LOCAL GROWTH OF RANDOM FIELDS WITH INDEPENDENT INCREMENTS

N. M. ZINCHENKO

(Translated by Durri-Hamdani)

In this paper, we consider the local growth in a neighborhood of the origin of a random field $\xi(t, s)$ with independent increments. A necessary and sufficient condition is obtained for a function $\varphi(t, s)$ satisfying certain conditions to be an upper function for the trajectories of the field $\xi(t, s)$.

For random processes with independent increments A.Ya. Khinchin [1] already proposed to solve the question of whether a function $\varphi(t)$ belonged to the class of upper (lower) functions for the process $\xi(t)$ depending on the convergence (divergence) of the integral

$$\int_0^{t_0} t^{-1} \mathbf{P}_c(t)\,dt, \quad \text{where } \mathbf{P}_c(t) = \mathrm{P}\{\xi(t) > c\varphi(t)\};$$

he also investigated the rate of growth of stable processes in a neighborhood of zero and at infinity. The integral criteria of Kolmogorov–Petrov and Chung Erdös–Sirao for Brownian motion are well known. Further study of stable processes was carried on in [2] and [3]. In [4], integral criteria are given for the rate of growth of stable processes with $0 < \alpha < 1$. Several important results pertaining to the behavior of random processes with independent increments in a neighborhood of zero and at infinity were derived by A. V. Skorokhod [5] (see also [6]).

There are several works in which the growth of random fields is investigated by means of integral tests: n–parameter Brownian motion in [7] and 2-parameter stable fields in [8].

In this paper, random fields with independent increments are studied under very general assumptions on the law of distribution of the increments. We follow the idea of the proofs of the assertions in [6] (see § 3, Chapter 4). To this end, we first of all generalize Skorokhod's inequality (see [5], [6])

$$(1) \qquad \mathrm{P}\{\sup_k S_k > x + c\} \le \alpha^{-1}\mathrm{P}\{S_n > x\},$$

where the $S_k, k = 1, \cdots, n$, are sums of independent random variables, $c > 0$, $\alpha = \min_k \mathrm{P}\{S_n - S_k > -c\} > 0$, to sums of independent random variables with multi-dimensional indices.

Skorokhod's Inequality for Sums of Independent Random Variables with Two-dimensional Indices

Let ξ_{kp} be independent random variables, $k \in \{1, \cdots, n\}$, $p \in \{1, \cdots, m\}$, and

$$S_{ij} = \sum_{k=1}^i \sum_{p=1}^j \xi_{kp}, \quad M_{nm} = \max_{\substack{1 \le i \le n \\ 1 \le j \le m}} S_{ij}, \quad \sigma^2 = \mathbf{E}(S_{nm})^2,$$

$$M_i = \max_{1 \le j \le m} S_{ij}, \quad T_i = \min_{1 \le j \le m}(S_{nj} - S_{ij}) = \min_j \sum_{k=i+1}^n \sum_{p=1}^j \xi_{kp}.$$

Lemma 1. *For $c > \sigma$,*

$$(2) \qquad \mathrm{P}\{\max_{\substack{1 \le i \le n \\ 1 \le j \le m}} S_{ij} > x + 2c\} \le \left(1 - \frac{\sigma^2}{c^2}\right)^{-2} \mathrm{P}\{S_{nm} > x\}.$$

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