**PSCL390 – Computational Psychology & Neuroeconomics**

**Instructor:** Kyle LaFollette (he/him) [kjlafoll@case.edu](mailto:kjlafoll@case.edu)

**Office/Student Hours\*:** [days/times] or by appointment at [zoom address]

\*These hours are for you, students, to have 1:1 conversations with me however you please. Please do not hesitate to use these hours – it’s better to start talking earlier in the semester than later! If you’d like to schedule a Zoom meeting, please email me – I usually respond within 48-hours.

**Course Times:** Wednesdays 2:15-3:05

**Location:** [location]

**Textbook\*:** Ma, W. J., Kording, K. P., & Goldreich, D. (2021). *Bayesian models of perception and action*. (n. p.) <http://www.cns.nyu.edu/malab/bayesianbook.html>

\*It’s free! We will use this textbook lightly in combination with other sources. You will NOT need to purchase any textbooks for this course.

**Course Description**: Computational modeling is one of the most critical and emergent methods in cognitive psychological and neuroeconomic research. Models are the framework for artificial agents who learn and behave like people. The overarching objective of this course and my goal as an instructor is to provide you with an interdisciplinary toolkit at the crossroads of cognitive psychology, artificial intelligence, machine learning, and statistics for building models of human learned behavior. By the end of this course, student should be equipped to do the following:

1. *Identify* key components of learned behavior (i.e., updating expectations, making choices, remembering historical outcomes) and their computational analogues.
2. *Recognize* canonical experimental paradigms for studying learned behavior and the components of learning that they emphasize.
3. *Apply* basic computational models of learned behavior to choice data and *understand* the pros/cons of each model for investigating different learning components.
4. *Evaluate* the quality of computational models for addressing different experimental problems.
5. *Create* a basic, plain language model to address an experimental problem of interest.

**Course Philosophy**: Computational models can be intimidating to the uninitiated, but they don’t have to be! My philosophy for teaching is to make modeling fun and intuitive for students of all skill levels. Students can expect to learn about models in the context of student-centered research questions: How do we learn to choose superior options; Why do we make mistakes; What are we thinking of when we make decisions? You will also learn to associate models with different types of experiments, which I hope will make the finer computational details more illustrative and memorable. Last, models will be taught in ‘plain language’ rather than mathematical notation. All students, regardless of technical background, will be well prepared to take what they learn in this class and apply those concepts to real research questions.

**Student Expectations / Grading:** Student expectations throughout the course will be based on the following elements: participation, weekly homework assignments, and a final project and presentation:

1. In-class participation (10%): Students will be given reading assignments each week. You are expected to have done the reading prior to each class period so that you can engage in conversation. Reading may be necessary to participate in in-class exercises, and your participation in those exercise will be considered when determining your final grade.
2. Attending office hours (10%): Students are required to schedule **at least** **two ~15-minute meetings** with me during office hours (in-person or over Zoom). The topic of our conversation is up to you – talk with me about class material, ideas, challenges, goals, or whatever else may be on your mind – just come prepared.
3. Weekly homework assignments (50%): Homework will be assigned each week based on that week’s material. Most of these assignments will be presented as worked modeling code, and you will be tasked with annotating that code in plain language. This does NOT require that you do any coding – just that you walk through the code yourself, carefully read through my comments, and interpret what the code is doing in your own words. Some assignments will even have short experiments for you to play! Each assignment will be worth 5% of your final grade, and will be graded based on the clarity and completeness of your annotations. Assignments are brief and shouldn’t take students more than 1-hour outside of class to complete. The lowest three homework scores will be automatically dropped. Graded assignments will be returned ~1-week post the turn-in date. If you are dissatisfied with your grade on any assignment, you can resubmit it no later that one-week post feedback. Your resubmitted homework will be reevaluated independently for a new grade.
4. Final project (30%): Students will be placed into teams around the 4th week of class based on their research interests. Once assigned a team, students must meet outside of class to identify a psychological research question that they would like to answer computationally. Teams can choose one of several provided questions/experiments or develop one of their own. Teams must meet with me no later that the 9th week of class to discuss their project idea (this can count as one of your two required office hours). Once approved, teams will work together to develop a plain language model similar to those worked on in weekly homework assignments. Your team will present your research question, theoretical experiment, and plain language model to the class in a **~*20-minute presentation*** during the final two-weeks of class. 10% of the project grade will be based on your presentation (see rubric), 15% based on your plain language model (see rubric), and 5% based on your performance as evaluated by your team.
5. Extra credit: Opportunities for extra credit will be available sporadically throughout the semester. These will usually be in the form of incentives for in-class exercises. Any extra credit accumulated will be capped at 5% of your final grade.

