Special Topics in Neuroscience & Bioengineering: Neuroinformatics Lab

NEUR461/BENG499 **Thursdays 1:30-4:10p, Krasnow 229**
http://krasnow1.gmu.edu/cn3/neur461.pdf

Prerequisites: Neur 327, Neur 335, Psyc 372, or permission of instructor.

Students in the neuroscience, psychology, biology, and bioengineering programs are especially encouraged to enroll.

Course Goals: This hands-on introduction to available and developing neuroinformatics infrastructures focuses on data processing, literature mining, and metadata annotation, with a special emphasis on neuronal morphology and hippocampal neuron types. The aim is to provide students with sufficient practical understanding of basic concepts and representative tools to participate confidently and actively in neuroscience projects with a substantial component of digital data. Prior computational experience is not required, and attendees will start using their newly acquired knowledge immediately.

Contents in Brief: Parties in the brain-mind relationship: neurons, networks, activity dynamics, mental states, knowledge, and plasticity. Neuron types: morphology, electrophysiology, biochemistry, development, and function. Connectomes: projectomes, synaptomes, mesoscopic maps, neural circuits, and potential connectivity. Inner reality: representation, learning, memory, and background information. A world-wide net: NeuroMorpho.Org, Hippocampome.Org, and other relevant electronic resources.

Method of Instruction and Evaluation: Weekly classes will intersperse lectures, online real-time demos, student discussion, and dry lab practical sessions. Active student participation is required. Mandatory readings and homework virtual labs will be assigned every week. Each class will begin with a homework discussion *by the students* (this will be an opportunity to review and expand the material as well). This means that each student will be called several times during the semester to explain and discuss how s/he answered the assigned question(s) to the rest of the class. I will provide the called student(s) with direct feedback and a grade corresponding to their answers upon request. Student attendance and punctuality are required (3 late arrivals >10 minute = 1 absence; 3 absences = 1 homework "F"). The exam will consist of a take-home literature annotation project followed by individual classroom presentations. Final grades will be based on 50% class participation and homework discussion, and 50% final project. Letter grades will be assigned as follows: A+ and A, 4.00; A-, 3.67; B+, 3.33; B, 3.00; B-, 2.67 (undergrad only); C+, 2.33 (undergrad only); C, 2.00; D, 1.00 (undergrad only); F, 0.00.

Instructor: Dr. Giorgio Ascoli - Ph. x3-4383, E-mail: ascoli@gmu.edu
Office location: Krasnow Institute, Rm. 223
Office hours: Mondays 3-4p or by appointment.

Required Text: G.A. Ascoli: Trees of the Brain, Roots of the Mind (MIT Press, 2015).
Other Material: Online web-sites and portals.

Technology Requirement: Ability to access the web and email communication. BYOD policy: students are encouraged to bring their own portable devices (laptops, tablets, phones) in class.

Class cancellation policy: If classes are cancelled I will notify students by email using their gmu address. If needed, missed time will be made up during reading week.

Honor Code: GMU Academic Policies apply in full (catalog.gmu.edu).

If you are a student with a disability and you need academic accommodations, please see me and contact the Disability Resource Center (DRC) at 703-993-2474. All academic accommodations must be arranged through that office.

(Approx.) Class Schedule of Topics and Readings

1) 1/26: Course introduction, goals, and format. Overview of neuroinformatics challenges and opportunities. Preview and brief description of resources and topics. Importance of axonal and dendritic morphology in neuroscience. Assignments: Read Preface & Chapters 1-3. Class slides available HERE.

Last day to add/drop classes with no tuition penalty: Monday January 30.

2) 2/2: Virtual Lab I - NeuroMorpho.Org. Digital reconstructions of neuronal morphology. Metadata, morphometry, and visualization. Perils and potential of data mining. Assignments: Spend at least 5 hours browsing NeuroMorpho.Org content & links.

3) 2/9: Virtual Lab II – Electrophysiological modeling: membrane biophysics, synaptic integration, and firing patterns. The NEURON simulation environment [Guest lecture by Diek Wheeler & Siva Venkadesh]. Class slides available HERE. Examples also available here!

[2/13 last day to drop with a 33% tuition penalty]

4) 2/16: Principles of the brain-mind relationship: neuronal morphology and mental states. The capability to acquire new knowledge. Axonal-dendritic overlaps as neural correlates of background experience. Assignments: Read chapter 4-6. Class slides available HERE. If you are interested, IIT.

5) 2/23: Virtual Lab III – Foundation of knowledge workflow… Data identification and annotation: full-text searches, literature mining, and in-class examples. Introduction to take-home project and final journal-club presentation. Assignments: dry-run dataset and metadata extraction. Cool VR use of NeuroMorpho.Org (swc) data here!

Last day to drop (with 67% tuition penalty): Friday February 24.

6) 3/2: Virtual Lab IV: Neuronal reconstructions: from image stacks to digital vector trees. NeuTube, Vaa3D, and other tracing tools. Hands-on activity: tracing example data set, both manually and automatically followed by editing [Guest-lecture by Sumit Nanda]. Allen Institute: Systematic Neuron Morphometry

7) 3/9: Neuronal diversity: species, brain regions, and neuron types. Implications for neuroscience research and bioengineering: Relevant recent Nature News & Views. Assignments: Read chapter 7-9 & Epilogue. Class slides available HERE.

Spring break week of 3/16. Recommendation: finish 90% of literature annotation project and select a paper for the final journal club presentation!

8) 3/23: Virtual Lab V – Data conversion, visualization, and editing. NeuronLand, CVapp, and common morphological irregularities in experimental data. Assignments: reproduce conversion and fixing from original to standardized data in NeuroMorpho.Org.

9) 3/30: Virtual Lab VI – Quantitative morphometrics & L-Measure. Local and global parameters, frequency distributions, relational analyses (e.g. Sholl plots), and statistical comparisons. Animated (!)

class slides available HERE. Assignments: reproduce all steps from Nature Protocols 2008 + identify and study article for journal club.

10) 4/6: Journal club dry-run brainstorming. Assignments: Finish literature annotation and email to me.

11) 4/13: Virtual Lab VII – Hippocampome.org. Neuron types of the mammalian hippocampus. Anatomical patterns, biophysical properties, and molecular markers. Assignments: [customize search & download]. Class slides available HERE.

12) 4/20 [today only: meet in room 222 instead of 229]: Overview of active neuroinformatics initiatives. Allen Brain Atlas, Human Connectome Project, SenseLab, CramTest.Info, BigNeuron, EU HBP, HHMI news, etc. Other tools and meta-reviews (Scholarpedia review). Assignments: Prepare final presentation and email me draft!

13) 4/27: Structure-activity relationship in the nervous system: towards a Periodic Table of the Neurons. Class slides available HERE.

14) 5/4: Final journal club Presentations.