

# ABSTRACTS

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## **EXIT TIMES AND INVARIANCE PRINCIPLE FOR SUMS OF NON I.I.D. RANDOM VARIABLES**

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We study the asymptotic behavior of the distributions of first-passage times over moving boundaries. At first sight, it looks natural to use in this analysis the strong approximations techniques, including the convergence rates.

However, we show that this approach is applicable only in particular cases. For example, it does not work for finding the asymptotics of the distribution of the first-passage time over a fixed boundary for a random walk that starts from a fixed value. Therefore, one has to seek for other approaches here.

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## **UNIVERSALITY FOR EXIT TIMES OF MARKOV PROCESSES**

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We will discuss the general ideas of the auxiliary stopping times that allows us to obtain general limit theorems for random walks constrained to some unbounded domains. We will also discuss an important ingredient of this approach – a construction of a harmonic (on the given domain) function. The approach will be illustrated with an example of random walks in cones.

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## **OVERVIEW OF THE RECENT PROGRESS ON EXIT TIMES FROM UNBOUNDED DOMAINS**

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We will discuss the recent progress in the area of the exit times and limit theorems for Markov processes in unbounded domains.

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## OPTIMAL REINSURANCE AND INVESTMENT STRATEGIES FOR AN INSURER UNDER MONOTONE MEAN-VARIANCE CRITERION

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We consider the monotone mean variance problem in this paper. The stock prices are assumed to be governed by the geometric Brownian motions while the cumulative claims process is assumed to be governed by the compounded Poisson process. We suppose that the admissible strategies are adapted to a filtration which is generated by the compounded Poisson process as well as the uncertainty of the stock prices rather than the Brownian motions. In this paper, we obtained the optimal strategy and the value function for the monotone mean-variance criterion which is an amended version of the classic mean-variance criterion. The optimal strategy has a characteristic of 'buy low, sell high'. We also obtained the monotone efficient frontier which is defined in section 4.2.

This is a joint work with Bohan Li.

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## SYSTEMIC RISK: AN ASYMPTOTIC EVALUATION

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The systemic risk (SR) has been shown to play an important role in explaining the financial turmoil in the last several decades and understanding this source of risk has been a particular interest amongst academics, practitioners, and regulators. The precise mathematical formulation of the SR is still scrutinized, but the main purpose is to evaluate the financial distress of a system as a result of the failure of one component of the financial system in question. Many of the mathematical definitions of the SR are based on evaluating expectations in extreme regions and therefore, Extreme Value Theory (EVT) represents the key ingredient in producing valuable estimates of the SR. Without doubt, the prescribed dependence model amongst the system components has a major impact over our asymptotic approximations. Thus, this paper considers various well-known dependence models in the EVT literature that allow us to generate SR estimates.

This is a joint work with Dr. Alexandru V. Asimit

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## ON THE CAT-AND-MOUSE MARKOV CHAIN AND ITS GENERALISATIONS

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We consider the so-called Cat-and-Mouse Markov chain, studied earlier by Litvak and Robert (2012). This is a 2-dimensional Markov chain on the lattice  $Z^2$ , where the first component is a

simple random walk and the second component changes when the components meet. We work with two generalisations of the model and obtain limiting laws of the last components.

This is a joint work with S.G. Foss and V.V. Shneer.

## MULTI-TYPE BRANCHING PROCESSES IN RANDOM ENVIRONMENT: CRITICAL AND STRONGLY SUBCRITICAL CASES

Vladimir Vatutin

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We describe the asymptotic behaviour of the survival probability of a multi-type branching processes in random environment. The class of processes we consider corresponds, in the one-dimensional situation, to the critical and strongly subcritical cases.

This is a joint work with Vitalii Wachtel and Elena Dyakonova.

**Acknowledgement:** This work was supported by the Russian Science Foundation under the grant 17-11-01173.

### REFERENCES

- [1] *Vatutin V., Dyakonova E.* Multitype branching processes in random environment: survival probability for the critical case. – *Theory Probab. Appl.*, 62:4 (2018), 506–521.
- [2] *Vatutin V., Wachtel V.* Multi-type subcritical branching processes in a random environment. – *Adv. in Appl. Probab.*, 50:A (2018), 281–289. arXiv: 1711.07453.

