Introduction to Neural Networks

PSY5038WF2018

University of Minnesota, Fall Semester, 2018

Instructor:
Dan Kersten: kersten@umn.edu

Abstract

Introduction to large scale parallel distributed processing models in neural and cognitive science. Topics include: linear models, statistical pattern theory, Hebbian rules, self-organization, non-linear models, information optimization, and representation of neural information. Applications to sensory processing, perception, learning, and memory.

Prerequisites

- linear algebra
- multivariate calculus

Software

Mathematica

Mathematica is the primary programming environment for this course. Students who have registered for the course will have Google Docs access through the Psychology Department's site license.

Alternatives: Mathematica is available in several labs on campus, go to http://www.oit.umn.edu/computer-labs/software/index.htm You may wish to purchase *Mathematica for Students* see http://www.wolfram.com/products/student/mathforstudents/index.html. You can also access ***Mathematica*** on the CLA servers:

If you never programmed before go here. If you have programming experience, go here.

For user help on using Mathematica, see: http://mathematica.stackexchange.com

Learning center: http://www.wolfram.com/learningcenter/

Writing

- Gopen, G. D., & Swan, J. A., 1990. The Science of Scientific Writing. American Scientist, 78, 550-558. (pdf)
- **Supplementary: **
  - The Sense of Style: The Thinking Person's Guide to Writing in the 21st Century (2014), Pinker, Steven. (amazon link)
  - Penrose, A. M., & Katz, S. B. (1998). Writing in the Sciences: Exploring Conventions of Scientific Discourse. New York: St. Martin's Press, Inc.
  - American Psychological Association. (2009). Publication manual of the American Psychological Association (6th ed.). Washington, DC: American Psychological Association
- **Writing assistance.** THE CENTER FOR WRITING offers free one-to-one writing assistance to undergraduate and graduate students, with appointments up to 45 minutes. Nonnative speaker specialists are available. For more information, see http://writing.umn.edu.
- Psychology department resources: http://writing.psych.umn.edu/student-resources

Grade Requirements

There will be programming assignments, as well as a final project. The grade weights are:

- Exercise/programming assignments: 55%
- Final project presentations: 5 %

- Final project : 40% (four parts: 2%+5%+5%+28%)

  The programming assignments will use the *Mathematica* programming environment. No prior experience with *Mathematica* is necessary. [

  ](http://www2.publabs.umn.edu/publab/text/locations.html)Assignment due BEFORE class start time (9:45 am) on the day due. You can use the downloaded Mathematica notebook for the assignment as your template, add your answers, and email your finished assignment to the TA. You can copy and paste any code bits you need from the Lecture notebooks. But of course, you cannot copy and paste code or any other answer materials from someone else.

Final Project Assignment

This course teaches you how to understand cognitive and perceptual aspects of brain processing in terms of computation. Writing a computer program encourages you to think clearly about the assumptions underlying a given theory. Getting a program to work, however, tests just one level of clear thinking. By writing *about* your work, you will learn to think through the broader implications of your final project, and to effectively communicate the rationale and results in words.

Your final project will involve: 1) a computer simulation and; 2) a 2000-3000 word final paper describing your simulation. For your computer project, you will do one of the following: 1) Devise a novel application for a neural network model studied in the course; 2) Write a program to simulate a model from the neural network literature ; 3) Design and program a method for solving some problem in perception, cognition or motor control. The results of your final project should be written up in the form of a short scientific paper, describing the motivation, methods, results, and interpretation. Your paper will be critiqued and returned for you to revise and resubmit in final form. You should write for an audience consisting of your class peers. You may elect to have your final paper published in the course's web-based electronic journal.

Completing the final paper involves 3 steps:

1. **Outline**. You will submit a working title and paragraph outline by the deadline noted in the syllabus. These outlines will be critiqued in order to help you find an appropriate focus for your papers. (**2%** of grade). (Consult with the instructor or TA for ideas well ahead of time).
2. **Complete draft**. You will then submit a complete draft of your paper (**2000-3000 words**). Papers must include the following sections: Abstract, Introduction, Methods, Results, Discussion, and Bibliography. Use citations to motivate your problem and to justify your claims. Figures should be numbered and have figure captions. Cite authors by name and date, e.g. (Marr & Poggio, 1979). Use a standard citation format, such as APA. Papers must be typed, with a page number on each page.Each paper will be reviewed with specific recommendations for improvement. (**5%** of grade)
3. **Peer commentary**. Each student will submit a paragraph on an anonymous paired project draft (**5%** of grade)
4. **Final draft**. You will submit a final revision for grading. (**28%** of grade). The final draft must be turned in by the date noted on the syllabus. Students who wish to submit their final papers to be published in the class electronic journal should turn in both paper and electronic copies of their reports.

If you choose to write your program in Mathematica, your paper and program can be combined can be formated as a Mathematica notebook. See: Books and Tutorials on Notebooks.

Your paper will be critiqued and returned for you to revise and resubmit in final form. You should write for an audience consisting of your class peers.