COG403(W21): Seminar in Cognitive Science

Yang Xu

Day/Time/Location: **Wednesday 14pm–17pm ET**

Lecture times: **14–15:10pm ET and 16–17pm ET**

In-class lab time: **15:15–15:55pm ET**

Instructor: Yang Xu

Contact: yangxu@cs.toronto.edu

Office Hours: **Friday 14:15–15:15pm ET**

_Syllabus might be adjusted as the course progresses._

**Description**
This course is a sequel to COG260: Data, Computation, and The Mind. It provides advanced treatment of cognitive science topics by focusing on computational tools for research in this field. The course is organized roughly into four related topics: a) a bootcamp that discusses the mathematical and computational basics; b) neural networks and paradigms of learning; c) probabilistic inference and its links to optimal behaviour under uncertainty; d) efficient communication and the evolution of language. We will discuss classic and recent papers on these topics. All students are expected to take the initiative in leading the paper discussions. Students will also build and evaluate computational models with real-world data in a project. 

**Prerequisites:** COG260, CSC148H1, (MAT135H1, MAT136H1)/ MAT137Y1, 0.5 FCE in statistics.

**Objectives**

1. Introduce common tools for computational approaches to cognition.
2. Develop skills in computational thinking and modelling.
3. Build experience in scientific presentation and writing.

**Recommended References**

**Deliverables and Assessments**

- Paper presentation (including slides) 20%
- Paper summary 15% (~1% per paper)
- Labs 1-2 30%
- Project proposal 5%
- Project report 15%
- Project presentation (including slides) 10%
- Code repository 5%

**Grading Scale**

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<th>Percentage</th>
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<td>90 - 100%</td>
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**Policies and guidelines**

- Students are expected to attend the lectures and labs.
- Students should complete the labs individually and collaborate in pairs on the projects. Plagiarism is strictly forbidden and any such case if identified will be reported according to the university guidelines (see http://www.governingcouncil.utoronto.ca/Assets/Governing+Council+Digital+Assets/Policies/PDF/ppjun011995.pdf).
- Every student is expected to present. PDF slides should be emailed to the instructor at least two days prior to the presentation.
- Every non-presenting student is expected to raise one non-clarification question related to the paper presented.
- Critical summary (including one summary paragraph and one non-clarification question) of each paper should be submitted online at least one day prior to the class in which the paper will be presented.
- Programming tasks from the lab and project assignments should be completed in Python or Python Jupyter Notebooks.
- Late deliverables, labs, or written assignments will be discredited at 1 point per delayed hour based on the time stamps of submission. Exceptional circumstances should be explained in writing to the course instructor, at least three days prior to the due date.
Schedules and Readings (due/required items are highlighted)

• **Jan 13 (Wed)** Cognition and Computation
  
  Course overview
  
  Background readings for this and the following weeks:
  
  
  
  
  
  
  **Assignment**: Email the TA *prior to the class next week* 3 preferred paper choices for presentation; choose numerically indexed papers from the following Readings and Presentations sections.

• **Jan 20 (Wed)** Computational Basics
  
  **In-class lab on probabilities**

• **Jan 27 (Wed)** Connectionism and Neural Networks
  
  **Readings and Presentations (summary due 1 day before):**
  
  
  – In-class lab on distributions
  
  
  Background readings:
  
  
  
  **Lab 1 out**

• **Feb 3 (Wed)** Deep Learning
  
  **Readings and Presentations (summary due 1 day before):**

- **In-class lab on maximum likelihood estimation**


Background readings:

**Project announcement**

- **Feb 10 (Wed) Bayesian Inference**

  **Readings and Presentations (summary due 1 day before):**


- **In-class lab on Bayes theorem**


Background readings:

  **Lab 1 due; Lab 2 out**

- **Feb 24 (Wed) Probabilistic Graphical Models**

  **Readings and Presentations (summary due 1 day before):**


- **In-class lab on entropy**


Background readings:

**Project proposal due**

- **Mar 3 (Wed) Optimal Cue Integration**

  **Readings and Presentations (summary due 1 day before):**


  – **In-class lab on mutual information**


  Background readings:


  **Lab 2 due**

- **Mar 10 (Wed) Efficient Communication**

  **Readings and Presentations (summary due 1 day before):**


  – **In-class lab on principle of maximum entropy**


  Background readings:


- **Mar 17 (Wed) Semantic Universals**

  **Readings and Presentations (summary due 1 day before):**

- In-class lab on clustering


Background readings:

- **Mar 24 (Wed)** Semantic Variation


- Research talk

Background readings:

- **Mar 31 (Wed)** Guest Lecture

- Research talk

- Project presentation and report requirements

- **Apr 7 (Wed)** Student Project Presentations

  Project report due Monday the following week (10am ET) after presentation
Paper–Project Presentation Guidelines

- Paper presentations should take about 25-30 minutes, allowing time for question and answering. Project presentation duration will be announced in due time.
- Joint presentations should distribute the labour evenly between the presenters.
- Presenters in a joint presentation will be assessed individually.
- Presentation structure should be roughly as follows:
  
  * Motivation* - *Background* - *Materials and Methods* - *Results* - *Limitations and Extensions* - *Conclusion*.

*Background* should provide sufficient context by a brief discussion of 2-3 prior work relevant to the paper, e.g., drawn from *Background readings* or elsewhere.

- Presenters should emphasize clarity and encourage class participation.
- Whiteboard may be used to facilitate the presentation.
- Slides should be submitted as a single PDF to the instructor, with name(s) on the front page.
- Tips for presenting: [https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1005373](https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1005373).

Project Report Guidelines

- Report should be 5-6 pages long with 1 additional page of references.
- Report should follow the LaTeX template here: [https://github.com/rlevy/cogsci-template](https://github.com/rlevy/cogsci-template).
- Report should be structured as follows:
  
  *Abstract* - *Introduction* - *Materials and Methods* - *Results* - *Discussion*.

*Materials and Methods* should provide GitHub ([https://github.com/](https://github.com/)) or OSF ([https://osf.io/](https://osf.io/)) link to code/data.

- Report not conforming to the above standards will not receive any credit.
- Reporting style should support replication of the analyses and results described.
- Report and appendix should be submitted as a single PDF, with name(s) on page 1.
- Tips for writing: [https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1005619](https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1005619).