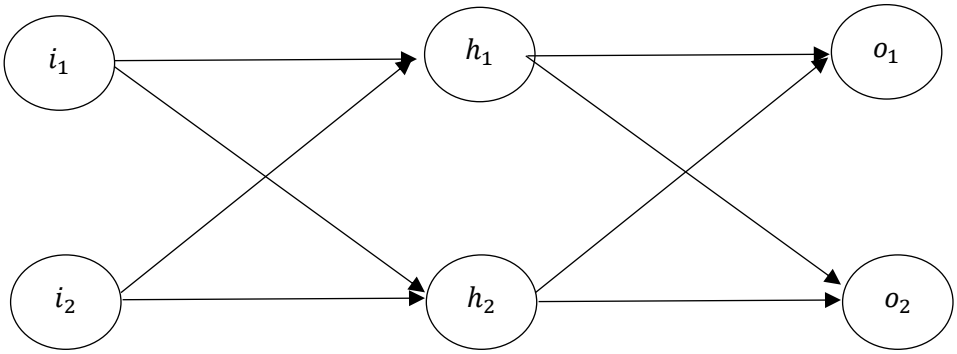
NEURAL NETWORK

ASSIGNMENT - 01

Q. Implement Neural Network in Python/R.



Initial Values:

$I = [0.50 \quad 0.10]$

$W_1 = \begin{bmatrix} 0.15 & 0.25 \\ 0.20 & 0.30 \end{bmatrix}, \quad W_2 = \begin{bmatrix} 0.35 & 0.45 \\ 0.40 & 0.50 \end{bmatrix}$

$B_1 = [0.35 \quad 0.35], \quad B_2 = [0.60 \quad 0.60]$

Target Outputs:

$O = [0.01 \quad 0.99]$

Activation Function: Sigmoid Function $= \frac{1}{1+e^{-x}}$

Loss Function: Mean Squared Error $= \frac{1}{2}\sum(\hat{y} - y)^2$

Answer.

Code : -

```python
import numpy as np

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

def sigmoid_derivative(x):
    return x * (1 - x)
```

```
# Initial values
I = np.array([0.50, 0.10])
W1 = np.array([[0.15, 0.25], [0.20, 0.30]])
W2 = np.array([[0.35, 0.45], [0.40, 0.50]])
B1 = np.array([0.35, 0.35])
B2 = np.array([0.60, 0.60])
target_outputs = np.array([0.01, 0.99])

# Forward propagation
h_input = np.dot(I, W1.T) + B1
h_output = sigmoid(h_input)

o_input = np.dot(h_output, W2.T) + B2
network_output = sigmoid(o_input)

# Calculate mean squared error loss
loss = np.mean((target_outputs - network_output) ** 2)

# Backpropagation
# Calculate output layer errors and deltas
output_error = target_outputs - network_output
output_delta = output_error * sigmoid_derivative(network_output)

# Calculate hidden layer errors and deltas
hidden_error = np.dot(output_delta, W2)
hidden_delta = hidden_error * sigmoid_derivative(h_output)

# Update weights and biases
learning_rate = 0.5
W2 += learning_rate * np.outer(output_delta, h_output)
B2 += learning_rate * output_delta

W1 += learning_rate * np.outer(hidden_delta, I)
B1 += learning_rate * hidden_delta

# Print the updated weights and biases
print("Updated weights W1:\n", W1)
print("Updated biases B1:\n", B1)
print("Updated weights W2:\n", W2)
print("Updated biases B2:\n", B2)
```

