COMP 766/LING 483/LING 682: Probabilistic Programming, Fall 2026
Mon 13:00–16:00

Instructor Tim O'Donnell
timothy.odonnell@mcgill.ca
Office hours: By Appointment.

1 Overview
This course is an introduction to probabilistic programming, an emerging field at the intersection of programming languages and probability theory. The central idea in probabilistic programming is to represent probabilistic models as programs, and use special metaprograms (e.g., compilers and interpreters) to implement inference, learning, and prediction. Topics include the mathematical foundations of probabilistic programming; probabilistic modeling (including generative modeling for model classes such as regression, clustering, sequence modeling, and structure learning); and exact and approximate algorithms for inference (including enumeration, Monte Carlo methods, and variational inference). The course has two distinguishing emphases. First, example models throughout the course will be drawn from the computational cognitive sciences of language: computational linguistics, computational psycholinguistics, and quantitative linguistics. Second, the course will make systematic use of agentic coding tools: students will develop disciplined workflows for building and criticizing probabilistic models with coding agents.

2 Learning outcomes
By the end of the course, students will be able to: (i) formalize models from the cognitive sciences and linguistics as probabilistic programs; (ii) understand the mathematical foundations of probabilistic programming languages; (iii) choose and analyze exact and approximate inference algorithms (including enumeration, Monte Carlo methods, and variational inference); (iv) use agentic tooling to develop, test, calibrate, and criticize probabilistic models in a reproducible, disciplined workflow; and (v) design, execute, and report an original modeling project.

3 Prerequisites
COMP 251 (and prerequisites COMP 250, MATH 240) and COMP/LING 445, or equivalent background in programming languages and probability theory at the level of MATH 323. Comfort programming in multiple languages and paradigms. Mathematical maturity (e.g., having taken proof-based mathematics courses).

4 Course structure
Tentative plan. All details below are tentative and will be finalized by the end of the add/drop period.

The course meets in a single weekly three-hour block. The course will use a variety of probabilistic programming languages during the term depending on application—possibly including Pluck (exact inference via lazy knowledge compilation) and Gen (programmable Monte Carlo inference) and others.

Course materials, official announcements, and assessment submissions will be managed through myCourses. The course will likely also use a Slack workspace for informal discussion.

Classes 3–11 will each include two 45-minute student presentations, for a total of 18 presentation slots.

5 Method of evaluation
- Group paper presentation (35%). Students will work in groups to give a 45-minute presentation based on work selected from a curated list of papers. 80% of the presentation grade will be shared by the group and based on the presentation's accuracy, depth, organization, and clarity; 20% will be individual and based on each student's command of their portion and ability to answer questions.
- Individual final modeling project (40%). Each student will develop an original probabilistic model of some aspect of language. The project must formulate and implement a generative model and an appropriate inference procedure, evaluate the resulting model, and explain the modeling choices and results. Deliverables will include source code, a reproducible repository, and a written report.
- Written midterm examination (15%). The midterm will be completed individually and is planned as a 90-minute, in-person, closed-book and closed-notes examination without AI assistance, scheduled outside regular class time during the week of October 19. The exact date, time, and room are subject to scheduling. It will

assess mathematical and conceptual understanding of probability, information theory, probabilistic models, and inference.

- Written final examination (10%). The final examination is planned as a 60-minute, in-person, closed-book and closed-notes examination, completed individually without AI assistance during the final class meeting on Thursday, December 3. It will consist of short mathematical derivations and conceptual questions about probabilistic models and inference methods.

Late or missed work receives a grade of zero unless accommodated under McGill policy.

6 Use of generative AI and agentic tools

AI coding agents may be used for presentations and projects. All use must be disclosed. They may not be used on examinations.

7 Readings

Any supplemental readings will be posted to myCourses as needed. The notebooks and other materials used during lectures and presentations will be the main resources for the course.

8 McGill policy statements

McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures (see www.mcgill.ca/students/srr/honest/ for more information).

In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French written work that is to be graded. This does not apply to courses in which acquiring proficiency in a language is one of the objectives.

9 Course schedule

- Class 1: Monday, August 31 — Introduction and course overview.
- Monday, September 7 — Labour Day — No Class
- Class 2: Monday, September 14
  - Note: Tuesday, September 15 [Add/Drop deadline]
- Class 3: Monday, September 21
- Class 4: Monday, September 28
- Monday, October 5 — Provincial election — No Class
- Monday, October 12 — Fall reading break / Thanksgiving — No Class
- Class 5: Monday, October 19
- Class 6: Monday, October 26
- Class 7: Monday, November 2
- Class 8: Monday, November 9
- Class 9: Monday, November 16
- Class 10: Monday, November 23
- Class 11: Monday, November 30
- Class 12: Final session. Thursday, December 3 — follows a Monday schedule (written final examination and overflow)
- Thursday, December 17 at 23:59 — Final project submission