New York University Tandon School of Engineering
Department of Electrical and Computer Engineering
Machine Learning
Fall 2021
Instructor: Yury Dvorkin

Course Prerequisites
1) Undergraduate Probability
2) Mathematical Maturity: https://en.wikipedia.org/wiki/Mathematical_maturity

Lectures
- Every Thu at 2-4 pm
- Location: 370 Jay St, Rm 202
- Zoom translation: yes, will be live, recorded and posted on Brightspace. Zoom Link: https://nyu.zoom.us/j/99311721683
- Slides + handwritten notes

Brightspace: https://brightspace.nyu.edu/d2l/home/125057

Office hours
Prof. Yury Dvorkin (by appointment, please e-mail: dvorkin@nyu.edu)

PhD CA (homework solutions and problems, questions about material, communication with students via Slack/Zoom):
    Baleegh Ahmad (ba1283@nyu.edu)
    Office hours: Fri at 10 am – 12 pm
    Zoom link: https://nyu.zoom.us/j/7496469847

Lead M.Sc. CA (grading, homework solutions and problems, questions about material, communication with students via Slack/Zoom):
    Zulong Ye (zy2010@nyu.edu)
    Office hours: Mon, Tue and Wed at 11am – 2 pm.
    Zoom link: https://nyu.zoom.us/j/7537276684

    Sai Vikas Mandadapu (sm9510@nyu.edu)
    Office hours: Wed and Thu at 10 am – 12 pm and Friday at 2-5 pm
    Zoom link: https://nyu.zoom.us/j/2316404908

M.Sc. CAs (grading, homework solutions and problems, questions about material, communication with students via Slack/Zoom):
    Po-Wen (Steven) Fang (email: pwf227@nyu.edu)
    Office hours: Mon and Tue at 3-3:30 pm
    Zoom link: https://nyu.zoom.us/j/7496469847

Pragdheesh Ramaswamy Shanmugam (email: pr2179@nyu.edu)
Office hours: Tue and Wed at 11:30 am -1:00 pm
Zoom link: https://nyu.zoom.us/j/4609827232

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*
- Very trivial, easy-to-follow textbook: *Data mining and machine learning*, M.J. Zaki.

Homework

For coding, preferred environments is Matlab or Python; keep in mind that it is your responsibility to ensure that your submission is executable as is. **Homework submissions are due at midnight on the due day.**

COVID disclaimers and accommodations:

- Lectures will be in person, but you are welcome to attend them remotely (via zoom links); there will be *no* penalty for not showing up in person

- It is mandatory to comply with *all* NYU policies on preventing the spread of COVID-19. Please review these policies here: https://www.nyu.edu/about/policies-guidelines-compliance/policies-and-guidelines/building-access-policy.html

- Office hours will be held online

Course Work and Grading

Your final grade will be determined roughly as follows:

Homeworks	30%

Midterm	30%
Final	40%

Tentative Schedule

- Week 1 (09.09.2021): 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

- Week 2 (09.16.2021): Perceptron, Online & Stochastic Gradient Descent, Convergence Guarantee, Perceptron vs. Linear Regression, Multi-Layer Neural Networks, Back-Propagation

  Due date for Homework 1.

- Week 3 (09.23.2021): Generalization Guarantees, VC-Dimension, Nearest Neighbor Classification (infinite VC dimension), Structural Risk Minimization, Support Vector Machines

- Week 4 (09.30.2021): Kernels and Mappings and (Topic 7) Introduction to Probability Models

- Due date for Homework 2.

- Week 5 (10.7.2021): Discrete Probability Models, Independence, Bernoulli Distribution, Text: N a ï v e Bayes, Categorical / Multinomial Distribution, Text: Bag of Words and (Topic 9) Continuous Probability Models, Gaussian Distribution, Maximum Likelihood Gaussian, Sampling from a Gaussian

- Week 6 (10.14.2021): 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.

- **Week 7 (10.21.2021): MIDTERM (in person)**

- Week 8 (10.28.2021): Mixture Models and Hidden Variables, Clustering, K-Means, Expectation Maximization and (Topic 13) Expectation Maximization

  Due date for Homework 4.

- Week 9 (11.04.2021): Structuring Probability Functions for Storage, Structuring Probability Functions for Inference, Basic Graphical Models, Graphical Models, Parameters as Nodes

- Week 10 (11.11.2021): NO CLASS (VETERAN'S DAY HOLIDAY)

- Week 11(11.18.2021) Bayes Ball Algorithm and (Topic 16) Junction Tree Algorithm

- Week 12 (11.25.2021) NO CLASS (THANKSGIVING HOLIDAY)

- Week 13 (12.02.2021) JTA and (Topic 19) HMM

- Week 14 (12.09.2021) HMM

  Due date for Homework 5.

- **Week 15 (Final Week) FINAL EXAM (in person)**

LAST BUT NOT THE LEAST: 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.