Syllabus
Introduction to the Methods of Computational Neuroscience and Psychology
Fall 2011
PSYCH 420/792

Britt Anderson

1 Instructor Information

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2 Course Description

This course is intended for students, undergraduate and graduate, who wish to learn more about computational methods and their application to neuroscience and psychological topics.

Student Type A: knows psychology, but little to no math and would like to learn how to combine the two.

Student Type B: knows maths (or engineering, computer science, etc), but little psychology and would like to learn how the two can be combined.

For the psychologist whose last math course was in grade 11, don't despair. This course is meant for you. If you have the skills to be an honors psych student you have all the brain power needed to master this material. As long as you are willing to work hard you will succeed and get a grade that you are happy with.

However, saying that is not the same as saying it is easy. The course may require you to push yourself into areas where you are not confident or comfortable, and it may take a fair amount of time. The trade off is that I will not be an unmerciful grader. I take into account your effort and your skill level when I grade. I want to make the classroom a "safe place" for intellectual exploration.

From students from a computational background, I ask the same effort and make the same offer: make an effort to stretch and expand your skill set, e.g. use a new programming language that you have never used before, and I won't penalize you if it crashes.

2.1 Goals

First, become better consumers of cognitive neuroscience research. By exploring how computational techniques are used in cognitive neuroscience research you will become a more knowledgeable and critical reader of research papers. No more should the words: model, computation, or equation, lead you to skip from introduction to discussion.

Second, develop a computational vocabulary. I want you to know what some of those squiggly symbols mean and what a programmer actually does. This will help with the first goal of being a critical consumer of computational research, and it will also help you to be an effective collaborator in computational research. Even if you don't go on to do any programming on your own, you should have a better understanding of what a programmer does, how she does it, and to propose suggestions that are sensible.

Third, we will dispel the notion that computational approaches require some special cognitive ability or months spent learning some arcane language. Anyone who has ever used a spreadsheet to sum a column of numbers is enough of a computer programmer to do real work. For this reason, you can do everything this course requires using Excel or LibreOffice Calc. I hope you will try to move beyond the spreadsheet, but you don't have to.

In summary, the goals for the course are to become informed readers of research articles using computational techniques, learn enough mathematical and computational terminology to be active scientific collaborators, and to actually program computational simulations at a rudimentary level.

2.2 Topics

The course is organized into modules. I go through as many as I can given the mix of students and their abilities.

The basic format is repeated for each topic in the table (after the introduction). First, I try to give some context

Why Computational Psychology/Neuroscience?	
Build your own neuron	differential equations
Neural networks	linear algebra and neural networks
Reaction Time Modeling	probability
Production Systems	logic
Social Interactions	agents

Table 1: The list of mathematical topics and their companion psychological or neuroscience application.

for the topic. Then I give a little primer on the maths involved. Then I will guide you through a series of exercises, some done in class and some down as homework, that increase in complexity and work towards a concrete implementation of some computational method.

3 Textbook

I have tried my best to find a textbook, but I can't find one. So, I have decided to write my own. If I can pull it off, SAGE publishing will publish it. Your class has a unique opportunity to influence the finished project. I will be distributing draft chapters as we go along. Feel free to send me corrections of typos and anyother suggestions you have that you think will improve the clarity.

In the meantime, you can also look to other sources for ideas. There is one textbook on computational approaches to *cognitive* neuroscience. This is the book: *Computational Explorations in Cognitive Neuroscience: Understanding the Mind by Simulating the Brain*. I really like this book, but it is too detailed for our purposes, and it limits itself to utilizing a single software program. The version that the book refers to, is not available in the same form anymore, so there are small compatability issues.

There are several good textbooks on *computational* neuroscience, but they, too, either bind themselves to one particular computer language, or are too technical for us. Two pretty good books are *Theoretical Neuroscience* by Dayan and Abbott (this one is fairly deep) and *Fundamentals of Computational Neuroscience* by Trappenberg (a bit more basic, but reliant on MATLAB).

4 Course Requirements, Expectations, and Grading

4.1 Requirements

There really are no mathematical pre-requisites beyond an interest in the material and a willingness to work. Any prior calculus, linear algebra, or programming experience will be convenient, but it is not necessary, the course is intended to be self-contained. If you want to get anything out of this course you will probably have to work pretty hard, but the pressure to do so, will have to be self-applied. Just because the course is classed as a "seminar" does not mean that it is all about reading and talking. You will have to work to learn anything. From the psychology standpoint, the material of PSYCH 261, Physiological Psychology is the basic builing block.

