Assighment #1

1. 編譯結果

```
(base) zhouchou@zhoudeMacBook-Air NNXOR_array % gcc -o main main.c
(base) zhouchou@zhoudeMacBook-Air NNXOR_array %
```

2. 執行結果

```
(base) zhouchou@zhoudeMacBook-Air NNXOR_array % ./main

weightsIH[0][0]: -0.499992
weightsIH[1][0]: -0.368462
weightsIH[2][0]: 0.255605
weightsIH[0][1]: -0.041350
weightsIH[1][1]: 0.032767
weightsIH[2][1]: -0.281041
weightsIH[0][2]: -0.452955
weightsIH[1][2]: 0.178865
weightsIH[2][2]: 0.179296
weightsIH[0][3]: 0.434693
weightsIH[1][3]: -0.116498
weightsIH[2][3]: 0.019416
weightsHO[0][0]: 0.330965
weightsHO[1][0]: -0.465428
weightsHO[2][0]: -0.446538

        Network Results  ( epoch= 3000  )

Pat     Input1          Input2          Targets         Outputs
0       0.000000        0.000000        0.000000        0.111581
1       0.000000        1.000000        1.000000        0.848079
2       1.000000        0.000000        1.000000        0.854278
3       1.000000        1.000000        0.000000        0.207287

        Accuracy = 100.000000%
```

XOR-Neural-Network (input=2,epoch=3000)

```
(base) zhouchou@zhoudeMacBook-Air NNXOR_array % ./main

weightsIH[0][0]: -0.499992
weightsIH[1][0]: -0.368462
weightsIH[2][0]: 0.255605
weightsIH[3][0]: -0.041350
weightsIH[0][1]: 0.032767
weightsIH[1][1]: -0.281041
weightsIH[2][1]: -0.452955
weightsIH[3][1]: 0.178865
weightsIH[0][2]: 0.179296
weightsIH[1][2]: 0.434693
weightsIH[2][2]: -0.116498
weightsIH[3][2]: 0.019416
weightsIH[0][3]: 0.330965
weightsIH[1][3]: -0.465428
weightsIH[2][3]: -0.446538
weightsIH[3][3]: 0.029700
weightsHO[0][0]: 0.171149
weightsHO[1][0]: -0.492302
weightsHO[2][0]: -0.116584
weightsHO[3][0]: -0.433158

        Network Results  ( epoch= 3000  )

Pat     Input1          Input2          Input3          Targets         Outputs
0       0.000000        0.000000        0.000000        0.000000        0.094308
1       1.000000        1.000000        1.000000        1.000000        0.228205
2       0.000000        1.000000        1.000000        0.000000        0.229850
3       1.000000        0.000000        1.000000        0.000000        0.288808
4       1.000000        1.000000        0.000000        0.000000        0.270597
5       1.000000        0.000000        0.000000        1.000000        0.901507
6       0.000000        0.000000        1.000000        1.000000        0.902940
7       0.000000        1.000000        0.000000        1.000000        0.895678

        Accuracy = 50.000000%
```

XOR-Neural-Network (input=3,epoch=3000)

```
(base) zhouchou@zhoudeMacBook-Air NNXOR_array % ./main

weightsIH[0][0]: -0.499992
weightsIH[1][0]: -0.368462
weightsIH[2][0]: 0.255605
weightsIH[3][0]: -0.041350
weightsIH[0][1]: 0.032767
weightsIH[1][1]: -0.281041
weightsIH[2][1]: -0.452955
weightsIH[3][1]: 0.178865
weightsIH[0][2]: 0.179296
weightsIH[1][2]: 0.434693
weightsIH[2][2]: -0.116498
weightsIH[3][2]: 0.019416
weightsIH[0][3]: 0.330965
weightsIH[1][3]: -0.465428
weightsIH[2][3]: -0.446538
weightsIH[3][3]: 0.029700
weightsHO[0][0]: 0.171149
weightsHO[1][0]: -0.492302
weightsHO[2][0]: -0.116584
weightsHO[3][0]: -0.433158

        Network Results  ( epoch= 5000  )

Pat     Input1          Input2          Input3          Targets         Outputs
0       0.000000        0.000000        0.000000        0.000000        0.015966
1       1.000000        1.000000        1.000000        1.000000        0.479911
2       0.000000        1.000000        1.000000        0.000000        0.043747
3       1.000000        0.000000        1.000000        0.000000        0.510793
4       1.000000        1.000000        0.000000        0.000000        0.043536
5       1.000000        0.000000        0.000000        1.000000        0.982815
6       0.000000        0.000000        1.000000        1.000000        0.983446
7       0.000000        1.000000        0.000000        1.000000        0.965117

        Accuracy = 75.000000%
```

