COMP 4107: Neural Networks – Assignment 1 – Winter 2026 –

Due: January 28, 2026

Group 51
Andrew Wallace - 101210291
Christer Henrysson - 101260693
Amr Altaweel -

Getting started

Instructions:

`Insert any instructions here`

Question 1 [10 marks]

Please see `assignment1.py` for implementation of `artificial_neuron`.

Question 2 [10 marks]

Please see `assignment1.py` for implementation of `gradient_descent`.

Question 3 [10 marks]

Please see `assignment1.py` for implementation of `pytorch_module`.

Question 4 [10 marks]

(a) Gradient Descent I

We are given the function:

$$f(a,b) = \frac{1}{2}((ax_1 + b - y_1)^2 + (ax_2 + b - y_2)^2) \tag{1}$$

Assuming x_1, x_2, y_1, y_2 are constants, the derivative (gradient) of f is as follows:

$$\nabla f(a,b) = \begin{bmatrix} \frac{\partial f}{\partial a} \\ \frac{\partial f}{\partial b} \end{bmatrix}$$

$$\frac{\partial f}{\partial a} = \frac{1}{2}\frac{\partial f}{\partial a}(ax_1 + b - y_1)^2 + \frac{1}{2}\frac{\partial f}{\partial a}(ax_2 + b - y_2)^2$$

$$\frac{\partial f}{\partial a} = x_1(ax_1 + b - y_1) + x_2(ax_2 + b - y_2)$$

$$\frac{\partial f}{\partial b} = \frac{1}{2}\frac{\partial f}{\partial b}(ax_1 + b - y_1)^2 + \frac{1}{2}\frac{\partial f}{\partial b}(ax_2 + b - y_2)^2$$

$$\frac{\partial f}{\partial b} = (ax_1 + b - y_1) + (ax_2 + b - y_2)$$

$$\nabla f(a,b) = \begin{bmatrix} x_1(ax_1 + b - y_1) + x_2(ax_2 + b - y_2) \\ (ax_1 + b - y_1) + (ax_2 + b - y_2) \end{bmatrix}$$

Below are the parameters and results from our experiment:

- $\nabla f(a,b) = \begin{bmatrix} x_1(ax_1 + b - y_1) + x_2(ax_2 + b - y_2) \\ (ax_1 + b - y_1) + (ax_2 + b - y_2) \end{bmatrix}$
- $x_1 = 3$
- $x_2 = -2$

- $y_1 = 0.5$
- $y_2 = -0.75$
- Initial guess $= x_0 = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$
- Learning rate = alpha $= \alpha = 0.05$
- Value of a at minimum $= 0.2499956502209206$
- Value of b at minimum $= -0.249951760210792$
- Minimum value for $f = 2.2402285941984945 \times 10^{-9}$