Utah State University
Deep Learning Neural Networks
Syllabus – Fall 2017

Course Title: Deep Learning Neural Networks

Instructor: Todd K. Moon

Office: EL 154

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Class Time: MWF 2:30–3:20, EL 109

Office Hours: MWF 9:30–10:30. Other hours by appointment.

Prerequisite: A background in probability and linear algebra.

Textbook: *Deep Learning*, by Ian Goodfellow, Yoshua Bengio, Aaron Courville.

Homework/Programming: There will be regular homework and programming assignments. weekly. It is your responsibility to make sure that you do it and understand the concepts.

A great deal of learning can be accomplished by programming algorithms and testing them for yourself. **Python** is to be used for all programming assignments.

Late Policy: Absolutely no late work will be accepted without *prior* consultation with the instructor. Work that is not turned in on time without approval will not be scored.

Cheating: Don't do it! The instructor reserves the right to fail any student who can be justifiably accused of cheating.

Disabilities: In cooperation with the Disability Resource Center, reasonable accomodation will be provided for qualified students with disabilities. Please meet with the instructor during the first week of class to make arrangements. Alternate format print materials (large print, audio, diskette or Braille) willl be available through the Disability Resource Center.

Students should write their own programs. (See below.)

Exams: The scheduled final exam date is Wednesday, December 16, at 9:30.

Reading

The textbook *Deep Learning* is an excellent resource, and you would be cheating yourself by not digging into it deeply. There is so much in it that we will not be able to cover it all in class, so I will be relying on your maturity and integrity to do a lot of the learning by reading. This will be especially true at the beginning of the semester as you gain perspective on the field of machine learning.

I will also be relying on your understanding of the prerequisite material of linear algebra and probability presented in chapters 2 and 3. We will not be going these chapters over these formally in class, but will simply make use of the results as we proceed through the semester. I expect to be able to use these concepts without apology.

Programming, Python, and TensorFlow

Ultimately, the TensorFlow machine learning package will be used in the class. This is a widely-used neural network software toolkit, developed by google.

TensorFlow is built on the Python Language. As a result, it is necessary to be familiar with Python in this course.

TensorFlow is described at `tensorflow.org`. There are tutorial pages that will be part of the class reading requirements.

Despite these tutorials, the TensorFlow page does not really describe the art and science of neural networks. In order for you to understand and internalize how neural networks actually work, you will be implementing neural network algorithms of your own before turning to TensorFlow. You will be implementing a linear classifier (perceptron) as well as a multilayer neural network trained using backpropagation. Because you will need to be familiar with Python to run TensorFlow (and because Python is a good language to be able to put on your resume), **these programming assignments must be done in Python**.

You will need to download a Python distribution onto your own machine. There are many Python distributions. I recommend the one available at `continuum.io`. They have a free download that comes with all the most commonly-used packages, including `numpy` and `matplotlib`. (I think I recommend Python Version 3.6, but I'm not sure. Python versioning is a dark science.) Once you have downloaded the their distribution (which they call `anaconda`), I recommend using the `spyder` application. This is an `yPython` console, which means that it has command line history and generally functions as an IDE for Python.

If you are not familiar with the Python language, there are a number of ways to learn. You can go to `wiki.python.org` and see a list of a large number of tutorials. Also, I have posted the beginnings of a Python tutorial (still incomplete) on the class website.

You will also need to download the TensorFlow package. This is available at `tensorflow.org`.

Programs should all be done on an individual basis, though of course you may assist each other. This means: *You are to write your own code.* Any line of code that you turn in should be written by you, or be part of that code provided by the instructor. You should not be downloading program code from the web, nor taking lines of code from people in this class.

When you work together, that means that you work out ideas together to come to understand them. However, when you sit down to write code, the code you write must be your own!

Any evidence that this policy has not been followed will result in a score of 0 on that programming assignment. If there is evidence of a second violation, the student will be flunked from the class.

Course Outline

The following outline is subject to change.

- Overview: What are neural networks?

- The linear classifier. The perceptron. (And some review of some pattern recognition, linear algebra and optimization.)
- Review of probability: Pattern Recognition
- Gradient based optimization
- Machine learning basics
  - Learning algorithms
  - Overfitting, underfitting
- Deep feedforward networks.
- Regularization for deep learning
- Convolutional networks
- Recurrent and Recursive Nets
- TensorFlow
- Research topics. May include linear factor models, autoencoding, representation learning, Monte Carlo methods, Boltzmann machines, generative models.

Grading

Grades will be based on homework, programming exercises, including exercises with TensorFlow, a midterm, and a final.

The scores will be weighted as follows:

Homework/Programming	65 %
Midterm	15 %
Final	20 %

Grades are according to the following scale:

A	$\geq 93\%$
A-	$\geq 90\%$
B+	$\geq 87\%$
B	$\geq 84\%$
B-	$\geq 80\%$
C+	$\geq 77\%$
C	$\geq 74\%$
C-	$\geq 70\%$
D+	$\geq 67\%$
D	$\geq 64\%$
D-	$\geq 60\%$
F	$< 60\%$