4.2 Expectations

I expect you to attend every class or send me advance notice indicating why you cannot. There will be periodic assignments during the course. You must complete all assignments. If you complete a reasonable effort at every assignment then you will pass. I hope to use much of our class time for group discussion and small projects. My grading scheme is subjective. Because there are a relatively small number of students I will learn each of your names and I will become a pretty good judge of your capabilities. I will judge whether you are making an effort and I will adjust my evaluation for what I understand to be your level of computational expertise. A computer science major and a psychology major might not get the same grade for the same assignment.

4.3 Grading

There are three graded components:

- Classroom assignments and homework 50% aggregated
- Peer Evaluations 20%
- Presentation/Project 30%

The class room assignments and homework are assignments that you do alone, or in collaboration (just make sure that I know in advance who is collaborating with whom and that if I question you later you are able to demonstrate an understanding of the work submitted). They are announced in class, distributed on d2L (the ACE replacment) and returned in electronic drop boxes on d2l.

To meet the major goal of making you informed consumers of computational approaches the course builds towards an in-class final presentation. These are often done individually, but I am open to pairs of students working together if the collaboration improves the offering, and not just as a way of lessening the work. For example, a psychologist collaborating with a neuroscientist might provide a synergy that neither working alone could do. The presentations can take different forms. For example,

you could present based on an article you have read, describing the method or elaborating on the technique. You could give a lecture; pick a topic of interest and present a mini - version of what I do. Or you could actually try to do something. Make it a mini-research presentation based on some method you learned or idea you had during the course. The overarching principle is that you should be able to effectively present scientific matter to an audience of your peers. More information on the details of the presentation and the rubric used for scoring will be distributed during the course.

Graduate students have to meet all the obligations of the undergraduates and in addition will have to deliver a more extensive presentation (both in duration and in content).

No midterms or finals are projected at this time.

5 D2L

I will be trying to use D2L for everything. We have a course web page where all readings and assignments will be posted. Drop boxes in the course web page will be used for you to submit your assignments. A discussion forum on our course web page will be there for the discussion of topics that you think other students might be able to answer for you, or that you think other students will be interested in my comments.

Some of the assignments will have templates of spreadsheets that you can work from as a starting point.

I will use the grade book to keep you informed of your performance on the assignments.

6 Communications

6.1 Email

Please email me through the d2l page. It is good for both of us if our academic correspondence goes through the course page. This gives us both a record of what was sent and when. Because of this I will only answer email inquiries about the course through the d2l site. You should verify that d2l forwards your email, or that you check the course site regularly.

6.2 Other

In general, email is not a very good communication media for anything but simple inquiries. If you have a deep question, or personal issue, please come by and see me. My office hours are listed above. If you come by and my door is open, please feel free to knock and see if I am busy. I am also happy to schedule a time for an appointment and my office extension is available if you want to check on my availability before walking over to PAS.

7 The Official Course Outline

If there is a discrepancy between the hard copy outline and the outline posted on d2l, the outline on d2l will be deemed the official version. Outlines on d2l may change as instructors develop a course, but they become final as of the first class meeting for the term.

8 Students with Disabilities

The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.

9 Concerns About the Course or Instructor

9.1 Informal Stage

We in the Psychology Department take great pride in the high quality of our program and our instructors. Though infrequent, we know that students occasionally find themselves in situations of conflict with their instructors over course policies or grade assessments. If such a conflict arises, the Associate Chair for Undergraduate Affairs (Dr. Colin Ellard) is available for consultation and to mediate a resolution between the student and instructor. Dr. Ellards contact information is as follows:

Email: cellard@uwaterloo.ca
Ph 519-888- 4567 ext 36852

9.2 Formal Stage

A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. See Policy 70 and 71 below for further details.

10 Academic Integrity, Academic Offenses, Grievance, and Appeals

Academic Integrity: in order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility.

Discipline: A student is expected to know what constitutes academic integrity, to avoid committing academic offenses, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about 'rules' for group work/collaboration should seek guidance from the course professor, academic advisor, or the Undergraduate Associate Dean. When misconduct has been found to have occurred, disciplinary penalties will be imposed under Policy 71 - Student Discipline. For information on categories of offenses and types of penalties, students should refer to Policy 71 - Student Discipline, http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70 - Student Petitions and Grievances, Section 4, http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm

Appeals: A student may appeal the finding and/or penalty in a decision made under Policy 70 - Student Petitions and Grievances (other than regarding a petition) or Policy 71 - Student Discipline if a ground for an appeal can be established. Read Policy 72 - Student Appeals, http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm

Academic Integrity website (Arts):
http://arts.uwaterloo.ca/arts/ugrad/academic_responsibility.html

Academic Integrity Office (UW):
http://uwaterloo.ca/academicintegrity/