Homework Assignment 1: Due at April 7

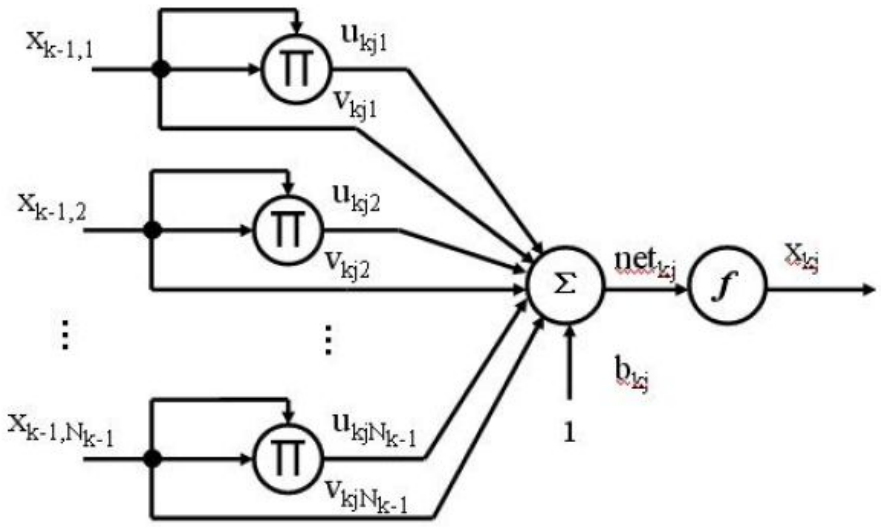
Suppose the output of each neuron in a multilayer perceptron network is

$$x_{kj} = f\left(\sum_{i=1}^{N_{k-1}} (u_{kji}x_{k-1,i}^2 + v_{kji}x_{k-1,i}) + b_{kj}\right)$$

$$\text{for } k = 2, 3, \cdots, M \text{ and } j = 1, 2, \cdots, N_k$$

where both u_{kji} and v_{kji} are the weights connecting the ith unit in the layer $k-1$ to the jth unit in the layer k, b_{kj} is the bias of the jth unit in the layer k, N_k is the number of units in the k $(1 \leq k \leq M)$, and $f(.)$ is the sigmoidal activation function.

The structure of the unit is shown as the following figure.



This network is called multi-layer quadratic perceptron (MLQP).

Homework Assignment 1 (2)

1. Please derive the back-propagation algorithms for MLQPs in both on-line learning and batch learning ways.

2. Write programs to implement the on-line learning and batch learning back-propagation algorithms for training MLQPs with one hidden layer

3. Run your programs to classify the two-spiral problem and compare the training time and generalization performance of the on-line learning and batch learning methods (the number of hidden units can be set to 10).

Homework Assignment 1 (3)

Two-spiral problem：
Data Format：

Dim 1	Dim 2	Label
-0.0978	0.5476	1
0.0978	-0.5476	0

Training set： two_spiral_train
Test set： two_spiral_test