

# Neural Network Methods for Signals in Engineering and Physical Sciences

PHYS 417 Spring 2023

Time & Room: TBD

Instructor: Shih-Chieh Hsu

Prerequisites: Python skills at an equivalent level as CSE160, STAT180, EE 241, ASTR 300, AMATH 301 or PHYS 434.

This course provides a practical introduction to Neural Networks, and their applications in the analysis of signal data common in engineering and physical sciences. Students will build computational skills for training neural networks, understanding, and working with modern algorithms: Convolutional Neural Network, Recurrent Neural Network. The course will conclude with projects developing Neural Network models to solve data analysis problems from the frontier of science including High Energy Physics, Multi-messenger Astrophysics and Neuroscience.

Topics to be covered including:

1. Part I: Introduction to Neural Network Methods (Week 1-4)
  - a. Machine Learning, python, numpy and Matplotlib
  - b. Neural Network and PyTorch
  - c. Deep Learning
  - d. Convolutional Neural Networks
2. Part II: Sequence Models (Week 5-7)
  - a. Recurrent Neural Networks
  - b. Data Analysis and Modeling of Sequences
  - c. Sequence Data Analysis with Neural Network
3. Part III: Applications to Science and Engineering Signal (Week 8-10)
  - a. Particle physics - LHC data
  - b. Multi-messenger Astrophysics - Gravitational Wave data
  - c. Neuroscience - Brain tumor data

Students will use industry-standard tools (Git, Python, PyTorch) to work on weekly lab assignments and form a team of two to apply the techniques studied in class to real-world scientific datasets.