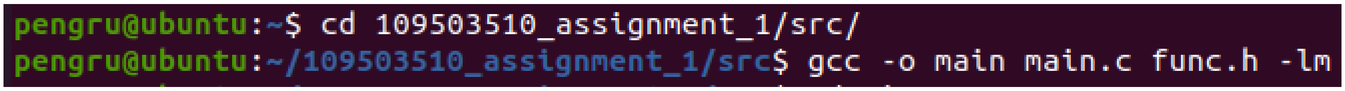
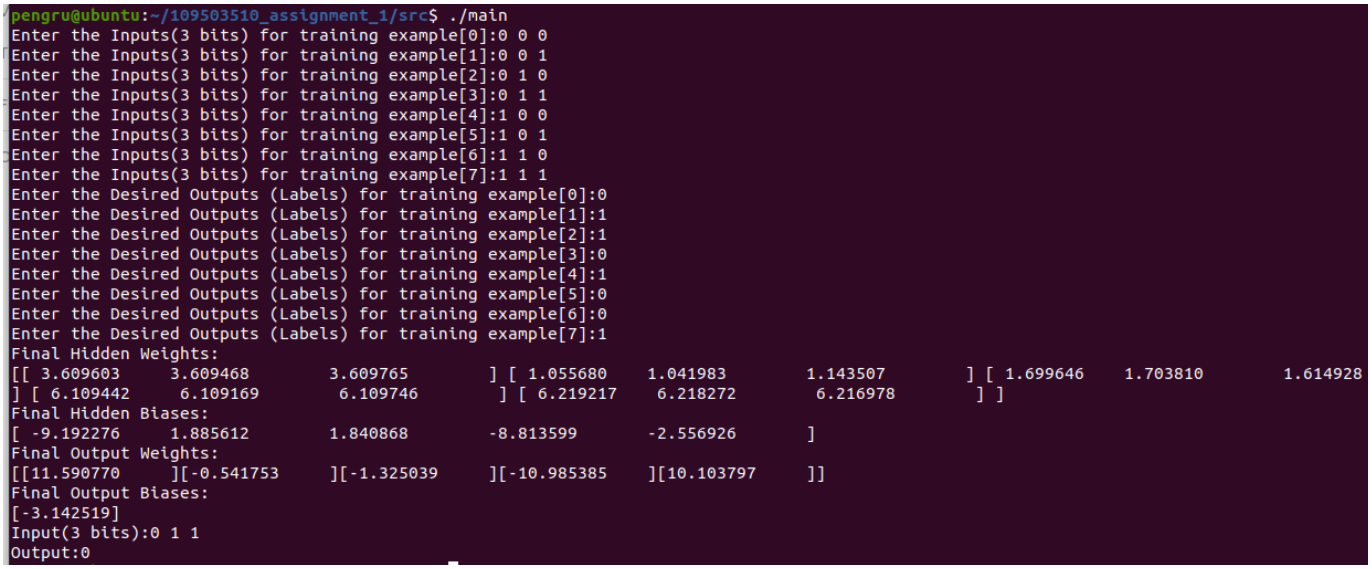
Assignment #1
通訊三 109503510 龍芃如

1. 編譯結果



```
pengru@ubuntu:~$ cd 109503510_assignment_1/src/
pengru@ubuntu:~/109503510_assignment_1/src$ gcc -o main main.c func.h -lm
```

