

AMATH 410, Introduction to Computational Biology and Chemistry
Case Study Presentation and Course Project

These two components will represent 5 and 30 percent of the course grade.

The point of the case study and course project is to allow each student to explore the area of the computational life sciences covered in AMATH 410 that most interests him or her. Both will also allow students to proceed at a pace, with computational and mathematical tools, that are an appropriate challenge to him or her. The course project should therefore be a challenging and an enjoyable undertaking.

Projects may be done in groups of one, two, three, or four students – and you are strongly encouraged to choose to work in a group. Of course, if you work in a pair, group of two (three, or four), the project will be expected to be more complete and interesting. **IF YOU ARE FROM A ENGINEERING, PHYSICS, OR MATH BACKGROUND OR MAJOR, YOU ARE ENCOURAGED TO CONSIDER WORKING WITH SOMEONE FROM BIOLOGY, AND VICE-VERSA.**

GUIDELINES FOR CASE STUDY PRESENTATION:

- **Identify a paper from the research literature on which to base your case study presentation and course project (see below).** Each student will give a brief (5 minute) in-class presentation of a paper that applies the modeling and computational techniques we have learned in the course. If you are working in a group of two (three, or four) or more people, you may give a combined presentation of up to ten (fifteen, or twenty) minutes. It doesn't have to take the full time. Each student will be expected to give part of the presentation, however. These studies will then be developed into course projects.
- For your case study presentation,
 - Prepare 3 slides (powerpoint, or other software). Slide 1: intro to topic. Slide 2: mathematical or computational model used. Slide 3: conclusions / insight from this model. If there are many different conclusions, summarize or pick several key conclusions.
 - Either (1) print out a hardcopy of these slides on transparencies (overheads), much preferred OR (2) print out nine (9) copies of the slides on paper, and bring them to class the day you are to present. A hardcopy is required and electronic copies are **not** acceptable – do not bring your presentation on a disk or laptop or email it to me. This is to save time with projector setup (with eight presentations to do in very limited time).
 - Prepare and **practice** a presentation of the main ideas in these three slides. Time yourself as you practice – it is difficult to give a summary of anything in a few minutes! But this is exactly what happens in many research conferences.

GUIDELINES FOR COURSE PROJECT:

- Write MATLAB code that implements one of the central models in the paper (or the central model, if there is only one). Reproduce one or several of the associated figures in the paper, or at the very least some of the model results behind one of these figures. (See guidelines below.)
- Identify an interesting new question that can be asked about the model and topic of the paper.
- Extend or modify the MATLAB code to answer this question.

- Prepare a paper describing your findings. This paper should have 5 sections: introduction, reproduction of results in paper, novel results, discussion, appendix. The appendix should include all MATLAB code used to reproduce figures in the paper and to extend them to answer your research question.

GUIDELINES FOR CHOOSING A PAPER AND TOPIC FROM THE RESEARCH LITERATURE:

General:

- The topic should be in the life sciences, at any scale.
- For some models, the MATLAB code for implementing the model will be available somewhere – maybe even given together with the paper. That is OK, and please go ahead and use it! But if this is the case, you need to (1) state that you started with an existing MATLAB program in your report, and (2) do quite a bit more “new” exploration than otherwise with this model. You get the picture. You need to have a substantial level of effort put into this final project – if there’s less on programming the model in the first place to get it working and to reproduce a figure(s) in the paper, there needs to be more on exploring its dynamics beyond what the paper does.

How to find a paper:

- A superb place to look for these papers is in the references section for each chapter of our textbook, Ellner and Guckenheimer (E+G).
- Some example papers and topics from Ch. 2 are below, to give you an idea of what to look for in this and any of the later chapters.
 - Easterling et al, 2002 (citation given on p. 29 of E+G).
 - The papers cited in section 2.6 of E+G: exploring elasticity and other questions.
 - The papers cited in section 2.7.2 of E+G: density dependence.
- Other topics:
 - **The Hodgkin-Huxley Model of a spiking neuron.** Hodgkin and Huxley, A quantitative description of membrane current and its application to conduction and excitation in a nerve. *Journal of Physiology* 117: 500-544. **Also see, Lab Manual section 11, where MATLAB starting code is given.**
 - **Simple Model of Spiking Neurons.** *IEEE Transactions on Neural Networks* (2003) 14:1569- 1572. Also see link to paper at <http://vesicle.nsi.edu/users/izhikevich/publications/spikes.htm> , where MATLAB starting code is given.
 - **Statistical models for gene network architectures.** Network motifs in the transcriptional regulation network of *Escherichia coli*. Shai S. Shen-Orr, Ron Milo, Shmoolik Mangan, Uri Alon. *Nature Genetics* Volume 31, 2002.
 - **Computing neural networks** *Proc. NatL Acad. Sci. USA* Vol. 79, pp. 2554-2558, April 1982. Neural networks and physical systems with emergent collective computational abilities. J. J. HOPFIELD
 - **Dynamics of Infectious Disease** A Tale of Two Futures: HIV and Antiretroviral Therapy in San Francisco, S. M. Blower, H. B. Gershengorn, R. M. Grant, 28 JANUARY 2000, VOL SCIENCE.

- **Dynamics of Infectious Disease II** Many superb references are given in section 6.8 of E+G!
- **Agent-based models** Choose a paper from sections 8.1-8.5 of E+G. Note that some useful starter MATLAB code is given in the textbook itself in these sections.

- **OTHER RESOURCES:**

- Access articles via
<http://www.lib.washington.edu/types/ejournals/>
- Find articles on topics of interest via searching the web of science: linked from
<http://www.lib.washington.edu/types/databases/>