CS 760 Spring 2021 Syllabus

Key Course Offering Information

General Identifying Information

Institution Name: University of Wisconsin–Madison
Course Subject, Number and Title: CS 760 Machine Learning
Credits: 3 credits
Course Designations and Attributes: Grad 50% - Counts toward 50% graduate coursework requirement
Course Description: Computational approaches to learning: including inductive inference, explanation-based learning, analogical learning, connectionism, and formal models. What it means to learn. Algorithms for learning. Comparison and evaluation of learning algorithms. Cognitive modeling and relevant psychological results.
Requisites: Graduate/professional standing.
Meeting Time and Location: MWF 2:30PM - 3:45PM, online teaching
Instructional Modality: virtual
Instructor Contact Info: Yingyu Liang, CS6393, office hour Wed 5-6pm, yliang@cs.wisc.edu
Teaching Assistant Contact Info (if applicable):
Xufeng Cai, office hour Th 8:30-9:30pm, xcai74@wisc.edu
Diwanshu Jain, office hour Mon 5-6pm, diwanshu@wisc.edu

Course Learning Outcomes

1. Identify the nonparametric methods (decision trees and nearest neighbor methods). Apply them on real problems and solve the problem.

2. Identify and summarize the evaluation metrics and methods for machine learning and apply them on real problems.

3. Identify the Naïve Bayes method and apply it to given synthetic problems.

4. Identify the regression methods (linear regression and logistic regression). Demonstrate the knowledge about error analysis in regression.

5. Summarize the architecture and training of neural networks (feedforward supervised networks, recurrent neural networks, and unsupervised networks). Demonstrate the knowledge about the regularization methods.

6. Illustrate bias-variance trade-off, and PAC learning framework.

7. Identify the structure of Bayesian network and summarize their learning methods. Apply them to given synthetic problems.

8. Identify the model and learning method for Support Vector Machines. Demonstrate the knowledge about the convex optimization needed in the learning.

9. Identify the modeling of reinforcement learning. Demonstrate the knowledge about Bellman equation, value iteration, and Q-learning.

10. Demonstrate knowledge about dimension reduction, PCA, and ensemble methods.

How Credit Hours are Met by the Course

This class meets for two, 75-minute class periods each week over the spring semester and carries the expectation that students will work on course learning activities (reading, writing, problem sets, studying, etc) for about 3 hours out of the classroom for every class period.

Regular and Substantive Student-Instructor Interaction

Interaction with faculty and instructional staff in this course include:

1. *Participation in regularly scheduled lectures*
2. *Personalized comments for each student's assignment and exam*
3. *Interaction with students on Canvas and Piazza, including answering questions, making announcements, setting up polls, etc.*
4. *Weekly office hours*

Instructor-to-Student Communication

Course Overview

Machine Learning is concerned with computer programs that automatically improve their performance through experience (e.g., programs that learn to distinguish between images of cats and dogs, analyze the sentiment behind text data, and play games like Go and Starcraft). This course provides an introduction to the theory and practical methods for machine learning, and is designed to give a graduate-level student a thorough grounding in the methodologies, mathematics and algorithms of machine learning. Topics covered include nearest neighbor method, decision tree learning, Support Vector Machines, Bayesian networks, neural networks, unsupervised learning and reinforcement learning. The course covers theoretical concepts such as inductive bias, the PAC learning framework, etc. Assignments include some written exercise and short programming experiments with various learning algorithms.

Course Website and Digital Instructional Tools

- Course website: https://pages.cs.wisc.edu/~yliang/cs760_spring21/index.html
- Canvas: https://canvas.wisc.edu/courses/230969
- Piazza: https://piazza.com/wisc/spring2021/cs760

Discussion and/or Laboratory Sessions

None.

Required Textbook, Software and Other Course Materials

- No required textbook.
- The following books are all optional, but recommend to buy one of them.
    - Pattern Recognition and Machine Learning, Chris Bishop.
    - Machine Learning: A Probabilistic Perspective, Kevin Murphy.
    - Understanding Machine Learning: From Theory to Algorithms, Shalev-Shwartz, Ben-David.

Homework and Other Assignments

- 8 homework assignments.
- Assignments will be posted and submitted on Canvas.
- All homework assignments must be done individually. Cheating and plagiarism will be dealt with in accordance with University procedures (see the Academic Misconduct Guide for Students). Hence, for example, code for programming assignments must not be developed in groups, nor should code be shared. You are encouraged to discuss with your peers, the Tas or the instructor ideas, approaches and techniques broadly, but not at a level of detail where specific implementation issues are described by anyone. If you have any questions on this, please ask the instructor before you act.
- Homework assignments will include written problems and sometimes programming. Accounts will be provided on the Computer Sciences Department's instructional Unix workstations located in rooms 1350, 1351, and 1370. Homework is typically due the minute before class starts on the due date. Late submissions will not be accepted. Assignment grading questions must be raised with the TAs within 72 hours after it is returned. Regrading request for a part of a homework question may trigger the grader to regrade the entire homework and could potentially take points off. Regrading will be done on the original submitted work, no changes allowed. We will drop one lowest homework score from your final homework average calculation. The drop is meant for emergency. We do not provide additional drops, late days, or homework extensions. We encourage you to use a study group for doing your homework. Students are expected to help each other out, and if desired, form ad-hoc homework groups.

Exams, Quizzes, Papers and Other Major Graded Work

- There will be two exams: midterm and final.
- Midterm Exam: March 12.
  Topics covered: all topics in lectures up to the exam; related slides and notes (unless specified otherwise).
- Final Exam: May 6.
  Topics covered: all topics in lectures after Midterm Exam; related slides and notes (unless specified otherwise).
- Exam format: There will be a midterm exam and a final exam. All exams will be conducted online through Canvas. Students are allowed to choose their own exam schedule within a window of 24 hours. Makeup exams will not be scheduled. Please plan for exams at these times and let us know about any exam conflicts during the first two weeks of the semester. If an emergency arises that conflicts with the exam times, email us as soon as possible. Emergency exam conflicts will be handled on a case-by-case basis. Exam grading questions must be raised with the instructor within 72 hours after it is returned. If a regrade request is submitted for a part of a question on the exam, the grader reserves the right to regrade the entire exam and could potentially take points off.

Course Schedule/Calendar

See the course website: https://pages.cs.wisc.edu/~yliang/cs760_spring21/schedule.html

Grading

The grading for the course will be based on (temporally, may subject to changes later):

- homework assignments (8 anticipated): 60%
- Midterm: 20%
- Final: 20%

Academic Policies and Statements

ACADEMIC INTEGRITY STATEMENT

By virtue of enrollment, each student agrees to uphold the high academic standards of the University of Wisconsin-Madison; academic misconduct is behavior that negatively impacts the integrity of the institution. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these previously listed acts are examples of misconduct which may result in disciplinary action. Examples of disciplinary sanctions include, but are not limited to, failure on the assignment/course, written reprimand, disciplinary probation, suspension, or expulsion.

DIVERSITY & INCLUSION STATEMENT

Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals. The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world.