Syllabus
Introduction to the Methods of Computational Neuroscience and Psychology
Winter 2013
PSYCH 420/792

Britt Anderson

1 Instructor Information

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Office Hours: Wednesday 13:00 - 15:00

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

However, saying that you will earn a good grade is not the same as saying the course is easy. The course may require you to push yourself into areas where you are not confident or comfortable, and it may take a lot 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 summed a column of numbers in a spreadsheet has the skills to program a computer, because telling Excel to sum a column of numbers *is programming*. For this reason, the course begins with exercises that can be done in Excel or LibreOffice Calc and introduces you to using a more traditional computer language to do the same thing.

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.

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.

The basic format is repeated for each topic in the table (after the introduction). First, I try to give some context 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. In general, I try to use our class time for discussion, exploration, experimentation, and expect you to do reading and homework outside of class. I will not be spending three hours a week lecturing.

3 Textbook

I have could not find a textbook for this course so I have gradually accumulated my own course notes, and compiled them into a book, which I will make available to you as a pdf. It is also being reviewed by SAGE publishing, so please do not distribute it to others or share electronic copies. I would be pleased if you informed me of typos and other mistakes that I can fix. And of course if you have more general suggestions, I would be pleased to hear them.

There are other sources that supplement the goals of this course. The book *Computational Explorations in Cognitive Neuroscience: Understanding the Mind by Simulating the Brain*, covers a number of useful topics, but I am not a big fan of the software that it uses. *Computational Modeling in Cognition* also has some good material. In addition, there are several good textbooks on *computational* neuroscience, but they tend not to deal with psychological topics as much, and may be more technical than some of us are ready for. Two 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). An additional one I like, and that is available on line is: Spiking Neuron Models.

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 building 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
- Classroom Participation 20%
- Final Presentation or 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 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 a final project. This can differ depending on your interests and background, but it has to be approved by me. I hope to be able to use the last few classroom sessions for sharing this work with each other by having you present it. I am open to students collaboration, especially where it combines expertise. For example, a psychologist collaborating with a neuroscientist might provide a synergy that neither working alone could do.

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 The Official Version of the Course Outline

The outline posted on *Learn* will be deemed the official version. Outlines on *Learn* may change as instructors develop a course, but they become final as of the first class meeting for the term.

6 Students with Disabilities

The AccessAbility Services (AS) Office, 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 AS Office at the beginning of each academic term.

7 Concerns About the Course or Instructor

7.1 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. Myra Fernades) is available for consultation and to mediate a resolution between the student and instructor. Dr. Fernandess contact information is as follows:

Email: mafernan@uwaterloo.ca
Ph 519-888- 4567 ext 37776

7.2 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.

8 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, https://uwaterloo.ca/secretariat/policies-procedures-gu

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.ht In addition, consult: http://www.adm.uwaterloo.ca/infosec/Policies/policy70.ht for the Faculty of Arts greivance processes.

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.ht

Academic Integrity website (Arts):
http://www.adm.uwaterloo.ca/infosec/Policies/policy72.ht

Academic Integrity Office (UW):

http://arts.uwaterloo.ca/arts/ugrad/academic_responsibility.html