Neural Networks and Deep Learning

(ANLY-590) Fall 2020

Instructors: Keegan Hines & Jason Wittenbach		**Time:**	Mon 6:30 – 9:00 PM
TAs: Zirong Chen, Haotian Xue, Robin Wang		**Place:**	Zoom for now

This course focuses on the practice and applications of deep learning. We explore foundational concepts, structuring popular networks and implementing models through various technologies such as Tensorflow and Keras. Topics that are explored throughout this course include image recognition, machine translation, and natural language processing. The course provides a high-level overview of many popular network structures and state of the art frameworks. Parallelism, GPU distributed computeing and cloud technologies are also introduced along the way given their importance in both inference and parameter fitting phases of model construction in deep networks.

Prerequisites: ANLY-511 (Probabilistic Modeling and Statistical Computing), ANLY-512 (Statistical Learning Theory) or equivalent, Linear Algebra, Multivariable Calculus, comfort with Python.

Asynchronous Learning: This is a crazy time. We know many of you are in many different timezones, and might never be able to attend live Zoom lectures or labs. We aim to facilitate both synchronous and asynchronous learning. All lectures will be recorded and posted shortly after class. Lab activities will not be due immediately, but will be due within two days of the live lab. Our final projects will be shared asynchronously through either written or recorded formats. Our midterm exam will be taken in Canvas and can be taken at a time appropriate to your local time. In the past, certain course activities have been group-based (such as homework and the final project), however feel free to work alone if you are unable to find a convenient partner or group. Please let us know if other concerns arise due to your unique situation(s).

Office Hours: Recurring review session with TAs will be announced. Office hours can be scheduled by appointment or before/after ML Journal Club (see below).

Textbooks:

- Ian Goodfellow, Yoshua Bengio, Aaron Courville, *Deep Learning*. MIT Press 2016.
- Michael Nielsen. *Neural Networks and Deep Learning* : http://neuralnetworksanddeeplearning.com/
- Chollet, *Deep Learning with Python*. Manning Press.

Lab: For some (but not all) weeks of the semester, the second half of our Monday sessions will be broken out into Labs. In these, you will focus on hands-on coding and practice with the concepts. For each of the labs, you will have to turn in your completed work. You can work in groups, but everyone has to turn in their own copy.

Topics To Be Covered:

- Basic concepts: Model accuracy, prediction accuracy, interpretability, supervised and unsupervised learning, linear and logistic regression, regularization.
- Artificial neural networks, feedforward, activation functions, loss functions
- Non-linear optimization, gradient descent, backpropagation
- Deep learing tooling: Keras, Tensorflow, AWS

- autoencoders, dense embeddings, dimensionality reduction
- convolutional networks, transfer learning, applications in image processing and NLP
- recurrent networks, LSTM, GRU, applications in NLP
- Potential special topics: GANs, Reinforcement Learning, Multitask Learning, Machine Translation

Grading Policy: About 3 homework sets: 30%, 1 hour in-class mid-term exam: 25%, Lab: 15%, final project: 30%. No final exam.

Grading Scheme: A: 91.5% or more, A- : 89.5% or more, B+ : 88% or more, B: 81.5% or more, B- : 80% or more, C: 65% or more, D: 55% or more

The break points for these grades may be lowered, but will not be raised.

ML Journal Club: An (optional) hour session every week where Keegan and Jason will discuss a recent publication in the field. Papers discussed in journal club might entail topics we haven't yet discussed in class, but we will try to be pedagogical as we discuss any new ideas. This session is completely optional and is only for your own interest/enrichment in cutting-edge topics. You are encouraged to read papers beforehand and ask any questions. Date and time TBD. All session will be recorded for later viewing.

Honor Code: Please be aware of the academic integrity rules. They may be found in ch. VI of the the Graduate Bulletin. Academic misconduct includes plagiarism, unacknowledged paraphrase, cheating, fabrication of data, fabrication, alteration, or misrepresentation of academic records, facilitating academic dishonesty (i.e. helping or allowing others to violate these rules), unauthorized collaboration. misuse of otherwise valid academic work, misuse of academic resources, and depriving others of equal access to academic resources. Please look at the Graduate Bulletin for a detailed explanation, and stick to these rules.

Homework and Labs: In this class, you are *encouraged to collaborate* with other students when you study and when you do your homework (and labs). When working on a homework assignment or a practice exercise, start by yourself, then talk to other students, ask questions, and share your ideas, then complete the work on your own. Everyone must turn in their own version of assignments. If you do work with other students, simply make note of who you collaborator with and you will be in compliance with the Honor Code. Feel free to seek out help online, there are many great tutorials and code examples.

Midterm Exam: You are *not allowed to collaborate* with other students or seek any human help on the mid-term. If we identify that you and another student exchanged information or messages pertinent to the exam content during the exam window, you will receive a 0 on the exam.

Software and Computers: Python will be used throughout the course, with a heavy reliance upon scientific computing libraries such as Numpy, Tensorflow, and Keras. Students are expected to have a strong working knowledge of Python computing and ability to set up their working environment as needed on their own laptop. We'll rely heavily on Google Colab notebooks.

Course Website: The course will use Canvas, https://canvas.georgetown.edu/. Announcements, homework assignments and solutions, course material such as documentation, links, data sets and notebooks will all be posted there. You can look up your grades, and online surveys will also be conducted here. It is recommended that you visit this page once a day (or set up notifications), as announcements will usually only appear here.

Zoom Class Etiquette:

- Please try to keep cameras on. We realize some of you are in difficult situations where it is not possible to do so. But if you can, please have your camera on and have no hesitation to unmute and ask questions.

- If you are more comfortable, feel free to use the chat to ask questions.

Accommodations For Students With Disabilities: Students with documented disabilities have the right to specific accommodations that do not fundamentally alter the nature of the course. Please alert me should you require accommodations.

Title IX: Sexual Misconduct and Sexual Harassment

Georgetown University is committed to providing a safe and hospitable environment for all members of its community. Sexual Misconduct subverts the University's mission, and threatens permanent damage to the educational experience, careers, and well-being of students, faculty, and staff.

Please refer to these University resources: https://georgetown.app.box.com/s/ecqtjvivcuqsnqpbjxtp

The dates for the midterm exam will be announced later.