Output : -

```
Epoch 0, Loss: 0.29388381339376796
Updated weights W_hidden:
 [[0.14816051 0.24789328]
 [0.1996321  0.29957866]]
Updated biases B_hidden:
 [[0.34632102 0.34578656]]
Updated weights W_output:
 [[0.30735953 0.46223151]
 [0.35636715 0.51251618]]
Updated biases B_output:
 [[0.53003449 0.62006976]]


Epoch 1000, Loss: 0.000250692741027138
Updated weights W_hidden:
 [[0.36498792 0.45911908]
 [0.24299758 0.34182382]]
Updated biases B_hidden:
 [[0.77997584 0.76823816]]
Updated weights W_output:
 [[-1.21653689  1.23126088]
 [-1.19492138  1.29410816]]
Updated biases B_output:
 [[-1.85434021  1.78838763]]
```

```
Epoch 2000, Loss: 8.293036645040265e-05
Updated weights W_hidden:
 [[0.39664292 0.49059351]
 [0.24932858 0.3481187 ]]
Updated biases B_hidden:
 [[0.84328584 0.83118702]]
Updated weights W_output:
 [[-1.31272222  1.32398265]
 [-1.29223618  1.38791863]]
Updated biases B_output:
 [[-1.98499544  1.91433449]]


Epoch 3000, Loss: 3.990556005248462e-05
Updated weights W_hidden:
 [[0.4132193  0.50705999]
 [0.25264386 0.351412  ]]
Updated biases B_hidden:
 [[0.8764386  0.86411998]]
Updated weights W_output:
 [[-1.36234107  1.37230495]
 [-1.34240702  1.43677849]]
Updated biases B_output:
 [[-2.05134198  1.97894709]]
```

```
Epoch 4000, Loss: 2.2447371809971256e-05
Updated weights W_hidden:
 [[0.42390389 0.51766814]
 [0.25478078 0.35353363]]
Updated biases B_hidden:
 [[0.89780779 0.88533629]]
Updated weights W_output:
 [[-1.3941431   1.40339634]
 [-1.37455192  1.46820508]]
Updated biases B_output:
 [[-2.09350252  2.02016545]]


Epoch 5000, Loss: 1.3766101234771549e-05
Updated weights W_hidden:
 [[0.43148396 0.52519133]
 [0.25629679 0.35503827]]
Updated biases B_hidden:
 [[0.91296793 0.90038267]]
Updated weights W_output:
 [[-1.41664165  1.4254347 ]
 [-1.3972879   1.49047602]]
Updated biases B_output:
 [[-2.12316235  2.04921862]]
```

```
Epoch 6000, Loss: 8.917900057033357e-06
Updated weights W_hidden:
 [[0.43716934 0.53083261]
 [0.25743387 0.35616652]]
Updated biases B_hidden:
 [[0.92433868 0.91166522]]
Updated weights W_output:
 [[-1.43349049  1.44195625]
 [-1.41431178  1.5071692 ]]
Updated biases B_output:
 [[-2.14528523  2.07091174]]


Epoch 7000, Loss: 5.999436455182756e-06
Updated weights W_hidden:
 [[0.44159118 0.53521931]
 [0.25831824 0.35704386]]
Updated biases B_hidden:
 [[0.93318237 0.92043862]]
Updated weights W_output:
 [[-1.44658317  1.45480179]
 [-1.42753885  1.52014659]]
Updated biases B_output:
 [[-2.16242431  2.08772729]]
```

```
Epoch 8000, Loss: 4.1484009891876865e-06
Updated weights W_hidden:
 [[0.44511881 0.53871837]
 [0.25902376 0.35774367]]
Updated biases B_hidden:
 [[0.94023762 0.92743674]]
Updated weights W_output:
 [[-1.45702288  1.46504704]
 [-1.43808469  1.53049601]]
Updated biases B_output:
 [[-2.17605832  2.10110735]]


Epoch 9000, Loss: 2.9285988188932394e-06
Updated weights W_hidden:
 [[0.44798613 0.54156211]
 [0.25959723 0.35831242]]
Updated biases B_hidden:
 [[0.94597225 0.93312422]]
Updated weights W_output:
 [[-1.46550617  1.47337271]
 [-1.44665356  1.53890567]]
Updated biases B_output:
 [[-2.18711646  2.11196004]]
```

```
Epoch 10000, Loss: 2.1010814285644154e-06
Updated weights W_hidden:
 [[0.4503501  0.54390641]
 [0.26007002 0.35878128]]
Updated biases B_hidden:
 [[0.9507002  0.93781282]]
Updated weights W_output:
 [[-1.47249951  1.48023542]
