New York University Tandon School of Engineering
Department of Electrical and Computer Engineering

Machine Learning

Fall 2021

Instructor: Anna Choromanska

Course Prerequisites

1) Undergraduate Probability
2) Mathematical maturity: https://en.wikipedia.org/wiki/Mathematical_maturity

Office hours

Prof. Anna Choromanska:
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PhD Assistant:

Main CA:

Grading CAs:

Course Description

Machine Learning is nowadays one of the most rapidly developing technical fields both in the academia and industry. It is also a fundamental tool used in a wide range of different data science fields. This course presents the basic concepts, techniques, and algorithms in machine learning from both theoretical and practical perspective. The program of the course includes empirical risk minimization, support vector machines, kernels, clustering, principal component analysis, Expectation-Maximization, graphical models, and neural networks.

Textbook

There is no textbook required. The list of recommended texts:

- *Pattern recognition and machine learning*, C.M. Bishop
- *Pattern classification, R. O. Duda, P. E. Hart, and D.G. Stork*
- *T. Jebara. Course notes, Machine Learning*
- *S. Dasgupta. Course notes, CSE 291: Topics in unsupervised learning*

Homeworks

For coding, preferred environments is Matlab. **Homeworks are due at midnight on the given day.**

Course Work and Grading

Your final grade will be determined roughly as follows:

Homeworks	30%
Midterm	30%
Final	40%

Tentative Schedule

- Week 1 (09.07.2021): (Topic 2) Regression, Empirical Risk Minimization, Least Squares, Higher Order Polynomials, Under-fitting / Over-fitting, Cross-Validation and (Topic 3) Additive Models and Linear Regression, Sinusoids and Radial Basis Functions, Classification, Logistic Regression, Gradient Descent

  Homework 1 is released and due 09.21.2021.

- Week 2 (09.14.2021): (Topic 4) Perceptron, Online & Stochastic Gradient Descent, Convergence Guarantee, Perceptron vs. Linear Regression, Multi-Layer Neural Networks, Back-Propagation, Demo: LeNet, Deep Learning

- Week 3 (09.21.2021): (Topic 5) Generalization Guarantees, VC-Dimension, Nearest Neighbor Classification (infinite VC dimension), Structural Risk Minimization, Support Vector Machines

  Due date for Homework 1.
  Homework 2 is released and due 10.05.2021.

- Week 4 (09.28.2021): (Topic 6) Kernels and Mappings and (Topic 7) Introduction to Probability Models

- Week 5 (10.05.2021): (Topic 8) Discrete Probability Models, Independence, Bernoulli Distribution, Text : Naïve Bayes, Categorical / Multinomial Distribution, Text: Bag of Words and (Topic 9) Continuous Probability Models, Gaussian Distribution, Maximum Likelihood Gaussian, Sampling from a Gaussian

  Due date for Homework 2.
  Homework 3 is released and due 10.19.2021.

- Week 6 (10.19.2021): (Topic 10) Classification with Gaussians, Regression with Gaussians, Principal Components Analysis and (Topic 11) Maximum Likelihood as Bayesian Inference, Maximum A Posteriori, Bayesian Gaussian Estimation

  Due date for Homework 3.
  Homework 4 is released and due 11.02.2021.

- **Week 7 (10.26.2021): MIDTERM**

- Week 8 (11.02.2021): (Topic 12) Mixture Models and Hidden Variables, Clustering, K-Means, Expectation Maximization and (Topic 13) Expectation Maximization

  Due date for Homework 4.
  Homework 5 is released and due 12.07.2021.

- Week 9 (11.09.2021): (Topic 14) Structuring Probability Functions for Storage, Structuring Probability Functions for Inference, Basic Graphical Models, Graphical Models, Parameters as Nodes

- Week 10 (11.16.2021): (Topic 15) Bayes Ball Algorithm and (Topic 16 Part 1) Junction Tree Algorithm

- Week 11(11.23.2021) (Topic 16 Part 2 and Topic 17) Junction Tree Algorithm

- Week 12 (11.30.2021) (Topic 18) JTA and (Topic 19) HMM

- Week 13 (12.07.2021) (Topic 20) HMM

  Due date for Homework 5.

- **Week 14 (12.14.2021) FINAL EXAM**

Inclusion Statement

The NYU Tandon School values an inclusive and equitable environment for all our students. I hope to foster a sense of community in this class and consider it a place where individuals of all backgrounds, beliefs, ethnicities, national origins, gender identities, sexual orientations, religious and political affiliations, and abilities will be treated with respect. It is my intent that all students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength, and benefit. If this standard is not being upheld, please feel free to speak with me.

I personally will have zero tolerance to acts of racism, sexism, homophobia, xenophobia, or any other known form of discrimination. You get caught; you will face consequences. No exceptions, no excuses.