JOHNS HOPKINS
WHITING SCHOOL
of ENGINEERING

CS 482/682 Machine Learning: Deep Learning

Spring 2020

Instructor
Silvio Amir samir@jhu.edu

Teaching Assistants
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Office Hours
Silvio Amir Fri, 10-11am
Keshuai Xu, TBD ,TBD-TBD
Shijie Wu, TBD, TBD-TBD

Schedule
Time: Mon, Wed, Fri 8.30-9:45
Location: Hackerman B17

Synopsis
Deep learning has emerged as powerful tool for solving data-intensive learning problems such as supervised learning for classification or regression, dimensionality reduction, and control. As such, it has a broad range of applications including speech and text understanding, computer vision, medical imaging, and perception-based robotics. The goal of this course is to introduce the basic concepts of deep learning (DL). The course will include a brief introduction to the basic theoretical and methodological underpinnings of machine learning, commonly used architectures for DL, current challenges, and specialized applications to computer vision, natural language processing, speech understanding, and medicine. Students will be expected to solve several DL problems on standardized data sets and will be given the opportunity to pursue team projects on unsupervised and self-supervised learning.

Prerequisites
(AS.110.201 or AS.110.212 or EN.553.291) and (EN.553.310 EN.553.311 or EN.553.420 or EN.560.348) and (EN.601.475 or equivalent); Calc III and numerical optimization recommended. Recommended co-req: EN.601.382.

Instructional Material

A fairly exhaustive list of additional reading material (including textbooks, blog articles, tutorials, and scientific articles) will be made available in the Resource section of Piazza. Assignments, course material, and links to relevant resources will be posted on Piazza. Students are encouraged to post any questions and discussions on Piazza as well. Please note that, while you can remain anonymous to peers, posting anonymously to instructors is disabled. Assignments will be submitted through Gradescope.

Lab Classes

The lab classes will provide additional hands-on and tutorial support for developing machine learning solutions using python, Numpy and Pytorch. It will go into detail on practical methods for scalable learning on large data sets, and other practical issues in setting up DL systems.

Grading

The course has 6 assignments alternating between written and programming in the first two thirds of the semester, a midterm exam, and culminates in a final project that you complete in groups of four. Individual grades will be computed as a weighted combination of these factors:

(1) Homework Assignments: 45%
(2) Midterm Exam: 20%
(3) Final Project: 35%

Grading Policies

For late assignment submissions, you have a total of 3 late days that can be used one day at a time, specifically no smaller quantity than day can be used but you can use multiple days for the same homework. Late days must be requested ahead of submission deadline via private message to instructors on Piazza. There will be no late days accepted for the final project.

Topics and Schedule (subject to change)

Homework assignments are released / and are due Fridays (latest submission 11.59pm).

Week 1: Overview and Introduction.

- Lecture 1. Overview and Course Logistics
- Lecture 2. Image Classification, Linear Models and Loss Functions
- Lab: Python, Numpy, Matplotlib, Jupyter Notebook, Google Collab

Week 2: Linear Models.

- Lecture 3. Optimization and Regularization
- Lecture 4. Text Classification and Gradient-based Representation Learning
- Lab: Word Embeddings
- Homework 1 released

Week 3: Deep Neural Networks.

- Lecture 5. History of and Introduction to Neural Networks
- Lecture 6. Backpropagation and Computational Graphs Pt I
- Lab: Backpropagation and Computational Graphs Pt II
- Homework 2 released
- Homework 1 due

Week 4: Convolutional Neural Networks.

- Lecture 7. Convolutional Neural Networks
- Lecture 8. Convolutional Neural Networks pt II
- Lab: Its not working! Help! AKA debugging
- Homework 3 released
- Homework 2 due

Week 5: Training Neural Networks.

- Lecture 9. Training Part I: Activation, Initialization, Preprocessing, Dropout, Batch norm
- Lecture 10. Training Part II: Update rules (Momentum), Augmentation, Transfer Learning
- Lab
- Homework 4 released
- Homework 3 due

Week 6: Architectures.

