Syllabus Fall 2025

MCS 548 – Mathematical Theory of Artificial Intelligence

Instructor: Lev Reyzin, SEO 417, `lreyzin@uic.edu`
Time & location: M-W-F, 1:00-1:50pm at Computer Design Research and Learning Center (CDRLC) 1405
Credit hours: 4 credits (39221)
Prerequisites: Prerequisite background: Familiarity with the design and analysis of algorithms, basic computational complexity theory, and mathematical maturity.
Office hours: TBD
Website: `http://homepages.math.uic.edu/~lreyzin/f25_mcs548/`
Required textbook: Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar. *Foundations of Machine Learning, second edition*
Optional textbook: Shai Shalev-Shwartz and Shai Ben-David. *Understanding Machine Learning: From Theory to Algorithms*

Topics: This course will focus on the mathematical foundations of computational learning theory. Example topics include: PAC learning, agnostic learning, online learning, bandit problems, statistical queries, learning with experts, inductive inference, query learning, boosting, support vector machines, and neural networks. This course is represented in the mathematical computer science prelim.

Weekly schedule: Week 1: intro ML and AI, Week 2: PAC, Week 3: PAC continued, Week 4: Rademarcher complexity, Week 5: VC dimension, Week 6: boosting, Week 7: statistical queries, Week 8: SVM, Week 9: online learning, Week 10: online learning continued, Week 11: Littlestone dimension, Week 12: bandits, Week 13: neural networks, Week 14: student presentations, Week 15: student presentations

Assignment and exam dates (<u>estimated</u>): problem set 1 due 9/12/25, problem set 2 due 10/13/25, problem set 3 due 11/14/25.

Grading: Course grades will be determined according to the following breakdown.

- 45% take-home problem sets

- 30% research project – each student will be required to complete a small research project
- 25% in-class presentation – each student will present a research paper on a topic related to his or her research project and be expected to answer questions about it

Grades may also be adjusted upward or downward depending on class participation.

Attendance and participation: In addition to the grading policies outlined above, a student's grade might be adjusted *slightly*, e.g. a point, upward for positive contributions through class participation. Moreover, students are responsible for *all material covered in lectures*, in problem sets, and in assigned readings.

Problem set collaboration policy: Unless otherwise specified on an assignment, students may discuss problem sets with one another, but they *must write the solutions on their own.* Collaborators (people you speak to about an assignment) must be named at the top of the assignment. The use of AI tools during write-up is not allowed.

Late work policy: Problem sets are to be turned in on Gradescope by the start of class on the day they are due. In general, late work will not be accepted. Exceptions must be asked for *in advance of the due date* and will be made rarely, on a case-by-case basis.

Classroom environment: University classes play an important role in educating students and imparting a deep understanding of the course materials and topics. With this goal in mind, students are urged to speak their minds, explore ideas and arguments, play devil's advocate, and engage in civil but robust discussions. Students ought to do business in the proper currency of respectful intellectual discourse—a currency consisting of reasons, evidence, and arguments.

Disclamer This syllabus is intended to give the student guidance on what may be covered during the semester and will be followed as closely as possible. The instructor reserves the right to modify, supplement, and make changes as course needs arise.

Disability policy: Students with disabilities who require accommodations for access and participation in this course must be registered with the Office of Disability Services (ODS). Please contact ODS a 312/413/-2183 (voice) or 312/413-0123 (TTY).