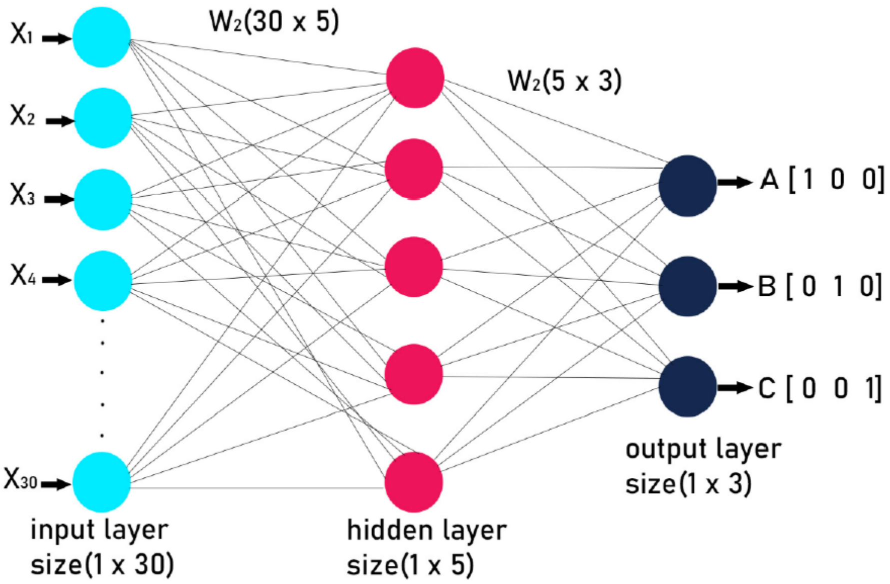
Week 3: Lab 3 Machine Learning Part 2

3. Artificial Neural Network:

In this problem, we will develop a very simple and easy neural network for the classification of three only three alphabets A, B, or C. The neural network consists of three layers including input layer, hidden layer, and output layer as shown in figure below. We will write a variety of function to achieve this task based on mean square root error loss function.



Step 1: Creating a dataset

```
# A
a =[0, 0, 1, 1, 0, 0,
   0, 1, 0, 0, 1, 0,
   1, 1, 1, 1, 1, 1,
   1, 0, 0, 0, 0, 1,
   1, 0, 0, 0, 0, 1]
# B
b =[0, 1, 1, 1, 1, 0,
   0, 1, 0, 0, 1, 0,
   0, 1, 1, 1, 1, 0,
   0, 1, 0, 0, 1, 0,
   0, 1, 1, 1, 1, 0]
# C
c =[0, 1, 1, 1, 1, 0,
   0, 1, 0, 0, 0, 0,
   0, 1, 0, 0, 0, 0,
   0, 1, 0, 0, 0, 0,
   0, 1, 1, 1, 1, 0]
# Creating labels
y =[[1, 0, 0],
   [0, 1, 0],
   [0, 0, 1]]
```

Step 2: Dataset visualization

```
import numpy as np
import matplotlib.pyplot as plt
# visualizing the data, ploting A.
plt.imshow(np.array(a).reshape(5, 6))
plt.show()
```

Step 3: Pre-processing on dataset

```
x =[np.array(a).reshape(1, 30), np.array(b).reshape(1, 30),
                                np.array(c).reshape(1, 30)]

# Labels are also converted into NumPy array
y = np.array(y)
print(x, "\n\n", y)
```

Step 4: Defining ANN architecture

```
1st layer: Input layer(1, 30)

2nd layer: Hidden layer (1, 5)

3rd layer: Output layer(3, 3)
```

Step 5: Writing a Python Custom functions to Train and Test ANN

```
def sigmoid(x):
    return(1/(1 + np.exp(-x)))

# Creating the Feed forward neural network
# 1 Input layer(1, 30)
# 1 hidden layer (1, 5)
# 1 output layer(3, 3)

def f_forward(x, w1, w2):
    # hidden
    z1 = x.dot(w1)# input from layer 1
    a1 = sigmoid(z1)# out put of layer 2

    # Output layer
    z2 = a1.dot(w2)# input of out layer
    a2 = sigmoid(z2)# output of out layer
    return(a2)

# initializing the weights randomly
def generate_wt(x, y):
    l =[]
    for i in range(x * y):
        l.append(np.random.randn())
    return(np.array(l).reshape(x, y))

# for loss we will be using mean square error(MSE)
def loss(out, Y):
    s =(np.square(out-Y))
    s = np.sum(s)/len(y)
    return(s)

# Back propagation of error
def back_prop(x, y, w1, w2, alpha):

    # hiden layer
    z1 = x.dot(w1)# input from layer 1
    a1 = sigmoid(z1)# output of layer 2
    # Output layer
    z2 = a1.dot(w2)# input of out layer
    a2 = sigmoid(z2)# output of out layer
    # error in output layer
    d2 =(a2-y)
    d1 = np.multiply((w2.dot((d2.transpose()))).transpose(),
                                   (np.multiply(a1, 1-a1)))

    # Gradient for w1 and w2
    w1_adj = x.transpose().dot(d1)
    w2_adj = a1.transpose().dot(d2)

    # Updating parameters
    w1 = w1-(alpha*(w1_adj))
```

```
    w2 = w2-(alpha*(w2_adj))

    return(w1, w2)

 def train(x, Y, w1, w2, alpha = 0.01, epoch = 10):
    acc =[]
    losss =[]
    for j in range(epoch):
        l =[]
        for i in range(len(x)):
            out = f_forward(x[i], w1, w2)
            l.append((loss(out, Y[i])))
            w1, w2 = back_prop(x[i], y[i], w1, w2, alpha)
        print("epochs:", j + 1, "======== acc:", (1-(sum(l)/len(x)))*100)
        acc.append((1-(sum(l)/len(x)))*100)
        losss.append(sum(l)/len(x))
    return(acc, losss, w1, w2)

def predict(x, w1, w2):
    Out = f forward(x, w1, w2)
    maxm = 0
    k = 0
    for i in range(len(Out[0])):
        if(maxm<Out[0][i]):
            maxm = Out[0][i]
            k = i
    if(k == 0):
        print("Image is of letter A.")
    elif(k == 1):
        print("Image is of letter B.")
    else:
        print("Image is of letter C.")
    plt.imshow(x.reshape(5, 6))
    plt.show()
```

Step 6: Train ANN for Alphabet Classification

```
w1 = generate_wt(30, 5)
w2 = generate_wt(5, 3)
print(w1, "\n\n", w2)
acc, losss, w1, w2 = train(x, y, w1, w2, 0.1, 100)
```

Step 7: ANN Training visualization

```
# ploting accuraccy
plt1.plot(acc)
plt1.ylabel('Accuracy')
plt1.xlabel("Epochs:")
plt1.show()

# plotting Loss
plt1.plot(losss)
plt1.ylabel('Loss')
plt1.xlabel("Epochs:")
```

```
plt1.show()
```

```
print(w1, "\n", w2)
```

Step 8: Inference Phase

```
predict(x[1], w1, w2)
```