Boston University Metropolitan College

Machine Learning

MET CS 767

Course Format (On Campus)

Reza Rawassizadeh
rezar@bu.edu
Office hours: by appointment

Course Description

In this course, first, we review the statistics we have learned and learn some new concepts required for generative machine learning. Next, we review regressions and then regularization methods. Afterward, we review basic decision trees, to prepare ourselves for learning new gradient boosting classification algorithms. We study state-of-the-art gradient boosting methods in detail, including XGBoost, LightGBM, and CatBoost.

The second phase of this course is dedicated to neural networks and deep learning. First, we learn classical neural network concepts, including perceptron and multilayer perceptron. Next, a convolutional neural network and a recurrent neural network will be studied. Afterward, the self-supervised learning algorithms (SOM, Autoencoders, and GAN) will be explored. We finalize this course by learning attention mechanisms and transformer architecture. If we have time, we describe common transformer-based architectures and report on contrastive learning models, such as diffusion architectures.

Books

Some chapters of the instructor ongoing book: https://github.com/Rezar/MLBook

Besides, students who are willing to use extra resources can check the following books:

- Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems (Aurelien Geron).
- An Introduction to Statistical Learning: with Applications in R (James et al.)
- Dive into Deep Learning (Zhang et al.)

Course Requirements

- Students should be familiar with Python programming language and some reasonable mathematics.
- Students must pass CS 544 or CS 555, and CS 688 or CS 699 or CS 677.
- This course includes lots of theories and except for assignments, we do not go into implementation details. Students should be able to learn Keras, TF or Pytorch on their own.

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Class Policies

1) **Attendance & Absences** – Class attendance is not mandatory but highly recommended. All quizzes and the final exam will be done inside the class, and online exams are impossible.
2) **Assignment Completion & Late Work** –50% to 60% of the final grade comes from assignment and project delivery. Late submission of homework is associated with a penalty of 10% grade reduction for any single day.
3) **Academic Conduct Code** – "Cheating and plagiarism will not be tolerated in any Metropolitan College course. They will result in no credit for the assignment or examination and may lead to disciplinary actions. Please take the time to review the Student Academic Conduct Code: http://www.bu.edu/met/metropolitan_college_people/student/resources/conduct/code.html.

Grading Criteria

50% to 60% of the final grade comes from assignments and project delivery, 30% to 35% from the final exam, and 15% to 20% from quizzes.

Class Meetings, Lectures & Assignments

Lectures, Readings, and Assignments are subject to change and will be announced in class as applicable within a reasonable time frame.

Date	Topic	Assignments Due
Session 1	Review on Machine Learning Concepts	NA
Session 2	Statistics Required for Generative Models	14 days after Session 2
Session 3	Review on Regression Algorithms	NA
Session 4	Regression Regularization and Evaluation	14 days after Session 4
Session 5	Decision Trees and Ensemble Learning Algorithms	NA
Session 6	Gradient Boosting Decision Trees	14 days after Session 5
Session 7	Basics of Neural Network I	NA
Session 8	Basics of Neural Network II	14 days after Session 8
Session 9	Convolution and Convolutional Neural Network	NA
Session 10	Recurrent Neural Network	14 days after Session 10
Session 11	Generative Neural Networks I (Self- Organized Maps, RBM, Encoder/Decoder)	NA
Session 12	Generative Neural Networks II (GAN, GAN challenges, and GAN based Architecture)	14 days after Session 12
Session 13	Attentions and Transformer Architecture	NA
Session 14	Transformer Models and Applications	NA