CPSC 644-600: Cortical Networks

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- Office: HRBB 322B (or HRBB 507), M 10:30am-11:30am, WF 4-5pm.
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- Enter username: `644`, password: (_____), in case you are asked.

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Introduction

From the course catalog: The architecture of the mammalian cerebral cortex; its modular organization and its network for distributed and parallel processing; cortical networks in perception and memory; neuronal microstructure and dynamical simulation of cortical networks; the cortical network as a proven paradigm for the design of cognitive machines.

About this semester: This course will provide necessary background for modeling the structure (anatomy), function (physiology), and growth (development) of neurons, neuronal circuits, and neuronal networks. Various computational concepts, techniques, and tools necessary for modeling neural systems will be introduced. A selected set of latest papers in the field of computational neuroscience and neuroinformatics will be surveyed.

Textbook(s) and Other Material

- **Required:** Peter Dayan and L. F. Abbott, Theoretical Neuroscience, MIT Press, 2001.
- **Recommended:** Thomas Trappenberg, Fundamentals of Computational Neuroscience, 2nd Edition, Oxford UP, 2010.
- Gordon M. Shepherd (Editor), The Synaptic Organization of the Brain, Oxford UP, 2004.
- Risto Miikkulainen, James A. Bednar, Yoonsuck Choe, and Joseph Sirosh, Computational Maps in the Visual Cortex, Springer, 2005.
- Fred Rieke and David Warland and Rob de Ruter van Steveninck and William Bialek, Spikes: Exploring the Neural Code, MIT Press, 1997.
- Wulfram Gerstner and Werner M. Kistler, Spiking Neuron Models: Single Neurons, Populations, Plasticity, Cambridge UP, 2002.
- James M. Bower and David Beeman, The Book of GENESIS, Telos, 1998.
- Erik De Schutter (Editor), Computational Neuroscience: Realistic Modeling for Experimentalists, CRC Press, 2001.
- Christof Koch and Idan Segev, Methods in Neuronal Modeling, MIT Press, 1998.
- Michael A. Arbib (Editor), The Handbook of Brain Theory and Neural Networks, MIT Press, 2003.
- Leo Van Hemmen and Terrence Sejnowski (Editors), 23 Problems in Systems Neuroscience, Oxford UP, 2006.

Topics to be Covered

- Essential terminiology and basic neuroanatomy
- Neuron: physiology, computational models
- Neuron: morphology, statistical modeling and reconstruction
- Circuits: thalamus, model of the thalamus, neocortex, cerebellum, basal ganglia, network analysis, and dynamics
- Neural coding
- Natural image statistics and representational learning
- Visual system: physiology, development, and modeling
- Motor system: decoding internal state, relation to sensory receptive field development, response tuning

Computer Usage

- You would have gotten a CS computer account by now. If you did not have one already, a new one was supposed to be created once you registered for this course.
- We will use GNU Octave, an open-source clone of Matlab. `http://octave.org`.

Grading

- Short quiz (one or two): 10%
- Programming assignments/exercises (30%): about 2 short exercises (15% each). Skeleton code will be provided.
- Paper commentaries (20%): for the reading assignments each week, a brief (one paragraph) comment/critique must be submitted.
- Term project (40%): proposal, presentation, and final report.

Grading will be on the absolute scale. The cutoff for an 'A' will be at most 90% of total score, 80% for a 'B', 70% for a 'C', and 60% for a 'D'. However, these cutoffs might be lowered at the end of the semester to accomodate the actual distribution of grades.

Pretty Standard Academic Policy

- All work should be done individually, unless otherwise noticed. Discussions are encouraged, but the submitted material must be in your own words.
- All references must be properly cited, including internet web pages (URL must be provided). If plagarism is detected, i.e. without proper citation and quotation, you will automatically receive an F. When in doubt, please ask the instructor if it is reasonable to include other's work in your assignments.
- See the syllabus for statement regarding students with disabilities.

Weekly Schedule

See the course web page. The references will be updated soon.

Resources

- General resources: **http://faculty.cs.tamu.edu/choe/resources/**.
- General reading list with tips on reading: **http://faculty.cs.tamu.edu/choe/reading/** (password required).
- While you have time (i.e. at the beginning of the semester), explore a bit. One emphasis of this course is to increase your ability to *actively* seek relevant information and form new thoughts and relations, and also obtain the skill to evaluate the ideas. A general guideline will be sprinkled here and there throughout the course. Use your web-surfing skills developed for your personal entertainment. You will be surprised how useful it can be (of course I'm not saying that entertainment is not productive).

How to Read and Explore

- Sections 1.1 and 1.2 of: http://courses.cs.tamu.edu/choe/689-reading/reading.html
- Research ethics: `http://www.cs.cmu.edu/~dst/Ethics/ethics07.pdf`
- Wise up (Claxton):

  `http://faculty.cs.tamu.edu/choe/lab/howto/choe-nil06fall.pdf`

  `http://faculty.cs.tamu.edu/choe/lab/docs/claxton.wiseup99.pdf`

  `http://faculty.cs.tamu.edu/choe/lab/howto/wiseup.html`
- Critical thinking (Browne and Keeley):
  `http://faculty.cs.tamu.edu/choe/lab/docs/browne.arq07.pdf`

Next

- Crash course in neuroscience: basic stuff (terminology, etc.) you need to know to be able to read neuroscience and computational neuroscience literature.