

# Short Assignment 4 - Solutions

## Problem 1 (2.5 points)

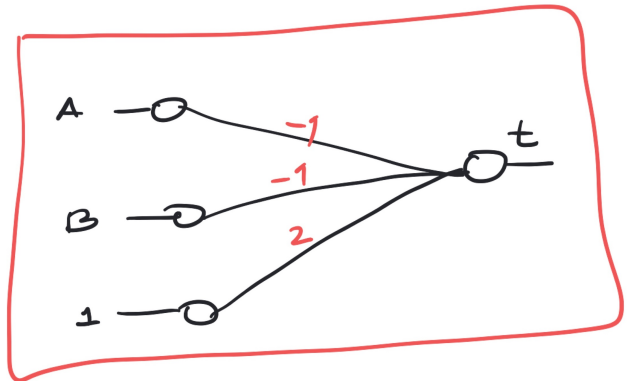
Draw a Perceptron to implement the NAND gate  $\overline{A \cap B} = \overline{A} \cup \overline{B}$  using the threshold activation function  $\phi(x) = \begin{cases} 1, & x > 0 \\ 0, & x \leq 0 \end{cases}$ .

```
In [1]: from IPython.display import Image
        Image('figures/nand_gate.jpg', width=800)
```

Out[1]: NAND

$$t = \overline{A \cap B} = \overline{A} \cup \overline{B} \equiv \text{NOT } A \text{ OR NOT } B$$

A	B	$\overline{A \cap B}$
0	0	1
0	1	1
1	0	1
1	1	0



$$t = \phi(-A - B + 2)$$

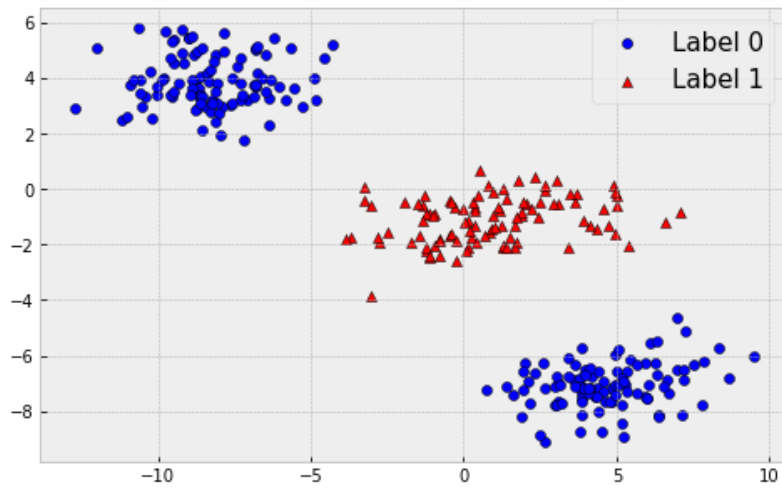
$$\text{where } \phi(x) = \begin{cases} 1, & x > 0 \\ 0, & x \leq 0 \end{cases}$$

## Problem 2 (5 points)

Consider the following two-dimensional data set and desired values for a two-class classification problem:

```
In [2]: Image('figures/classification.png', width=400)
```

Out[2]:

