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ABSTRACTS OF TALKS GIVEN AT THE 7TH INTERNATIONAL CONFERENCE ON STOCHASTIC METHODS, I*

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The Seventh International Conference on Stochastic Methods (ICSM-7) was held June 2–9, 2022 at Divnomorskoe (near the town of Gelendzhik) at the Raduga sports and fitness center of the Don State Technical University. ICSM-7 was organized by the Steklov Mathematical Institute of Russian Academy of Sciences (Steklov International Mathematical Center; Department of Theory of Probability and Mathematical Statistics); Moscow State University (Department of Probability Theory); National Committee of the Bernoulli Society of Mathematical Statistics, Probability Theory, Combinatorics, and Applications; and the Don State Technical University (Department of Higher Mathematics). The conference chairman (presiding remotely) was A. N. Shiryaev, a member of the Russian Academy of Sciences, who chaired the previous three conferences and also headed the Organizing Committee and the Program Committee.

Many leading scientists from Russia, France, Portugal, and Tadjikistan took part in ICSM-7. Russian participants came from Veliky Novgorod, Voronezh, Zernograd, Kaluga, Kizil, Maikop, Moscow, Nizhni Novgorod, Rostov-on-Don, Samara, St. Petersburg, Sochi, Syktyvkar, Taganrog, Tomsk, Tyumen, Ufa, and Chelyabinsk. Approximately one-quarter of the talks were given by postgraduate and undergraduate students. Twenty-nine talks were given at joint sessions, and 36 talks were presented at parallel sessions.

Financial support from the Steklov International Mathematical Center (Steklov Mathematical Institute of Russian Academy of Sciences), Russia, was invaluable for the successful work of the conference.

At the opening of the conference, I. V. Pavlov, the Organizing Committee Deputy Chair, read the following welcome message from A. N. Shiryaev to the conference participants.

Dear Colleagues!

Despite numerous difficulties, our Rostov-on-Don probabilists have managed to gather all of us in this wonderful Black Sea city at the 7th International Conference on Stochastic Methods. This is essentially the only current large conference on probability theory, mathematical statistics, and their application.

We all know that the classical probability theory is mainly associated with the limiting theorems such as the law of large numbers, the central limit theorem, and the Poisson theorem. This topic continues to occupy a worthy place in probability theory and is presented at our conference. The limit theorems play an important role in probability theory as a link, say, between models with discrete and continuous times, and as a phenomenon that reveals the meaning of the very concept of probability.

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A large number of talks at the conference are devoted to applications of probability theory and mathematical statistics, which corresponds to the very name of the conference as a conference on stochastic methods. Last year, despite the pandemic, we successfully held the 6*th conference (via Zoom) in Moscow, where representatives of all five continents participated. In total,* 47 *talks were given. The Moscow conference was dedicated to the bicentenary of our wonderful mathematician, Pafnutii L'vovich Chebyshev. The number of works of Chebyshev on the probability theory is small (just four). But all of them played a decisive role in the formation and maturation of probability theory.*

This year, in July, the 33*rd European conference on statistics, in the broad sense of the word "statistics" (including mainly its economic aspects), was supposed to be held. The World Congress of Mathematics in St. Petersburg (Russia) was also scheduled. Unfortunately, these events did not take place. We hope that, in the future, ordinary contacts with foreign colleagues will continue and we will, for example, have the opportunity to visit the* 43*rd conference on stochastic processes and their applications, which should be held in Lisbon (Portugal) in July* 2023*. In Soviet times, we actively participated in the organization of international scientific activities. In this regard, let us recall the Soviet–Japanese symposia and the first World Congress of the Bernoulli Society in Tashkent* (1986)*. I would like to hope that following the example of our Rostov-on-Don colleagues, there will be young people who would organize conferences of young researchers. Events like summer workshops are also rare in Russia nowadays.*

The next year will be marked by the 120*th anniversary of the birth of A. N. Kolmogorov, and we should all work to have a successful* 8*th conference dedicated to this date. We would be grateful for the advice, suggestions, and help.*

It remains to wish everyone successful work, and, of course, many sunny days at this beautiful Black Sea resort!

