Assignment 3 – Logistic Regression and Backpropagation

Soft Deadline: November 08th, 2020
Hard Deadline: November 22nd, 2020

(Unlike previous assignments, any submission post soft deadline will be deducted atleast 40% marks. Please submit in time. Thanks!)

Introduction

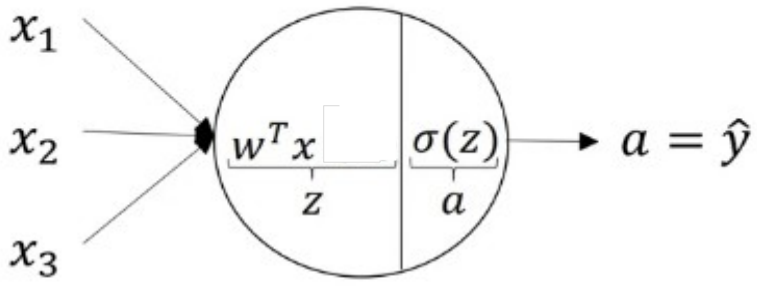
In this assignment, you will be able to apply your knowledge about Neural Networks for both Forward and Back-propagation, while building on the foundation of Logistic Regression.

Some background review:

In Logistic Regression, we output the weighted inputs (i.e. w^Tx) through the Sigmoid function. *(For some details about the Probability distribution by Sigmoid function and it's background, please refer to the Science journal's paper shared in the group earlier).*

A neural network consists of input layer, followed by hidden layers and finally an output one. Networks with multiple hidden layers would be covered later on in the Deep Learning section; this assignment considers an ANN with just one hidden layer.

Following is the diagram



$$z = w^T x$$

$$a = \sigma(z)$$

Figure 1: Computation of a neuron's final output, y-hat (or $y^{'}$), is carried out in couple of steps: $z = w^Tx$ (where w_0 is our bias term as saw in the case of Perceptron in earlier lectures) and this z is transformed through sigmoid function to get a which is y-hat (or $y^{'}$). Credits: DeepLearning.AI/Andrew Ng/Coursera

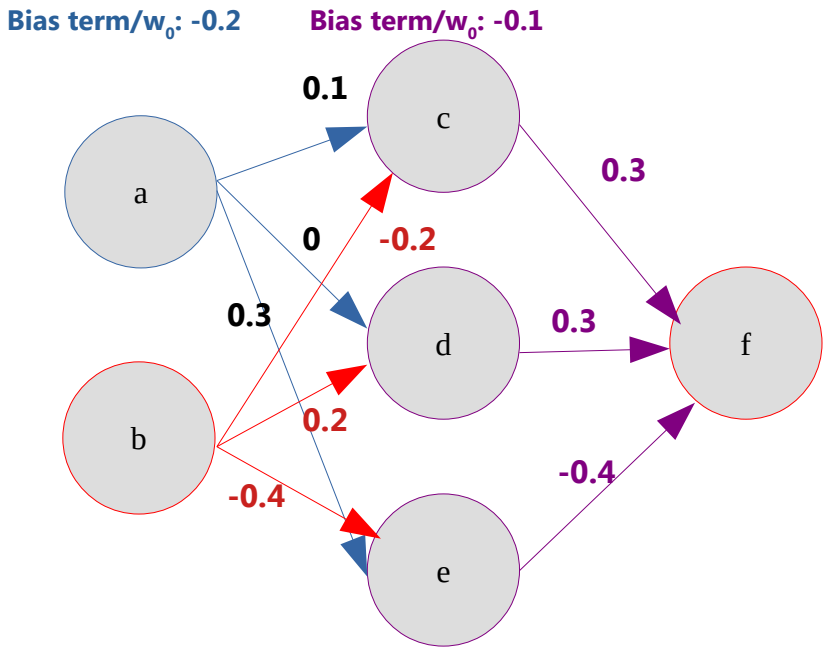
Question 1: Consider a (pre-trained) weather-prediction system taking temperature (in Celcius), air pressure (in kPa) and humidity (in %). ***(3)***

Assuming the above system to be trained on the Logistic Regression, predict whether it will rain today or not based on the given weights [-45 0.5 0.2 0.3]:

i. Temperature: 32, Pressure: 100, Humidity: 45
ii. Temperature: 21, Pressure: 120, Humidity: 21

Question 2: Apply forward propagation (recall from review above that output of a neuron is calculated in couple of steps: $w^T x$, followed by sigmoid) to calculate the value of following neurons outputs. To make things simpler, w_0 is same across all neurons in the following layers: ***(7)***

1. d
2. f



Question 3: Apply Backpropagation on the above example (just one complete iteration by hand will do, rest can be implemented in code) while assuming that correct value of 'f' (which is same as y') should be **0.1**. Show your complete calculations. ***(15)***

Question 4: Implement the backpropagation algorithm for the above neural network by coding.***(25)***

Some Tips:

- If you take some help from some friend, an online tutorial or code, please give it due credit by citing the reference. Using someone's work without attribution is plagiarism and will result in whole assignment getting zero marks.
- I am available to guide in the assignment, but before sending a query (or meeting in person), make sure to ask the following questions first:
  1-) What have I done so far?
  2-) Where did I get stuck (and possibly why) precisely?
  3-) Did I try to search a solution online? (And how much)
  4-) Do I use StackOverflow as frequently as my study demands me to?
