SYLLABUS
IE 8703: Optimization in Deep Learning

INSTRUCTOR:	Haifeng Wang, Ph.D.
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CLASS TIME AND LOCATION:	M W 03:30PM - 04:45PM MCCAIN 125 (Face to face sections) -Recorded videos (Asynchronous online)
OFFICE HOURS:	M W 01:30PM - 03:00PM (McCain 260P) or by appointment
WEBSITE:	canvas.msstate.edu Recorded lecture access for online sessions https://oc-engage.engr.msstate.edu/engage/ui/index.html

CATALOG DESCRIPTION

(Prerequisite: IE 4733/MA 4733 and IE 4683/6683 or equivalent). Three hours lecture. An introduction to deep learning models and their optimization; gradient methods, mirror descent; proximal gradient methods, and mirror gradient.

PREREQUISITES:

IE 4733 Linear Programming or MA 4733 Linear Programming or equivalent courses; IE 4683/6683 Machine Learning with Industrial Engineering Applications or equivalent courses; Experience with Python programming; Or consent of instructor.

COURSE OBJECTIVES

- To learn and practice the fundamentals of different optimization methods and understand their roles in deep learning.
- To be able to implement learned optimization algorithms to train deep learning models.
- To be able to design simple optimization algorithms on deep learning training for real problem datasets.

COMMUNICATION

Website: canvas.msstate.edu. Course announcements and communication will be sent via CANVAS email. Students are responsible for checking their email frequently.

TEXTBOOK**S**

Here is a list of reference books:

1) Goodfellow, Ian, Yoshua Bengio, Aaron Courville, and Yoshua Bengio. *Deep Learning*. Vol. 1, no. 2. Cambridge: MIT press, 2016.
2) Aggarwal, Charu C. *Linear Algebra and Optimization for Machine Learning.* Springer International Publishing, 2020.
3) Sra, Suvrit, Sebastian Nowozin, and Stephen J. Wright, eds. Optimization for Machine Learning. MIT Press, 2012.

SOFTWARE

- Python 3 (https://www.python.org/). All examples provided will be coded in Python.
- Anaconda (https://www.anaconda.com/distribution/, free) or PyCharm (https://www.jetbrains.com/pycharm/, free)

GRADE DETERMINATION:

- Homework 30%
- Exam 25% (tentatively around April 17th)
- Course Project 35%
- Participation 10%

Final letter grades will be determined:

A	100%	to	90%
B	< 90%	to	80%
C	< 80%	to	70%
D	< 70%	to	60%
F	< 60%	to	0%.

Grades will be posted on-line. Disputations of assignment or exam grade should be discussed with the professor within one week from the date the grade is submitted. As a note: A request for grade review will result in a complete regrading of the assignment or exam, not only those items in the request.

Homework (30%): 4 homeworks will be assigned. Late homework will not be accepted (unless it is the result of an officially excused absence). All homeworks are based on individual effort.

Exam (25%): There will be one take-home exam.

Course Project (35%): The objective of the course project is to develop a better understanding of the course materials through a hands-on research project. The focus of the project should be the development/implementation of optimization approaches. Each project may include **up to two team members** on an agreed topic. Additional information will be provided through the CANVAS course website.

Proposal report (10%)
Final presentation (10%)
Final report (15%)

Participation (10%): CANVAS discussions (both on-campus and online students), and short tutorial presentations (recorded videos posted on CANVAS) will be considered for participation.

Suggestions: Suggestions for improvement are welcome at any time.

EXPECTED TOPICS COVERED

Topics Covered	Contact hours
Introduction	1
Perceptron	2
Multiplayer neural network	2
Backpropagation	3
Convolutional neural network	2
Deep learning tools I- Keras	3
Deep learning tools II- Pytorch	3
Recurrent neural network	2
Backpropagation through time	1
Midterm exam (TBD)	3
Review of Linear Algebra and Optimization Basics	2
Function Convexity and Smoothness	2
Optimality conditions	2
Convergence	2
Gradient methods	3
Proximal and projected gradient descent	2
Stohastic gradient method	1
Subgradient methods	1
Mirror gradient methods	2
Final exam (TBD)	3
Final project presentation	3

UNIVERSITY SYLLABUS STATEMENT

"The Mississippi State University Syllabus contains all policies and procedures that are applicable to every course on campus and online. The policies in the University Syllabus describe the official policies of the University and will take precedence over those found elsewhere. It is the student's responsibility to read and be familiar with every policy. The University Syllabus may be accessed at any time on the Provost website under Faculty and Student Resources and at https://www.provost.msstate.edu/faculty-student-resources/university-syllabus"

AI POLICY: AI USE DISCOURAGED IN THIS COURSE

It is expected that all submitted work is produced by students themselves. Use of a Generative AI tool to complete an assignment constitutes academic dishonesty and will be reported as an Honor Code Violation. Submitted work may be filtered through turnitin.com AI Writing Detection. This review may initiate further discussion about the authenticity of the submission which could result in a more formal review through the Honor Code Council.