

Homework Assignment 4

Due May 2, 2025

- Submit your answers for **Problems 1-3** in a PDF document.
 - For **Problem 4**, submit your **Python code** along with **graphs** of your results and a short discussion on what you observed in each problem.
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1) Perceptron Model Calculation (Hand Calculation)

- Given a simple perceptron with weights $w_1 = 2$, $w_2 = -3$, $w_3 = 1.5$ and input values $x_1 = 1$, $x_2 = 0$, $x_3 = 1$, calculate the output assuming the threshold is **0**. Use the perceptron rule:
 - **Output** = 1 if the weighted sum is greater than the threshold, otherwise **0**.

2) Activation Functions (Hand Calculation)

- For a neuron with input $x = 1.0$ and weight $w = 2.5$, calculate the output using:
 - **Sigmoid Activation Function:**
 - **ReLU Activation Function:**
 - **Tanh Activation Function:**

3) Design a Neural Network Topology (Conceptual)

- Design a neural network to classify whether a person should attend a music festival. The inputs are:
 - Weather forecast (good or bad)
 - Availability of tickets (yes or no)
 - Friends attending (yes or no)
- Specify the number of inputs, weights, activation function, and output for this simple model.

4) Smallest Neural Network for MNIST Classification (Python Implementation)

- Your task is to design the smallest possible neural network with a single hidden layer that can classify the MNIST handwritten digits with at least **92% accuracy** for the MNIST TEST dataset.
- Calculate the number of floating point operations (meaning number of multiplications and additions) your neural networks requires to generate a single output. We have gone over this in class, so use the same approach we did there.

- **Requirements:**

- Use python based on the code developed in the labs to implement your model.
- The network should contain a **single hidden layer** and output predictions for **10 classes** (digits 0-9).
- The network should be trained on the **MNIST** dataset.

- Report the architecture you used, including the size of the hidden layer, what activation functions, and the achieved accuracy.

Good luck, and feel free to ask questions during office hours or on the discussion board if you get stuck!