Academics

EECS 453 Principles of Machine Learning

Course Instructor: Prof. Qing Qu

Course Time: Mon/Wed 12:00 PM – 1:30 PM, 3 credit hour

Office Hour: Wed 3:30 PM – 5:00 PM

Prerequisite: EECS 351, or EECS 301, or any linear algebra courses

Notice: This is an entry-level ECE machine learning course targeted for senior EE & CE undergraduate, and junior master students outside SIPML area. All students outside EECS that want to learn the basics of ML are also welcome! **Compared to EECS 445, this course places slightly greater emphasis on mathematical principles and is better suited for students who have limited experience with programming and machine learning.**

Overview: The class will cover basic principles in machine learning, such as unsupervised learning (e.g., clustering, mixture models, dimension reduction), and supervised learning (e.g., regression, classification, neural networks & deep learning). For each topic, key algorithmic ideas/intuitions and basic theoretical insights will be highlighted.

Course Materials: slides and videos will be accessed via Canvas (TBA). Tentative topics that will be covered in this course are **supervised learning, unsupervised learning, and reinforcement learning**:

- Basics of probability, linear algebra, and optimization
- Regression and linear prediction
- Support vector machines and kernel methods
- Deep neural networks
- Dimension reduction: PCA, autoencoder
- Clustering (Kmeans, Mixture of Gaussians, EM)
- Representation learning: nonnegative matrix factorization, dictionary learning

Assessment: (i) 5 homework assignments (40%), (ii) mid-term exam (30%), (iii) course projects (25%), (iv) participation & course evaluation (5%)

Assessment	**Percentage**
Homework (5)	40%
Midterm Exam	30%
Projects	25%
Participation & Course Evaluation	5%

Textbook: We recommend the following books and articles, although we will not follow them closely.

- Foundations of Machine Learning, by Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar.
- The Elements of Statistical Learning: Data Mining, Inference, and Prediction, by Trevor Hastie, Robert Tibshirani, and Jerome Friedman.
- Deep Learning, by Ian Goodfellow, Yoshua Bengio, and Aaron Courville.
- Mathematics for Machine Learning, by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong.
- Linear Algebra and Optimization for Machine Learning, by Charu C. Aggarwal.

Related courses:

- EECS 445. Introduction to Machine Learning
- EECS 453. Applied Matrix Algorithms for Signal Processing, Data Analysis, and Machine Learning
- EECS 505. Computational Data Science and Machine Learning
- EECS 545. Machine Learning

Course Syllabus (**Note:** the schedule is tentative, and is subject to change during the semester.)

Week	Date	Topic	Contents	Homework, Review
Week-1-1	08/29	Introduction (Remote)	Course overview	
Week-1-2	08/31	Supervised Learning (Remote)	Introduction to supervised learning, linear models, regularization	**Linear Algebra Review**
Week-2-1	09/05	**Labor Day**	**No class**	
Week-2-2	09/07	Supervised Learning	Learning Theory	**Probability Review, HW1 Release**
Week-3-1	09/12	Supervised Learning	Linear regression I	
Week-3-2	09/14	Supervised Learning	Linear regression II	**Python Review**
Week-4-1	09/19	Supervised Learning	Linear Classifiers	
Week-4-2	09/21	Supervised Learning	Linear Discriminant Analysis	**HW1 Due, HW2 Release**
Week-5-1	09/26	Supervised Learning (remote)	Logistic regression	
Week-5-2	09/28	Supervised Learning (remote)	Optimization methods I	
Week-6-1	10/03	Supervised Learning	Optimization methods II	
Week-6-2	10/05	Supervised Learning	Support vector machine (SVM) I	**HW2 Due, HW3 Release**
Week-7-1	10/10	Supervised Learning	Support vector machine (SVM) II	
Week-7-2	10/12	Supervised Learning	Support vector machine (SVM) III	
Week-8-1	10/17	**Fall Study Day**	**No class**	
Week-8-2	10/19	Supervised Learning	Dual SVM	**HW3 Due**
Week-9-1	10/24	Supervised Learning	Nonlinear models, kernel methods	
Week-9-2	10/26	Supervised Learning	Introduction to deep neural networks I	
Week-10-1	10/31	Supervised Learning	Introduction to deep neural networks II	
Week-10-2	11/02	Supervised Learning	Introduction to deep neural networks III	
Week-11-1	11/07	**Midterm**	**Midterm**	
Week-11-2	11/09	Unsupervised Learning	Introduction to unsupervised learning, clustering problem, K-means	**Project Proposal Due, HW4 Release**
Week-12-1	11/14	Unsupervised Learning	K-means, mixtures of Gaussian, expectation maximization	
Week-12-2	11/16	Unsupervised Learning	Dimension reduction, PCA	
Week-13-1	11/21	Unsupervised Learning	Dimension reduction II	
Week-13-2	11/23	**Thanksgiving**	**No Class**	
Week-14-1	11/28	Unsupervised Learning (Remote)	Representation learning, matrix factorization	**HW4 Due, HW5 Release**
Week-14-2	11/30	Unsupervised Learning (Remote)	Autoencoder & self-supervised learning	
Week-15-1	12/05	Unsupervised Learning	Generative Models	**HW5 Due**
Week-15-2	12/07	**Final Presentation**		

- Electrical and Computer Engineering

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