ELEC 4800/5800 Special Topics
Homework: Neural Networks

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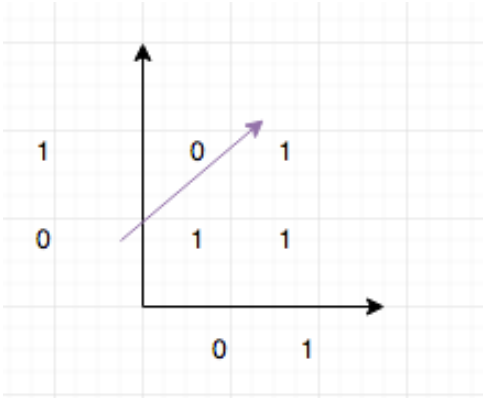
Put all answers in ML_HW_NN_LastName

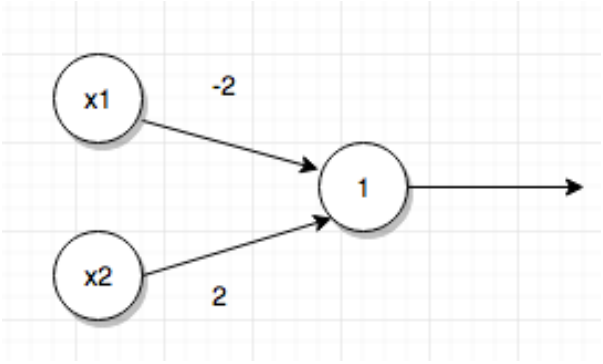
[Problem 1] – Consider the following Boolean function.

x_1	x_2	$y = \neg x_1 \cup x_2$
0	0	1
0	1	1
1	0	0
1	1	1

[Part A] Can this function be represented by a perceptron? Explain your answer with a graph in the X/Y domain.



[Part B] If yes, draw a perceptron that represents it. Otherwise, build a multilayer neural network that will.



[Problem 2] – Consider a data set with inputs (X0,X1) and an output (Y). How many free parameters are needed into each of these two models:

[Part A] Neural network with one hidden layer and 9 neurons in that layer.

Parameters are the connections between neurons.

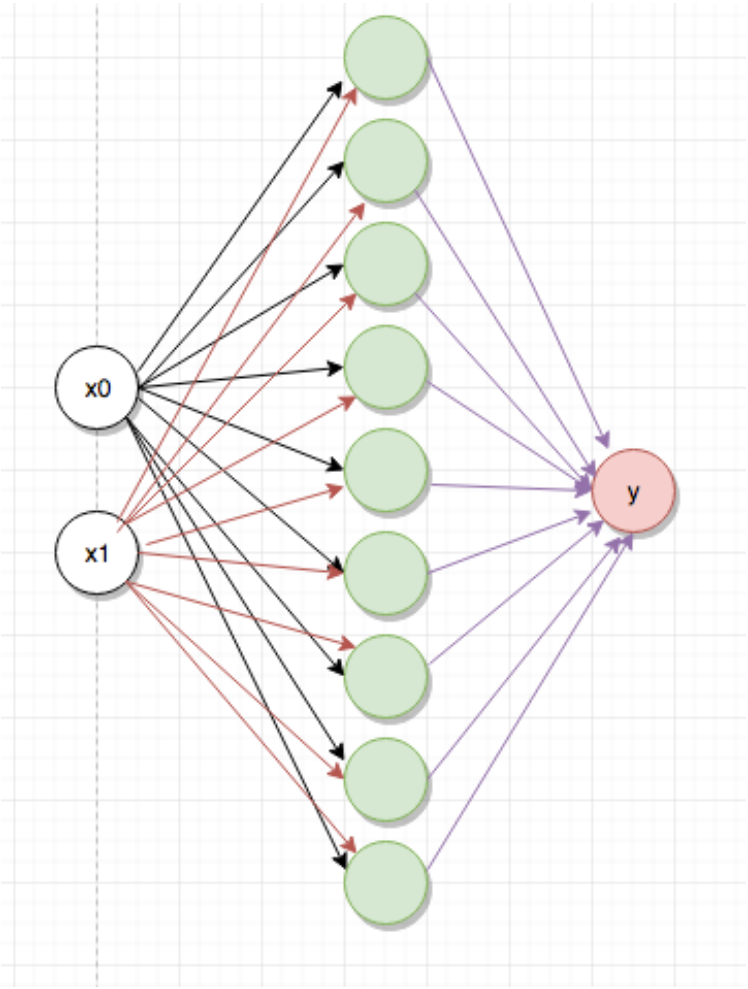
$$\therefore \ (2\times9) + (9\times1) = \ 27 \ parameters$$

[Part B] Neural network with two hidden layers and three neurons for each of the layers.