## MULTI-TYPE BRANCHING PROCESSES IN RANDOM ENVIRONMENT: INTERMEDIATELY AND WEAKLY SUBCRITICAL CASES

Elena Dyakonova

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We investigate the asymptotic behaviour of the survival probability of a multi-type branching processes in random environment. The class of processes we consider corresponds, in the one-dimensional situation, to the intermediately and weakly subcritical cases.

This is a joint work with Vladimir Vatutin.

**Acknowledgement:** This work was supported by the Russian Science Foundation under the grant 17-11-01173.

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## INFINITELY RAMIFIED POINT MEASURES AND BRANCHING LÉVY PROCESSES

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An infinitely ramified point measure is a random point measure that can be written as the terminal value of a branching random walk of any length. This is the equivalent, in branching processes theory, to the notion of infinitely divisible random variables for real-valued random variables. In this talk, we show a connection between infinitely ramified point measures and branching Lévy processes, a continuous-time particle system on the real line, in which particles move according to independent Lévy processes, and give birth to children in a Poisson fashion.

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## BARAK-ERDÖS GRAPHS AND THE INFINITE-BIN MODEL

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Barak-Erdős graphs are the directed acyclic version of Erdős-Rényi random graphs: the vertex set is  $\{1, \dots, n\}$  and for each  $i < j$  with probability  $p$  we add an edge directed from  $i$  to  $j$ , independently for each pair  $i < j$ . The length of the longest path of Barak-Erdős graphs grows linearly with the number of vertices, where the growth rate  $C(p)$  is a function of the edge probability  $p$ .

Foss and Konstantopoulos introduced a coupling between Barak-Erdős graphs and a special case of an interacting particle system called the infinite-bin model. Using this coupling, we show that  $C(p)$  is analytic for  $p > 0$  and is differentiable once but not twice at  $p = 0$ . We also show that the coefficients of the Taylor expansion at  $p = 1$  of  $C(p)$  are integers, suggesting that  $C(p)$  is the generating function of some class of combinatorial objects.

This is a joint work with Bastien Mallein (Université Paris-13).

## REFERENCES

- [1] *B. Mallein and S. Ramassamy*, Barak-Erdos graphs and the infinite-bin model, preprint arXiv:1610.04043 (2016).
- [2] *B. Mallein and S. Ramassamy*, Two-sided infinite-bin models and analyticity for Barak-Erdos graphs, Bernoulli, to appear.

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## ONCE-REINFORCED RANDOM WALK ON A CYLINDER GRAPH

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The once-reinforced random walk is random walk on a graph which moves along the edges of the graph while favoring edges which have already been traversed at some prior time. This model was introduced by Keane almost 30 years ago and is now well understood when the

ambient graph is a tree. On the other hand, very little is known about the behavior of the walk when the graph contain cycles. In this talk, I will revisit unpublished results from Vervoort and explain how one can prove recurrence and a shape theorem for the walk when the underlying graph is a cylinder.

## SUBEXPONENTIAL TAIL ASYMPTOTICS FOR MARKOV CHAINS

Dmitry Korshunov

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We consider a time-homogeneous stable Markov chain on the real line such that any exponential moment of the chain distribution does not exist. We study asymptotics of the tail distribution of the chain and of its stationary version assuming subexponentiality of jumps. The results obtained are useful for deriving asymptotics for stochastic difference equations under subexponential type conditions.

## LOCAL THEOREMS FOR COMPOUND SEMI-MARKOV RENEWAL PROCESSES (MULTIDIMENSIONAL ARITHMETIC CASE)

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We consider a compound semi-Markov renewal process, defined by ergodic Markov chain with finite set of states and array of arithmetic vectors, that satisfied Cramér's condition. We obtain the local limit theorem in domain of normal, moderate and large deviations.

This is a joint work with Yambartsev A.

The work is supported by the Russian Science Foundation under grant 18-11-00129.

