CS484 Introduction to Machine Learning (Fall 2024)

Instructor Contact

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Course Description

Introduce fundamental problems in machine learning. Provide understanding of mathematical concepts, and algorithms used in machine learning. Provide understanding of the limitations of various machine learning algorithms and the way to evaluate performance of learning algorithms.

Topics will include supervised learning, unsupervised learning, semi-supervised learning; Machine learning tasks will cover regression, classification (generative vs. discriminative), clustering, dimensionality reduction, linear models, nonlinear models, etc. Recent advanced topics, such as graph neural networks, trustworthy learning, federated learning, generative models, are also covered.

Topics NOT covered: Reinforcement learning, Bayesian learning, Active learning, Sequential models, Sampling methods, Optimization theory, etc.

Textbook (Free e-book)

- Pattern Recognition and Machine Learning, by Christopher M. Bishop
- Machine Learning: A Probabilistic Perspective, by Kevin P. Murphy

Course Evaluation

- 5 assignments (50%)
- Project presentation (15%)
- Final take-home exam (35%)

Course Objectives

- Know the specific machine learning task in real-world problems
- Know how to formulate a problem and specify its solution
- Good understanding of machine learning algorithms (key ideas, pros & cons, etc.)

Prerequisites

Probability; Linear algebra; Optimization; Algorithms; Computer Programming (Python, Matlab, C)

Grades

Assignments	Points Possible	Final Grade%
Assignment 1	100 points	10%
Assignment 2	100 points	10%
Assignment 3	100 points	10%
Assignment 4	100 points	10%
Assignment 5	100 points	10%
Project Presentation	100 points	15%
Take-home Final Exam	100 points	35%
Total		100%

Notes: 1) About assignment submission: Please submit you solution to the Blackboard via a single pdf (either use word/latex or write down your solution and then scan it); If you also submit the source code, please upload the source files separately and DO NOT use a zip file. 2) About late submission: All assignments are due by **Sunday at 11:59 PM**. 50% of the grade will be deducted for that assignment if it is late within 1 day (24 hours). You will get a 0 grade if the assignment is late more than 1 day. 3) About using GenAI: Per the university rule, it is **NOT** allowed to use GenAI (ChatGPT, Perplexity.AI, Gemini, Claude, etc) to generate your solution.

Course Recordings

Synchronous (live) sessions in this course will be recorded for students enrolled in this class section to refer to throughout the semester. Class recordings are the intellectual property of the university or instructor and are reserved for use only by students in this class and only for educational purposes. Students may not post or otherwise share the recordings outside the class in any form.

Final Exam and Project Presentation

A week is allocated for the final take-home exam.

Up to 3 students can form a group to collaboratively complete the final project about ML. An initial project topic (along with the group members) is due at the end of **Week 10**. Please let me and TAs know as early as possible if you decide to change the research topic after the due date. Each group will have a **6-min** presentation about your (collaborative/individual) project. ALL group members should clearly clarify their contributions in the project.

Academic Integrity

You are welcome to discuss assignments with classmates, but all final work must be your own. Academic dishonesty of any kind may result in a 0 grade on the assignment, a reduction in final grade, and/or referral to the Dean. The IIT code of Academic Honesty (https://www.iit.edu/student-affairs/student-handbook/fine-print/code-academic-honesty) can be found in the undergraduate handbook.

Disability Accommodations

Reasonable accommodations will be made for students with documented disabilities. In order to receive accommodations, students must obtain a letter of accommodation from the Center for Disability Resources (CRD). The CDR is located in Life Sciences Room 218, telephone 312 567.5744 or disabilities@iit.edu.

(Tentative) Course Syllabus

CB = Christopher M. Bishop; KM = Kevin P. Murphy

Week No.	Date	Content	Homeworks
Week 1	Aug 19	Intro + Machine learning basics	Reading: Linear algebra & probability review
	Aug 21	Regression: Linear regression, least square, geometric interpretation (KM Ch. 7.1-7.3, CB Ch. 3.1)	
Week 2	Aug 26	Regression (Regularization): Ridge regression, LASSO (CB Ch. 3.1.4, KM Ch. 7.4 13.3,13.4)	
	Aug 28	Classification (discriminative models): Fisher Linear Discriminant Analysis (LDA), Perceptron (CB Ch. 4.1)	HW1: Regression
Week 3	Sep 2	Labor day (No class)	
	Sep 4	Classification (discriminative models): Support vector machines (SVM), kernels (CB Ch.7.1)	HW1 due: Sunday 23:59:59 PM
Week 4	Sep 9	Classification (Prob. discriminative models): (Multi-class) Logistic regression, Iterative reweighted least square (CB Ch. 4.3, KM Ch. 8.28.3)	
	Sep 11	Classification (Prob. generative models): Gaussian discriminative analysis (GDA), Naïve bayes classifier (NB) (KM Ch. 4.2, 3.5, CB Ch. 4.2)	HW2: (Linear & nonlinear) classification
Week 5	Sep 16	Nonlinear classification: (K) nearest neighborhood / /Machine learning theory basics?	
	Sep 18	Clustering: K-means;	HW2 due: Sunday
Week 6	Sep 23	Clustering: GMM (CB Ch. 9)	
	Sep 25	Clustering: Graph basics, Graph Laplacian, Spectral clustering (KM Ch. 25.4)	HW3: Clustering
Week 7	Sep 30	Dimensionality reduction (linear models): PCA/SVD	
	Oct 2	Dimensionality reduction (nonlinear models): Manifold learning: LLE, LE	HW3 due: Sunday
Week 8	Oct 7	Fall break (No class)	
	Oct 9	**TAs: HW1-2 solutions**	HW4: Dim reduction

Week 9	Oct 14	Semi-supervised learning: Transductive SVM & Co-Training	
	Oct 16	(Graph-based) semi-supervised learning: Label propagation: Gaussian harmonic function (GHF), Local & global consistency (LGC)	HW4 due: Sunday
Week 10 **(Advanced topics)**	**Oct 21**	**Introduction to Deep Neural Networks (MLP, CNN, ResNet, AlexNet, Backprop)**	Initial project topic due: Sunday
	Oct 23	**Introduction to Graph Neural Networks (GCN, GSATE, GAT, etc.)**	HW5: Semi-supervised learning
Week 11	**Oct 28**	**Introduction to Generative models (GAN, VAE, DDPM)**	
	Oct 30	**Introduction to Deepfakes**	HW5 due: Sunday
Week 12	**Nov 4**	**Introduction to Large Language Model and its watermarking methods**	
	Nov 6	**Introduction to Adversarial ML** **(Or HW 3-4 solutions)**	
Week 13	Nov 11	Project presentation	
	Nov 13	Project presentation	
Week 14	Nov 18	Project presentation	
	Nov 20	Project presentation	
Week 15	Nov 25 Nov 27	Project presentation (pending) Thanksgiving (No class)	Final exam
Week 16	Dec 2,4	Final take-home exam due	Final exam due **Dec 2**