of Heston, Bates and one with a tempered stable jump correction. The report compares the capabilities of these models to grasp key stylized facts for the financial markets. Also, the report discuss a measure modification via correction coefficients for smooth shifting between the risk measures.

FORECASTING TROPOSPHERIC OZONE (O_3), NITROGEN DIOXIDE (NO_2) AND PARTICULATE MATTER (PM_{10}) HOURLY CONCENTRATIONS USING MIXTURE OF DYNAMIC GENERALIZED ADDITIVE MODELS

28 Mar
16:30 -
16:55

Neyko M. Neykov

National Institute of Meteorology and Hydrology, Bulgaria

Air quality management in Sofia city relies heavily on time series data obtained from air monitoring stations as a basis for determining population exposure to airborne pollutants. Hourly air pollution concentrations data of nitrogen dioxide (NO_2), tropospheric ozone (O_3) and particulate matter (PM_{10}) have been collected at six monitoring stations of the Executive Environment Agency in Sofia city for the period 01.01.2017-31.12.2022 yrs. Accurate forecasting of concentrations of the pollutants will allow early warning procedures to be improved, which is useful for safety reasons and enables, for example, traffic restrictions or a decision to make public transport free. Therefore the need for development of forecasting air quality tools is an important issue for public authorities.

In this talk we discuss several methodological issues including the estimation schemes, the introduction of deterministic forecasts to weather models, and how to deal with forecasting at various horizons from some hours to 72 hours ahead. In particular the focus will be on the joint use of the deterministic Weather Research and Forecasting (WRF) model which characterize the atmospheric conditions in Sofia from ground surface up to 5500 m height and delivers meteorological derivatives which serve as input into mixture of Generalized Additive time series regression Models (GAMs). Mixture of dynamic GAMs with log-normal and gamma distributions will be considered because the hourly air pollutant concentrations are positive and right skewed distributed on the real line. As a consequence of GAMs usage, the non-linear impact of meteorological predictors on air pollution concentrations is assessed and quantified. The models are fitted to data for the period 2017-2021 while the accuracy forecasts are assessed on the test data for the period 2022 following the rolling forecasting origin cross-validation procedure. Standard forecast accuracy metrics such as mean absolute error, root mean square error and correlation coefficients between observed and forecast values will be discussed.

EXTREME VALUE PROPERTIES OF LONG-RANGE PERCOLATION MODELS

27 Mar
17:30 -
17:55

Ercan Sönmez
University of Stuttgart

We consider both a discrete and continuous variant of long-range percolation on $\mathbf{R}^d$ in which an edge between two points at distance r is present with probability $\overline{g}(r)$. We elucidate yet unrevealed properties these models exhibit, namely by investigating the longest edge with at least one endpoint within some finite observation window, as the volume of this window tends to infinity. We show that the length of the latter in the continuous model, after normalizing by some appropriate centering and scaling sequences, asymptotically behaves like one of each of the three extreme value distributions, depending on choices of the probability $\overline{g}(r)$. In the discrete variant the results are more intriguing and we encounter subtle differences to the continuous model, in which we prove convergence in distribution for all of the cases considered. Parts of the proof employ the Chen-Stein method, a general result on Poisson approximation related to Stein's method and Palm calculus.

The talk is based on a joint work with Arnaud Rousselle.

SUBCRITICAL MARKOV BRANCHING PROCESS WITH BOREL DISTRIBUTION IN ITS ASYMPTOTIC

28 Mar
17:30 -
17:55

Assen Tchorbadjieff
Institute of Mathematics and Informatics, Bulgarian Academy of Sciences

An important practical question concerning the study of branching processes is the "cause and effect" inference. Let us consider the subcritical Markov branching process starting with one particle. In particular, we focus on the case when the conditional limit law is given by the Borel distribution, supported by the positive integers. We find the probability law of the branching mechanism, leading to this asymptotic, and all characteristics of the number of particles alive. In this case, the probability generation functions are given by the Lambert-W function on its principal branch. The talk is based on joint work with Penka Mayster.

Author Index