Neuro-AI synergy: a dual perspective

AS.360.111(07)
Th 10:30AM - 1:00PM Shriver Hall 104

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Course Description

"Neuro-AI synergy" will introduce students to the interdisciplinary field where neuroscience and artificial intelligence cross road. Through one introductory session followed by four journal discussion sessions, students will ponder the questions: How similar are the brain and deep neural networks? In what aspects do they differ? Will bio-plausible AI research propel the field of machine learning forward? How may DNN research help us better understand the brain? Just like there are many active debates in the neuro-AI research field, dual perspectives are encouraged in this course; students will also learn to voice their arguments based on scientific literatures and results. As the world of scientific research grows to be more interdisciplinary, this course hopes to use Neuro-AI as a case-study in such intersection to better prepare students for an integrated scientific research world.

Learning Objectives

1. Students will learn key concepts in the latest Neuro-AI research field;
2. Students will read primary research articles and identify the arguments and logic in the experimental designs;
3. Students will apply knowledge from scholarly articles to contextualize and analyze primary source documents;
4. Dual perspectives are encouraged in the course and students will learn to voice their arguments based on scientific literature and results

Course Requirements

This course is graded on a Satisfactory/Unsatisfactory (pass/fail) basis. In order to receive a grade of S, students must complete **all** of the following requirements:

1. Attend all class sessions.
2. Active participation in all sessions, including making contribution to the discussion sessions.
3. Complete weekly short written assignments (four in total). Each assignment contain 2-3 questions, the answer to each question should be 1-2 sentence long. All assignments will be posted to Canvas after the first lecture and students should submit the completed questions to Canvas no later then the start of the session. Any incomplete/late assignment will be treated as missing assignment.

Attendance

Full attendance is both mandatory and essential for your learning. In the case of absence, regardless of the reason for the absence, a make-up essay assignment must be completed for the missed session, in addition to the normal pre-session written assignments. The essay must be at least 1000 words and can be in response to any of the following two questions:

1. Suggest one follow-up experiment for the discussed paper of the session.
2. Find a primary research paper (not review paper) related to the discussed paper, read it, then compare and contrast it to the discussed paper. A related paper can be either prompting a counter argument or backing the discussed paper with more evidence.

The make-up essay should be submitted preferably before the next session and no later than the end of this course. If you have any absence and did not submit a 1000-word make-up essay by the end of this course, you will receive a grade of unsatisfactory for the course.

*Office hours: M-F, by appointment

Course Schedule & Assignment Due Dates

The course is planned to be 5 sessions, each 2-hr, with an additional 15 min break. Before each journal discussion session, you are expected to read one assigned paper, complete the pre-session written assignment and submit to Canvas. The goal of the written assignment is to help you understand the primary research paper and prepare you for the discussion session. During the session, you are expected to actively contribute to the discussion. The discussion session constitute the majority of the course time and are designed to help you voice your arguments based on scientific literature and results.
All readings may be accessed through the hyperlinks. Required readings are highlighted by orange color. Other extension readings are for reference and not required. For accessing the paper through hyperlink, if only the abstract is shown, please click access via institute and use JHU login. All papers have free acess via JHU.

March 30 Introduction to Neuro-AI. [Lecture]

- Introduction to the course, Neuro-AI synergy research, and David Marr's 3 levels of analysis [**?**].
- No pre-session assignment.

April 6 DNN is very similar to the brain. [Journal discussion]

- Students will read, comprehend and discuss the primary research paper **Brain-score** [**?**].
- **Pre-session assignment 1 due by April 6 10:30am**.
- Extension readings: Auditory cortex [**?**], Navigation (grid cells) [**?**].

April 13 DNN differ from the brain in key ways. [Journal discussion]

- Students will read, comprehend and discuss the primary research paper **Asymmetric Backpropagation** [**?**].
- **Pre-session assignment 2 due by April 13 10:30am**.
- Extension readings: Dale's [**?**]; Recurrent connection [**?**]

April 20 Neuroscience may help deep learning? [Journal discussion]

- Students will read, comprehend and discuss the primary research paper **VOneNet** [**?**].
- **Pre-session assignment 3 due by April 20 10:30am**.
- Extension readings: slightly different perspective from the same lab - brain may not be adversarially robust at a single neuron level [**?**]

April 27 DNN may help neuroscientists? [Journal discussion]

- Students will read, comprehend and discuss the primary research paper **DeepDream** [**?**].
- **Pre-session assignment 4 due by April 27 10:30am**.
- Extension readings: alternative approach from the Livingstone lab [**?**]. A deep learning framework for neuroscience [**?**]. Genetic bottleneck hypothesis [**?**].

Contact Me

Email is the best way to contact me. I will try my best to answer emails within one working day; I also expect that you will do the same. I am happy to meet with you at any time to discuss a problem youre encountering in class or just to chat more about the course topic and research work! I also encourage you, and greatly appreciate it, to give me any feedback on which aspects of my teaching are or are *not* working well for you. If you feel more comfortable sharing questions or feedback anonymously, you can do so at any time using this link.

Academic Integrity

Undergraduate students enrolled in the Krieger School of Arts and Sciences or the Whiting School of Engineering at the Johns Hopkins University assume a duty to conduct themselves in a manner appropriate to the University's mission as an institution of higher learning. Students are obliged to refrain from acts which they know, or under circumstances have reason to know, violate the academic integrity of the University. For more information, please see here.

Accommodations

If you are a student with a registered accommodation for a disability, please let me know. If you believe you might require accommodations, please contact Student Disability Services (studentdisabilityservices@jhu.edu, 410-516-4720) or in-person at 385 Garland Hall.