XOR-Neural-Network (input=3,epoch=5000)

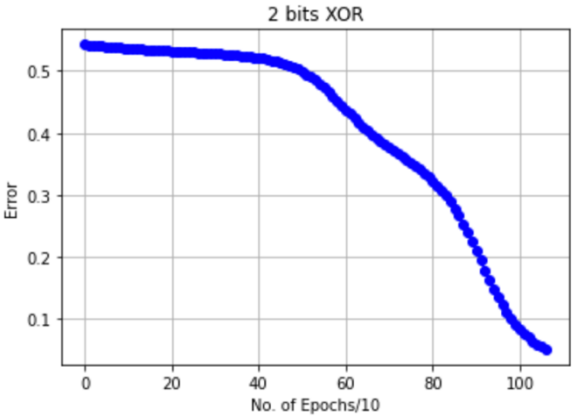
```
(base) zhouchou@zhoudeMacBook-Air NNXOR_array % ./main

weightsIH[0][0]: -0.499992
weightsIH[1][0]: -0.368462
weightsIH[2][0]: 0.255605
weightsIH[3][0]: -0.041350
weightsIH[0][1]: 0.032767
weightsIH[1][1]: -0.281041
weightsIH[2][1]: -0.452955
weightsIH[3][1]: 0.178865
weightsIH[0][2]: 0.179296
weightsIH[1][2]: 0.434693
weightsIH[2][2]: -0.116498
weightsIH[3][2]: 0.019416
weightsIH[0][3]: 0.330965
weightsIH[1][3]: -0.465428
weightsIH[2][3]: -0.446538
weightsIH[3][3]: 0.029700
weightsHO[0][0]: 0.171149
weightsHO[1][0]: -0.492302
weightsHO[2][0]: -0.116584
weightsHO[3][0]: -0.433158

        Network Results  ( epoch= 10000  )

Pat     Input1          Input2          Input3          Targets         Outputs
0       0.000000        0.000000        0.000000        0.000000        0.005295
1       1.000000        1.000000        1.000000        1.000000        0.760525
2       0.000000        1.000000        1.000000        0.000000        0.039423
3       1.000000        0.000000        1.000000        0.000000        0.195168
4       1.000000        1.000000        0.000000        0.000000        0.044240
5       1.000000        0.000000        0.000000        1.000000        0.982221
6       0.000000        0.000000        1.000000        1.000000        0.976683
7       0.000000        1.000000        0.000000        1.000000        0.995914

        Accuracy = 87.500000%
```

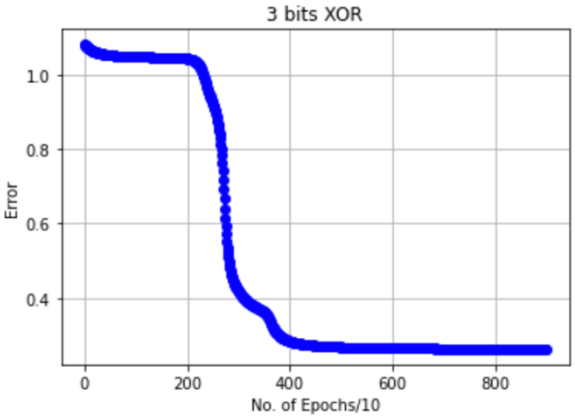
XOR-Neural-Network (input=3,epoch=10000)

3. 分析

首先由結果可知，epoch 在 3000 內，input=2 時的準確率達 100 %，不過同樣的 epoch 在 input=3 時準確率只有 50 %，但是隨著 epoch 次數越高準確率也有所提升。

由下圖可知 input=2 且 epoch 在大約 1100 時，偏差（error）近似於零，確實目標與收斂結果誤差少準確率會高。而 input=3 時，epoch 在 3000 時，偏差大約為 0.4，目標與收斂結果還有一段距離準確率就偏低。


2 bits XOR
Error
No. of Epochs/10
0.5
0.4
0.3
0.2
0.1
0
20
40
60
80
100


3 bits XOR
Error
No. of Epochs/10
1.0
0.8
0.6
0.4
0
200
400
600
800