Biologically Intelligent Exploration (85-435 & 85-735)

Monday & Wednesday, 4:00-5:20 pm. Remote instruction.

Instructor

Dr. Erik Peterson, Erik.Exists@gmail.com

Office Hours

Monday & Wednesday, 3:00-4:00 pm, and by appointment

Course Overview

We will cover exploration as a broad problem in biology, and its computational accounts.

Tentative schedule

Week	Title	Topic
1	What the eff is exploration!?	We begin by considering some definitions. We spend time in lab on logistics and getting python working.
2	The Runaround.	We discuss random searching, and what is optimal when. AKA Diffusion, Lévy flights, and patches.
3	Snnnnniiiifff!	Exploration driven by the senses, and gradients in the environment. AKA Follow your nose.
4	The perfect plan!	Exploration driven by memory. AKA Tourists and salesman.
5	Air quotes cognition	Exploring and ruminating. AKA optimal decision making with noisy sensors.
6	Please don't eat me!	Exploration in prey hunted by predators, predators exploring for moving prey.
7	Be best	Exploration for reward, when losses and costs don't matter. AKA Exploration without regret.
8	Oh my, the dilemma.	Exploration for reward when losses and costs do matter. AKA Exploring with regret.
9	Oh no, the cat.	Exploration out of curiosity and to maximize information value. AKA it's a ok to play.
10	What, dilemma!?	Unifying curiosity and reward to solve the dilemma. AKA The professor babbles on about his own work.
11	A foraging philosopher.	Information foraging as reasoning? We talk about the work of David Barack.
12	The kids are alright.	Exploration in kids, in development, and across the lifespan.
13	Inside fish, mice, and monkeys.	Three examples of exploration at work in neural circuits.
14	Projects	Final work and presentations

*** May be changed at instructor's discretion.*

Prerequisite Knowledge

A basic proficiency in Python. Completion of 85-213 or 85-211 and either 21-111 or 21-120 or 21-115.

Text & Readings

- Text: TBD.
- Readings: can be found on Github.

Learning objectives

This course is designed to get at the fundamentals of exploration as a broad problem in biology. Successfully meeting the objectives of this course will allow you to learn:

- To evaluate and communicate research from cognitive science, neuroscience, animal behavior, and computational modelling.
- To critically analyze mathematical theories and computational models of behavior.
- To think critically about both theoretical and empirical material.
- To guide content discussions.

Grades

Your final grade will be based on the below. Percentages show the contribution of each to the final grade.

- **Attendance & Participation** (10%): You will be graded on your participation in this course, including your participation in class activities and attendance. Attendance will be taken at the start of each class. It is your responsibility to indicate your attendance. Barring exceptional circumstances that are discussed with me in person, missing more than 3 classes will result in a 0% grade for Attendance. Participation involves active discussion during class.
- **Critical Questioning** (15%). At the start of class students will submit one question about the reading for that lecture (if there was a reading). Students should be prepared to discuss their question in class, and to provide an initial suggestion as to how the question might be answered or to discuss why the question is important and challenging. Students are required to do this for each lecture and can have the expectation of being called upon at least twice a semester to present their question.
- **Lab Assignments** (35%): A selection of applied exercises will be assigned, often in class,

to better and test your understanding of material covered in lectures and readings.
- **Final Project** (40%): There will be one final hands on computational project where you build or extend a model of exploration. This project should extend beyond what was covered in class, and should point towards solving a new or open scientific problem. Example projects will be provided. All analysis, summaries, and visualizations will be presented as Jupyter notebooks accessible on GitHub. The final project will require a 5 minute *video* presentation of your results.

Tools

- **Jupyter Notebooks**. Final projects and most assignments will be presented as a Jupyter notebook http://jupyter.org/
- **Github**. You are expected to keep your final project materials organized on Github, a free version control repository. As students, you are able to register for the discounted student version which allows you to keep your repository private (see https://education.github.com/. The class GitHub page will be setup by the first day of class.

Code of Conduct

By enrolling this course, you agree to abide by the following codes of conduct. Cheating & Plagiarism: Cheating and plagiarism are defined in the CMU Student Handbook, and include (1) submitting work that is not your own for assignments; (2) copying ideas, words, or graphics from a published or unpublished source without appropriate citation; (3) submitting or using falsified data. Any student who is found cheating or plagiarizing on any work for this course will receive a failing grade for that work. Further action may be taken, including a report to the dean.

Accommodations

All efforts will be made to minimize conflict with students' religious schedules (e.g., holidays, prayer services, etc.) and/or any disabilities. Students should consult with the Equal Opportunity Services (EOS) office at the beginning of the semester in order to set up any necessary accommodations for the class.