ESS345: Computational Geology
Department of Earth Sciences, University of Toronto
Winter 2015

Information

Meeting times: Monday and Wednesday, 2-4 in ES 2100
Instructor: Charly Bank, <charly.bank@utoronto.ca>, (416) 978-4381
office: Dept. of Geology, Earth Sciences Centre, 22 Russell St., room ES 2107
office hours: drop-in, or by appointment
teaching assistant: Alex Boivin
material: notes booklet (bound, ruled/squared), memory stick or other external data storage / transfer device, access to computer/ laptop with MATLAB (check the Mathworks website for a student license `http://www.mathworks.com/academia/student_version/`)
suggested book: Stormy Attaway: MATLAB: A Practical Introduction to Programming and Problem Solving, Elsevier 2009
course website on Blackboard

About this course

Calendar description: High-level computer programming to manipulate, analyse, and visualise geologic datasets, and to solve geologic problems that require mathematical and physical concepts. Students work in Matlab, write reports, give oral presentations, and work in teams.

This course probably can count towards APGO accreditation as a "Computer Programming" credit in the "Additional Foundation Science" (1B) educational units. Note however that APGO assesses the knowledge requirement on a case-by-case basis.

Your key task as students in this course is to program. To engage you with this task we have assembled a set of geologic datasets you have to analyse following an approach called problem-based learning (PBL). In this approach, the problem doesn't serve as an example or application of the same material presented in lectures; rather, the problem is the starting point from which learning proceeds. This is similar to the way things work in the research or industry world: a problem must be solved, and the researchers figure out (1) what the pertinent questions are; (2) what the key scientific concepts are; (3) what methods to use to go about solving the problem; and (4) what information they need to gather, and whether they are missing any important knowledge.

In this course, we want to train you, the students, to be able to deal with these types of situations, because they will help you in later courses, in your student research, and in graduate work, or the job market. In light of this, there will be fewer lectures in this course than you are likely accustomed to. We have divided the course roughly into six two-week units; each unit will center around a major geological problem whose solution will require you to employ several different methods, to learn new mathematics and geology, and to integrate multiple elements of information together into a single package. We will begin with some introductory material, and we will help you learn to use a few programming (and other) tools that will enable you to perform the required analyses. In each unit, we will start with small problems and ease into the major task of the unit.

During the course of the semester, you should become more and more adept at approaching problems with less and less guidance from us, the instructors - so that by the end of the course, you will be able to tackle nearly any geological problem, identify the holes in your knowledge / experience, and figure out how to fill in those holes and solve the problem.

Objectives

By the end of this course you will be able to:
1. recognize a range of mathematical concepts embedded in geological problems
2. understand key principles of high-level computer logic and programming
3. apply computer programming to solve/model/visualize geological questions
3. solve quantitative problems associated with and analyze quantitative solutions to geological questions,
5. present your reasoning orally and in writing, and
6. work both independently and as a member of a team.
In addition you will probably also be learning new content, both geologically and mathematically.

Assessment

The objectives for this course combine learning of content with development of new skills. A portfolio will allow you to showcase how your learning will have developed over the term. Your portfolio will combine four elements:

1. Notes diary: a bound book with handwritten notes which you keep like a diary to document your thought process, it should include overviews of the mathematical concepts and computational skills you and your teammates learned about.
2. Finished reports of your problem sets: these will be team products. Teams will be assigned randomly, and change for each assignment. The reports are not mere answers to the problem sets; rather they will be organized like typical science articles (we will discuss this organization in class and provide you with a template).
3. Reflections on your team's work and your performance as a team member.

In addition to the assignments you will engage in a small original research project, which we will assess via a written report and oral presentation. This report will undergo a peer-review process. This year's projects will aim at helping create an online repository of teaching modules.

Note that your contribution to group work, including feedback on others' work, is an important component of evaluation.

This is the breakdown of your final grade:
60%: portfolio, including five problem sets
20%: research project
10%: oral presentation
10%: contribution to group work
The course will not entail a final exam. We will discuss assessment rubrics with you in class.

Tentative schedule and topics

week of	geologic topic	math concepts	programming concepts
1	introduction to Matlab	–	arrays
2+3	1. CO_2 in atmosphere	linear, exponential	functions, algorithm testing
4+5	2. sea-level rise	projections, gradients	statements
5+6	3. Pacific plate velocity	linear interpolation	curve fitting
–	*Reading Week*	–	–
7+8	4. analysis of directional data	descriptive statistics	text files I/O
8-10	individual projects	–	–
11	presentations and peer review	–	–
12	5. groundwater modeling	differential equations	stepsize

Note that most cycles cover 3 class meetings (only the first problem set will stretch over 2 weeks. Reports are due at the start of the next cycle; your notes diary will be reviewed periodically.

Group work

Groups can provide an awesome working experience, or be very frustrating. Two of the key reasons why groups fail are lack of communication and different expectations. This course requires you to engage in good team work; after all good team skills are the number one expectation of future employers. Unfortunately the university culture does not yet train students for team work.

In this course we want to help you become reliable members of a team. You will be guided from a very structured approach towards a more personal one. At the start, each team member will be given a specific task that s/he can complete without input from the others. However, for the group project to succeed you will need to combine your individual work; but your grade will be based on your individual work. In the second stage you will be required to sign a group contract that spells out the expectations of each group member. Again each member will have a task that can be completed without the others' help, but the project will remain incomplete unless you finish it together. At this stage your grade will combine both an individual as well as a group portion. In the final stage groups will divide the work themselves and only the group project will be graded. Part of the deliverable will be a note of who did what and how the work was divided, in other words your grade may deviate from the group grade if it is clear that you did not "pull your weight" or contributed beyond expectation.

Notes

Communication: The course website is the repository for information. Please mark emails clearly with "ESS345" in the subject line, we will try to answer in one working day.

Late hand-in policy: if you miss a deadline for a valid reason that is out of your control please let us – and your group! – know as soon as possible.

Academic integrity : Note that group work does not mean that you can be more lax with integrity. The University of Toronto treats cases of academic misconduct very seriously. Please read the note posted at http://www.es.utoronto.ca/programs/undergraduate/useful-links/

Remarking of assignments: If you wish for a remark of an assignment please resubmit your work within one week of our returning it to you. Provide a brief note what you would like us to check. Be aware that your grade for this component of the course may go up or down.

Accommodation: Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please feel free to approach me and/or Accessibility Services at (416) 978 8060; accessibility.utoronto.ca

Earth science help centre: times and locations TBA. Please do take advantage to talk to these experienced TAs.