Knight Foundation School of Computing and Information Sciences

Course Title: Advanced Topics in Machine Learning **Date:** 11/01/2019

Course Number: CAP 6619

Number of Credits: 3

Subject Area: Intelligent Systems	**Subject Area Coordinator:** **email:**
Catalog Description: Advanced course on machine learning principles and techniques. Students propose, implement, and present a collaborative project with advanced machine learning techniques.	
Textbook: Ian Goodfellow, Yoshua Bengio, and Aaron Courville. ***Deep Learning***. The MIT Press, Cambridge, Massachusetts, 2016.	
References: Articles from relevant Journals and Conferences.	
Prerequisite Courses: CAP 5610	
Corequisite Courses: None	

Type: Elective

Prerequisite Topics:

- Calculus
- Linear Algebra
- Introductory Machine Learning
- Introductory Statistics concepts
- Basic Programming (e.g., Python, MATLAB or R)

Course Outcomes:

Students who successfully complete this course will be able to:

1. Describe and explain a selection of concepts, algorithms and models used in deep learning to solve real-world problems;
2. Apply the most established deep learning algorithms;
3. Formulate a deep learning problem from scratch and utilize appropriate machine learning algorithms to solve the formulated problem;
4. Describe techniques that are believed to be important for future research;
5. Identify and explain metrics for optimizing deep models.

Outline:

Topic	Number of Lecture Hours (Total: 37.5 hours = 15 weeks * 2 lectures/week * 1.25 hrs/lecture)	Outcome
1. Machine Learning Basics: Supervised and unsupervised learning; Overfitting and underfitting; Hyper parameters and validation sets; Stochastic gradient descent.	2	1
2. Deep Feedforward Networks: Architecture Design; Hidden units; Back propagation.	2	1, 2
3. Regularization for Deep Learning: Norm penalties; noise robustness; early stopping; sparse representation; dropout; adversarial training.	2	1, 3, 5
4. Optimization for Training Deep Models: Challenges in neural network optimization; Parameter initialization strategies; Algorithms with adaptive learning rates.	2	5
5. Convolutional Networks: Convolution operation; Variants of convolution function; Efficient convolution algorithms; Neuroscientific basis for convolutional networks	3	1, 2, 3, 5
6. Sequence Modeling: Recurrent neural networks; Recursive neural networks, Long Short-Term Memory and Other Gated RNNs.	4	1, 2, 3, 5
7. Practical Methodology: Performance Metrics; Default Baseline Models; Selecting Hyperparameters; Debugging Strategies;	2	3,5
8. Applications of Established Deep Learning: Computer Vision; Speech Recognition; Natural Language Processing.	2	2, 3
9. Linear Factor Models: Probabilistic PCA and Factor Analysis; Independent Component Analysis.	3	1, 4
10. Autoencoders: Regularized Autoencoders; Denoising Autoencoders; Contractive Autoencoders.	3	1, 4
11. Deep Generative Models: Boltzmann Machines; Restricted Boltzmann Machines; Deep Belief Networks; Deep Boltzmann Machines; Boltzmann Machines for Real-Valued Data; Convolutional Boltzmann Machines; Directed Generative Nets; Evaluating Generative Models.	5	4, 5