Course Outline - Machine Learning (CSE 445)
Section 1
Department of ELectrical and Computer Engineering
North South University

Spring 2022

Instructor:	Dr. Sifat Momen	**Time:**	MW 9:40 - 11:10
Email:	sifat.momen@northsouth.edu	**Place:**	online/hybrid

Textbook:

1. Hands-on Machine Learning with Scikit-Learn, Keras & Tensorflow: Concepts, Tools and Techniques to Build Intelligent Systems by *Aurélien Géron*, O'REILLY, 2019.
2. Machine Learning by *Tom M. Mitchell*, McGraw-Hill Education, 1^{st} edition, 1997.

References:

1. Introduction to Machine Learning with Python: A guide for Data Scientists by *Andreas C. Müller & Sarah Guido*, O'Reilly Media, 1^{st} edition, 2016.
2. Hands-on Explainable AI (XAI) with Python: Interpret, visualize, explain and integrate reliable AI for fair, secure, and trustworthy AI apps by *Denis Rothman*, Packt Publishing Ltd., July 2020.

Objectives: This is a foundation course on Machine learning. After completing this course successfully, a student should have deep insights on machine learning concepts and will have the knowledge of applying machine learning in understanding and forecasting data. Students will gain practical knowledge of how to collect, pre-process and apply ML algorithms. Students will have profound understanding on the classification of learning: Unsupervised and supervised learning, Connectionist learning and Reinforcement learning. Students will learn different classification and regression algorithms including decision tree induction, KNN, naïve bayes algorithm, support vector machine, linear regression, logistic regression and artificial neural network. Ensemble learning techniques will also be covered in substantial details. Unsupervised learning algorithms for clustering such as K-means and dbscan will be explored in this course. Feature selection and feature engineering will also be covered extensively in this course. Students will get pragmatic tips on machine learning issues including dealing with imabalance data, tackling overfitting of model on training data, tackling curse of dimensionality and understanding the bias variance tradeoff. Finally, students will learn about techniques pertaining to model interpretability.

Prerequisites: It is expected that students pursuing this course have a mature level of understanding in algorithms, linear algebra and probability & statistics.

Tentative Lecture Sequence:

- Introduction to Machine learning and Concept learning
- Data Quality, Data Visualization and Data Pre-processing Techniques
- Introduction to classification problem, zeroR and oneR classifier, confusion matrix
- Decision tree induction and tackling overfitting of the model on the dataset
- Strategies of testing & training
- Performance metrics for classification problem
- Feature selection and engineering
- Instance based learning
- Naive Bayes Classifier
- Linear Regression
- Ridge and Lasso Regression
- Bias and Variance
- Handling imbalanced dataset
- Logistic Regression
- Support Vector Machine
- Introduction to unsupervised learning, partitional and hierarchical clustering
- K-Means Clustering Algorithm
- Ensemble learning & Random Forest, Bagging and Boosting
- Hyperparameter Optimization
- Adaboost
- Artificial Neural Network
- Dimensionality Reduction
- Mixture models and EM (optional)
- Explainable ML Techniques

Assessment weights: Assignment (5%), Quiz (10%), Midterm (25%), Final (30%), Project (30%).

N.B.: One of the deliverables of the project is a paper. More details regarding paper template and submission will be given later. The paper has to written using LaTeX.

Course Policy:

- In no way, there will be any makeup of final exam.
- In case of an absolute emergency, if a student misses the midterm exam, a proper application, backed up by supporting documents, has to be provided. After careful inspection, if I feel that this can be approved, then an arrangement of makeup exam will be made. However, a student will incur a 20% penalty for this.
- Failure to submit the project will result in an **F** grade.
- Lack of knowledge of academic honesty policy is not a reasonable explanation for a violation. Exhibiting any kind of academic dishonesty will not be condoned and will be dealt strictly.