CCNU-UOW
CSCI964 Computational Intelligence
Spring 2020

Laboratory Exercise 3 (Week 3)

1 Task One: Multi-layer Perceptron

Write codes (could be any programming language) to implement MLP using Backpropagation algorithm.

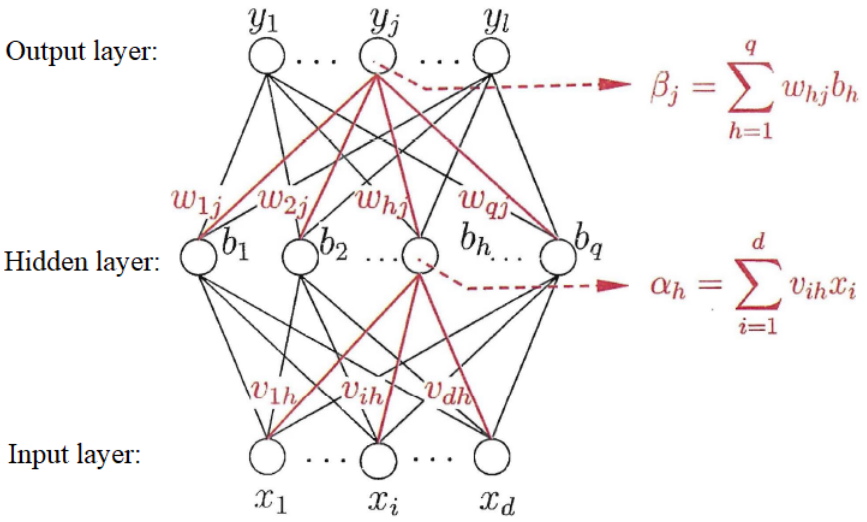

Figure 1: Flowchart of MLP

2 Task Two: Iris classification

Use MLP to implement classification on Iris dataset.

Algorithm 1 BP algorithm for MLP training

Input: training dataset $D = \left\{\left(\boldsymbol{x}^k, \boldsymbol{y}^k\right)\right\}_{k=1}^{m}$;
learning rate $\eta \in (0, 1)$

Process:

1. randomly initialize w_i, θ
2. **repeat**
3. for all $\left(\boldsymbol{x}^k, \boldsymbol{y}^k\right) \in D$ do
4. compute $\widehat{y}^k$ through the forward process
5. compute the gradient of output layer g_j

$$g_j = -\frac{\partial E_k}{\partial \hat{y}_j^k} \cdot \frac{\partial \hat{y}_j^k}{\partial \beta_j} = -\left(\hat{y}_j^k - y_j^k\right) f'\left(\beta_j - \theta_j\right) = \hat{y}_j^k\left(1 - \hat{y}_j^k\right)\left(y_j^k - \hat{y}_j^k\right) \tag{1}$$

$$\triangle w_{hj} = \eta g_j b_h \tag{2}$$

6. compute the gradient of hidden layer e_h

$$e_h = -\frac{\partial E_k}{\partial b_h} \cdot \frac{\partial b_h}{\partial a_h} = b_h(1 - b_h) \sum_{j=1}^{l} w_{hj} g_j \tag{3}$$

$$\triangle v_{ih} = \eta e_h x_i \tag{4}$$

7. update w_{hj} and θ_j through

$$w_{hj} \leftarrow w_{hj} + \triangle w_{hj} = w_{hj} + \eta g_j b_h \tag{5}$$

$$\theta_j \leftarrow \theta_j + \triangle \theta_j = \theta_j - \eta g_j \tag{6}$$

8. update v_{ih} and γ_h through

$$v_{ih} \leftarrow v_{ih} + \triangle v_{ih} = v_{ih} + \eta e_h x_i \tag{7}$$

$$\gamma_h \leftarrow \gamma_h + \triangle \gamma_h = \gamma_h - \eta e_h \tag{8}$$

9. end for
10. **until** $|E_{t+1} - E_t| \leq \varepsilon$ **or** $t >= T$ **in which** t **stands for Epoches for training**

Output: w_{hj}, θ_j, v_{ih} and γ_h.