**Outline for Deep Learning Course**

**Machine Learning 410**

**January, 2018**

1. **Lesson 1: Introduction to Deep Learning**
   1. What is deep learning and why do we care?
   2. Why is representation so important in AI?
   3. Introduction to feed forward networks.
   4. Introduction to loss functions
   5. Activation functions
   6. Introduction to back propagation and the chain rule
   7. Introduction to Keras and working with tensors
   8. Homework/lab: Regression with a deep feed forward network
2. **Lesson 2: Regularization for Deep Learning**
   1. Overfitting and Regularization
   2. L1 and L2 regularization
   3. Early stopping
   4. Dropout regularization
   5. Loss functions and information theory
   6. Measuring convergence with Keras
   7. Deep network architecture, depth vs. width
   8. Homework/lab: Sentiment analysis with IMBD reviews
3. **Lesson 3: Optimization for Deep Learning**
   1. Gradients and optimization
   2. Second order methods
   3. Adaptive optimization methods
   4. Scaling and stochastic gradient decent
   5. RMSProp
   6. Homework/lab: TBD
4. **Lesson 4: Convolutional Neural Nets and Images Part 1**
   1. Representation in neural nets
   2. Introduction to convolution operators
   3. Pooling
   4. Semi-supervised learning
   5. Working with images in Keras
   6. Homework/lab: MNIST classification
5. **Lesson 5: Convolutional neural nets and images Part 2**
   1. Convolutional architectures
   2. Using pre-trained convolutional networks
   3. Dropout for convolutional networks
   4. Visualization of convolutional networks
   5. Deep convolutional architectures
   6. Homework/Lab: Cat and dog identification with regularization
6. **Lesson 6: Recursive Neural Nets and Time Series**
   1. Introduction to recursive neural nets
   2. Recurrent NN architectures
   3. Working with time series data
   4. Text analysis with recursive neural nets
   5. Dropout regularization for recursive neural nets
   6. Homework/Lab: Predicting bicycle demand
7. **Lesson 7: Deep text analytics**
   1. Bi-directional recursive neural nets for text
   2. Embedding models for text
   3. Convolutional neural nets for text
   4. Homework/Lab: Classification of news articles
8. **Lesson 8: Practical considerations and Advanced Architectures**
   1. Using Tensor Board to visualize deep neural networks
   2. Avoiding vanishing gradients
   3. Renormalization in deep networks – Batch normalization
   4. Searching hyperparameter space
   5. Auto encoders (optional)
   6. Keras API and non-sequential models
   7. HomeworkLab:
9. **Lesson 9: Deep Reinforcement Learning**
   1. Introduction to reinforcement learning
   2. Markov processes
   3. The Bellman equations
   4. Reward functions and state-value
   5. Q learning
   6. Deep Q Learning and function approximation
   7. Double Deep Q Learning
10. **Lesson 10: Applications of Deep Learning or Intro to Tensor Flow?**