The Coders' Club

Machine Learning: G1

Week 4: Assignment

Topic:
Neural Networks: Representation

Some Additional Courses:

- Machine Learning Onramp (MathWorks)
  https://www.mathworks.com/learn/tutorials/machine-learning-onramp.html

- Deep Learning Onramp (MathWorks)
  https://www.mathworks.com/learn/tutorials/deep-learning-onramp.html

- AI From the Data Center to the Edge – An Optimized Path Using Intel® Architecture (Intel AI)
  https://software.intel.com/en-us/ai/courses/data-center-to-edge

- Machine Learning (Intel)
  https://software.intel.com/en-us/ai/courses/machine-learning

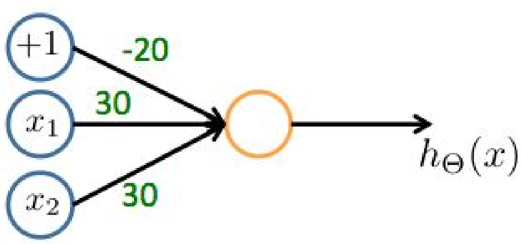
- Deep Learning (Intel)
  https://software.intel.com/en-us/ai/courses/deep-learning

Logistic Regression

Q.1. Which of the following statements are true? Check all that apply.

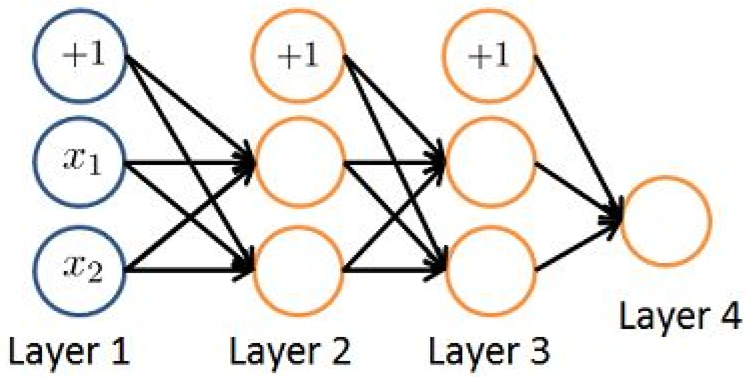
- The activation values of the hidden units in a neural network, with the sigmoid activation function applied at every layer, are always in the range (0, 1).
- A two layer (one input layer, one output layer; no hidden layer) neural network can represent the XOR function.
- Any logical function over binary-valued (0 or 1) inputs x_1 and x_2 can be (approximately) represented using some neural network.
- 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 $a_1^{(3)} + a_2^{(3)} + a_3^{(3)} = 1$.

Q.2. 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?



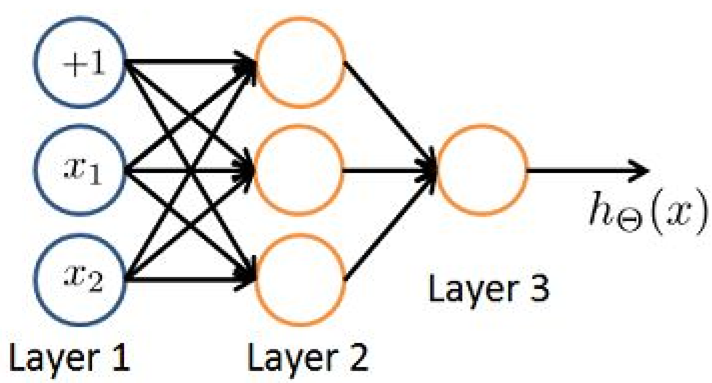
- OR
- AND
- NAND (meaning “NOT AND”)
- XOR (exclusive OR)

Q.3. 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.



- $a_1^{(3)} = g(\Theta_{1,0}^{(2)} a_0^{(2)} + \Theta_{1,1}^{(2)} a_1^{(2)} + \Theta_{1,2}^{(2)} a_2^{(2)})$
- $a_1^{(3)} = g(\Theta_{1,0}^{(1)} a_0^{(1)} + \Theta_{1,1}^{(1)} a_1^{(1)} + \Theta_{1,2}^{(1)} a_2^{(1)})$
- $a_1^{(3)} = g(\Theta_{1,0}^{(1)} a_0^{(2)} + \Theta_{1,1}^{(1)} a_1^{(2)} + \Theta_{1,2}^{(1)} a_2^{(2)})$
- The activation $a_1^{(3)}$ is not present in this network.

Q.4. You have the following neural network:



You'd like to compute the activations of the hidden layer $a^{(2)} \in R^3$. 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.

- a2 = sigmoid(Theta1 * x);
- a2 = sigmoid(x * Theta1);
- a2 = sigmoid(Theta2 * x);
- z = sigmoid(x); a2 = (Theta1 * z)

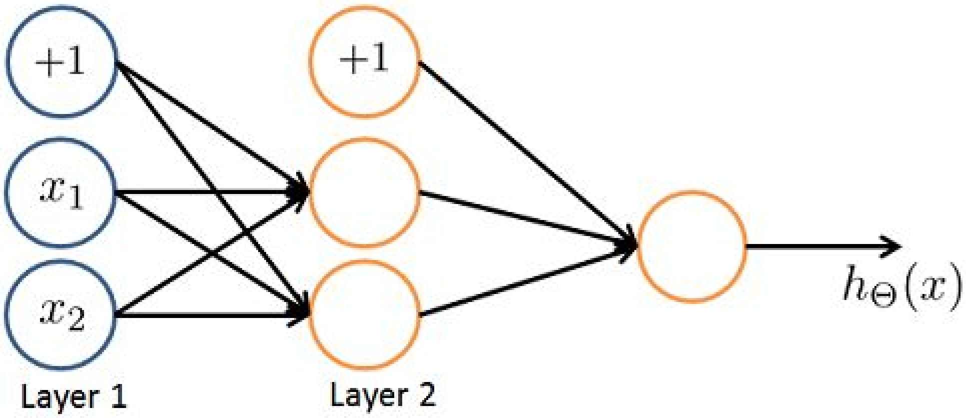
Q.5. You are using the neural network pictured below and have learned the parameters

$$\Theta^{(1)} = \begin{bmatrix} 1 & 1 & 2.4 \\ 1 & 1.7 & 3.2 \end{bmatrix}$$

(used to compute $a^{(2)}$) and $\Theta^{(2)} = [1 \quad 0.3 \quad -1.2]$ (used to compute $a^{(3)}$) as a function of $a^{(2)}$). Suppose you swap the parameters for 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 $\Theta^{(2)} = [1 \quad -1.2 \quad 0.3]$. 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