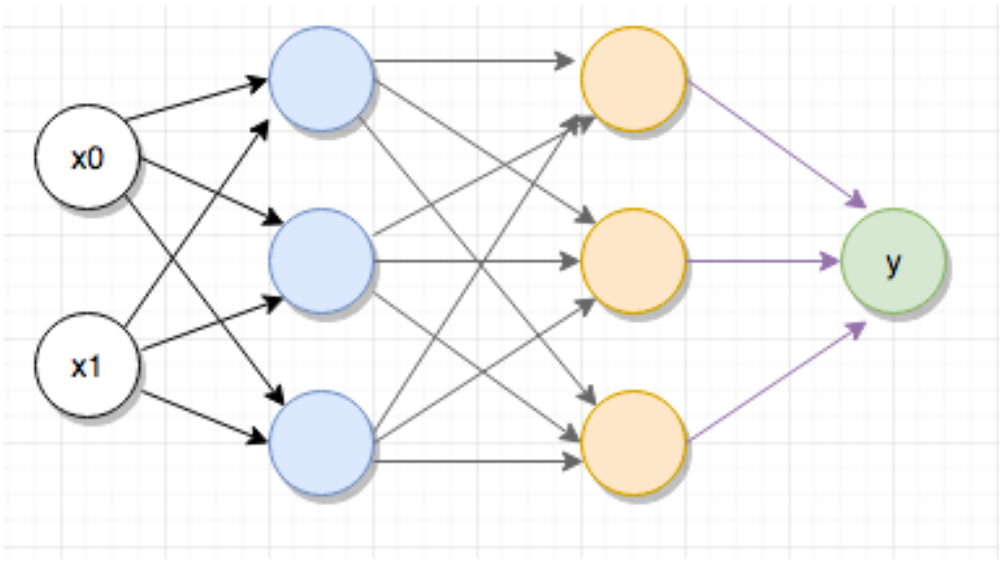
$$(2\times3) + (3\times3) + (3\times1) = \ 18 \ parameters$$

[Part C] Draw the architectures of Part A and Part B.

PartA



PartB



[Part D] How many calculations are required to execute a forward propagation of each neural network model in Part A and Part B.

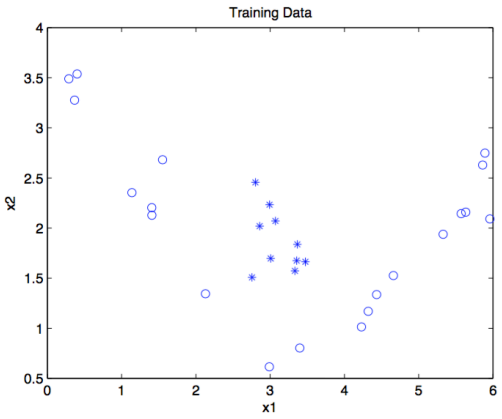
PartA

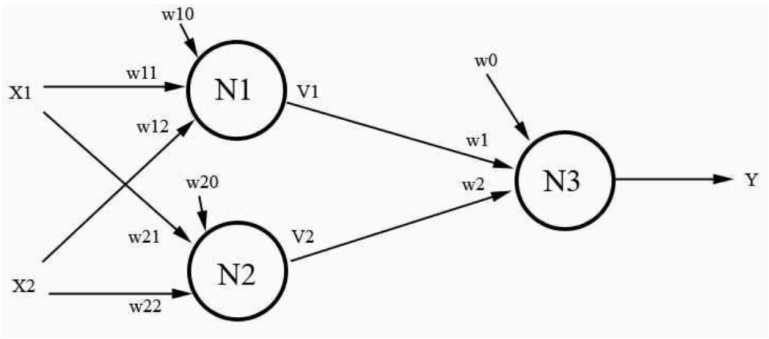
$$First\ Set = x \times w_1 = 2 \times 9 = 18$$
$$Second\ Set = First\ Set + Intermediate_1 = (2 \times 9) = 18$$
$$Third\ Set = Second\ Set \times w_2 = 1 \times 9 = 9$$
$$Total = 45\ calculations\ for\ forward\ propogation$$