- Lecture 11. Inverse Classroom: Network Architectures for Computer Vision
- Lecture 12. Network Architectures for NLP: CNNs and RNNs
- Lab
- Homework 5 released
- Homework 4 due

Week 7: Sequence Models.

- Lecture 13. LSTM, GRUs and Seq2Seq Models
- Lecture 14. Attention, Self-attention and Transformer Networks
- Lab
- Homework 5 due

Week 8: Spring break.

Week 9: Review and Exam.

- Lecture 15. Tips and Tricks (TAs) + Review
- Lecture 16. Midterm Exam
- Lab
- Homework 6 released

Week 10: Unsupervised Learning.

- Lecture 17. Unsupervised and Self-supervised Learning
- Lecture 18. Autoencoders, Variational Autoencoders, and Disentanglement
- Lab
- Homework 6 due

Week 11: Generative Models.

- Lecture 19. Inverted Classroom: BERTology and Text Generation
- Lecture 20. Generative Adversarial Networks
- Lab

Week 12: Current Topics.

- Lecture 21. Generalization, domain gaps, and explainable AI
- Lecture 22. Hands-on: Domain gaps and black boxes
- Lab

Week 13: Current Topics.

- Lecture 23. Guest Lecture: Deep Reinforcement Learning
- Lecture 24. DL for Health Care
- Lab

Week 14: Wrap-up.

- Lecture 25.Guest Lecture: Human-centered AI, ethics, etc.
- Lecture 26. Wrap-up
- Lab

Ethics

The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition. Report any suspected violations to the instructor. You can find more information about university misconduct policies on the web at these sites:

- Undergraduates: `e-catalog.jhu.edu/undergrad-students/student-life-policies/`
- Graduate students: `e-catalog.jhu.edu/grad-students/graduate-specific-policies/`

Personal Wellbeing

- If you are sick, in particular with an illness that may be contagious, notify us by email but do not come to class and may require accommodation regarding homework. Visit the Health and Wellness Center: 1 East 31 Street, (410) 516-8270. Also refer to: http://studentaffairs.jhu.edu/student-life/support-and-assistance/absences-from- class/illness-note-policy/
- All students with disabilities who require accommodations for this course should contact me at their earliest convenience to discuss their specific needs. If you have a documented disability, you must be registered with the JHU Office for Student Disability Services (385 Garland Hall; (410) 516-4720; http://web.jhu.edu/disabilities/) to receive accommodations.
- If you are struggling with anxiety, stress, depression or other mental health related concerns, please consider visiting the JHU Counseling Center. If you are concerned about a friend, please encourage that person to seek out these services. The Counseling Center is located at 3003 North Charles Street S-200 and can be reached at (410) 516-8278 and online at http://studentaffairs.jhu.edu/counselingcenter/ .

Class Climate

I am committed to creating an online classroom environment that values the diversity of experiences and perspectives that all students bring. Everyone here has the right to be treated with dignity and respect. I believe fostering an inclusive climate is important because research and my experience show that students who interact with peers who are different from themselves learn new things and experience tangible educational outcomes. Please join me in creating a welcoming and vibrant classroom climate. Note that you should expect to be challenged intellectually by me, the teaching assistants (TAs), and your peers, and at times this may feel uncomfortable. Indeed, it can be helpful to be pushed sometimes in order to learn and grow. But at no time in this learning process should someone be singled out or treated unequally on the basis of any seen or unseen part of their identity.

If you ever have concerns in this course about harassment, discrimination, or any unequal treatment, or if you seek accommodations or resources, I invite you to share directly with me or the TAs. I promise to take your communication seriously and to seek mutually acceptable resolutions and accommodations. Reporting will never impact your course grade. You may also share concerns with the Computer Science Department Chair (Randal Burns, randal@cs.jhu.edu) or Director of Undergraduate Studies (Joanne Selinski, joanne@cs.jhu.edu), the Assistant Dean for Diversity and Inclusion (Darlene Saporu, dsaporu@jhu.edu), or the Office of Institutional Equity (oie@jhu.edu). In handling reports, people will protect your privacy as much as possible, but faculty and staff are required to officially report information for some cases (e.g. sexual harassment).