**Question # 1 : Compute the output of the following neural network, when :**

*Inputs* :

*Weights (Input to Hidden)* :

*Weights (Hidden to Output)* :

*Biases* :

**The activation functions of the neurons are both ReLU functions. Provide all steps. You may use python to do the step-by-step computation.**

For the first two neurons, we’ll define them as and with inputs and .

*Neuron #1 ( ) :*

has inputs

*Neuron #2 ( ) :*

has inputs

Moving onto the output neurons, we now have the inputs and .

*Output Neuron #1 ( ) :*

has inputs

*Output Neuron #2 ( ) :*

has inputs

*Final Outputs ( and ) :*

**Question # 2 : Assume the ground truth in the training for input is , the current w’s are the values in Question 1, and the loss function is defined as :**

Compute and . Provide all steps. You may use Python to do step-by-step computation.

We have the values and from the previous question.

With the Ground Truth Values and . We can now plug into the Loss function :

We need to solve these gradients :

Now to compute the necessary values for the gradients.

Gradient of Output with respect to Weight for :

From these values we can solve for :

Now to solve for the remaining values.

Solving for :

And finally solving for :

Now we can solve for :

Final Answers ( and ) :

**Question #3 : Now we add a softmax output lay for multi-class classification. Assume there are two classes – class 1 and class 2. The ground truth for input is class 2, the current w’s are the values in Question #1 and the loss function is cross-entropy. Compute and . Provide all steps. You may use Python to do the step-by-step computation.**

Considering our calculated and given values here :

Lets now apply the softmax function of the exp over the sum of exps.

The softmax outputs are then :

In the question it is stated that the ground truth is class 2 so we can tell

Utilizing this for our gradient of loss with respect to our previously calculated softmax outputs is :

For ,

For

We now can solve for the .

Now we need to compute to properly solve for .

Now we can solve for using our previous value in from Question #2.

Final Answers ( and ) :