

General Course Information

Course Description

This is a graduate course that covers the basic concepts in probabilistic modeling of the spatial and/or temporal phenomena in the subsurface environments. It introduces the students to classical and modern spatial estimation and stochastic simulation techniques including variogram-based, objected-based and training image-based methods. Topics include stochastic processes, multivariate distributions, variogram modeling, spatial interpolation (e.g., variations of kriging and cokriging), stochastic simulation (e.g., sequential Gaussian simulation), object-based simulation methods and multiple-point geostatistics. The GSLIB and SGeMS software will be introduced and case studies from energy industry and environmental sciences will be discussed.

Prerequisites

The material in this course would require basic familiarity with linear algebra and probability and statistics.

Course Instructor

Behnam Jafarpour
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Office Hours

Thursdays 14:00-16:00 (HED 313)
or by appointment.

Lectures

Lectures take place in **Room OHE-100C** and are scheduled for **Fridays 12:00pm – 2:40pm**. Four tutorial sessions are included for introduction to GSLIB and SGeMS software.

Text Book

Reading material for each topic will be posted to DEN. While there is no required textbook for this course, some suggested references are provided at the end of this document.

Homework (30%)

There will be a total of **Six (6) problem sets** that account for 30% of the final grade. Problem sets will be provided at the end of the lecture on the specified dates in the tentative schedule sheet (posted to DEN) and are due before lecture begins on the due date. Late homework submissions will not be accepted unless prior arrangement is made with the instructors.

Exam (40%)

There will be one two-hour **closed-book** exam for this course (a formula sheet will be provided by the instructor).

Exam Date: November 9, in Class

Term Project (30%)

Each student is required to choose a topic for class project and confirm it with the instructor by **September 28**. A list of potential topics will be posted to DEN. Students are not limited to choose a topic from that list, but all selected project topics must be approved by the instructor before September 28. Students are expected to provide two progress reports (on **October 19** and **November 16**), each carrying 10% of the project grade, a 15-minute presentation (30% of the project grade), and a final project report (50% of project grade). Total contribution of the class project to final grade is 30%. The content, format, and grading criteria for the above components are listed in the **Term Project** information sheet.

Grading Policy

Homework = 30% Exam = 40% Project = 30%

Academic Integrity Syllabus Statement

Students are expected to adhere to the USC Student Conduct Code. Students are encouraged to consult with the instructor when in doubt about the violating the Conduct Code.

Disabilities Services and Program (ASP) Policy Statement

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me or the TA as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m. – 5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.

Suggested Texts

You may find sections of the following texts to be useful references in preparing for this course.

1. Isaaks E.H., Srivastava R.M. (1989): *An Introduction to Applied Geostatistics*, ISBN: 0195050134.
2. Goovaerts P. (1997): *Geostatistics for Natural Resources Evaluation*. Oxford University Press.
3. Chiles J.P., Delfiner P.. (1999): *Geostatistics: Modeling Spatial Uncertainty*, John Wiley and Sons Inc., NY.
4. Remy N., Boucher A., Wu J. (2009): *Applied Geostatistics with SGeMS – A User's Guide*, ISBN: 9780521514149
5. Deutsch C.V., Journel A.G. (1998): *GSLIB: Geostatistical Software Library and User's Guide*. Oxford University Press.

Tentative Syllabus and Schedule

Week	Date	Lecture	Readings	Out	In
Introduction and Review Material (1 Week)					
Topic 1: Introduction					
1	08-31	No Lectures → Make-Up (TBD)			
1	TBD	T1L1: Course Information, Objectives, and Expectations T1L2: Course Overview T1L3: Review of Linear Algebra and Vector Calculus	T1L1 T1L2 T1L3	HW1	
Part 1: Univariate and Bivariate Statistics (2 Weeks)					
Topic 2: Review of Probability and Univariate Statistics (1 Week)					
2	09-07	T2L1: Discrete and Continuous Random Variables T2L2: Moments and Expectation	T2L1 T2L2		
3	09-14	No Lecture (ECMOR-XII) → Make-Up (TBD)		HW2	HW1
	TBD	T3L1: Common Distributions and CDF Transformations T3L2: Normal Distribution and Test of Normality T3L3: Sampling and Monte-Carlo Simulation	T3L1 T3L2 T3L3		
Topic 4: Bivariate Statistics (1 Week)					
4	09-21	T4L1: Bivariate Distributions, Covariance and Correlation T4L2: Stationary Random Processes	T4L1 T4L2		
SGeMS Session 1: Statistical Data Analysis					
Part 2: Two-Point Spatial Statistics (6 Weeks)					
Topic 5: Second-Order Spatial Statistics (1 Week)					
5	09-28	T5L1: Two-Point Spatial Relations T5L2: Variogram and Its Properties T5L3: Variogram Inference and Modeling	T5L1 T5L2 T5L3	HW3	HW2
Topic 6: Linear Spatial Estimation and Kriging (1 Week)					
6	10-05	T6L1: Linear Estimators and Their Properties T6L2: Spatial Estimation and Kriging T6L3: Simple Kriging (SK)	T6L1 T6L2 T6L3		
SGeMS Session 2: Variogram Modeling and Kriging					
Topic 7: Variations of Kriging (2 Weeks)					
7	10-12	T7L1: Ordinary Kriging and Kriging with Trend T7L2: Block Kriging	T7L1 T7L2	HW4	HW3
8	10-19	T7L3: Sequential Indicator Kriging (SIK) T7L4: CoKriging	T7L3 T7L4		Progress Report 1
Topic 8: Stochastic Simulation (2 Weeks)					
9	10-26	T8L1: Estimation vs. Conditional Simulation T8L2: Sequential Gaussian Simulation (SGS)	T8L1 T8L2	HW5	HW3
10	11-02	T8L3: Sequential Indicator Simulation (SIS) T8L4: Co-Simulations	T8L3 T8L4		
SGeMS Session 3: Sequential Simulation					
11	11-09	EXAM (in Class)			
Part 3: Pattern-Based Spatial Statistics (4 Weeks)					
Topic 9: Object-Based Modeling (1 Week)					
12	11-16	T9L1: Limitations of Two-Point Geostatistics T9L2: Modeling Discrete Geologic Objects	T9L1 T9L2	HW6	HW5
13	11-23	No Lecture (Thanksgiving)			Progress Report 2
Topic 10: Multiple Point Geostatistics (3 Weeks)					
14	11-30	T10L1: Introduction to Multipoint (MP) Geostatistics T10L2: Formulation of MP Geostatistics T10L3: MP Conditional Simulation (SNESIM Algorithm)	T10L1 T10L2 T10L3		HW6
15	12-07	T10L4: Alternative Facies Modeling Techniques	T10L4		
SGeMS Session 4: Multipoint Statistical Simulation					
Project Presentations & Report (1 Week)					
16	12-14	Project Presentations (11AM-1:00PM)			Project Presentations
	12-17	Final Project Report			Project Report Due

Statement for Students with Disabilities

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Statement on Academic Integrity

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. *Scampus*, the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the recommended sanctions are located in Appendix A: <http://www.usc.edu/dept/publications/SCAMPUS/gov/>. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: <http://www.usc.edu/student-affairs/SJACS/>.