COMPSCI 390A Introduction to Machine Learning

Number of Credits: 3
Type of Course and Format: Lecture
Book: None. Readings will be provided using open access digital resources.
Prerequisites: COMPSCI 220 (or COMPSCI 230), COMPSCI 240 (or STAT 515), and Math 233. A grade of C or better is required for all prerequisites.

Course Description
The course provides an introduction to machine learning algorithms and applications. Machine learning algorithms answer the question: “How can a computer improve its performance based on data and from its own experience?” The course is roughly divided into thirds: supervised learning (learning from labeled data), reinforcement learning (learning via trial and error), and real-world considerations like ethics, safety, and fairness. Specific topics include linear and non-linear regression, (stochastic) gradient descent, neural networks, backpropagation, classification, Markov decision processes, state-value and action-value functions, temporal difference learning, actor-critic algorithms, the reward prediction error hypothesis for dopamine, connectionism for philosophy of mind, and ethics, safety, and fairness considerations when applying machine learning to real-world problems.

Learning Objectives
To understand the mathematical representation of machine learning problems and techniques for solving them; to be capable of applying machine learning algorithms responsibly to real problems, accounting for issues of safety and fairness; to be prepared for ethical considerations that arise with the use of machine learning; to understand key machine learning concepts including regression, classification, neural networks, and reinforcement learning, among others.

Grading
- Homework Assignments (60%)
- Midterm (15%)
• Final Exam (25%)

The following table will be used for converting numerical grades at the end of the course to letter grades. Minimum values are inclusive, while maximum values are exclusive (except for 100). For example, 90 corresponds to an A, not an A-.

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Schedule

The course will be divided in to thirds. The list below indicates planned topics, in order. This is subject to alteration, depending on pacing and student abilities.

Part I: Supervised Learning

1. Introduction, gradient descent, and linear regression. [Week 1]
2. Non-Linear regression and stochastic gradient descent. [Week 2]
3. Neural Networks, deep learning, and backpropagation. [Week 3]
4. Classification and over-fitting. [Week 4]

Part II: Reinforcement Learning

1. Introduction and Markov decision processes. [Week 5]
2. State-value functions, action-value functions, and the Bellman equation. [Week 6]
3. Temporal difference learning. [Week 7]
4. Actor-critic algorithms and their relation to stochastic gradient descent. [Week 8]

Part III: Ethics, Safety, Fairness, and Connections to other Areas

1. Connections to psychology and neuroscience. [Week 9]
2. Connections to philosophy. [Week 10]
3. Issues of safety, fairness, accountability, and transparency when applying
   machine learning to make decisions that impact people. [Week 11]

4. Ethical considerations when applying machine learning. [Week 12]

**Part IV: Conclusion** This fourth part of the course is not listed in the dis-
  cussion of the course being broken into thirds because it will likely be a single
  concluding lecture (perhaps two).

1. A high-level survey of other topics in machine learning, including natural
   language processing, computer vision, robotics, intelligent tutoring sys-
   tems, and ecological and social science applications. This includes pointers
   to other courses for continued learning at UMass. [Week 13]

**Accommodation Statement**

The University of Massachusetts Amherst is committed to providing an equal
educational opportunity for all students. If you have a documented physical,
psychological, or learning disability on file with *Disability Services* (DS), you
may be eligible for reasonable academic accommodations to help you succeed
in this course. If you have a documented disability that requires an accomo-
dation, please notify me within the first two weeks of the semester so that we
may make appropriate arrangements.

**Class Policies**

**Attendance:** There is no required attendance policy; students who cannot
attend class are responsible for any material covered during their absence. Late
arrivals must enter the classroom quietly and discreetly.

**Exams:** The midterm and final exams will be open notes, though no electronic
devices will be allowed (except perhaps a calculator).

**Collaboration on Assignments:** Instructions regarding allowed collaboration
and consultation of outside sources will be included with each assignment, and
may vary from assignment to assignment.

**Late Submissions:** Homework submissions will be accepted up to 48 hours
after the due time with a 10% penalty if turned in within the first 24 hours and
an additional 10% penalty if turned in within the second 24 hours. Submissions
will not be accepted later without instructor permission.

**Academic Honesty**

Since the integrity of the academic enterprise of any institution of higher ed-
ucation requires honesty in scholarship and research, academic honesty is re-
quired of all students at the University of Massachusetts. Academic dishon-
esty is prohibited in all programs of the University. Academic dishonesty in-
cludes but is not limited to: cheating, fabrication, plagiarism, and facilitat-
ing dishonesty. Appropriate sanctions may be imposed on any student who
has committed an act of academic dishonesty. Instructors should take reasonable steps to address academic misconduct. Any person who has reason to believe that a student has committed academic dishonesty should bring such information to the attention of the appropriate course instructor as soon as possible. Instances of academic dishonesty not related to a specific course should be brought to the attention of the appropriate department Head or Chair. Since students are expected to be familiar with this policy and the commonly accepted standards of academic integrity, ignorance of such standards is not normally sufficient evidence of lack of intent. Further details can be found here: https://www.umass.edu/honesty/sites/default/files/academic_honesty_policy_rev_sen_doc_no16-038a.pdf