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Tail probability estimates for additive functionals

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Abstract

In this paper, based on techniques of Malliavin calculus, we obtain an explicit bound for tail probabilities of a general class of additive functionals. Applications to fractional Brownian motion and Cox-Ingersoll-Ross process are given to illustrate the theory.

Keywords: Tail probabilities, Additive functionals, Malliavin calculus.

2010 MSC: 60G22, 60H07, 91G30.

1. Introduction

A fractional Brownian motion (fBm) of Hurst parameter $H \in (0, 1)$ is a centered Gaussian process $B^H = (B_t^H)_{t \geq 0}$ with covariance function

$$R_H(t, s) := E[B_t^H B_s^H] = \frac{1}{2}(t^{2H} + s^{2H} - |t - s|^{2H}).$$

It is known that B_t^H admits the so-called Volterra representation (see e.g. [11] pp. 277-279)

$$B_t^H = \int_0^t K_H(t, s) dW_s, \quad (1.1)$$

where $(W_t)_{t \geq 0}$ is a standard Brownian motion, the Volterra kernel $K_H(t, s)$ is defined by

$$K_H(t, s) = C_H \left[\frac{t^{H-\frac{1}{2}}}{s^{H-\frac{1}{2}}} (t-s)^{H-\frac{1}{2}} - \left(H - \frac{1}{2}\right) \int_s^t \frac{u^{H-\frac{3}{2}}}{s^{H-\frac{1}{2}}} (u-s)^{H-\frac{1}{2}} du \right], \quad s \leq t,$$

where C_H is a constant depending only on H .

Motivation of this paper comes from a result given by Nourdin and Viens in [10], where they used their new theory to obtain an upper bound for tail probabilities of fractional Brownian additive functionals

$$\int_0^1 Q(B_s^H) ds, \quad (1.2)$$

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