A. N. Shiryaev, I. V. Pavlov, P. A. Yaskov, T. A. Volosatova

The abstracts of the talks and presentations given at the conference are provided below.

V. I. Afanasyev (Steklov Mathematical Institute of Russian Academy of Sciences, Moscow, Russia)**. On local times of conditional random walks.** [1]

Let $X_1, X_2, \dots$ be independent r.v.'s with the same arithmetic distribution with maximal span 1, and let $\mathbf{E}X_1 = 0$, $\mathbf{E}X_1^2 := \sigma^2 \in (0, +\infty)$. Consider a random walk $S_0 = 0$, $S_i = \sum_{j=1}^{i} X_j$, $i \in \mathbf{N}$. Next, let $T = \min\{i > 0\colon S_i \leqslant 0\}$. Consider the *stopped random walk* $\widetilde{S}_i = S_i$ for $i < T$ and $\widetilde{S}_i = 0$ for $i \geqslant T$. We set $\widetilde{\xi}(k) = |\{i \geqslant 0\colon \widetilde{S}_i = k\}|$.

Let $\{W^+(t),\, t \geqslant 0\}$ be a Brownian meander and $l^+(u)$ be its local time, i.e., $l^+(u) = \lim_{\varepsilon \to 0} \varepsilon^{-1} \int_0^{+\infty} I_{[u,u+\varepsilon]}(W^+(s))\, ds$ for $u > 0$.

Theorem 1. *As* $n \to \infty$,

$$\left\{ \frac{\sigma \widetilde{\xi}(\lfloor u\sigma\sqrt{n} \rfloor)}{\sqrt{n}},\, u \geqslant 0 \;\middle|\; T > n \right\} \to \{l^+(u),\, u \geqslant 0\},$$

where the symbol $\to$ *means the convergence in distribution in the space* $D[0, +\infty)$ *with the Skorokhod topology.*

[1]This work was performed at the Steklov International Mathematical Center with the support of the Ministry of Science and Higher Education of the Russian Federation (agreement 075-15-2019-1614).

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V. A. Kutsenko, E. B. Yarovaya (Lomonosov Moscow State University, Moscow, Russia)**. Branching random walk in random environment with Gumbel potential.** [11]

We consider a branching random walk (BRW) on $\mathbf{Z}^d$ with continuous time in random environment. A BRW is based on a simple symmetric random walk. At each point $\mathbf{Z}^d$, a particle either dies or produces two offsprings with random intensities $b_0(\omega,x)$ and $b_2(\omega,x)$. In a fixed environment, the moments of the number of offsprings of a particle at a point x at time $t=0$ are random and denoted by $m_n(t,\omega,x)$ for the entire population and by $m_n(t,\omega,x,y)$ for the subpopulation at point y. We extend the proofs from [1] to BRWs with random environment (*potential*) $V(t,\omega,x)=b_2(\omega,x)-b_0(\omega,x)$ with Gumbel type distribution.

Theorem. *Let* $\ln\mathbf{P}(V>z)\sim -e^z$ *as* $z\to\infty$. *Then, for the moments* $\langle m_n^p\rangle$ *with initial conditions* $m_n(0,\cdot\,,y)=\delta_y(\,\cdot\,)$ *and* $m_n(0,\cdot\,)\equiv 1$,

$$\lim_{t\to\infty}\frac{\ln\langle m_n^p\rangle}{\ln\langle e^{pnVt}\rangle}=1,$$

where $n,p\in\mathbf{N}$, *and the angular brackets denote the expectation with respect to the probability measure generated by the random environment.*

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D. F. Kuznetsov (Peter the Great Saint-Petersburg Polytechnic University, Russia)**. A new approach to series expansion of iterated Stratonovich stochastic integrals of arbitrary multiplicity with respect to components of a multi-dimensional Wiener process.**

The following theorem is proved in [1, sections 2.10–2.15].