## LIMIT THEOREMS FOR RECORD INDICATORS IN THRESHOLD $F^\alpha$ -SCHEMES

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In Nevzorov's  $F^\alpha$ -scheme, one deals with a sequence of independent random variables whose distribution functions are all powers of a common continuous distribution function. A key property of the  $F^\alpha$ -scheme is that the record indicators for such a sequence are independent. This allows one to obtain several important limit theorems for the total number of records in the sequence up to time  $n \rightarrow \infty$ . We extend these theorems to a much more general class of sequences of random variables obeying a "threshold  $F^\alpha$ -scheme" in which the distribution functions of the variables are close to the powers of a common  $F$  only in their right tails, above certain non-random non-decreasing threshold levels. Of independent interest is the characterization of the growth rate for extremal processes that we derived in order to be able to verify the

conditions of our main theorem. We also establish the asymptotic pair-wise independence of record indicators in a special case of threshold  $F^\alpha$ -schemes.

This is a joint work with P. He.

## CLASSICAL RUIN PROBABILITY PROBLEM

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## SPINE DECOMPOSITIONS AND LIMIT RESULTS FOR MODELS WITH BRANCHING STRUCTURE

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Consider a Galton-Watson process  $((Z_n)_{n \geq 0}; \mathbf{P})$  with offspring distribution  $\mu = (\mu(n))_{n \geq 0}$ . Let  $L$  be a random variable with law  $\mu$ . Assume that  $Z_0 = 1$  and the process is critical in the sense that

$$(0.1) \quad \mathbf{E}[L] = \sum_{k=0}^{\infty} k\mu(k) = 1.$$

Suppose  $L$  has finite variance

$$(0.2) \quad 0 < \sigma^2 := \sum_{k=0}^{\infty} (k-1)^2 \mu(k) = \sum_{k=0}^{\infty} k(k-1) \mu(k) < \infty.$$

For simplicity, we will call a Galton-Watson process with offspring distribution  $\mu$  a  $\mu$ -Galton-Watson process.

In this talk, I will describe a 1-spine decomposition and a 2-spine decomposition for the critical Galton-Watson tree and use the 2-spine decomposition to give a probabilistic proof of Yaglom's theorem: conditional on  $(Z_n > 0)$ , the law of  $\frac{Z_n}{n}$  converges to the exponential distribution.

Then I will establish a 1-spine decomposition theorem and a 2-spine decomposition theorem for some critical superprocesses. These two kinds of decompositions are unified as a decomposition theorem for size-biased Poisson random measures. These decompositions can be used to give probabilistic proofs of the asymptotic behavior of the survival probability and Yaglom's exponential limit law for some critical superprocesses.

The talk is based on a joint works with Renming Song and Zhenyao Sun.

## RANDOM WALKS WITH SWITCHINGS AND THE RUIN PROBABILITY

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We obtain some limit theorems for the maximum of the oscillating random walk with two levels of switchings by using corresponding limit theorems for the ruin probability. In addition, we discuss bounds for the ruin probability under heavy tailed distribution of summands.

The work is supported by the Russian Science Foundation under grant 18-11-00129.

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**CRITICAL MULTITYPE BRANCHING PROCESSES**

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We describe some properties of critical branching processes with either infinite second moment of the offspring distribution or infinite first moment of the lifetime distribution.

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**LIMIT DISTRIBUTIONS OF THE PEARSON STATISTICS FOR  
NONHOMOGENEOUS POLYNOMIAL SCHEME**

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We consider nonhomogeneous polynomial scheme and find conditions on the probabilities of outcomes under which it is possible to describe limit distributions of the Pearson statistics.

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**ON THE DISTRIBUTION TAIL OF THE SUM OF THE MAXIMA OF TWO  
RANDOMLY STOPPED SUMS IN THE PRESENCE OF HEAVY TAILS**

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Consider two independent sequences of independent identically distributed random variables  $\{\xi_i\}$  and  $\{\eta_j\}$ . Assume, that  $\xi_1$  and  $\eta_1$  have finite negative expectation. Put

$$S_k = \sum_{i=1}^k \xi_i, \quad \bar{S}_n = \max_{0 \leq k \leq n} S_k$$

and, similiary,

$$T_l = \sum_{j=1}^l \eta_j, \quad \bar{T}_m = \max_{0 \leq l \leq m} T_l,$$

where  $S_0 = T_0 = 0$  by definition.