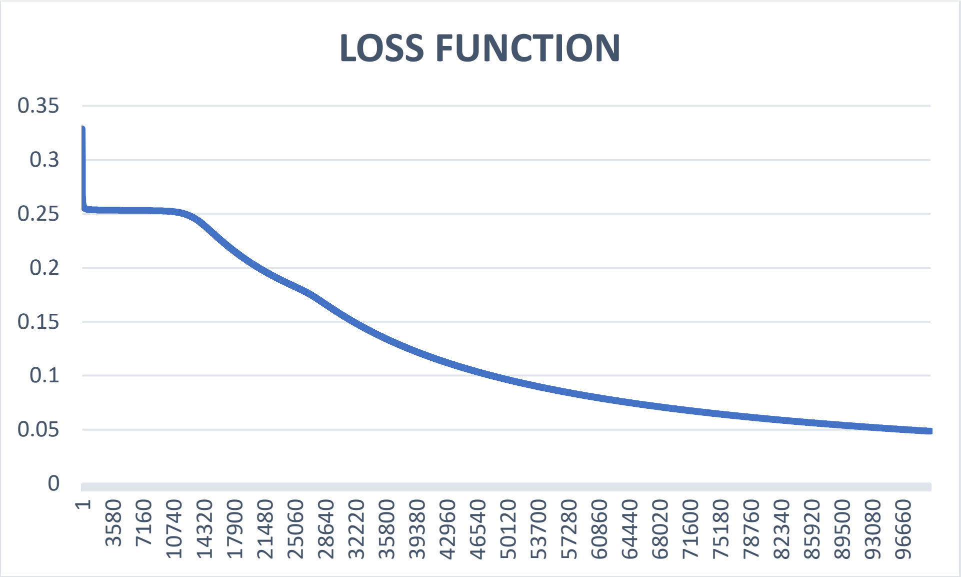
2. 執行結果



```
pengru@ubuntu:~/109503510_assignment_1/src$ ./main
Enter the Inputs(3 bits) for training example[0]:0 0 0
Enter the Inputs(3 bits) for training example[1]:0 0 1
Enter the Inputs(3 bits) for training example[2]:0 1 0
Enter the Inputs(3 bits) for training example[3]:0 1 1
Enter the Inputs(3 bits) for training example[4]:1 0 0
Enter the Inputs(3 bits) for training example[5]:1 0 1
Enter the Inputs(3 bits) for training example[6]:1 1 0
Enter the Inputs(3 bits) for training example[7]:1 1 1
Enter the Desired Outputs (Labels) for training example[0]:0
Enter the Desired Outputs (Labels) for training example[1]:1
Enter the Desired Outputs (Labels) for training example[2]:1
Enter the Desired Outputs (Labels) for training example[3]:0
Enter the Desired Outputs (Labels) for training example[4]:1
Enter the Desired Outputs (Labels) for training example[5]:0
Enter the Desired Outputs (Labels) for training example[6]:0
Enter the Desired Outputs (Labels) for training example[7]:1
Final Hidden Weights:
[[ 3.609603     3.609468        3.609765        ] [ 1.055680    1.041983        1.143507        ] [ 1.699646    1.703810        1.614928
] [ 6.109442     6.109169        6.109746        ] [ 6.219217    6.218272        6.216978        ] ]
Final Hidden Biases:
[ -9.192276     1.885612        1.840868        -8.813599       -2.556926       ]
Final Output Weights:
[[11.590770     ][-0.541753     ][-1.325039     ][-10.985385    ][10.103797     ]]
Final Output Biases:
[-3.142519]
Input(3 bits):0 1 1
Output:0
```

3. 分析

用 Mean-Square Error 計算 error function，每 10 個 epoch 計算一個值，用 excel 畫出圖表，可以看出在前段的 loss 下降速度很快，有一小段的 loss 幾乎沒有變動，之後才慢慢下降，收斂到 0.05 左右。



4. 遇到的問題
    a. 一開始使用gcc -o main main.c func.h的時候，會一直跳出undefined reference to `exp'，已經加上#include <math.h>還是有一樣的問題，之後是上網查，發現在程式碼後面加上-lm，link到math library，就可以成功編譯。
    b. 不知道如何用pointer的方式傳遞二維陣列，花了一些時間上網查詢如何使用pointer對函式傳遞二維陣列。
    c. 在做3個bits判斷的時候，為了讓輸出正確且loss變小，改過learning rate，也有試過adagrad，但成效不佳，目前的方法是調整learning rate、增加訓練次數和增加hidden layer的node數量。

5. Reference
   https://towardsdatascience.com/simple-neural-network-implementation-in-c-663f51447547