CMSC 838B & 498Z - Differentiable Programming for Agentic AI and Physical Intelligence

Fall 2026

Meeting Place: IRB 2207
Meeting Time: Tues/Thur 2:00pm - 3:15pm

Instructor: Ming C. Lin
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Office Hours: TR 3:15pm or By Appointment

TA: Shrey Patel
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Prerequisites

CMSC 330, CMSC 351, CMSC 422 or 421, Linear Algebra OR Instructor's approval

Course Description

This is an advanced graduate and upper-level undergraduate course on "*Differentiable Programming*", a new programming and ML design paradigm in which a numerical program can be differentiated through automatic differentiation, enabling gradient-based optimization of parameters in machine learning pipeline. 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 and design paradigm for agentic AI systems and physical intelligence, 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 *real-time* or *accelerated* calculations on big data. This course will examine how differentiable programming works, from theoretical foundations, practical design and consideration, to system implementation and optimization. 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 physics, differentiable geometry, differentiable rendering, differentiable vision, and more.

The overall goal of this course is to survey some of the most important recent developments 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 a 1:1 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 page at the following URL:

https://www.cs.umd.edu/class/fall2026/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.