Grade boundaries will be set to the following:

1. ≥ 90%
2. 80-89%
3. 70-79%
4. 60-69%
5. ≤ 59%

Altogether, this is a 1-credit course and so students are not expected to be spending more than 3-hours outside of class on course requirements. It’s anticipated that students will spend ~1-hour reading, ~1-hour working on homework, and ~1-hour meeting with their project team / working on their final project per week.

**Attendance:** Students are expected to regularly attend all classes and participate in class discussion. This course is very discussion oriented – as such, 10% of your final grade requires that you attend class to participate. Students are expected to come prepared to class, contribute to the learning process, provide feedback, and share ideas. Failure to attend class and participate in in-class excises will result in a reduced participation grade. That said, students will be permitted 1 missed day before their participation grade is adversely affected. Absences related to medical or family emergency (with documentation), religious holidays or events observed will be honored. Please coordinate planned absences with me to the best that they can be anticipated.

**Homework Policy and Late Penalties:** Homework assignments are expected to be turned in on Canvas no later than 11:59PM the day before they are due. Late assignments will receive ***a full letter grade per day penalty***. Exceptions to this policy will only be granted for serious medical or family emergency that is documented by the Dean’s office. Resubmitted assignments (see Grading) are due exactly 7-days from the time of receipt, and will not be accepted beyond that period, no exceptions.

**University Student Code of Conduct:** (<https://case.edu/studentlife/university-policies/student-code-conduct>) The University Student Code of Conduct serves to support the overall mission and core values of Case Western Reserve University. This includes civility and the free exchange of ideas, civic and international engagement, appreciation for the distinct perspectives and talents of each individual, academic freedom and responsibility, positive treatment and ethical behavior.

**Academic Integrity Policy:** (<https://bulletin.case.edu/undergraduatestudies/academicintegrity/>) Academic integrity addresses all forms of academic dishonesty, including cheating, plagiarism, misrepresentation, obstruction, and submitting without permission work to one course that was completed for another course. If any member of the University community suspects that an undergraduate student has violated academic integrity standards, they shall advise the student and the departmental chair and consult with the Dean of Undergraduate Studies about the appropriate course of action.

**Undergraduate Academic Policies and Procedures:** (<https://bulletin.case.edu/undergraduatestudies/policies/>)

**Student Support Services:** (<https://case.edu/studentlife/accommodatedtesting/>) Academic accommodations can be provided after registering with the Office of Accommodated Testing and Services (OATS, Sears 440). Accommodations cannot be provided retroactively.

**Disability Accommodations:** (<https://case.edu/studentlife/disability/getting-started>) Students at Case Western Reserve are not required to disclose disability information to anyone. However, in order to use services and appropriate accommodations, students should notify Disability Resources. The Disability Resources staff is available to all students (undergraduates, graduates, and professional students). Students should call the office at 216.368.5230 and schedule appointments as needed. Please note: Consideration for accommodations will not begin until the documentation is received and reviewed. Minimally, after receipt of all information, the disability resources office will need one week to process your request. Reasonable accommodations are available for students who have a documented disability. Please notify the instructor immediately (no later than the first week of class) of any accommodations needed for this course. Disability Resources must approve all accommodations. Accommodations cannot be provided retroactively.

**Diversity and Inclusion:** (<https://case.edu/studentlife/university-policies/discrimination-policy>) Science strives to be objective, yet much of academia is subjective and built historically on a small subset of privileged voices. It is critical for the future of science that universities consider each student’s unique background, perspective and experience as vital resources. I aim to make this course a safe learning environment for all students and to honor your diverse identities (e.g., gender, sexuality, race, ethnicity, nationality, religion, age, etc.). The course is designed to encourage teamwork and an open dialogue of information and ideas between students. Insensitivity and disrespect will not be tolerated.

