National University of Computer and Emerging Sciences, Lahore Campus

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Q N0 1. Back Propagation

Following is the skeleton of the back propagation learning algorithm for finding weights of a multilayer feed-forward neural network. The last seven statements of the algorithms are given at the end but are somehow mixed up. Your job in this question is to give us correct order these statements.

Mention where each statement resides in the skeleton by **marking/circling the correct choice** for each statement

Backpropagation Learning Algorithm

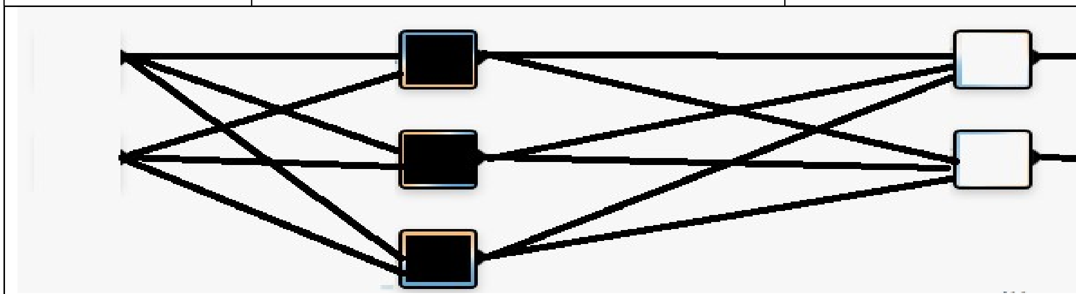
1 - Create the network and initialize all weights to small random numbers.
2 - A B C D E F
3 - A B C D E F
4 - A B C D E F
5 - A B C D E F
6 - A B C D E F
7 - A B C D E F

Following are the statements which you have to fit in the above algorithm. Here *o* is used for computed *output* and *t* is used for *target/actual output*

A = Update each network weight $w_{i,j}$ by $w_{i,j} = w_{i,j} + \Delta w_{i,j}$ where $\Delta w_{i,j} = \eta \delta_j x_{i,j}$
B = For each hidden unit h do $\delta_h = o_h(1 - o_h) \Sigma_{k \in outputs}\ w_{h,k}\ \delta_k$
C = Until convergence condition is met or max epochs, Do following
D = Input the training example to the network and compute all intermediate/final outputs *o*
E = For each training example, Do following
F = For each output unit k do $\delta_k = o_k\ (1 - o_k)\ (t_k - o_k)$

Q No 2: Neural Network Learning

Inputs	Hidden Neurons	Output neurons



Consider the neural network structure shown above with two inputs, three hidden neurons and two output neurons. Also assume that the **sigmoid** is being used as activation function for each neuron in this network and that MSE is used as the cost function at the output layer.

During the network training using error back-propagation learning algorithm, at some point in time the weights of three hidden neurons and two output neurons are given in the following table (Order of weights: Top to Bottom Neurons) and $\mathbf{w_0}$ is weight of the bias term.

Hidden Neuron Weights			Output Neuron Weights			
w_0	w_1	w_2	w_0	w_1	w_2	w_3
1	1	0	1	-1	1	-1
1	-1	1	1	1	1	1
1	-1	-1				

At this point, an input example **[1, 1]** with the corresponding output **[1, 0]** has been provided to the network

i) Compute all intermediate outputs and the final output of the neural network for this input vector.
ii) Compute the values of delta (error) for each of the output neuron.
iii) Use Error back-propagation mechanism to compute the values of delta for the hidden layer neurons.
iv) Show the updated weights of the network after this example has been processed using learning rate of your choice

Q3. Convolution Neural Networks

A) Suppose you have a dataset of images and you want to train a classifier using CNN. For each layer, you need to calculate the size of the associated feature maps, and the number of parameters. The notation follows the convention:
• CONVOLUTION (L, M) represents a convolutional layer with M filters, each them of size L × L, Padding and stride parameters are always 1 and 1 respectively.

• POOLING (P) indicates a P × P pooling layer with stride P and padding 0.

• FULLY-CONNECTED (N) means fully-connected layer with N neurons.

Assume that the input is a RGB image of dimensions 128 * 128 * 3;

Layer	Dimensions of Activation map	# of parameters
INPUT	n * n * 3	0
CONVOLUTION(7, 16)		
POOLING(2)		
CONVOLUTION(5, 64)		
POOLING(3)		
CONVOLUTION(3, 64)		
POOLING(2)		
FULLY-CONNECTED(v+1)		

B) Assume the following image and the filter, apply convolution and the pooling.

IMAGE

1	3	4	2	5	0
3	5	2	1	2	1
2	1	4	3	3	3
1	2	3	2	5	2
3	1	5	4	3	0

FILTER

1	0	-1
1	1	-1
1	0	-1

(i) Apply convolution with Padding and stride parameters as 0 and 2 respectively.
(ii) Apply Average pooling on the feature map obtained in the previous step. 1 × 2 pooling layer with stride 1 and padding 1.