Machine Learning/Deep Learning

Overview

Instructor Name and Contact Information:

N. Rich Nguyen, Ph.D.

Office Hours: Wednesdays 5:00 - 6:00 pm EDT or by appt.

Email: nn4pj@virginia.edu

Subject Area and Catalog Number: Data Science SYS

6016 **Year and Term:** Fall 2020

Class Title: Machine Learning/Deep Learning

Level: Graduate

Credit Type: Graded

Class Description

This is a graduate-level course on machine learning with fundamental concepts for computational data analysis, including pattern recognition, prediction, and visualization. Topics include applied math, machine learning basics, deep neural networks, convolutional networks, sequence modeling, generative learning, and deep reinforcement learning. The course will focus on using open-source libraries such as NumPy, Keras, and TensorFlow. Students are required to have sufficient computational background to complete several substantive programming assignments.

Required Text

Goodfellow, Ian, Yoshua Bengio, and Aaron Courville, *Deep Learning* (Cambridge, MA: MIT Press, 2016).

Géron, Aurélien, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems* (O'Reilly Media, 2019).

Learning Outcomes

Upon successful completion of this course, you will be able to:

1. Create an end-to-end machine learning project at scale using open-source libraries such as NumPy, Keras, TensorFlow, and Google Cloud.

2. Formulate various supervised, unsupervised, and reinforcement learning models.

3. Apply practical skill sets on designing, deploying, and analyzing deep network architectures on complex real-world problems.
4. Articulate concepts, algorithms, and tools to build intelligent systems.

5. Analyze advanced approaches currently pursued by the machine learning community.

Delivery Mode Expectations

Web-based with weekly live meetings

Required Technical Resources and Technical Components

- UVA Zoom Account

Class Specific Information

Class Instruction and Activities

The topics covered in this course include the following:

- Mathematical frameworks and foundation of machine learning
- Artificial neural networks
- Deep network regularization
- Optimization for deep models
- Data processing and handling
- Convolutional neural networks
- Sequence modeling
- Generative learning
- Deep reinforcement learning
- Model deployment at scale
- Advanced topics in deep learning research
- Future of machine learning

Class Requirements

Prior to taking this course, you should meet the following prerequisites:

- At least one programming course
- Regression analysis
- Machine learning/data mining

The following are strongly recommended:

- Programming in Python (since Python will be used in this course)
- At least one course in linear algebra, statistics, and multivariate calculus

Class Schedule

Live sessions will be held on Tuesdays evenings from 7:00–8:00 p.m. EDT. Below is a list of specific dates.

Date	Time
09/01/2020	7:00–8:00 p.m. EDT
09/08/2020	7:00–8:00 p.m. EDT
09/15/2020	7:00–8:00 p.m. EDT
09/22/2020	7:00–8:00 p.m. EDT
09/29/2020	7:00–8:00 p.m. EDT
10/06/2020	7:00–8:00 p.m. EDT
10/13/2020	7:00–8:00 p.m. EDT
10/20/2020	7:00–8:00 p.m. EDT
10/27/2020	7:00–8:00 p.m. EDT
11/03/2020	7:00–8:00 p.m. EDT
11/10/2020	7:00–8:00 p.m. EDT
11/17/2020	7:00–8:00 p.m. EDT

Communication & Student Response Time

Discussion boards are set up in each module and are designed to be a place where students can reach

out to peers and instructors, and ask questions related to content and technology. Students are encouraged to check the discussion boards daily for updates and correspondence. Specific queries regarding your progress should be addressed to me via email, and you will receive a response within 24 hours. Throughout our time together, the sooner you inform me of any problem (personal or academic) that may affect your attendance or performance, the better the chance we have of solving it together.

Evaluation Standards and Assessments

Programming Assignments	Programming assignments will be implemented in Jupyter Notebooks and provide hands-on experience writing/modifying Python/TensorFlow/Keras code, while working with various datasets.
Codeathons	Student participation is required including submission to three codeathons to apply machine learning to solve real-world challenges.
Module Quizzes	At the end of each module, a module quiz will assess student knowledge and application of topics covered in reading assignments and modules.
Discussions	In every module, students are required to participate in a discussion on some advanced approaches pursued by the machine learning community.
Group Project	The group project is a large component of the course; it includes students working in groups of three to work on a real-world solution that makes a positive difference on the well-being of the commonwealth of Virginia. The project consists of several milestones: topic selection, data collection, proposal, modeling, tuning, deployment, presentation, and report.

Your final letter grade will be determined by the following scale:

Grade	From	To
A+	970	1,000
A	930	969
A-	900	929
B+	870	899
B	830	869
B-	800	829
C+	770	799

C	730	769
C-	700	729
D+	670	699
D	630	669
D-	600	629
F	0	599

Assignments Grading

Assignment	Total Points	Percentage	Due
4 Programming Assignments	280 (4 × 70) pts	28%	Modules 2, 6, 7, 9
3 Codeathons	150 (3 × 50) pts	15%	Modules 5, 8, 10
10 Quizzes	200 (10 × 20) pts	20%	Modules 1–10
12 Discussions	120 (12 × 10) pts	12%	All modules
1 Group Project	250 (1 × 250) pts	25%	Modules 3, 5, 6, 8–12

Programming Assignments

There will be four programming assignments. Each assignment will be graded for correct implementation, results, a thorough discussion of the results, and good organization, grammar, and spelling. This is a programming course, and doing the programming assignments is absolutely critical (and accounts for 28% of your grade). If the results you see when running your program do not match the results that the TA reports for your program, you should talk to the TA promptly. However, in all but the rarest of cases, you should be prepared to understand that the definitive test of your code is that made by the TA and what you are seeking in talking to the TA is an understanding of how to avoid losing points over similar discrepancies in the future. To put this another way, you should contact the TA, but if you understand why there is a difference, you should not assume that your assignment will be re-graded.