**Class Schedule (subject to revision when calendar is decided):**

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| Day | Topic | Assignments (due following week) |
| 1/18 | **Introduction** – what is computational psychology and neuroeconomics?, syllabus review | Homework #1; Chapter 1.1-1.4 |
| 1/25 | **Measurement theory** – Steven’s law, Fechner’s law, Luce’s laws, multidimensional scaling | Homework #2; Chapter 7.1-7.5 (ignore Steps1-3, instead read [Lee, 2008](http://www.socsci.uci.edu/~mdlee/SDTBayes.pdf)) |
| 2/1 | **Perceptual decisions** – discrimination, detection, confidence, signal-detection theory | Homework #3; Chapter 6.1-6.2; [Gershman, 2015](https://link.springer.com/article/10.3758/s13423-014-0790-3) |
| 2/8 | **Reinforcement learning I** – prediction, delta-updating rules, asymmetry, meta-learning | Homework #4; [Daw, 2014](http://www.princeton.edu/~ndaw/d13.pdf) pp.299-307 |
| 2/15 | **Reinforcement learning II** – Markov decision processes, Bellman’s equation, Kalman filtering, eligibility traces | Homework #5; Chapter 13.1-13.5 |
| 2/22 | **Decision-making** – expected utility theory, argmax, softmax function, | Homework #6; [Kable, 2014](https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.709.5577&rep=rep1&type=pdf) pp. 173-189; [Johnson & Ratcliff](https://cpb-us-w2.wpmucdn.com/u.osu.edu/dist/6/60429/files/2018/07/glimcher-chapter-1gtu9o2.pdf), 2014 pp. 39-44 |
| 3/1 | **Temporal dynamics** – intertemporal choice, self-control, diffusion | Homework #7; [Gershman, 2018](https://gershmanlab.com/pubs/Gershman18.pdf) |
| 3/8 | **Explore-exploit dilemma** – epsilon-greedy algorithm, upper-confidence bound algorithm, Thompson sampling | Homework #8; [Decker et al., 2016](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4899156/); [Daw et al., 2011 Supp.](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3077926/bin/NIHMS280176-supplement-01.pdf); Team meeting to approve project |
| 3/15 | NO CLASS - SPRING BREAK |  |
| 3/22 | **Mental models** – temporal difference learning, model-based vs. model-free control | Homework #9; [Sokol-Hessner et al., 2009](https://www.pnas.org/content/pnas/106/13/5035.full.pdf); [Supp](https://www.pnas.org/content/suppl/2009/03/16/0806761106.DCSupplemental/0806761106SI.pdf#nameddest=STXT). |
| 3/29 | **Prospect theory** – asymmetric value functions, probability weighting, reference points | Homework #10; [Rutledge et al., 2014](https://www.pnas.org/content/111/33/12252); [Supp](https://www.pnas.org/content/pnas/suppl/2014/07/31/1407535111.DCSupplemental/pnas.201407535SI.pdf?targetid=nameddest%3DSTXT). |
| 4/5 | **Emotion** – affect-as-information, mood maintenance, regret, signaling | Homework #11; [Zhang, Moisan, & Gonzalez, 2020](https://www.cmu.edu/dietrich/sds/ddmlab/papers/ZhangMoisanGonzalez2020.pdf); [Gulati, Nguyen, & Gonzalez, 2021](https://www.cmu.edu/dietrich/sds/ddmlab/papers/2021GulatietalAAAISymposium.pdf) |
| 4/12 | **Multi-person games I** – theory-of-mind, game theory, equilibria | Homework #12; [Feldman-Hall & Nassar, 2021](https://static1.squarespace.com/static/56100827e4b0a8aca363cc5f/t/6152266f26afc734f8ec1bba/1632773743995/2021_TICS_SocialComputations.pdf) |
| 4/19 | **Multi-person games II** – Prisoner’s dilemma, finite-state machines, social norms | Homework #13 |
| 4/26 | **Final project presentations** |  |