 [-1.45371701  1.54583718]]
Updated biases B_output:
 [[-2.19621848  2.12089203]]


Epoch 11000, Loss: 1.526830537875276e-06
Updated weights W_hidden:
 [[0.45232088 0.54586062]
 [0.26046418 0.35917212]]
Updated biases B_hidden:
 [[0.95464175 0.94172123]]
Updated weights W_output:
 [[-1.47832967  1.48595543]
 [-1.45960531  1.55161423]]
Updated biases B_output:
 [[-2.20379701  2.12832737]]
```

```
Epoch 12000, Loss: 1.121080159977352e-06
Updated weights W_hidden:
 [[0.45397848 0.54750416]
 [0.2607957  0.35950083]]
Updated biases B_hidden:
 [[0.95795695 0.94500833]]
Updated weights W_output:
 [[-1.48323379  1.4907654 ]
 [-1.46455812  1.55647195]]
Updated biases B_output:
 [[-2.21016508  2.13457319]]


Epoch 13000, Loss: 8.301717241692477e-07
Updated weights W_hidden:
 [[0.45538272 0.54889641]
 [0.26107654 0.35977928]]
Updated biases B_hidden:
 [[0.96076545 0.94779283]]
Updated weights W_output:
 [[-1.48738894  1.49483921]
 [-1.46875437  1.56058606]]
Updated biases B_output:
 [[-2.21555583  2.13985842]]
```

```
Epoch 14000, Loss: 6.190884115264384e-07
Updated weights W_hidden:
 [[0.45657938 0.55008278]
 [0.26131588 0.36001656]]
Updated biases B_hidden:
 [[0.96315875 0.95016556]]
Updated weights W_output:
 [[-1.49093051  1.4983099 ]
 [-1.47233085  1.56409096]]
Updated biases B_output:
 [[-2.22014709  2.14435779]]


Epoch 15000, Loss: 4.643981526791721e-07
Updated weights W_hidden:
 [[0.45760413 0.55109867]
 [0.26152083 0.36021973]]
Updated biases B_hidden:
 [[0.96520825 0.95219735]]
Updated weights W_output:
 [[-1.49396403  1.5012812 ]
 [-1.4753942   1.56709147]]
Updated biases B_output:
 [[-2.22407721  2.1482073 ]]
```

```
Epoch 16000, Loss: 3.500896178333095e-07
Updated weights W_hidden:
 [[0.45848527 0.55197216]
 [0.26169705 0.36039443]]
Updated biases B_hidden:
 [[0.96697054 0.95394433]]
Updated weights W_output:
 [[-1.49657313  1.50383537]
 [-1.47802889  1.5696707 ]]
Updated biases B_output:
 [[-2.22745561  2.15151458]]


Epoch 17000, Loss: 2.650279567990172e-07
Updated weights W_hidden:
 [[0.45924555 0.55272582]
 [0.26184911 0.36054516]]
Updated biases B_hidden:
 [[0.96849111 0.95545163]]
Updated weights W_output:
 [[-1.49882502  1.50603852]
 [-1.48030283  1.57189542]]
Updated biases B_output:
 [[-2.23037011  2.154366  ]]
```

```
Epoch 18000, Loss: 2.0135328994732052e-07
Updated weights W_hidden:
 [[0.45990348 0.55337798]
 [0.2619807  0.3606756 ]]
Updated biases B_hidden:
 [[0.96980697 0.95675596]]
Updated weights W_output:
 [[-1.50077435  1.50794445]
 [-1.48227121  1.57381998]]
Updated biases B_output:
 [[-2.23289201  2.15683175]]
```

```
Epoch 19000, Loss: 1.5344650583489948e-07
Updated weights W_hidden:
 [[0.46047426 0.55394374]
 [0.26209485 0.36078875]]
Updated biases B_hidden:
 [[0.97094852 0.95788749]]
Updated weights W_output:
 [[-1.50246604  1.50959735]
 [-1.48397941  1.57548901]]
Updated biases B_output:
 [[-2.23507981  2.15896939]]


Final Hidden Layer Output: [[0.77358124 0.78111511]]
Final Output: [[0.01034641 0.98966164]]
Final weights W_hidden:
 [[0.46097003 0.55443514]
 [0.26219401 0.36088703]]
Final biases B_hidden:
 [[0.97194007 0.95887028]]
Final weights W_output:
 [[-1.50393594  1.51103253]
 [-1.48546363  1.57693817]]
Final biases B_output:
 [[-2.2369802   2.16082488]]


** Process exited - Return Code: 0 **
Press Enter to exit terminal
```