PartB

$$First\ Set = x \times w_1 = 2 \times 3 = 6$$
$$Second\ Set = First\ Set + Intermediate_1 = (3 \times 3) = 9$$
$$Third\ Set = Second\ Set \times w_2 = 3 \times 3 = 9$$
$$Fourth\ Set = Third\ Set + Intermediate_2 = 3 \times 3 = 9$$
$$Fifth\ Set = Third\ Set + Intermediate_2 = 3 \times 1 = 3$$
$$Total = 36\ calculations\ for\ forward\ propogation$$

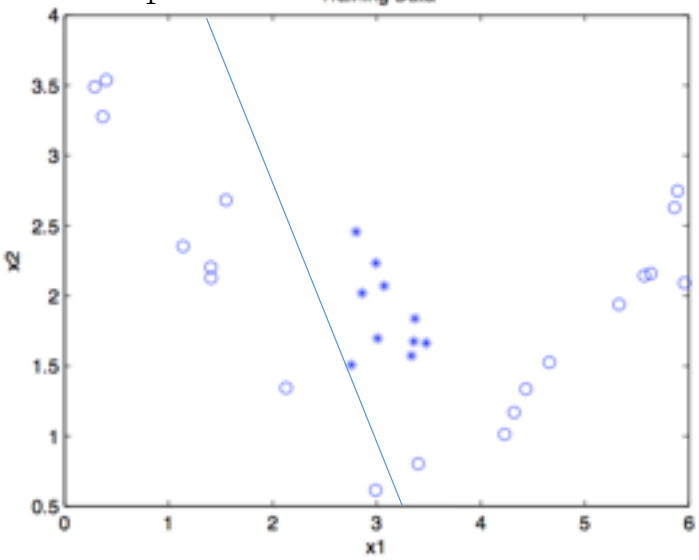
[Problem 3] – Use the following architecture and training data to set the weights (w) of the neural network so that it is capable of correctly classifying this dataset.



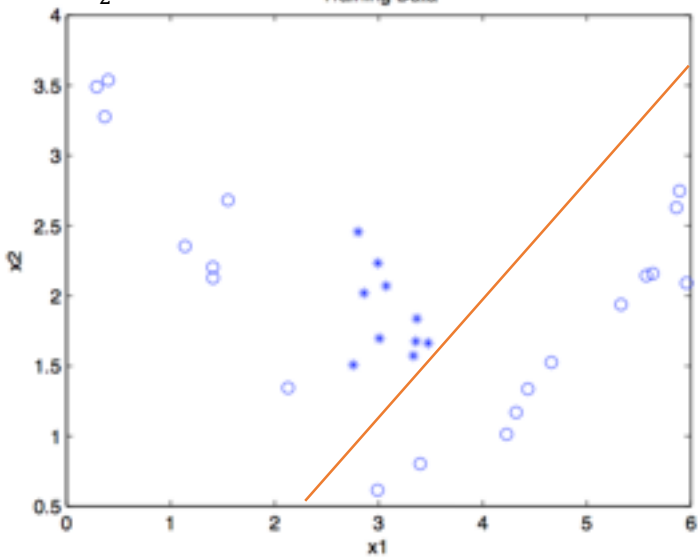


[Part A] Plot on two separate graphs, the decision boundaries for N_1 and N_2 (e.g., for neuron N_1, the line where w10+w11*X1+w12*X2 = 0) on the first two graphs.

N_1



N_2



[Part B] Design a 3rd graph axes V_2 and V_1, plot $\{V_1(x_1, x_2), V_2(x_1, x_2)\}$ for a few of the training points and provide a decision boundary so that the neural net will correctly classify the training data.

(pretend it's a parabola)