Consider two-dimensional stopping time  $(\nu, \mu)$ . Our goal is to find conditions for the following asymptotic equivalence to hold:

$$(0.3) \quad \mathbb{P}(\bar{S}_\nu + \bar{T}_\mu > x) \sim \mathbb{E}\nu \mathbb{P}(\xi_1 > x) + \mathbb{E}\mu \mathbb{P}(\eta_1 > x)$$

In the one-dimensional case the asymptotics  $\mathbb{P}(\bar{S}_\nu > x) \sim \mathbb{E}\nu \mathbb{P}(\xi_1 > x)$  hold given that the distribution of  $\xi_1$  is *strong subexponential* (Foss and Zachary, 2003).

We obtain (0.3) assuming that

$$\mathbb{P}(\xi_1 > x) \sim c_1 \bar{G}(x) \text{ and } \mathbb{P}(\eta_1 > x) \sim c_2 \bar{G}(x),$$

where  $c_1 + c_2 > 0$  and  $G$  is a strong subexponential distribution.

This is a joint work with Sergey Foss.

## BEHAVIOR OF ERDŐS–RÉNYI RANDOM GRAPHS CONDITIONED ON LARGE TRIANGLES AMOUNT

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We obtain a certain characterization of solution to the variational problem, describing limit behavior of dense random graphs, conditioned on containing excessively large number of triangles. Numerical simulations demonstrating said limit behavior was performed.

The work is supported by the Russian Science Foundation under grant 18-11-00129.

## LIMIT THEOREMS FOR SOME STATISTICS IN AN INFINITE URN SCHEME

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We consider the classical multinomial occupancy scheme with infinitely many urns, where urns are numbered and balls are thrown one-by-one at random, each goes to urn  $i = 1, 2, \dots$  with probability  $p_i$ . Here  $\{p_i\}$  is a non-increasing sequence of strictly positive probabilities, with  $\sum_i p_i = 1$ . We let  $X_{n,j}$  be the number of balls in urn  $j$ , out of the first  $n$  balls, and let  $X_n = (X_{n,j}, j = 1, 2, \dots)$ .

The number of non-empty urns,  $R_n = \#\{j : X_{n,j} > 0\}$ , is a *measure of diversity* of the sample of size  $n$ . A more detailed information is given by the statistics  $R_{n,k} = \#\{j : X_{n,j} = k\}$  ( $k = 1, 2, \dots$ ), the number of urns with exactly  $k$  balls (out of  $n$ ). Here  $R_n = \sum_k R_{n,k}$  and  $\sum_k k R_{n,k} = n$ . Here are other random variables studied in statistical applications  $U_n = \sum_{j=1}^{\infty} \mathbf{1}_{\{X_{n,j} \equiv 1 \pmod{2}\}}$  and  $M_n = n \cdot \sum_{j=1}^{\infty} p_j \cdot \mathbf{1}_{\{X_{n,j}=0\}}$ .

We will establish new functional CLT's for  $U_n(t)$  and  $M_n(t)$  processes. We will also discuss open problems and establish a number of auxiliary statements simplifying the study of these statistics.

## REFERENCES

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- [2] M. Chebunin. Functional central limit theorem in an infinite urn scheme for distributions with superheavy tails. *Siberian Electronics Mathematical Reports*, **14**, 2017, 1289–1298.

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**TEST FOR TEXT HOMOGENEITY VIA AN INFINITE URN MODEL**

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We use an elementary infinite urn model of text in natural language. We study the asymptotic behavior of the process of the number of different words in the case when the probabilities of the appearance of words obey the Zipf-Mandelbrot law. We construct a test for homogeneity of a text based on the study. We examine the homogeneity of texts in different languages.

This is a joint work with M. Chebunin, I. Pupyshv, N. Zakrevskaya.

Acknowledgements. The research was supported by RFBR grant 19-51-53010.

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**MANY GREEDY CLEANERS IN A POISSON ENVIRONMENT**

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I plan to review the basic greedy cleaning and greedy server models, recall known results and open questions. Next, I introduce a new model with many greedy cleaners a a star-like state space covered by a Poisson dust, and formulate limit theorem as the number of cleaners and the number of halflines forming the state space tend proportionally to infinity.

This is a joint work with Thomas Mountford (EPFL, Lausanne).