Deep Learning Spring 2024

Course Outline

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| Class Hours  **Thu**:  3:00 pm --- 5:30 pm,  Location Room:5  Office Hours and Contact Info.  **Faculty Name: Dr. Muhammad Safyan**  email: safyanch@gcu.edu.pk  **Teaching Assistant 1: TBA** | Course Basics  Core Course  Credit Hours: 3  Being offered MSCS  Practical and hands-on approach  5 to 6 programming assignments  Prerequisite  Enthusiasm, Energy and Imagination  Data Structures, Probability & Statistics, Linear Algebra and Basic Calculus  Programming skills and desire to read & implement. |

**Course Overview**

The focus of this course will be on fostering proficiency in both mathematical understanding and practical implementation. The journey begins with training a single perceptron, progressing to the training of deep neural networks. We delve into the challenges posed by training large networks and explore potential solutions. Exploring deep belief networks and recurrent neural networks, we then shift our attention to applications in computer vision, text processing, and speech processing. The overarching goal is to build your comfort and competence, enabling you to comprehend diverse research problems and, if inclined, proficiently implement applications based on deep learning principles..

**Course Objectives**

This deep learning course aims to provide participants with a comprehensive understanding of fundamental concepts and practical skills in deep neural networks. Students will explore various architectures, optimization techniques, and applications of deep learning in real-world scenarios. The course emphasizes hands-on experience through coding exercises, enabling participants to build and train neural networks. By the end, learners should be proficient in designing, implementing, and deploying deep learning models for tasks such as image recognition, natural language processing, and more. The goal is to equip participants with the knowledge and skills required to leverage the power of deep learning in diverse fields.

**Tentative Grading Policy**

* 20% Assignments
* 10% Quizzes
* 20% Midterm Exam
* 40% Final Exam

**Honor Code**

All cases of academic misconduct will credit Zero Mark. All assignments are to be done

**Tentative and Rough Course Outline**

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| **Weeks** | **Topics** | **Evaluations** |
| 1 | **Introduction to Deep Learning**  Difference between Machine Learning and Deep Learning  Basic Machine Learning: Linear & Logistic Regression,  Miscellaneous concept of ML, Evaluation Parameter form ML/DL Model |  |
| 2 | **Supervised Learning with Neural Networks**  Deep Learning, Single and Multi-Layer Neural Networks, , Gradient Descent, Backpropagation, Loss Functions  *Tutorial 1: Python/Numpy Tutorial* | Assignment 1 |
| 1 | **Hyper parameters tuning, Regularization and Optimization**  Parameters vs Hyper parameters, Why regularization reduces overfitting? Data Augmentation, Vanishing/Exploding gradients, Weight Initialization Methods, Optimizers  *Tutorial 2: Building a Linear Classifier* | Assignment 2 |
| 2 | **Convolutional Neural Networks**  Convolutional Filters, Pooling Layers, Classic CNNs: AlexNet, VGG, GoogleNet, ResNet, DenseNet. Inception Net Transfer Learning  *Tutorial 4: CNN Visualization* | Assignment 3 |
| 2 | **Deep Learning for Vision Problems**  Object Localization & Detection, Bounding box predictions, Anchor boxes, Region Proposal Networks, Detection Algorithms: RCNN, Faster RCNN, Yolo, SSD.  *Tutorial 5: Caffe & Object Detection* |  |
| 2 | **Sequence Models**  Recurrent Neural Networks (RNN), Gate Recurrent Unit (GRU), Long Short Term Memory (LSTM), Bidirectional RNN, Backpropagation through time. Image Caption Generation, Machine Translation, Text Generation & Summarization  *Tutorial 6: Image Captioning & Text Generation* | Assignment 4 |
| 1 | **Auto-Encoders & Generative Models**  Variational Auto-Encoders, Stacked Auto-Encoders, Denoising Auto-Encoders, Concept of Generative Adversarial Networks (GANs) | Assignment 5 |
| 3 | **Miscellaneous(if Time**  Capsule Networks, Convolutional LSTM, Attention Networks, Restricted Boltzmann Machine, One Shot Learning, Siamese Networks, Triplet Loss, Graph CNN, Approximate and Energy Efficient Design for Deep |  |

**Text Book**

* Text Book: Deep Learning by Ian Goodfellow

**Recommended Readings**

There is not assigned textbook, however following are recommended for reading.

* Book: <http://neuralnetworksanddeeplearning.com/>
* Courses
  + Machine Learning, Oxford – Nando de Freitas
  + Deep Learning for Natural Language Processing, Stanford
  + Convolutional Neural Networks for Visual Recognition, Stanford
  + A curated list of courses (Recommended)
  + Stanford Deep Learning Tutorial