Codeathons

There will be three codeathons on designing deep neural network architectures to solve complex technological, business, and societal problems. Make sure you get your hands dirty on the code. Hands-on is the best way to learn machine learning. You also have opportunities to tackle real-world scenarios. You are expected to demonstrate a strong understanding and in-depth analysis of the solution in each codeathon.

Module Quizzes

There will be 10 quizzes during the course of the semester. Each quiz will assess student knowledge and application of topics covered in reading assignments and modules. Any quiz that is missed due to an absence that is not a university-excused absence will result in a zero (0) for that grade. Any quiz that is missed due to a university-excused absence or due to circumstances that are approved by me beforehand must be made up within a week of the missed quiz.

Piazza Discussions

In every module, students are required to participate in a discussion on some advanced approaches pursued by the machine learning community. You are required to do some research on the discussion topics, answer a few prompted questions, and post your response on Piazza by the end of each module. You are also expected to respond to at least one other peer on their post with an appropriate and thoughtful comment.

Course Project

The course project to be undertaken in a group project called ML4VA. The group project, worth a total of 250 points (or 25% of the course grade) will consist of eight milestones, each worth a specific number of points toward the final grade:

1. Project literature review (30 pts)
2. Project proposal (20 pts)
3. Model design and implementation (30 pts)
4. Project checkpoint and contribution (30 pts)
5. Model interpretation (20 pts)
6. Model deployment and scale up (20 pts)
7. Project presentation (50 pts)
8. Project report (50 pts)

Details of the groups are:

- The required group size is **three**. Individuals may be able to work by themselves with good reason. Expectations will **not** be adjusted due to a smaller group size. Groups of more than three are strongly discouraged but can be allowed under extreme circumstances. Expectations for groups of four are **higher** than those for groups of three.
- In general, all group members will receive the same grade for graded assignments. However, group members will evaluate their peers, and any student who appears to not be contributing may be penalized.
- Each group will be **responsible** for assigning tasks to its group members.
- You are expected to work as a member of your group in this course and cooperate with your colleagues. There will be multiple working sessions and checkpoints to help your team to stay on track of the project. **Cooperation** means attending group meetings, completing your assignments properly and on time, letting your group know if you will be out of town, responding to email from your group, and so on. If there is a lack of cooperation by any group member, it must be brought to the attention of the instructor as soon as it happens. If the lack

of cooperation is serious, the offending group member's semester grade will be penalized.

Spirit of the Course

Students must attend weekly live sessions and complete the final project as a team. I encourage you to post on the forums and exchange ideas. For the programming assignments and quizzes, you should submit your own work.

Electronic Submission of Assignments

All assignments must be submitted electronically through Collab by the specified due dates and times. It is crucial to complete all assigned work—failure to do so will likely result in failing the class. For late assignments, 10% of the total grade will be deducted per day, where the day means 11:59 p.m. Eastern time cutoff. After three late days, it will be marked as 0 points.

Technical Support

Technical Specifications: Computer Hardware

Operating system: Microsoft Windows 8.1 (64-bit) or Mac OS X 10.10 Minimum hard drive free space: 100 GB, SSD recommended Minimum processor speed: Intel 4th Gen Core i5 or faster
Minimum RAM: 4 GB

Technical Support Contacts

UVaCollab: collab-support@virginia.edu

UVA Policies

SDS Grading Policies

The standing of a graduate student in each course is indicated by one of the following grades: A+, A, A–; B+,B, B-; C+, C, C–; D+, D, D–; F. B– is the lowest satisfactory grade for graduate credit.

Attendance

Students are expected to attend all class sessions. Instructors establish attendance and participation requirements for each of their courses. Class requirements, regardless of delivery mode, are not waived due to a student's absence from class. Instructors will require students to make up any missed coursework and may deny credit to any student whose absences are excessive. Instructors must keep an attendance record for each student enrolled in the course to document attendance and participation in the class.

University Email Policies

Students are expected to check their official UVA email addresses on a frequent and consistent basis to remain informed of university communications, as certain communications may be time sensitive. Students who fail to check their email on a regular basis are responsible for any resulting consequences.

Mid-Term and End-of-Class Evaluations

Students may be expected to participate in an online mid-term evaluation. Students are expected to complete the online end-of-class evaluation. As the semester comes to a close, students will receive an email with instructions for completing this. Student feedback will be very valuable to the school, the instructor, and future students. We ask that all students please complete these evaluations in a timely manner. Please be assured that the information you submit online will be anonymous and kept confidential.

University of Virginia Honor System

All work should be pledged in the spirit of the Honor System at the University of Virginia. The instructor will indicate which assignments and activities are to be done individually and which permit collaboration. The following pledge should be written out at the end of all quizzes, examinations, individual assignments, and papers: "I pledge that I have neither given nor received help on this examination (quiz, assignment, etc.)." The pledge must be signed by the student. For more information, visit www.virginia.edu/honor.

Special Needs

It is my goal to create a learning experience that is as accessible as possible. If you anticipate any issues related to the format, materials, or requirements of this course, please meet with me outside of class so we can explore potential options. Students with disabilities may also wish to work with the Student Disability Access Center to discuss a range of options to removing barriers in this course, including official accommodations. Please visit their website for information on this process and to apply for services online: sdac.studenthealth.virginia.edu. If you have already been approved for accommodations through SDAC, please send me your accommodation letter and meet with me so we can develop an implementation plan together.

About This Syllabus

This syllabus is to be considered a reference document that can and will be adjusted through the course of the semester to address changing needs. It is up to the student to monitor this page for any changes, as this syllabus can be changed without notification. The final authority on any decision in this course rests with the course instructor, not with this document.