ML ASSIGNMENT - 4

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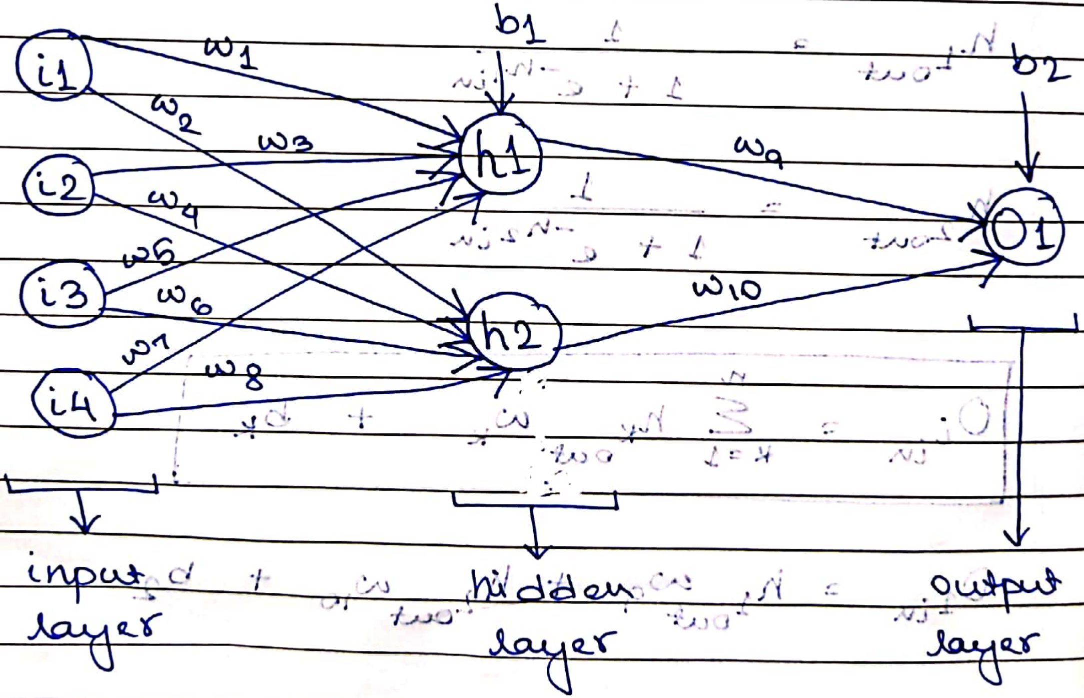
G1

Q A) Construct a NN with 4 terminals, a hidden layer of 2 neurons and an output layer of one neuron.

Soln.)



i1, i2, i3, i4 → input terminals

h1, h2 → hidden layer neurons

O1 → output layer neuron

b1, b2 → bias for hidden and output layer, respectively

Q8) Derive the mathematical model for the above ANN in (A) with sigmoid transfer function.

Soln.)

$$\boxed{h_{i_{in}} = \sum_{k=1}^{n} x_k w_k + b_k}$$

$$h_{1_{in}} = i_1 w_1 + i_2 w_3 + i_3 w_5 + i_4 w_7 + b_1$$

$$h_{2_{in}} = i_1 w_2 + i_2 w_4 + i_3 w_6 + i_4 w_8 + b_1$$

$$\boxed{h_{i_{out}} = \frac{1}{1+e^{-x}}}$$

, x = input to hidden layer neuron 'i'

$$h_{1_{out}} = \frac{1}{1 + e^{-h_{1_{in}}}}$$

$$h_{2_{out}} = \frac{1}{1 + e^{-h_{2_{in}}}}$$

$$\boxed{O_{i_{in}} = \sum_{k=1}^{n} h_{k_{out}} w_k + b_k}$$

$$O_{1_{in}} = h_{1_{out}} w_9 + h_{2_{out}} w_{10} + b_2$$

$$\boxed{O_{i_{out}} = \frac{1}{1 + e^{-y}}}$$

, y = input to output layer neuron 'i'

$$O_{1_{out}} = \frac{1}{1 + e^{-O_{1_{in}}}}$$

9c) Explain back-propagation learning algorithm.

Soln.) Back-propagation algorithm iteratively processes a set of training tuples and compares the network's prediction with the actual known target value. For each training tuple, the weights are modified to minimize the mean squared error between the network's prediction and the actual target value. Modifications are made in the 'backwards' direction, i.e., from the output layer, through each hidden layer down to the first hidden layer — hence, 'backpropagation'.

Steps: 1) Initialize weights (to small random values) and biases in the network.

2) Propagate the inputs forward (by applying activation function).

3) Backpropagate the error (by updating weights and biases).

4) Terminating condition (when error is very small, etc.)

Algorithm:

1) Initialize weights.

2) Present a pattern and target output.

3) Compute output:

$$O_j = f\left[\sum_{i=0}^{n} w_{ij} O_i\right]$$

$$\left[O_j = f(x_j) = \frac{1}{1+e^{-x_j}}\right]$$

4) Update weights:

$$w_{ij}(t+1) = w_{ij}(t) + \Delta w_{ij}$$

where $\Delta w_{ij} = \eta d_j O_i = -\eta \frac{\delta E}{\delta w_{ij}} = -\eta E w_{ij}$

$$\Delta w_{ij} = -\eta \frac{\delta E}{\delta w_{ij}}$$

$$\left[E = \frac{1}{2} \sum_{j} (t_j - O_j)^2\right]$$

Repeat starting at (2) until acceptaple level of error.