

Seminar on
Excursions of Random Fields

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&
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Engineering models of physical phenomena are often subject to significant uncertainties. Examples of this are well known from the field of soil mechanics, hydrological engineering, mechanical engineering, earthquake engineering, structural engineering and many others.

In principle most uncertain phenomena have a temporal and in many cases also a spatial component. The proper representation of these uncertainties in a given context depends on the physical phenomena itself and the model which is being applied to study the physical phenomena. In some cases it may be adequate to represent the uncertainties through simple random variables whereas in other cases it is necessary to represent uncertainties through random processes or random fields.

The present study group seminar is concerned about the modeling of uncertainties in engineering problems where random field representations are required. An introduction into the probabilistic modeling of random fields will form the first part of the seminar. Thereafter the emphasis will be directed on the assessment of observations of realizations of random fields, analysis of dependency in random fields and Kriging techniques. Based on this the statistical properties of excursion characteristics of random fields will be studied including maxima, out-crossings and areas of out-crossings.

The main emphasis will be directed towards the statistical modeling of random fields with differentiable sample paths but will cover both homogeneous and inhomogeneous random fields. Towards the end of the seminar new and very interesting developments in the modeling of random fields including the aspects of self-similarity will be reviewed and studied.

Through the seminar one or more exercises will be conducted relating real data on soil properties and concrete material properties to the context of the studied material.

Who should attend?

Researchers, Ph. D. students, post-docs and graduate students interested in the probabilistic modeling of uncertainties in two or more dimensions.

Mode

The seminar will be conducted as a study group under the responsibility of Prof. Faber and Dr. Baker. All participants will in turn be responsible for presenting a part of the material and for developing the examples.

Literature

Adler, Robert J. 1981. The Geometry of Random Fields. John Wiley & Sons.

Fenton, Gordon A. 1990. Simulation and Analysis of Random Fields. Ph.D. Thesis.
<http://www.engmath.dal.ca/engm/fenton/thesis.html>

Goovaerts, P. 1997. Geostatistics for Natural Resources Evaluation. Oxford Univ. Press, New-York, 483p.

VanMarcke, E. 1983. Random Fields: Analysis and Synthesis, Published by MIT Press, Cambridge MA; Web Edition by Rare Book Services, Princeton University, Princeton NJ, 1998. <http://www.princeton.edu/~evm/randomfields.html>.

Veneziano, D. 1978. Random Processes for Engineering Applications. Course lecture notes.

When and where?

On

Thursdays
17:00 – 18:00
ETH Hönggerberg, HIL E36.1

Agenda

W	Date	Speaker	Topic
1	03.11.05		Introduction and description of course material
2	10.11.05		Random variables and intro to random processes (Veneziano Ch 1-2) <ul style="list-style-type: none">• Random variables• Random processes
3	17.11.05		Random processes, continued (Veneziano Ch 2) <ul style="list-style-type: none">• Ergodicity• Convergence• Differentiability

4	24.11.05		<p>Second-order theory of random fields (Veneziano Ch 3, VanMarcke Ch 3)</p> <ul style="list-style-type: none"> • Homogeneity • Isotropy • Ergodicity • Homogeneous Gaussian random fields
5	01.12.05		<p>Estimating statistical properties of random fields (Goovaerts Ch 5)</p> <ul style="list-style-type: none"> • Linear estimation theory • Ordinary Kriging
6	08.12.05		<p>Numerical simulation of random fields (Fenton Ch 5)</p> <ul style="list-style-type: none"> • Simulation of random fields • Sequential Gaussian simulation (Goovaerts Ch 6)
7	15.12.05		<p>Simulation of space-time processes (Fenton Ch 5)</p>
8	22.12.05		<p>Excursions of Random Fields (VanMarcke Ch 4)</p> <ul style="list-style-type: none"> • Two-dimensional case <ul style="list-style-type: none"> ○ Examples of regions of excursion (numerical simulation results?) ○ Expected dimensions of excursions ○ Expected frequency of excursions ○ Distribution of maximum value in a random field • Generalization to n-dimensional case
	Break		
9	12.01.06		<p>Non-gaussian and non-homogeneous processes (Adler Ch 7)</p>
10	19.01.06		<p>Non-differentiable processes</p>
11	26.01.06		<p>Statistics of Level Excursions and Extrema (Fenton Ch 6)</p> <ul style="list-style-type: none"> • Total area of excursions • Expected number of excursions • Clustering of excursions
12	02.02.06		<p>Excursions of random fields by numerical methods (Goovaerts Ch 8)</p> <ul style="list-style-type: none"> • Sequential Gaussian simulation
13	09.02.06		<p>Survey of self-similarity in random fields, part 1 (Veneziano papers)</p>
14	16.02.06		<p>Survey of self-similarity in random fields, part 2 (Veneziano papers)</p>