COG260(F19): Data, Computation, and The Mind

Yang Xu

Lecture+Lab: Wednesday 10am-13pm @ BA 2200

Office Hours and Contact Details: See Quercus (http://q.utoronto.ca/).

Syllabus might be adjusted as the course progresses.

Description

This entry-level course takes an integrated approach to the study of the mind, drawing ideas from cognitive science, computer science, and data science. Why is this integration important? From a scientific perspective, there has been extensive confluence between the fields of cognitive science and computational intelligence over the past 70 years. Many successful approaches to computational intelligence have been inspired by human cognition, but machines have yet to acquire core human cognitive abilities such as how people reason about objects, categories, and relations, or how people learn and communicate. On the other hand, theories of cognition have often drawn on computational ideas and methodologies. The understanding of this confluence requires students to develop a broad vocabulary across the relevant disciplines, so that they may translate fluently between these fields. From a pragmatic perspective, the rise of “big data” has made it almost imperative for students in cognitive science and related disciplines to acquire basic skills in data manipulation, analysis, and modelling.

Central to this course is the theme of uncertainty. We will explore how uncertainty might arise and concern cognitive functions such as object recognition, numerical and spatial cognition, categorization, language and communication. In doing so, we will also discuss basic tools for handling uncertainty by drawing topics from exploratory data analysis, probability theory, and statistics.

This course will involve a combination of lectures, labs, and an open-ended project. Each lecture will typically cover one topic of importance in cognitive science. Each lab session will typically involve the analysis of a cognitive dataset, along with discussion of relevant computational concepts and methods. Towards the end of the term, students will work on a project where they will formulate and test their own hypotheses based on an extensive public dataset. There will be no written exam in this course.
**Prerequisite** CSC108 - Introduction to Computer Programming

**Objectives**
1. Develop a basic understanding of the relations between uncertainty and cognition.
2. Acquire basic knowledge for characterizing uncertainty computationally.
3. Develop practical skills in scientific exploration and data analytics.

**Textbook**
We will read a combination of published papers and book chapters. We will use *Stats* as a reference textbook for elementary statistics and data analytics: De Veaux, R. D., Velleman, P. F., & Bock, D. E. (2012) *Stats: Data and models, 3rd edition*. Pearson. In addition, we will use the reference booklet *An introduction to Python for data science applications* (Salas, 2016) for programming and data analysis with Python.

**Deliverables and Assessments**
Python Notebooks or code for the labs and the project should be submitted via Google Forms. Readings will be assessed through the labs. Required reading materials, data, starter Python Notebooks, and submission links for the labs and the project will be posted on Quercus.

- Participation in labs: 10%
- Labs 1-6: 60% (10% each)
- Project proposal: 5%
- Project presentation: 10%
- Project report: 15%

**Grading Scale**

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**Policies and guidelines**
- Attendances to labs and lectures are assumed.
- Students should work individually for the labs but collaborate in pairs for the final projects. Collaborators should be acknowledged (e.g., full names and student UIDs) in the front page of any assignment write-up. 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/ppjum011995.pdf](http://www.governingcouncil.utoronto.ca/Assets/Governing+Council+Digital+Assets/Policies/PDF/ppjum011995.pdf)).
- Project presentation is required from every student; project reporting styles should follow the guidelines provided at [http://advice.writing.utoronto.ca/types-of-writing/lab-report/](http://advice.writing.utoronto.ca/types-of-writing/lab-report/).
- Late 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 two days prior to the due date.
Lab + Lecture Schedules and Readings (due/required items are highlighted)

- **Sep 11 (Wed)** Lab 0 (Jupyter Notebook) + Introduction
  
  **Required reading:**

  **Optional readings:**

  **Recommended book:**

- **Sep 18 (Wed)** Lab 1 (data exploration) + Numerical cognition
  
  **Required reading:**

  **Technical reference:**
  - Chapters 1-3 in *Stats*.

  **Optional readings:**

  **Recommended book:**

- **Sep 25 (Wed)** Lab 2 (number estimation) (Lab 1 due) + Object recognition
 Required reading:

 Technical reference:
– Chapter 4 in *Stats*.

 Optional readings:

 Recommended book:

• **Oct 2 (Wed)** Lab 3 (mental rotation) (Lab 2 due) + Spatial cognition

 Required reading:

 Technical reference:
– Chapter 8 in *Stats*.

 Optional readings:
Recommended book:

• **Oct 9 (Wed)** Lab 4 (prototypicality) *(Lab 3 due)* + Categories

Required reading:

Technical reference:
– Chapter 7 in Stats.

Optional readings:

Recommended book:

• **Oct 16 (Wed)** Lab 5 (categorization) *(Lab 4 due)* + Categorization

Required reading:

Optional readings:

Recommended book:

**Oct 23 (Wed)** Lab 6 (word frequency) (Lab 5 due) + Words

**Required reading:**

**Technical reference:**

**Optional readings:**

**Recommended book:**

**Oct 30 (Wed)** Lab 7: Project orientation (Lab 6 due) + Languages

**Required reading:**

**Optional readings:**


*Recommended book:*

**Nov 13 (Wed)** Lab 8: Project analysis (**project proposal due**) + Judgment and decision making

*Required reading:*

*Optional readings:*


*Recommended book:*

**Nov 20 (Wed)** Lab 9: Project analysis + Research talk 1

*Optional readings:*
– TBD

**Nov 27 (Wed)** Lab 10: Project analysis + Research talk 2

*Optional readings:*
– TBD

**Dec 4 (Wed)** Data blitz (**project final presentation**)

**Dec 8 (Sun)** No class (**project final report due**)