Syllabus - NEUR 8790 – Introduction to Modeling for the Life Sciences – Fall 2011

(This syllabus provides a general course outline, however, deviations may be necessary.)

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Office: PSC 812, Tel.: 404-413-6420.
Office Hours: T 2:30-3:45pm, W 12:00-1:00pm, or by appointment.
Class: Tues / Thurs 1:00-2:15pm, Aderhold Learning Center 12.

Textbook: Most materials will come from selected journal papers and book chapters related to the central topics. However, we will select some material from chapters of the following textbook: Dynamic Models in Biology, by Stephen P. Ellner & John Guckenheimer (Princeton University Press), 2006. (Free chapters at http://press.princeton.edu/titles/8124.html)

Prerequisites: By instructor consent (a C or above in pre-calculus is beneficial).

Description: In this course we will ponder questions such as the following: What is the connection between (a) the ability of an F-16 fighter jet to maneuver much more nimbly than an F-4, (b) the possibility that small genetic modifications lead to large differences in phylogenetic outcome within a couple of generations, and (c) the ability of a neural circuit controlling limb motor patterns to switch an animal rapidly between locomotive gaits?

The class is intended for the non-mathematically literate, and yet we will consider non-elementary concepts from applied mathematics and modeling in the biosciences. A primary goal of this course is to increase basic literacy about modeling and simulation, and to promote future participation in collaborations with mathematicians and computational modelers. You will be motivated to appreciate that there are many insights from mathematical thinking that can improve biologists’ ability to comprehend and develop complex theories of biological mechanisms, even if they lack traditional training in mathematics.

We will focus on intuition and qualitative, geometric mathematical concepts. This will include ideas drawn from calculus and statistics (among other technical subjects) but a technical understanding of the math will not be assumed, nor will it be taught. This is not a remedial math course! We will discuss different biological systems that have been the subject of modeling through journal articles and book material. Among other topics, we will discuss evolutionary stable strategies in evolution and its abstract connection to the idea of attractors in brain states, small world and other kinds of structured networks in the brain, pattern formation concepts, rhythms in the nervous system. We will analyze the benefits, misconceptions, limitations, and pitfalls of modeling such systems when guided by experimental data, in terms of both the logic of mechanistic theories and their abstraction to mathematical principles.
**Format of semester:** Most classes will begin with a short lecture period about the week’s topic and how to approach the reading assignment, after which there will be student-led discussion of the last reading assignment. Students will form groups of 3 within the first two weeks of the semester, ideally consisting of members from different backgrounds. The role of the groups is primarily for the presentation later in the semester, but is also intended to ensure that students assist each other in understanding material outside of their comfort zone. There will be approximately one reading assignment per week (total of 10), from which groups will choose an article on which to present. Each group will collaboratively prepare and present a 15 minute critique of a reading assignment from the first half of the semester, to be given during class in the second half of the semester (approximately 5 minutes per presenter). The presentation will be followed by a student-led discussion. Students are responsible for ensuring their own adequate understanding of the material and what is required of them. One way to do this is through attendance at office hours. This is encouraged for further discussion and to provide the instructor an opportunity to aid students in staying on top of the material and their progress in writing, etc.

**Grading:** Your grade will be based on your participation in class (including collaborative presentations) and through three individual essays written during the semester related to reading assignments.

After the first two weeks, students can earn 5 – 10 points per class by participating constructively in a discussion. As students may not always have the opportunity to do this on any given day, they may make up for it on other days by earning extra credit points (the maximum is 60 points over the whole semester). Examples of criteria for participation points include an indication that an assignment has been thoughtfully read, or that alternative perspectives are effectively brought into consideration of the topic, or that effective help or insight is given in assisting colleagues in the understanding of a technical concept.

Grades for the group presentations will be assigned to each member of the group, based on clarity and communicative skill in their individual 5 min portion of the presentation, in addition to points for the overall insightfulness of the collaboratively prepared materials. Presentations may make use of technology but it is not required.

