Scientific Computing Seminars

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Talk Title: Spatial Random Fields based on Local Interactions and Applications to Spatial Interpolation

Invited by: George Karniadakis

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Abstract:

This presentation will focus on new possibilities for the interpolation of scattered observations and missing data on regular grids by means of Spartan spatial random fields (SSRFs). A brief overview of mathematical SSRF properties will be given. Model inference, spatial interpolation (prediction) and simulation in the framework of SSRFs will be reviewed. It will be shown that SSRFs can be derived from the Gaussian model of statistical field theory [1] or equivalently, from stochastic (Langevin) partial differential equations driven by white or color noise. In contrast with field theory, the focus of SSRFs is on short-range correlations which are important for the local structure and not on long-range properties of the covariance function near critical points. SSRF covariance models are characterized by sparse structure of the precision matrix (the inverse covariance matrix), at least for lattice data. The sparseness derives from the locality of the operators in the respective energy functional and leads to explicit spectral forms. In certain cases, the correlations in real space can be derived analytically by direct integration of the spectral representation, given by the Hankel transform of the density [2]. The availability of explicit approximate expressions for both the covariance and the precision matrix can help to overcome the curse of dimensionality in the numerical procedures of parameter inference, spatial interpolation and conditional simulation [3,4]. An application of SSRFs to the mapping of radioactivity ground dose rates using data from the European