

Deep Learning for Vision Systems (ECOM5448)

Assignment #02

Answer the following questions

Question 01

Why do we need activation functions?

Question 02

Name three popular activation functions and draw them?

Question 03

In which cases would you want to use each of the following activation functions: ReLU, tanh, logistic, and softmax?

Question 04

The convolution of a 2D image $f(x, y)$ and a kernel $h(x, y)$ is defined as

$$g(x, y) = (f * h)(x, y) = \sum_{\alpha=-\infty}^{\infty} \sum_{\beta=-\infty}^{\infty} f(\alpha, \beta) h(x - \alpha, y - \beta).$$

Perform the convolution below, i.e. calculate the image C.

- i. Using zero padding
- ii. Using Replicate padding

0	1	0	2		0	1	0		?	?	?	?
1	0	1	0		1	1	2		?	?	?	?
0	2	0	0		0	2	0		?	?	?	?

image A

*

kernel B

=

image C

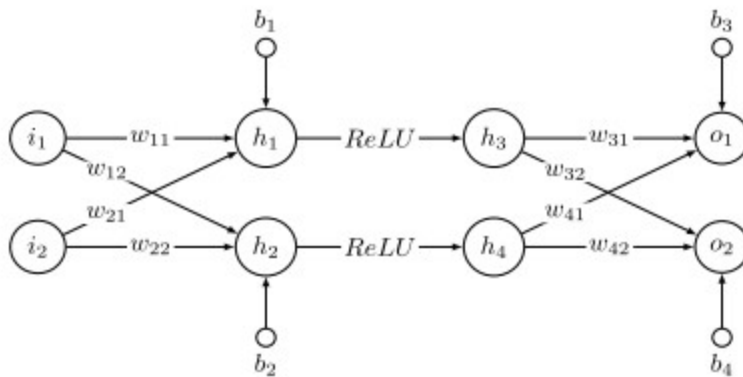
Question 05

Assume using MLP

- a. How many neurons do you need in the output layer if you want to classify email into spam or ham?
- b. What activation function should you use in the output layer?
- c. If instead you want to tackle MNIST, how many neurons do you need in the output layer, using what activation function?
- d. Repeat a and b questions for getting your network to predict housing prices as discussed in the class.

Question 06

Given the following neural network with fully connection layer and ReLU activations, including two input units (i_1, i_2), four hidden units (h_1, h_2) and (h_3, h_4). The output units are indicated as (o_1, o_2) and their targets are indicated as (t_1, t_2). The weights and bias of fully connected layer are called w and b with specific sub-descriptors.



The values of variables are given in the following table:

Variable	i_1	i_2	w_{11}	w_{12}	w_{21}	w_{22}	w_{31}	w_{32}	w_{41}	w_{42}	b_1	b_2	b_3	b_4	t_1	t_2
Value	2.0	-1.0	1.0	-0.5	0.5	-1.0	0.5	-1.0	-0.5	1.0	0.5	-0.5	-1.0	0.5	1.0	0.5

- Compute the output (o_1, o_2) with the input (i_1, i_2) and network parameters as specified above. Write down all calculations, including intermediate layer results.
- Compute the mean squared error of the output (o_1, o_2) calculated above and the target (t_1, t_2).
- Update the weight w_{21} using gradient descent with learning rate 0.1 as well as the loss computed previously. (Please write down all your computations.)

Question 07

Suppose you have an MLP composed of one input layer with 10 passthrough neurons, followed by one hidden layer with 50 artificial neurons, and finally one output layer with 3 artificial neurons. All artificial neurons use the ReLU activation function.

- What is the shape of the input matrix X ?
- What about the shape of the hidden layer's weight vector \mathbf{W}_h , and the shape of its bias vector \mathbf{b}_h ?
- What is the shape of the output layer's weight vector \mathbf{W}_o , and its bias vector \mathbf{b}_o ?
- What is the shape of the network's output matrix \mathbf{Y} ?
- Write the equation that computes the network's output matrix \mathbf{Y} as a function of \mathbf{X} , \mathbf{W}_h , \mathbf{b}_h , \mathbf{W}_o and \mathbf{b}_o .

- Last submission date: **Saturday, March 18, 2023.**