Theorem. *Let* $\psi_1(\tau),\ldots,\psi_k(\tau)\in C^1[t,T]$, *and let* $\{\phi_j(x)\}_{j=0}^{\infty}$ $(\phi_0(x)=1/\sqrt{T-t}$, $\phi_j(\tau)\in C[t,T])$ *be a basis in* $L_2[t,T]$ *such that the conditions* 1–3 *of Theorem* 2.30 *in* [1] *are met. Then*

$$J^*[\psi^{(k)}]_{T,t}^{(i_1\ldots i_k)}=\int_t^T\psi_k(t_k)\cdots\int_t^{t_2}\psi_1(t_1)\circ d\mathbf{W}_{t_1}^{(i_1)}\cdots\circ d\mathbf{W}_{t_k}^{(i_k)}=\underset{p\to\infty}{\mathrm{l.i.m.}}\,S_{T,t}^{(i_1\ldots i_k)p},$$

where $S_{T,t}^{(i_1\ldots i_k)p}=\sum_{j_1,\ldots,j_k=0}^{p}C_{j_k\ldots j_1}\zeta_{j_1}^{(i_1)}\cdots\zeta_{j_k}^{(i_k)}$, $\zeta_j^{(i)}=\int_t^T\phi_j(\tau)\,d\mathbf{W}_\tau^{(i)}$ *are i.i.d.* $N(0,1)$*-r.v.'s* $(i\neq 0)$, $k\in\mathbf{N}$, $C_{j_k\ldots j_1}$ *is the Fourier coefficient corresponding to the kernels* $K(t_1,\ldots,t_k)=\psi_1(t_1)\cdots\psi_k(t_k)\mathbf{1}_{\{t_1<\cdots<t_k\}}$ $(k\geqslant 2)$ *and* $K(t_1)=\psi_1(t_1)$,

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$t_1, \ldots, t_k \in [t,T]$, $i_1, \ldots, i_k = 0, 1, \ldots, m$, and $d\mathbf{W}_\tau^{(i)}$ and $\circ\, d\mathbf{W}_\tau^{(i)}$ are the Itô and Stratonovich differentials, respectively, $\mathbf{W}_\tau^{(0)} = \tau$. Moreover, for $\psi_1(\tau), \ldots, \psi_k(\tau) \in C^1[t,T]$, we have $\mathbf{E}\big(J^*[\psi^{(k)}]_{T,t}^{(i_1\ldots i_k)} - S_{T,t}^{(i_1\ldots i_k)p}\big)^2 \leqslant C/p^{1-\varepsilon}$ for the case of Legendre polynomials and the Fourier basis, where $\varepsilon = 0$ (the Fourier basis for $k = 1, \ldots, 5$ or polynomial basis for $k = 1, 2, 3$) or $\varepsilon > 0$ is arbitrarily small (a polynomial basis for $k = 4, 5$), and $C < \infty$ is independent of p.

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V. L. Litvinov (Samara State Technical University, Samara, Russia)**. Stochastic longitudinal oscillations of a viscoelastic rope with moving boundaries with due account of damping forces.**

The wide use of mechanical objects with moving boundaries in engineering calls for the development of methods of their calculation. In the case of longitudinal oscillation, the principal effect on damping comes from elastic imperfections of the material of the oscillated object [1]. The study of viscoelasticity involves the analysis of stochastic stability of stochastic viscoelastic systems, their reliability, etc. We consider stochastic linear longitudinal oscillations of a viscoelastic rope with moving boundaries with due account of the damping forces. The initial conditions and the external load are considered random. To obtain the characteristics of the r.v.'s of stochastic oscillations, one has to find statistical estimates for the solution of a system of random integro–differential equations. To this end, the relaxation kernel can be taken as an exponential function with a random component. With the help of a difference kernel, one can reduce the problem to a system of stochastic differential equations. The coefficients are evaluated via the statistical numerical Monte Carlo method (see [2]).

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V. N. Litvinov, N. N. Gracheva, N. B. Rudenko (Don State Technical University, Rostov-on-Don, Russia; Azov-Black Sea Engineering Institute of Don State Agrarian University, Zernograd, Russia)**. Probabilistic estimates of solutions of grid equations in heterogeneous computing systems.** [12]

The purpose of our study is to give a definition of functional dependencies of the execution time for solution of systems of linear algebraic equations (SLAEs) by a modified alternating-triangular iterative method (ATIM) on the dimension of fragments of a uniform 3D grid. Our studies are carried out for the most time-consuming stages of solving grid equations by ATIM, which involve solution of SLAEs with lower- and

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