GEOL 789E
Inverse Theory Seminar

Instructor: Ved Lekic
E-Mail: ved@umd.edu
Phone: 301 405 4086
Office: GEOL 3113
Office Hours: By appointment

Overview

This course aims to introduce and utilize new approaches in inverse theory and Bayesian analysis in Earth Science.

Topics

Seminar focusing on theory and practice of inferring unknown quantities from noisy geophysical observations. Emphasis is on understanding uncertainty, both in describing the effects of noise on observations, and quantifying the errors and trade-offs among inferred parameters. Topics include iterative-linearization and model-space-search approaches to non-linear problems, Bayesian formulations, and trans-dimensional inversion.

Requirements

The class is primarily centered around the application of inverse theory and Bayesian data analysis to a problem in Earth Science. During the first month of class, students will do a feasibility study on a potential project and present a proposal. The class as a whole will then decide on one or more topics to pursue. The students will present the final project as a group and work towards putting together a manuscript for publication in a scientific journal. Potential projects for consideration are on the following page, or students can choose their own topics. Class attendance is mandatory.

Evaluation

Your grade in this course will be a weighted average of performance on class attendance / participation, homework assignments, computational mini-projects, a midterm and a final exam. The weighting factors will be:

- 0.10 class attendance / participation
- 0.25 project proposal
- 0.15 final presentation
- 0.50 manuscript

Communication

Regular and emergency official communications will be via Announcements and other postings on the course ELMS website.

Textbook

"Data Analysis: A Bayesian Tutorial," by D. Sivia and J. Skilling.

Other useful texts

"Inverse Problem Theory," by A. Tarantola.

Important Dates

February 6
Last day for graduates to add a class.

April 13
Last day for graduates to drop a class.

Potential Project Topics

Inversion of gravity data:

Invert global gravity data for density structure. Investigate the ways different inversion approaches deal with the non-uniqueness in gravity inversion.

Frequency dependence of travel times:

Are seismic traveltimes dependent on frequency in a statistically significant way beyond what intrinsic attenuation produces?

Small quake detection:

Analyze array recordings to determine whether an earthquake occurred that was not in the catalog. How can we determine the probability that a seismic signal is caused by an earthquake?

Coda and scattering analysis:

Can we identify the presence and locations scatterers of long period energy in the coda? Can we find persistent scatterers in ambient noise correlations?

Intrinsic attenuation:

Where (if anywhere) is bulk attenuation required in the mantle? Can we use PcP arrivals to distinguish reflection coefficient effects from those of bulk attenuation in the mantle?

Lower mantle anisotropy:

Study anisotropy in the lower-most mantle using amplitude versus backazimuth analysis. Are there any lowermost mantle locations with sufficient backazimuthal coverage to study the amplitude variations of ScS or PcP?

Late policy

Assignments must be handed in hard copy, but you can e-mail them to meet a deadline and bring a printed copy later. Assignments will be accepted with a 5% per day late penalty, unless I grant an extension for extenuating circumstances. If you have not handed in an assignment by the time that it has been graded and returned to other students, it will no longer be accepted and will receive a grade of zero.

Academic integrity: The University of Maryland has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit http://www.studenthonorcouncil.umd.edu/whatis.html

The University of Maryland is one of a small number of universities with a student-administered Honors Code and an Honors Pledge, available on the web at http://www.jpo.umd.edu/aca/honorpledge.html. The code prohibits students from cheating on exams, plagiarizing papers, submitting the same paper for credit in two courses without authorization, buying papers, submitting fraudulent documents, and forging signatures. The University Senate encourages instructors to ask students to write the following signed statement on each examination or assignment: "I pledge on my honor that I have not given or received any unauthorized assistance on this examination (or assignment)."

Academic Accommodations: If you have a documented disability, you should contact Disability Support Services 0126 Shoemaker Hall. Each semester students with documented disabilities should apply to DSS for accommodation request forms which you can provide to your professors as proof of your eligibility for accommodations. The rules for eligibility and the types of accommodations a student may request can be reviewed on the DSS web site at http://www.counseling.umd.edu/DSS/receiving_serv.html.

Religious Observances: The University System of Maryland policy provides that students should not be penalized because of observances of their religious beliefs, students shall be given an opportunity, whenever feasible, to make up within a reasonable time any academic assignment that is missed due to individual participation in religious observances. It is the responsibility of the student to inform the instructor of any intended absences for religious observances in advance. **Notice should be provided as soon as possible but no later than the end of the schedule adjustment period (February 7)**. Faculty should further remind students that prior notification is especially important in connection with final exams, since failure to reschedule a final exam before the conclusion of the final examination period may result in loss of credits during the semester. The problem is especially likely to arise when final exams are scheduled on Saturdays.

CourseEvalUM: Your participation in the evaluation of courses through CourseEvalUM is a responsibility you hold as a student member of our academic community. Your feedback is confidential and important to the improvement of teaching and learning at the University as well as to the tenure and promotion process. CourseEvalUM will be open for you to complete your evaluations in the last weeks of the semester. Please go directly to the website (www.courseevalum.umd.edu) to complete your evaluations. By completing all of your evaluations each semester, you will have the privilege of accessing online, at Testudo, the evaluation reports for the thousands of courses for which 70% or more students submitted their evaluations.