

CMSC 838B & 498Z – Differentiable Programming

Fall 2021

Meeting Place:

Meeting Time: Tues/Thur 12:30pm - 1:45pm

Instructor: Ming C. Lin

Office: IRB-5162

E-mail: lin@cs.umd.edu

Office Hours: Tues/Thur After Class or By Appointment

Prerequisites: CMSC 330, CMSC 351, CMSC 422, and Linear Algebra *OR* Instructor’s approval

Course Description: This is an advanced graduate course on “Differentiable Programming”, a new programming paradigm in which a numerical program can be differentiated through automatic differentiation, allowing gradient-based optimization of parameters in the program. It has broad applications in Computer Graphics, Computer Vision, Deep Learning, Quantum Computing, System Control, and many more.

In this course, we will study this novel programming paradigm, where programs are treated as compositions of differentiable operations that can then be optimized to fit data with tremendous possibility to transform how we can utilize computers to perform calculations on big data.

This course will examine at how differentiable programming works, from theoretical foundations, practical design and consideration, to system implementation. The course will cover popular concepts like automatic differentiation, models to be integrated with deep learning (including convolutional and recurrent neural networks), as well as some specific instances in differentiable vision, differentiable rendering, differentiable physics, etc.

The overall goal of this course is to survey some of the most important recent development in differentiable programming, and not to teach you how to train pre-existing models (although you may learn to do that if you choose to do a course project). The aim of this course is to equip you with the broad knowledge and basic skills, so you can understand the literature and implement models and novel differentiable programming concepts. The intent is that after this course, you will develop the ability to critically evaluate and appreciate new system ideas, constructively dissect and criticize, and skillfully identify limitations and potential of various differentiable programming approaches.

Grading:

- For 1 credit option, you will be graded solely based on your attendance and in-class (either in-person or online) participation, plus a short presentation of your chosen topics.
- For 3 credit option, in addition to attendance and participation, and in-class presentation, the rest of your course work will consist of meeting multiple project milestones for your course project that you will work on throughout the semester.

Letter grades will not be assigned on the curve, but on absolute standards. Your final grade in this course will be determined solely by how much you learn.

In-Class Presentation: Each student is expected to lead a short lecture of his/her choice of topics, with the instructor's approval. All students are required to meet the instructor on one-to-one basis to discuss the lecture materials in detail prior to the presentation. One week before the scheduled presentation, s/he will be expected to submit a draft version of the presentation materials and an initial treatment of the selected topics. The instructor will provide timely feedback about the pre-talk. Reading materials and/or discussion issues will be posted on the course web site, at least one day prior to each lecture. All class members will be expected to have read the listed readings, by the start of the relevant class.

Course Project: Each student (possibly with a partner) choosing the 3-credit option is expected to propose and complete a final project, likely with substantial programming efforts related to differentiable programming – either on foundational techniques or in application areas of the student's choice. Many topics will be suggested, but students are free to select their own project topic.

Communication: In addition to the instructor's office hours, students can also arrange to meet the instructor by appointment and/or email correspondence. A class mailing list will be set up to broadcast important messages related to the class. Please send mail to lin@umd.edu to add yourself to the mailing list. Lecture notes, handouts, and class announcements will also be posted on the course home some page at the following URL:

<https://www.cs.umd.edu/class/fall2021/cmsc838b/>

Make-up Course Work: In exceptional circumstances (serious illness, university business, a death in the family), an extension or alternative arrangements may be granted. (The problems of student life, including the consequences of procrastination and commitments to other courses are not regarded as "exceptional circumstances".) However, such arrangements must be approved by the instructor BEFORE the due date. In circumstances that merit special consideration, documentation is usually available to the student, and the instructor feels most comfortable when a request for special accommodation is accompanied by appropriate written material supporting such a request.

COVID-19 Compliance: Students are required to comply with all campus policies related to COVID-19. Please refer to:

<https://umd.edu/4Maryland/students>