# CSCI-UA.0473-001 Introduction to Machine Learning

## Overview

This course introduces undergraduate computer science students to the field of machine learning. Assuming no prior knowledge in machine learning, the course focuses on two major paradigms in machine learning which are supervised and unsupervised learning. In supervised learning, we learn various methods for classification and regression. Dimensionality reduction and clustering are discussed in the case of unsupervised learning. If time permits, we will learn how to extend those methods to be *deep*.

## Target Audience

This course is aimed at 3rd- or 4th-year undergraduate students in computer science.

### For non-CS students

Please contact either Romeo Kumar <kumar _at_ cs.nyu.edu> or Leeann Longi <longi _at_ cs.nyu.edu>, the student adivors at the CS Department, directly.

## General Information

- **Lecture:** 9.30-10.45am on Mondays and Wednesdays at 60 5th Ave (110)
    - These are chalkboard lectures, and there will not be any slide.
    - Lectures on Wednesdays include lab sessions led by one of the graders.
- **Instructor**: Kyunghyun Cho
- **Graders**: Jason Lee, Andy Gan
- **Office Hours**
    - **Instructor**: 9.30-10.30 on Tuesdays at 60 5th Ave (616)
    - **Graders**: 11.00-12.00 on Wednesdays at 60 5th Ave (665)

- **Grading**: Homeworks (60%) + Final Exam (40%)
    - Failing the final exam will result in the fail of the overall course.
    - Failing to submit any one of the six homeworks will result in the fail of the overall course.
- **Final Exam**: May 9 @8.00-9.50

- **Course Site**:

    - **Piazza**: https://piazza.com/nyu/spring2018/csciua0473001/home
        - For discussion and announcements
    - **NYU Classes**: https://newclasses.nyu.edu/portal/site/f8297c7c-0402-4f4f-9fea-e1a6b0296297/page/9e524b17-8333-4a01-a023-0db319e26f80
        - For submitting homeworks
        - For distributing the grades

- **Book**: The following books are highly recommended but not necessary.
    - Kevin Murphy. Machine Learning: a Probabilistic Perspective. 2nd edition.
    - Chris Bishop. Pattern Recognition and Machine Learning.
    - Andreas C. Müller & Sarah Guido. Introduction to Machine Learning with Python.

- **Lecture Note**
    - The lecture note will be updated before each lecture at https://github.com/nyu-dl/Intro_to_ML_Lecture_Note/blob/master/lecture_note.pdf

- **Lab Sessions**
    - Some of the lectures on Wednesdays will be lab sessions run by graders. Lab sessions will use Python.
    - The lab materials are available in https://github.com/nyu-dl/Intro_to_ML_Lecture_Note/tree/master/notebook/labs

# Prerequisites

### Required

- MATH-UA 121 Calculus I
- CSCI-UA 310 Basic Algorithms
- MATH-UA 140 Linear Algebra

### Recommended

- MATH-UA 235 Probability and Statistics
- MATH-UA 234 Mathematical Statistics
- DS-GA 1001 Introduction to Data Science
    - Exercise materials are highly recommended.
- DS-GA 1002 Statistical and Mathematical Methods

# Schedule

Note that the schedule below is only a guideline. The content of each lecture will be decided as the course progresses.

| wk | Lecture | Lecture Note | Lab Session | Homework |
|---|---|---|---|---|
| 1 | Course Introduction | | | HW1 (JL) |
| | Classification: Problem setup | | | |
| 2 | Perceptron and Logistic Regression | | (JL) 01 | |
| | Loss functions and support vector machines | | (JL) 02 | |
| 3 | Model Selection, Regularization and Early Stopping | | (AG) 03 | HW2 (AG) |
| | | | | |
| 4 | Overfitting and Regularization | | (AG) 04 | |
| | Multi-Class Classification | | | |
| 5 | Presidents' Day (no class) | | | HW3 (JL) |
| | Multi-Class Classification and Weight Visualization | | (JL) 05, 06 | |
| 6 | Nonlinear Classification: k-Nearest Neighbour Classifier and Radial Basis Function Networks | | (JL) 07, 08 | |
| | | | | |
| 7 | Nonlinear Classification: Adaptive Basis Function Network | | (JL) 09, 10 | HW4 (AG) |
| | | | | |
| 8 | Spring Recess | | | |
| 9 | Recap of Probability and Distributions | | (AG) | |
| | Linear Regression and Bayesian Linear Regression | | | |
| 10 | Dimensionality Reduction via Matrix Factorization | | (AG)13, 13 | HW5 (AG) |
| | Principal Component Analysis and Non-Negative Matrix Factorization | | | |
| 11 | Nonlinear Principal Component Analysis: Deep Autoencoders, Metric Multidimensional Scaling (MDS) | | (AG) | |
| | k-Means Clustering | | | |

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|---|---|---|---|---|
| 12 | (Unorthodox) brief introduction to sequential decision making with policy gradient | | (JL) | HW6 (JL) |
| | | | | |
| 13 | Guest Lecture by Dr. Laura Noren | | | |
| | Q&A Session with TA's | | (AG) | |
| 14 | Final Exam | | | |

## Homeworks

There will be **bi-weekly homeworks**, starting from the second week of the semester. Each homework will be announced every second Monday, and will be due in 14 days (see NYU classes for actual dates). The answer must be **submitted via NYU Classes** within two weeks after the announcement, and there will be **no extension**. All the answers must be typesetted using either LaTeX or Microsoft Word and submitted as a **pdf file**. **Handwritten answers will not be accepted**. Each homework may include one or more programming assignments.

## Remarks

A student in this course is expected to act professionally. Please also follow the GSAS regulations on academic integrity found here http://gsas.nyu.edu/page/academic.integrity