Outline of a proposed graduate course on Deep Learning and its hands-on practice

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Title of the course: Stat 601.28: An Introduction to Deep Learning with applications in Tensorflow

Learning objectives: To meet the emerging interest of using deep learning in data analysis, this course will provide an opportunity to learn basic theories underlying deep learning with more emphasis on hands-on practice using standard libraries such as TensorFlow. After this course, students will achieve a comprehensive knowledge and skills the following: (1) General principles of deep learning theory; (2) Building blocks and design philosophy of TensorFlow; (3) How to implement frequently used DL models (e.g., CNN, RNN, etc.); (4) How to use DL to analyze high-dimensional data and the related skills such as hyperparameter tuning and regularization.

Prerequisites: Experience in any programming language (preferably Python, but not required); Math 213, Math 267, Stat 323 or equivalent.

Textbook: Goodfellow *et al*. Deep Learning. (https://www.deeplearningbook.org)
Francois Chollet. Deep Learning with Python.

Outline of the materials:

Block 1: Python and its coding conventions
- Overview of the Python language
- Coding conventions of Python
- TensorFlow and Keras

Block 2: Mathematical building block of neural networks
- Neural Network basics: cost function, gradients, forward and backward propagation
- Parameters and Hyperparameters
- Regularization
- Optimization

Block 3: Convolutional Neural Network
- Convolutional Neural Networks basic
- CNN architectures
- Object Detection

Block 4: Sequence Model &
- Recurrent Neural Networks intro
- Long Short Term Memory
- Overview of NLP

Block 5: Explainable AI
- SHAP, LIME
- Counterfactuals /Adversarial Attacks
- Layer-wise relevance Propagation