Week 2

Challenges

ECE 410/510
Spring 2025

Instructions:

- The challenges below are for you to delve deeper into the subject matter and to test your own knowledge.
- Try to solve at least one problem per week. More is obviously better.
- Practice "vibe coding" if necessary.
- Post your solution(s) in the `#weekly-challenges` Slack channel so everybody can appreciate what you did, ask questions, and make comments.
- Document everything for your portfolio and make your code available on Github.

Challenge #6

1. Implement a simple neuron (a.k.a. perceptron) with two inputs and a sigmoid activation function. Hints: https://machinelearningmastery.com/a-gentle-introduction-to-sigmoid-function
2. Use the perceptron learning rule (Google or LLM it) to train the neuron to realize the following binary logic functions:
    a. NAND
    b. XOR
3. Good video resources:
    a. A Gentle Introduction to Neural Networks: https://www.youtube.com/watch?v=b7oYqAlX_Bo
    b. But what is a neural network? https://www.youtube.com/watch?v=aircAruvnKk

Challenge #7

1. Visualize the learning process in a 2D-plane by representing the neuron's "line" that separates the space.
2. You can turn that in an animated visualization that illustrates every step of the weight updating process as you apply the perceptron rule.

Challenge #8

1. Implement a multi-layer feed-forward perceptron network. The network should have two input neurons, two hidden neurons, and one output neuron. Hints: https://machinelearningmastery.com/neural-networks-crash-course
2. Implement the backpropagation algorithm to train your network to solve the XOR logical function.