Students may choose when to submit their essays, based on their interest in the reading assignments. Students are strongly encouraged to distribute their essays throughout the semester. Essays should be written after the class has discussed the topic/article, and should be between three and five pages of typed text. *Only three essay submissions will be graded!* Students may confer on content outside of class, but their written work must be entirely their own (see rules about academic honesty). Grades will be assigned based on how concisely and clearly the student summarizes key issues related to the topic. This will be drawn from the relevant lecture material, the article itself, the results of the class discussion about the article, and their own extended reading and analysis. Based on written instructor feedback, students will have one opportunity to resubmit a graded essay for each essay for re-grading, due within 5 days of the original submission. A sample reading assignment and essay will be provided, to give an idea of what is expected. Students with more mathematical backgrounds are
expected to focus more on the biological science issues of the journal article, while the opposite is expected from students with more biological backgrounds.

The final score is made up from three equally-weighted categories, P(articipation), E(ssays), and G(roup) presentation:

- **P**: 12 weeks x (5 class participation points + possible 5 extra credit) = 60 maximum
- **E**: 3 essays x 20 points = 60
- **G**: 1 group presentation = 30 points for clarity/communication + 30 for content = 60
  (participation points for presenters may be given for effective discussion during the question and answer part)

An “A” grade will be awarded if the student scores at least 55/60 in two of the categories, and does not score below 45/60 in the other. Similarly, a “B” grade will be awarded if the student does not meet the criteria for an “A”, but scores over 45/60 in two categories, not below 40/60 in the third. After this, a student will obtain a “C” grade for scores above 40/60 in all three categories, and above 35/60 in all three for the “D” grade. Students not meeting any of these criteria will receive an “F”. (Students below the threshold in their lowest-scoring category who are otherwise scoring at a certain grade level will drop one letter grade per 10 points below). Students may enquire about their current course standing during the semester.

**Example grade calculations:**

1) Student scores: P = 58, E = 50, G = 55, earns an “A” grade.
2) Student scores: P = 46, E = 25, G = 50, would earn a “B” from P and G scores over 45, but for the low third score (between 10 and 20 points below 40) drops two grades and earns a “D”.

**Attendance:** You are required to attend all classes, particularly as you are graded for classroom interaction. You may be administratively withdrawn from the course by the instructor due to infrequent attendance in the first two weeks.

**W-Day:** September XX, 2012 is the last day to withdraw with a W course grade. If you withdraw after that day, you will receive an F course grade.

**Incomplete:** The conditions under which you may get an Incomplete (I) course grade can be found in §403.03 of the Faculty Handbook.

**Academic Honesty:** You may not cheat or plagiarize. See the Policy on Academic Honesty in §409 of the Faculty Handbook. Once groups have been determined within the first two weeks, all students will be required to sign a “contract” stating that they agree to the following: write all their own essays, help the other members of their group stay abreast of difficult material, fairly contribute to the materials and planning of the group presentation.

**Disruptive Behavior:** You must behave in a proper manner in class and on campus so that others and you may enjoy a peaceful and positive learning environment. See §401.08 of the Faculty Handbook on disruptive student conduct.

**Accommodations:** Late work for all graded assignments will not be accepted. Under extenuating circumstances and with appropriate documentation exceptions may be made. Scheduling conflicts must be worked out with me in advance. Please advise me right away if you have a documented disability that needs to be accommodated.
Learning Outcomes:

At the end of this course the students will be able to:

1. Comprehend modeling questions posed in the life sciences and distinguish between elementary types of model approach applicable to different classes of phenomena and types of data available.

2. Read the research literature for mathematical/computational modeling in the life sciences with a critical eye and an appreciation for how to assess and interpret modeling assumptions, choice of computational/analytical tools, scientific goals, and discussion of the results.

3. Write brief technical reports and give short presentations describing computational techniques, their application in the life sciences, including critical analysis of the assumptions and interpretations.

4. Collaborate with students from a different discipline to produce a short presentation about a specific research journal article.