Special Topics: Decisions and Actions

NEURL-UA 302
Prerequisites: NEURL-UA 220 (Behav & Integ NS)

This course will present the fundamental of the fields of sensory perception, actions, and decision making, as well as the links between them.

Course Organization
The course will consist of a series of lectures with background mandatory reading, mostly book chapters, reviews, or classical papers. The students are expected to read the background material before the class. Students will get much more out of the lectures if they have done the background reading before coming to class. To motivate this, there will be short quizzes about the reading material due the day before class (see grading below). There will also be a considerable amount of lecture content that will not be found in the readings; thus, class attendance and participation is very important.

In addition, on selective weeks, the lecture will be shorter and the second half of the class will be discussion sessions in which the class will critically evaluate primary literature relevant to the topics of the course. These will not be lecture-style, but rather the paper will be presented by the students, asked in random, in a discussion led by the Professor. Materials from these discussion papers will also be included in the quizzes (see below).

Readings
Most readings will be classical papers and reviews. The most relevant general neuroscience textbook is the 6th edition of "Neuroscience" by Purves, Augustine, Fitzpatrick, Hall, LaMantia, McNamara, and White; however, class sessions draw on material that is not in the textbook. Required readings will be drawn from reviews, journal articles, and book chapters and will be available electronically.

Course Philosophy
Much of the course material does not come from the textbook because I want to expose you to some of the really important issues in sensory perception and decisions, and I have not found a textbook that contains the right material and operates at the right level. The emphasis is on understanding core principles and ideas about how neural systems work and how we can start to understand how neural activity gives rise to behavior. We focus on a smaller number of topics but go into them in greater depth. As a result, simply memorizing facts will generally not yield good performance.

Evaluation
Each student’s grade will be determined by a combination of performance on exams, quizzes, and class participation. These components will be weighted as follows:
- 50% Take home Exam
- 30% Research proposal
- 20% Class Participation (including project presentation)

Exam:
The exam will consist of multiple-choice and short answer questions. In addition, there will be a few assay questions; from these you only need to answer one. These assay questions will involve more intricate problem-solving that will require students to synthesize material and
apply key concepts to hypothetical problems. The Exam will focus heavily on the material that we discuss in class, thus understanding deeply the material covered in lectures and discussions is the key to success (and this generally will not happen without classroom attendance).

**Research proposal:**
In this research paper, your group will come up with a novel hypothesis or question, and design an experiment to test it. The paper will follow a short grant format, with these sections (pages single-spaced, 11 pt):
- Specific aims (0.5-1 page, describing 2-3 questions or hypotheses you would like to test).
- Background and Significance (2-3 pages) – why is this question important and significant and what has been done previously to motivate it? What would be the broader benefits from answering this question/testing this hypothesis?
- Experimental plan (2 pages) – details about the experiment and data analyses themselves. What outcome would support or refute your hypothesis?

**Special Arrangements:** Students needing special arrangements should contact Dr. Angelaki and arrange an office visit.

**SCHEDULE**

**Class 1:** **Introduction: Basic principles of sensory perception; Concepts of psychophysical measurement and signal detection theory (Angelaki)**

Reading: (1) Appendix A, Goldstein, Sensation and Perception

**Class 2:** **Basic principles of perceptual decision making – sensory representation (Angelaki)**


**Class 3:** **Basic principles of perceptual decision making – evidence accumulation (Angelaki)**


**Class 4:** **Multisensory Decisions (Angelaki)**

Class 5: Decision models (Wang)
Quiz due: Monday, Feb 24 2020

Class 6: Causal Manipulations: microstimulation and inactivation (Angelaki)

Class 7: Bayesian decision models (Ma)

Class 8: Confidence in decisions (Ma)
Reading: Hsin-Hung Li & Wei Ji Ma Confidence reports in decision-making with multiple alternatives violate the Bayesian confidence hypothesis, https://www.biorxiv.org/content/10.1101/583963v1.full
Quiz due: Monday, March 23 by 5 pm

Class 9: Flexible decision-making through long-term integration of evidence (Kiani)

Class 10: Attention (Angelaki)
Short 3-min presentation of your project

Class 11: Reinforcement learning (Angelaki)
Class 12: Cognitive maps and flexible behavior – a shift towards cognition (Angelaki)

Class 13: Decisions in naturalistic tasks with active sensing (Angelaki)

Class 14: 10 min presentation of individual project

FINAL PAPER DUE: DATE TBD