**Machine Learning**

MET CS 767

Course Format (On Campus)

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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**

- Machine Learning & Artificial Intelligence: Concepts, Algorithms, and Models (Reza Rawassizadeh). Some chapters are available under this link: https://github.com/Rezar/MLBook

- 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.)

**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.

**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.*

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