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Modern Stochastics: Theory and Applications. IV

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Dedicated to the centenary of the birth of I.I. Gikhman

May 24-26 2018

Kyiv Ukraine

INTERNATIONAL CONFERENCE

MODERN STOCHASTICS: THEORY AND APPLICATIONS. IV

May 24-26, 2018, Kyiv, Ukraine

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Stationary processes with stable correlation functions

Yu.V. Kozachenko[1], M. Petranova[2]

We consider real- and complex-valued Gaussian stationary random processes with stable correlation functions, introduced in the paper [3]. In the case of complex-valued stationary processes, we consider proper complex random processes (PCR-processes). The existence of these processes was proved in the paper [2] and in the book [1]. Estimates of distribution of functional of a module of stationary Gaussian random processes are obtained. Behavior of the module of stationary proper complex-valued random process at infinity is studied, for example we prove such theorem.

Theorem 1. *Let $X = \{X(t), t \in [a,b]\}$ be stationary PCR Gaussian process and let $|X(t)| = \left(X_c^2(t) + X_s^2(t)\right)^{1/2}$. Then for*

$$u \geq \left(\frac{p}{\sqrt{2}} + \sqrt{\left(\frac{p}{2}+1\right)p}\right)\sigma^2(b-a)^{1/p}$$

where $\sigma^2 = E|X(t)|^2$, the following inequality holds

$$P\left\{\left\||X(t)|^2 - \sigma^2\right\|_{L_p([a,b])} > u\right\} \leq 2\sqrt{1 + \frac{u\sqrt{2}}{(b-a)^{1/p}\sigma^2}} \cdot \exp\left\{-\frac{u}{\sqrt{2}(b-a)^{1/p}\sigma^2}\right\}. \tag{1}$$

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An aplication of the theory of space F for calculation of the integrals depending on a parameter by Monte-Carlo method

Yu.V. Kozachenko[1], Yu.Yu. Mlavets[2]

Reliability and accuracy in space $C(T)$ for multiple integrals calculation by Monte Carlo method are established.

Let us consider the integral $\int_S f(s,t)p(s)d\mu(s) = I(t)$ assuming that it exists. Suppose $f(s,t)$ is a stochastic process on a probability space $\{S, \mathcal{A}, P\}$ and which we denote as $\xi(s,t) = \xi(t)$ and $I(t) = \int_S f(s,t)p(s)d\mu(s) = \int_S f(s,t)dp(s) = E\xi(t)$.

Theorem 1. *Let a stochastic process $\xi(t)$, $t \in T$ belong to the space $\mathbf{F}_\psi(\Omega)$ and let condition* **H** *hold with a constant C_ψ, $Z_n(t) - I(t) = \frac{1}{n}\sum_{i=1}^{n}(\xi_i(t) - I(t))$, where $\xi_i(t)$ are independent copies of the stochastic process $\xi(t)$.*

Assume that there exists a continuous increasing function $\sigma(h)$ such that $\sigma(0) = 0$ and $\sup_{\rho(t,s)\leq h} \left\|\xi(t) - \xi(s)\right\|_\psi \leq \sigma(h)$. Further, assume that

$$\int_0^z \varkappa\left(N\left(\sigma^{(-1)}(u)\right)\right) du < \infty$$

for all $z > 0$, where $\varkappa(n)$ is a majorant characteristic, $N(u)$ is the metric massiveness of the space $\mathbf{F}_\psi(\Omega)$, and $\sigma^{(-1)}(u)$ is the inverse function to $\sigma(u)$. Then $Z_n(t)$ approximates $I(t)$ with reliability $1-\delta$, $\delta > 0$ and accuracy ε in the space $C(T)$, if n is such that

$$\inf_{u\geq 1}\left(\frac{B(p)\psi(u)}{\varepsilon\sqrt{n}}\right)^u \leq \delta,$$

for all $0 < p < 1$, *where* $B(p) = 2\sqrt{C_\psi}\inf_{t\in T}\|\xi(t)\|_\psi + \frac{1}{p(1-p)}\int_0^{\gamma p} \varkappa\left(N\left(\sigma_1^{(-1)}(u)\right)\right)du$, $\sigma_1(u) = 2\sqrt{C_\psi}\sigma(u)$, $\gamma = \sigma_1\left(\sup_{t,s\in T}\rho(t,s)\right)$.

References

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Numerical approaches to project regional climate change in Ukraine in the 21st century

S.V. Krakovska

"Take urgent action to combat climate change and its impacts" is one of seventeen UN Sustainable Development Goals representing the most problematic aspects of modern human life. In order to be prepared for the action, predictions of future climate are necessary and climate models are the most reliable tools up to now. Notwithstanding that weather and climate are both among the most important for human life, but difficult for prediction natural stochastic processes, modern meteorology and climatology have developed some numerical approaches that allow to make forecasts based on up-to-date knowledge of physical, mainly thermodynamic laws. These approaches are realized in Atmosphere-Ocean Global Circulation Models (AOGCM), Limited Area Models (LAM) and Regional Climate Models (RCM) that all are used for both Numerical Weather Prediction (NWP) and Climate Change Projections (CCP). There are some dozens of such models in leading world meteorological centers, but results of a few of them are used in Ukrainian Hydrometeorological Institute (UHMI). Special procedures of verification, adjustment and tuning were developed in UHMI in order to apply data of AOGCM, LAM and RCM to the territory of Ukraine. Some of the procedures are rather standard, but some proposed approaches are original and novel. Simple but effective approaches for optimal RCM ensemble formation based on main statistics will be presented. Results of verification for temperature, precipitation, cloudiness and other main and specific climate indicators obtained from 14 RCM against gridded data set of instrumental observational network will be discussed. The main aspects of contemporary ideas about the Earth's climate system, global and regional climate models, climate change scenarios and pathways will be presented in the context of further possible incorporation of modern achievements of stochastic theory as application tools for climatology.

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Bivariate CLT for quadratic variations of Gaussian processes with the Orey index

K. Kubilius

We consider Gaussian processes with the Orey index. This index allows to consider Gaussian processes without stationary increments and with trajectories that are Hölder continuous up to the Orey index. The fractional Brownian motion, subfractional Brownian motion, bifractional Brownian motion are the examples of such processes.

Let $(X_t)_{t\in[0,T]}$ be a stochastic process. Denote

$$V^{\widehat{X}}_{in,T} = \sum_{k=1}^{in-1}\left(\Delta^{(2)}_{in,k}\widehat{X}\right)^2, \qquad \Delta^{(2)}_{in,k}\widehat{X} = \frac{\Delta^{(2)}_{in,k}X}{\sqrt{\mathbf{E}(\Delta^{(2)}_{in,k}X)^2}} \qquad i = 1,2,$$

$$\Delta^{(2)}_{in,k}\widehat{X} = \widehat{X}_{\frac{k+1}{in}T} - 2\widehat{X}_{\frac{k}{in}T} + \widehat{X}_{\frac{k-1}{in}T}, \quad 1 \le k \le in-1, \quad i = 1,2.$$

We find conditions supplying the bivariate CLT for quadratic variations of Gaussian process X with the Orey index γ. It means that

$$\sqrt{n}\begin{pmatrix} n^{-1}V^{\widehat{X}}_{n,T} - 1 \\ (2n)^{-1}V^{\widehat{X}}_{2n,T} - 1\end{pmatrix} \xrightarrow{d} \mathcal{N}(0;\Sigma_\gamma).$$

We apply this result to prove asymptotic normality of the estimators of the Orey index γ.

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