Week 4

Quiz 1-Neural Networks Representation

Ques1. Which of the following statements are true? Check all that apply.

- [ ] Suppose you have a multi-class classification problem with three classes, trained with a 3 layer network. Let $a_1^{(3)} = (h_\Theta(x))_1$ be the activation of the first output unit, and similarly $a_2^{(3)} = (h_\Theta(x))_2$ and $a_3^{(3)} = (h_\Theta(x))_3$. Then for any input x, it must be the case that $a_1^{(3)} + a_2^{(3)} + a_3^{(3)} = 1$.
- [x] The activation values of the hidden units in a neural network, with the sigmoid activation function applied at every layer, are always in the range (0, 1).
- [x] Any logical function over binary-valued (0 or 1) inputs x_1 and x_2 can be (approximately) represented using some neural network.
- [ ] A two layer (one input layer, one output layer; no hidden layer) neural network can represent the XOR function.

Answer:

A) Incorrect. The summation of the activation function is not necessary to be one.

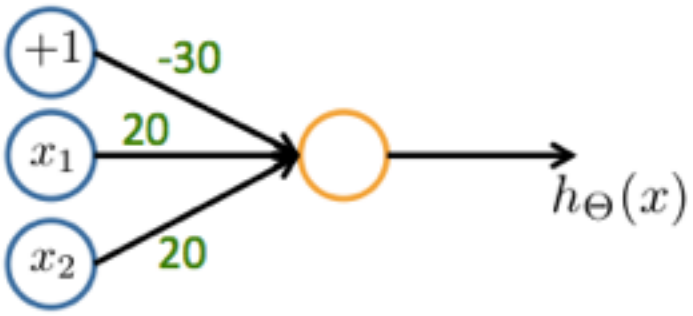
B) Correct. Sigmoid function will always give value in (0,1).

C) Correct. Some logical functions like AND, OR can be represented by two layers only, while some logical functions like XNOR needs to be represented by multiple layers.

D) Incorrect. XOR can not be represented by two layers.

Ques2.

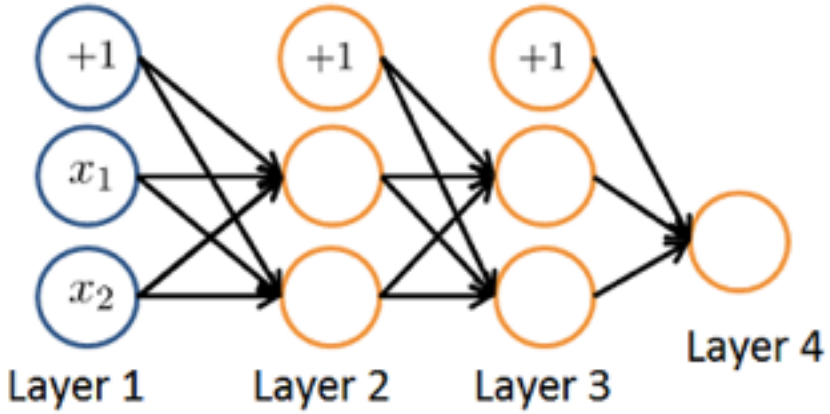
Consider the following neural network which takes two binary-valued inputs $x_1, x_2 \in \{0, 1\}$ and outputs $h_\Theta(x)$. Which of the following logical functions does it (approximately) compute?



- (●) AND
- ( ) NAND (meaning "NOT AND")
- ( ) OR
- ( ) XOR (exclusive OR)

Ques3.

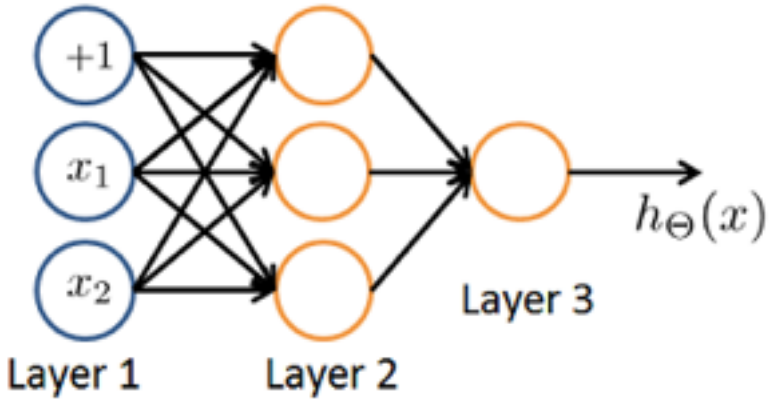
Consider the neural network given below. Which of the following equations correctly computes the activation $a_1^{(3)}$? Note: $g(z)$ is the sigmoid activation function.



