Neural Network Methods for Signals in Engineering and Physical Sciences

Phys 427/EE ???, Spring 2022

Instructors: Shih-Chieh Hsu and Eli Shlizerman

Description:

This course provides a practical introduction to neural networks, and hands-on analysis of signal data common in engineering and physical sciences.

Learning goal:

Students will acquire skills to use industry standard tools (git, Scikit-learn, TensorFlow) to build appropriate neural network models and solve data-driven analysis in engineering and physical sciences. Students will apply these skills to cutting-edge research data, and design their own neural network models to conduct a final project.

Credits: 4

Weekly meetings: 2 hour lectures plus 2 hour lab

Intended students: Physics, ECE, or AMath majors

Prerequisites: Python computing (ASTR300, AMATH 301, EE 241, CSE160, STAT180)

Textbook: To be decided

Resources: free Google Colab, or available computing resources from UW

Syllabus:

Part I - Introduction to Neural Networks Methods

Week1: Intro to Neural Networks (Lecture), Pytorch environment (Lab)

Week2: Machine Learning Practices and Problems (Lecture), Scikit-learn (Lab)

Week3: Deep Learning Practices (Lecture), Training Fully Connected Neural Networks (Lab)

Week4: Convolutional Neural Networks (Lecture), Image Classification with MNIST (Lab)

Week5: Sequence Models - Intro to Recurrent Neural Networks (Lecture), Training Recurrent Neural Networks (Lab)

Week6: Data Analysis and Modeling of Sequences (Lecture), Analysis: FFT, denoising (Lab)

Week7: Data Analysis and Modeling of Sequences with Neural Networks (Lecture), Examples from NLP, Population Dynamics (Lab)

Part II - Applications to Signals Data

Week8: Particle Physics Data, Gravitational Wave Data

Week9: Multi-messenger Astrophysics Data, Analysis of Neural Recordings

Week10: Project Report