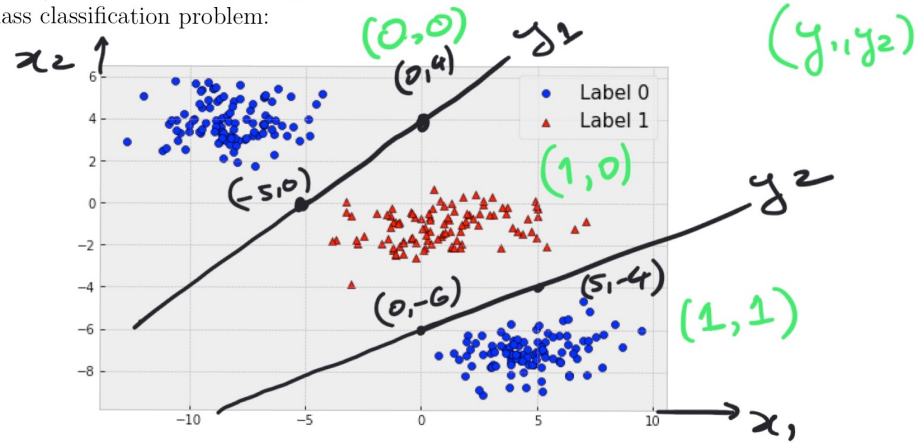


For the hard-limit activation function  $\phi(x) = \begin{cases} 1, & x > 0 \\ 0, & x \leq 0 \end{cases}$ , define a neural network structure and the associated parameter values that can solve this classification problem with zero error on this dataset.

In [3]: `Image('figures/MLP-solution.jpg',width=800)`

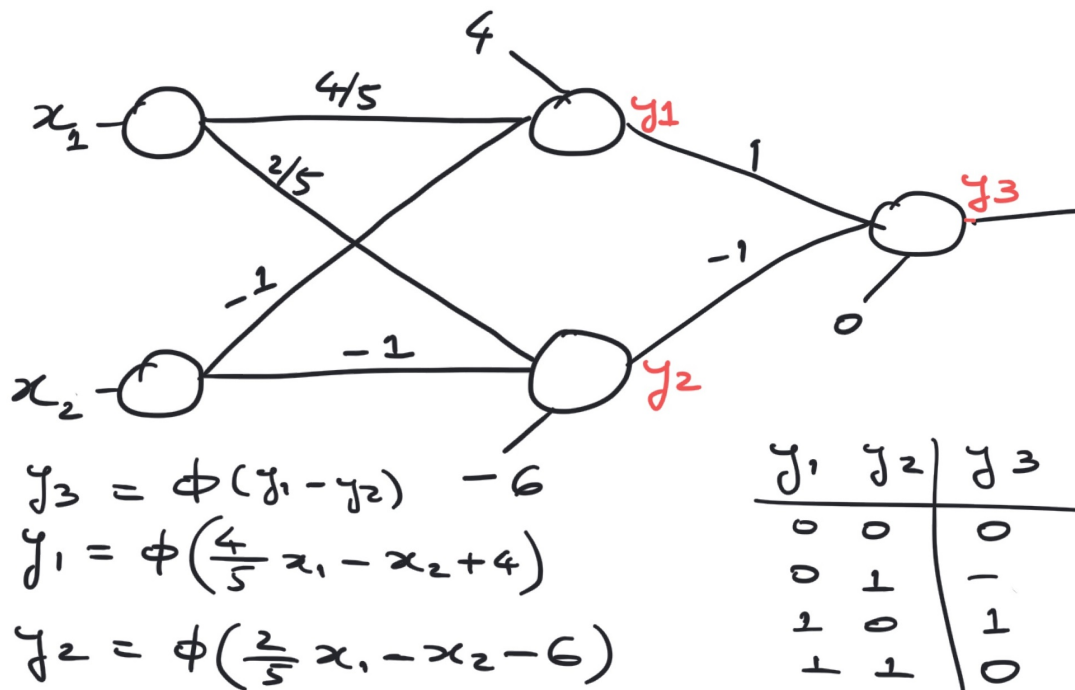
Out[3]:

6. (15 points) Consider the following two-dimensional data set and desired values for a two-class classification problem:



For the hard-limit activation function  $\phi(x) = \begin{cases} 1, & x > 0 \\ 0, & x \leq 0 \end{cases}$ , define a neural network structure and associated parameter values that can solve this classification problem (with zero error on this data set).

$$x_2 = \frac{4}{5}x_1 + 4 \quad \text{and} \quad x_2 = \frac{2}{5}x_1 - 6$$



## Submit Your Solution

Confirm that you've successfully completed the assignment.

Along with the Notebook, include a PDF of the notebook with your solutions.

`add` and `commit` the final version of your work, and `push` your code to your GitHub repository.

Submit the URL of your GitHub Repository as your assignment submission on Canvas.

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