- $a_1^{(3)} = g(\Theta_{1,0}^{(2)} a_0^{(2)} + \Theta_{1,1}^{(2)} a_1^{(2)} + \Theta_{1,2}^{(2)} a_2^{(2)})$
- $a_1^{(3)} = g(\Theta_{1,0}^{(2)} a_0^{(1)} + \Theta_{1,1}^{(2)} a_1^{(1)} + \Theta_{1,2}^{(2)} a_2^{(1)})$
- $a_1^{(3)} = g(\Theta_{1,0}^{(1)} a_0^{(2)} + \Theta_{1,1}^{(1)} a_1^{(2)} + \Theta_{1,2}^{(1)} a_2^{(2)})$
- $a_1^{(3)} = g(\Theta_{2,0}^{(2)} a_0^{(2)} + \Theta_{2,1}^{(2)} a_1^{(2)} + \Theta_{2,2}^{(2)} a_2^{(2)})$

Ques4.

You have the following neural network:



You'd like to compute the activations of the hidden layer $a^{(2)} \in \mathbb{R}^3$. One way to do so is the following Octave code:

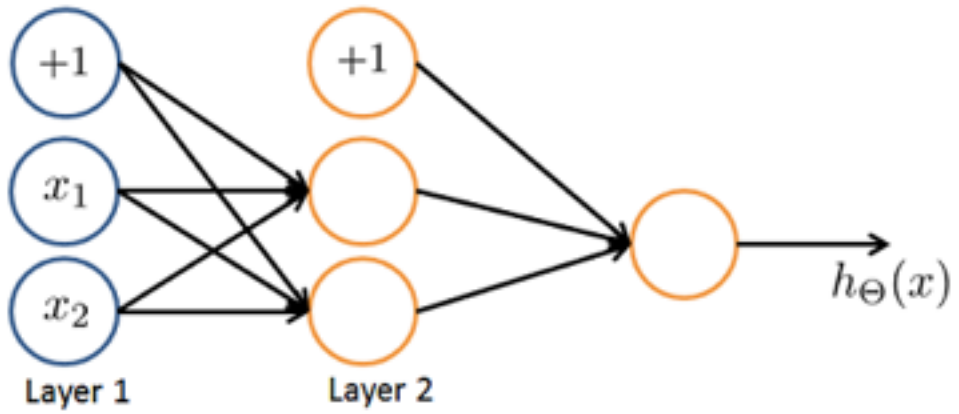
```
% Theta1 is Theta with superscript "(1)" from lecture
% ie, the matrix of parameters for the mapping from layer 1 (input) to layer 2
% Theta1 has size 3x3
% Assume 'sigmoid' is a built-in function to compute 1 / (1 + exp(-z))

a2 = zeros (3, 1);
for i = 1:3
  for j = 1:3
    a2(i) = a2(i) + x(j) * Theta1(i, j);
  end
  a2(i) = sigmoid (a2(i));
end
```

You want to have a vectorized implementation of this (i.e., one that does not use for loops). Which of the following implementations correctly compute $a^{(2)}$? Check all that apply.

Answer:
a2 = sigmoid (Theta1 * x);

Ques5.

You are using the neural network pictured below and have learned the parameters $\Theta^{(1)} = \begin{bmatrix} 1 & 1 & 2.4 \\ 1 & 1.7 & 3.2 \end{bmatrix}$ (used to compute $a^{(2)}$) and $\Theta^{(2)} = \begin{bmatrix} 1 & 0.3 & -1.2 \end{bmatrix}$ (used to compute $a^{(3)}$} as a function of $a^{(2)}$). Suppose you swap the parameters for the first hidden layer between its two units so $\Theta^{(1)} = \begin{bmatrix} 1 & 1.7 & 3.2 \\ 1 & 1 & 2.4 \end{bmatrix}$ and also swap the output layer so $\Theta^{(2)} = \begin{bmatrix} 1 & -1.2 & 0.3 \end{bmatrix}$. How will this change the value of the output $h_\Theta(x)$?



- (●) It will stay the same.
- ( ) It will increase.
- ( ) It will decrease
- ( ) Insufficient information to tell: it may increase or decrease.