A SPECIAL ISSUE ON

Gaussian Processes: Analysis and Inference

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Preface

Gaussian processes constitute a convenient and successful framework to study the behavior of continuous random evolutions, because of their closure under limits of linear operations, their parsimonious use of parameters, and the ease with which they can be adapted to applications. Their simplicity belies the intricate properties that continue to make these processes the object of deep mathematical and statistical studies, with a number of emerging directions of research.

The twelve original research and review articles in this special issue of Communications on Stochastic Analysis delve into a wide range of these rich areas. The articles give a broad perspective on Gaussian processes and fields and their extensions, as a branch of probability theory, with a dual emphasis on the stochastic analysis of their fine properties and the statistical estimation of their parameters.

The path and other fine properties of Gaussian processes and fields are studied using core probabilistic tools. Michel Weber relates the zeros and the local infima for the most fundamental Gaussian process, Brownian motion. Dongsheng Wu and Yimin Xiao study local times for anisotropic Gaussian fields, and, with Anne Estrade, their packing dimensions. Mario Wschebor presents a review of techniques which have emerged since the 1990's to estimate the tails of the maxima of Gaussian fields satisfying certain smoothness assumptions. Hana Kogan, Michael Marcus, and Jay Rosen provide a review of results for a new class of models, the permanental processes, which are generalizations of squares of Gaussian processes.

Bridging the boundary between fine properties and stochastic evolutions, David Marquez, Carles Rovira, and Samy Tindel provide a complete picture of the disorder regimes for a lattice-bound continuous-time polymer in a space-time Gaussian white-noise environment. The archetypical long-memory and self-similar Gaussian process, fractional Brownian motion (fBm), gives rise to a wealth of new extensions. Terhi Kaarakka and Paavo Salminen explore the stochastic Langevin equation with a Gaussian driving force to relate its solution to time-changed fBm. Litan Yan, Guangjun Shen, and Kun He develop a stochastic calculus for the sub-fBm, a Gaussian process that arises from certain branching particle systems.

Delving into statistical inference, Alexandra Chronopoulou, Ciprian Tudor, and Frederi Viens work with power variations for the non-Gaussian extensions of fBm known as Hermite processes, to estimate their long-memory parameter. Joshua Levy and Murad Taqqu push the estimation of long-range dependence beyond tools built on Gaussian fields by considering certain fractional stable motions. Mamikon Ginovyan develops an efficient estimation procedure for functionals of the unknown spectral density of Gaussian stationary processes on the line. Ning Lin and Sergey Lototsky study the convergence of the maximum likelihood estimator for the undamped harmonic oscillator with Gaussian white noise forcing.

We hope this special issue will stimulate probabilists, stochastic analysts, and mathematical statisticians to continue to examine Gaussian processes and fields and their extensions. We think the articles herein demonstrate to what extent the topics and tools employed in their study are far from linear or compartmentalized, as they form a complex network of ideas, at the confines of probability theory, stochastic analysis, and statistical inference.

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