Boston University Metropolitan College

Generative AI

MET CS 793

Course Format (On Campus)

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Course Description

In this course, first, we learn statistical concepts required for generative artificial intelligence. Next, we review regressions and optimization methods. Afterward, we review traditional neural network architectures, including perceptron and multilayer perceptron. Next, we move to Convolutional Neural Networks and Recurrent Neural Networks and close this part with Attention and Transformers.

The second part of the course focus on generative neural networks. We start with traditional self-supervised learning algorithms (Self Organized Map and Restricted Boltzmann Machine). Then, we explore Auto Encoder architectures and Generative Adversarial Networks. Afterward, we moved toward architectures that construct generative models, including recent advances in NLP e.g., BERT, InstructGPT (ChatGPT architecture). Finally, we describe Neural Radiance Field and text-2-image models.

Books

Some chapters of the instructor's ongoing book: https://github.com/Rezar/MLBook
Besides, students who are willing to use extra resources can check the following books:

- 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, Tensor Flow, or Pytorch on their own. Besides, they need to be able to use cloud services such as Google Colab environment to build and train their neural network model.

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 taking an online exam are impossible.
2) **Assignment Completion & Late Work** –40% - 50% 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) **Quiz and Final exam –** 50%- 60% of the final grade comes from quizzes and the final exam. This course requires a good understanding of mathematics and lots of theoretical concepts to learn. Quiz and final exams focused on concepts and not coding.
4) **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

Student grades are the sum of their assignments, final exam, and quizzes. The resulting grade will be calculated as follows.

A	95-100
A-	90-94.99
B+	85-89.99
B	80-84.99
B-	75-79.99
C+	70-74.99
C	65-69.99
F	<65

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 for Generative AI	14 days after Session 2

Session 3	Review on Regression Algorithms	NA
Session 4	Regression Evaluation and Optimizations	14 days after Session 4
Session 5	Basics of Neural Network I	NA
Session 6	Basics of Neural Network II	14 days after Session 5
Session 7	Convolution and Convolutional Neural Network, Recurrent Neural Network	NA
Session 8	Attentions and Transformer Architecture	14 days after Session 8
Session 9	Generative Neural Networks I (Advances in Natural Language Processing toward Large Language Models)	NA
Session 10	Generative Neural Networks II (Open-source Large Language Models, Fine-tuning Large Language Models, Evaluation of Large Language Models, Prompt Engineering and Task Completion Methods)	14 days after Session 10
Session 11	Generative Neural Networks III (Self- Organized Maps, RBM)	NA
Session 12	Generative Neural Networks IV (Auto Encoders, Generative Adversarial Network, Image Synthesis Architectures)	14 days after Session 12
Session 13	Generative Neural Network V (NeRF and text-to-image models)	14 days after Session 13
Session 14	Review and/or Project Presentations	NA