ECE 457B
Fundamentals of Computational Intelligence
Winter Term

Instructor:
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Schedule:
Mondays and Fridays: 10:00 am-11:20 am

Course Description:
The course discusses fundamentals and recent advances made in the field of computational intelligence. The course focuses on highlighting the latest tools of machine learning and approximate reasoning for building accurate models based either on collected data or past experiential knowledge stored in the form of rule base. The course covers fundamental aspects of machine learning for building model prediction and powerful classifiers. It highlights concepts in supervised and unsupervised learning, artificial neural networks, deep learning, feature extraction, feature selection, dimensionality reduction, classification and clustering, support vector machines. It also tackles aspects related to approximate reasoning based on fuzzy set theory to build reliable and easily interpreted inference engines when data is scarce. Various performance metrics will be studied to assess the validity of the produced models. Throughout the course, multiple examples and case studies are provided in significant application domains, from autonomous driving to intelligent manufacturing, from natural language understanding to speech recognition and computer vision, from stock market prediction to disease early detection and diagnosis.

Prerequisite Material:
Linear algebra, advanced calculus, discrete mathematics, Boolean algebra or equivalent, optimization.

Material for the Course:
All material related to the course (lectures, assignments, other pertinent documents) and updates are posted on LEARN. Lectures are taught on Team

Course Textbooks (nice to have but not mandatory):
Machine Learning, S. Marsland, 2nd Edition, CRC Press, 2015

Dive into Deep Learning, A. Zhang, Z. Lipton, M. Liu, and A. Samola, Release.16.0, 2021

Computational Intelligence: A Methodical Introduction, R. Kruse, C. Borgelt, C. Braune, 2nd Edition, Springer, 2016

Soft Computing and Intelligent Systems Design, F. Karray and C. de Silva, Addison Wesley Pub. 2004

Other pertinent readings will be posted online (on Learn platform) on regular basis.

Main Topics:
The course will be divided in modules. Approximate duration of various modules is provided below:

1. Overview on machine learning using connectionist modelling: learning and acquisition of knowledge, features of neurocomputing; supervised vs unsupervised, reinforcement learning (one week and half)
2. Concepts in data preparation, feature selection, dimensionality reduction (one week)
3. Major classes of artificial neural networks for classification, clustering and regression: from simple structures to multilayer neurons, kernel-based networks, self-organizing maps, support vector machine, performance metrics (two weeks and half)
4. Deep learning and applications (two \ weeks)
5. Fuzzy set theory, generalized fuzzy operations and composition of relations (one week and half)
6. Approximate reasoning, fuzzy logic decision-based systems (one week and half)

Course Marking Scheme:

- Assignments (45 %: (1)15%, (2)15%, (3)15%): Three assignments (Dropbox submission).
- Three quizzes (55 %: (1)15%, (2)15%, (3) 25%): Held on Learn's Quizz platform

Turnitin:
Text matching software (Turnitin®) will be used to screen assignments in this course. This is done to verify that use of all materials and sources in assignments is authentic. Students will be given an option if they do not want to have their assignment screened by Turnitin®.

Attendance:
The instructor encourages students to attend regularly the lectures and the tutorials (whether taught online or in person).