T81-558: Applications of Deep Neural Networks
Washington University in St. Louis
Fall 2016, Mondays, 6 - 8:30 PM, Seigle Hall, #109

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This syllabus is subject to change as the semester progresses.

Course Description: Deep learning is a group of exciting new technologies for neural networks. By using a combination of advanced training techniques neural network architectural components, it is now possible to train neural networks of much greater complexity. This course will introduce the student to deep belief neural networks, regularization units (ReLU), convolution neural networks and recurrent neural networks. High performance computing (HPC) aspects will demonstrate how deep learning can be leveraged both on graphical processing units (GPUs), as well as grids. Deep learning allows a model to learn hierarchies of information in a way that is similar to the function of the human brain. Focus will be primarily upon the application of deep learning, with some introduction to the mathematical foundations of deep learning. Students will use the Python programming language to architect a deep learning model for several of real-world data sets and interpret the results of these networks.

Prerequisite(s): None; however, general programming experience is assumed. The Python programming language will be used for this class and reviewed as appropriate. Elements from mathematics (generally at a Calculus I level) will be introduced and explained.

Credit Hours: 3

Text: *Artificial Intelligence for Humans, Volume 3: Deep Learning and Neural Networks*, 1st Edition
Author(s): Jeff Heaton; **ISBN-13:** 978-1505714340 (it is not necessary to purchase volumes 1& 2)

Course Objectives:
At the completion of this course, students will be able to:

1. Explain how neural networks (deep and otherwise) compare to other machine learning models.
2. Determine when a deep neural network would be a good choice for a particular problem.
3. Demonstrate their understanding of the material through a final project.

Grade Distribution:

Class Attendance & Participation	10%
Programming Assignments (4)	40%
Midterm Exam (Takehome)	20%
Final Project	30%

Letter Grade Distribution:

>= 97.00	A+	73.00 - 76.99	C
93.00 - 96.99	A	70.00 - 72.99	C-
90.00 - 92.99	A-	67.00 - 69.99	D+
87.00 - 89.99	B+	63.00 - 66.99	D
83.00 - 86.99	B	60.00 - 62.99	D-
80.00 - 82.99	B-	<= 59.99	F
77.00 - 79.99	C+		

Course Policies:

- **General**
  - **No makeup quizzes or exams will be given.**
  - Grades in the **C** range represent performance that **is below expectations**; Grades in the **B** range represent performance that **meets expectations**; Grades in the **A** range represent work that is **excellent**.
  - Grades will be maintained online. Students are responsible for tracking their progress by referring to the the university's Blackboard system.
- **Programs and Assignments**
  - Students are expected to work independently. **Offering** and **accepting** solutions from others is an act of **plagiarism**, which is a serious offense and **all involved parties will be penalized according to the Academic Honesty Policy**. Discussion amongst students is encouraged, but when in doubt, direct your questions to the professor, tutor, or lab assistant.
  - Programs that fail to compile will not receive a grade higher than 79%. Programs that do not produce the correct output will not receive a grade higher than 89%. Original programs that produce the expected output will always receive 100%. For multi-question programming assignment, each question is evaluated individually.
  - **No late assignments will be accepted under any circumstances**.
- **Attendance and Absences**
  - Attendance is expected and will be taken each class. You are allowed to miss **1** class during the semester without penalty. Any further absences will result in point and/or grade deductions.
  - Students are responsible for all missed work, regardless of the reason for absence. It is also the absentee's responsibility to get all missing notes or materials.

Academic Honesty Policy Summary:

Introduction

In addition to skills and knowledge, COLLEGE/UNIVERSITY aims to teach students appropriate Ethical and Professional Standards of Conduct. The Academic Honesty Policy exists to inform students and Faculty of their obligations in upholding the highest standards of professional and ethical integrity. All student work is subject to the Academic Honesty Policy. Professional and Academic practice provides guidance about how to properly cite, reference, and attribute the intellectual property of others. Any attempt to deceive a faculty member or to help another student to do so will be considered a violation of this standard.

Instructor's Intended Purpose

The student's work must match the instructor's intended purpose for an assignment. While the instructor will establish the intent of an assignment, each student must clarify outstanding questions of that intent for a given assignment.

Unauthorized/Excessive Assistance

The student may not give or get any unauthorized or excessive assistance in the preparation of any work.

Authorship

The student must clearly establish authorship of a work. Referenced work must be clearly documented, cited, and attributed, regardless of media or distribution. Even in the case of work licensed as public domain or Copyleft, (See: http://creativecommons.org/) the student must provide attribution of that work in order to uphold the standards of intent and authorship.

Declaration

Online submission of, or placing one's name on an exam, assignment, or any course document is a statement of academic honor that the student has not received or given inappropriate assistance in completing it and that the student has complied with the Academic Honesty Policy in that work.

Consequences

An instructor may impose a sanction on the student that varies depending upon the instructor's evaluation of the nature and gravity of the offense. Possible sanctions include but are not limited to, the following: (1) Require the student to redo the assignment; (2) Require the student to complete another assignment; (3) Assign a grade of zero to the assignment; (4) Assign a final grade of "F" for the course. A student may appeal these decisions according to the Academic Grievance Procedure. (See the relevant section in the Student Handbook.) Multiple violations of this policy will result in a referral to the Conduct Review Board for possible additional sanctions.

The full text of the Academic Honesty Policy is in the *Student Handbook*.

Course Outline:
The weekly coverage might change as it depends on the progress of the class.

Class	Content
Class 1 08/29/2016	• Python for Machine Learning
Labor Day 09/05/2016	**NO CLASS** - Labor day
Class 2 09/12/2016	• Introduction to TensorFlow • Neural Network & Machine Learning Basics • Assignment: Read Chapter 1
Class 3 09/19/2016	• Training a Neural Network • Assignment: Read Chapters 4 & 5
Class 4 09/26/2016	• Classification & Regression • Assignment: **Program 1 Due**
Class 5 10/03/2016	• Backpropagation • Assignment: Read Chapter 6
Class 6 10/10/2016	• Preprocessing • Assignment: **Program 2 Due**
Fall Break 10/17/2016	**NO CLASS** - Fall Break
10/24/2016	**NO CLASS** - Instructor out of town, presentation posted as makeup.
Class 7 10/31/2016	• Convolutional Neural Networks • Assignment: **Take Home Midterm Due**
Class 8 11/07/2016	• Kaggle Datasets • Evaluating Neural Network Performance
Class 9 11/14/2016	• Regularization and Dropout • Assignment: Read Chapter 12, **Program 3 Due**
Class 10 11/21/2016	• Timeseries and Recurrent Neural Networks • Assignment: Read Chapter 13
Class 11 11/28/2016	• Architecting Neural Networks • Assignment: Read Chapter 14
Class 12 12/05/2016	• Application of Neural Networks • Assignment: **Program 4 Due** (submitted on Kaggle.com)
Class 13 12/12/2016	• Neural Network Ensembles • GPU, HPC and Cloud