Neural Networks & Deep Learning (Spring 2021, DATA 542)

Schedule
This course is being taught asynchronously. You will be able to choose when to engage with each lecture. Labs and tests can be submitted up until the due date.

Instructor
Dr. **Dan** Runfola
danr@wm.edu
ISC 1269
Office Hours: Tuesday 8:00AM to 9:30AM ; (See notes on office hours below)
757.221.1970

Please let me know if you have any documented disabilities that may impact your performance in this class.

Course Description: This course teaches the foundations of Neural Networks and Deep Learning. Students entering into this course should have, at minimum, a background in data preprocessing, cleaning, manipulation, and dimensionality reduction within python. Through an applied learning project, you will learn how to implement a machine learning project from design to implementation in the context of neural networks. Topics we will cover include the basic building blocks of neural networks, RNNs, convolutional networks and computer vision, backpropagation basics and strategies (including inductive transfer approaches), differences between technical implementations (i.e., TensorFlow, Keras, Torch), and more.

Prerequisite(s):

1. **Proficiency in Python.** All class assignments are provided and coded in python.
2. **Basic Statistics.** You should understand distributions, standard deviations, means, and other basic principals. You should be comfortable with basic notation.
3. **Basic knowledge of Machine Learning.** You should have a basic understanding of topics such as cost functions and optimization strategies (i.e., gradient descent).

To achieve the above, we recommend DATA 310 (Applied Machine Learning), **or** a combination of CSCI 241 and an approved statistics or quantitative course as listed in the catalogue. If you believe you have the above knowledge but have not taken those courses, please reach out to the instructor prior to registration.

Credit Hours: 4

Office Hours:
Office hours will be held twice weekly, and anyone can attend them to ask questions. All office hours will be held in a live Google Meet, which will be recorded and posted for other students to see. If you have a question that pertains specifically to you and need a private slot with me, you can schedule a time using the "Schedule a Meeting" link on https://github.com/DanRunfola.

Time Slot A: 8:00AM to 9:30AM, Tuesday. Meet Link: meet.google.com/hrm-yque-ccg
Time Slot B: 11:00AM to 12:35PM, Wednesday. Meet Link: meet.google.com/ijg-riyy-yro

Materials:
A free SciClone account is needed in order to access the William and Mary High Performance Cluster (HPC). Registration can be started at https://hpc.wm.edu/acctreq/ .

Please note this course is exceptionally computationally intensive. If you intend to work on your own laptop, please ensure it has at least a dedicated NVIDIA graphics card with CUDA capabilities. If you do not have a laptop with an NVIDIA graphics card, you should consider the use of online services such as Google's Collaboratory or Paperspace's Gradient. Both provide online access to GPUs - sometimes free of cost. Because online services regularly change, I will not be able to provide support specific to those options.

Discussion & Questions: We will be using Piazza for class discussion. The system is catered to getting you help fast and efficiently from classmates, the TA, and myself. I will be checking Piazza *much* more regularly than my email, so if you have a question it should be your go-to; note you can post questions both anonymously and with your name attached (it's up to you!). If you have any problems or feedback for the developers, email team@piazza.com.
Find our class signup link at: piazza.com/wm/spring2021/data442

Submitting Projects and Assignments: We will be using gradescope.com for assignment submission throughout this course. After you create an account, you will need entry code MZ2R7Y.

Grade Distribution:

Assignment 1	20%
Assignment 2	20%
Assignment 3	20%
Midterm	20%
Final	20%

Letter Grade Distribution:

>= 93.00	A	73.00 - 76.99	C
90.00 - 92.99	A-	70.00 - 72.99	C-
87.00 - 89.99	B+	67.00 - 69.99	D+
83.00 - 86.99	B	63.00 - 66.99	D
80.00 - 82.99	B-	60.00 - 62.99	D-
77.00 - 79.99	C+	<= 59.99	F

Late / Poor Performance Policy: Assignments will not be accepted late, excepting in documented circumstances (i.e., an illness with a doctor's note).

Assignments:
There are three lab assignments you will turn in throughout this course; these assignments will make up 60% of your grade. Each assignment will provide you with a series of challenges to solve using your knowledge of neural networks and machine learning more broadly. You will submit a python file with your solution sets for each assignment; the assignments are by design very challenging, and should take you multiple weeks to complete. You can submit your assignment's python file as many times as you would like to try new solutions; it is highly recommended you get started early.

Midterm and Final: A written midterm and final will test your knowledge of content presented during the course. Both will be worth 20% of your grade.

Important Dates: The add and drop deadline this semester is February 5th, 2021, and withdrawal deadline is March 29th, 2021.

Do not cheat!

Academic dishonesty is taken very seriously. Make sure to cite all of your work, and do not turn in work that is not yours! Cases of academic dishonesty will be evaluated and acted upon in accordance with William and Mary policies, which can be found at http://www.wm.edu/offices/deanofstudents/services/ student-conduct/

Course Outline:
The course outline can be found below. The weekly content might change as it depends on the progress of the class.

Week of	
Jan 25th **What to Watch:** *Lecture 1:* Course Introduction & the History of Deep Learning **What to Work On:** *Lab 0: Making Sure You Understand How You Will Be Graded* Lab 0 is due on Feb 8th, and worth 5 bonus points. **What to Submit:** *No assignments are due this week.*	**1**
Feb 1st **Basics of Image Classification** What is Image Classification? What are the challenges? What are some solutions?	**2**
8th	**3**
15th **Optimization** Loss Functions Separability Stochastic Gradient Descent (SGD)	**4**
22nd	**5**
Mar 1st **Neural Networks** Backpropagation MLP Architecture	**6**
8th	**7**
15th **Convolutional Neural Networks** What is a Convolution? Pooling Relevance to Images	**8**

Week of	
22nd *Assignment 1 due at midnight!*	**9**
29th **Computational and Technical Considerations for Deep Learning** Physical Hardware (CPU, GPU, Tensors) TensorFlow, Keras, Torch Computation graphs	**10**
Apr 5th	**11**
12th **How to Train your Network I** Activation Functions Preprocessing Initialization Normalization	**12**
19th	**13**
26th **How to Train your Network II** Inductive Learning Gradient Checks Update Options Regularization in Nets ...and more!	**14**
May 3rd *Project Proposals Due!*	**15**