Assignment-1 Report

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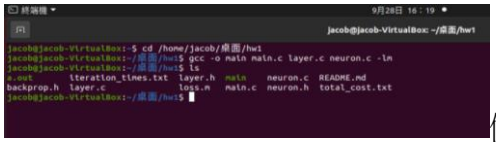
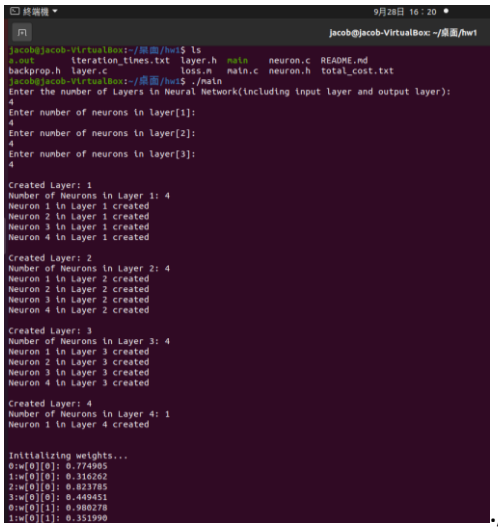
1.編譯結果

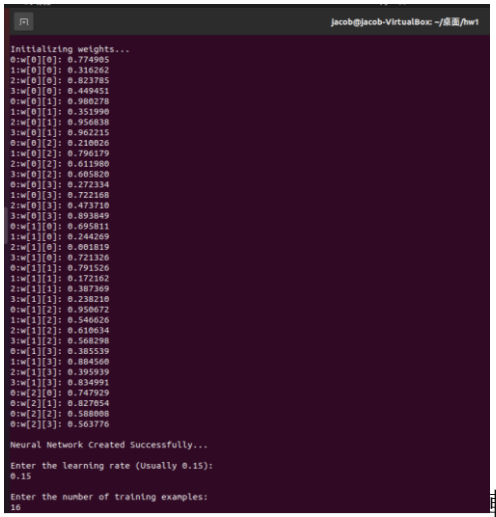


使用 gcc 此命令 compile，並以 ls 確認是否 compile

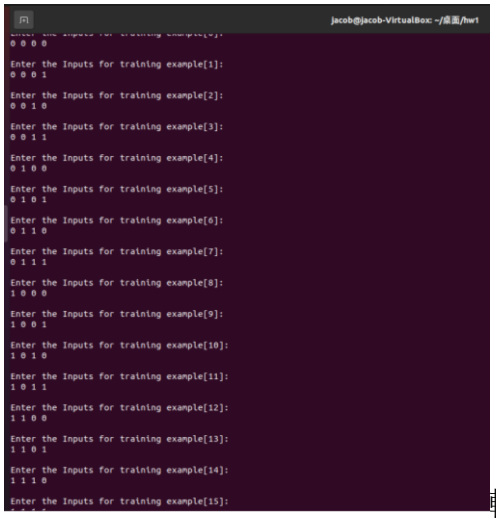
2.執行結果(目標為 4bitXOR 運算，2 層 hidden layers 及每層各 4 個 neurons)



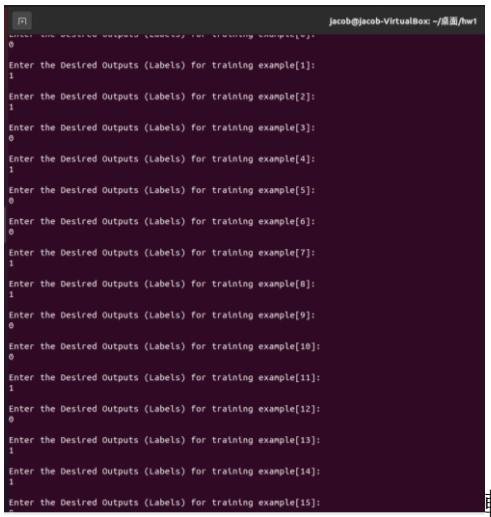
./main 啟動並輸入 layer 跟 neuron 的數量



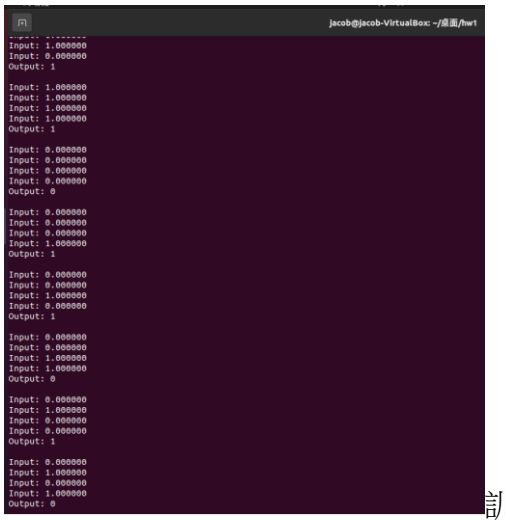
輸入 learning rate 及 training data 的數量



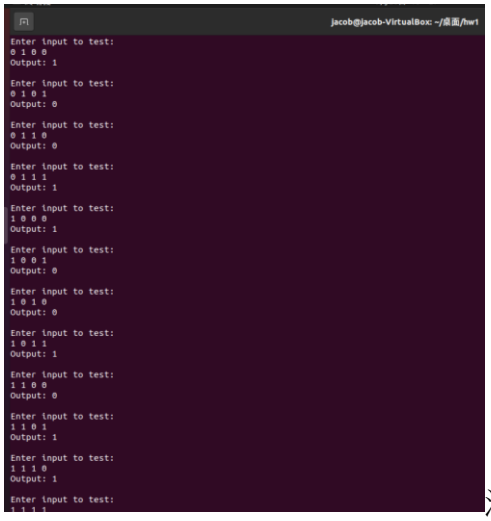
輸入 input，根據[x]輸入其二進制之 x 值##



輸入其對應的輸出值



訓練過程，設定為 10000 次 epochs



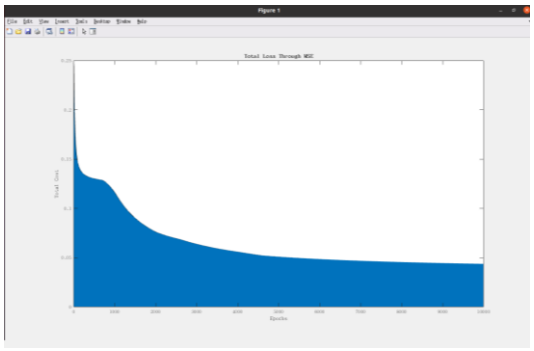
測試訓練結果，正確率來到 94%(15/16)

##由於此開源是將所有可能值當成 training data，因此 4bit 的 input data 為 15 個

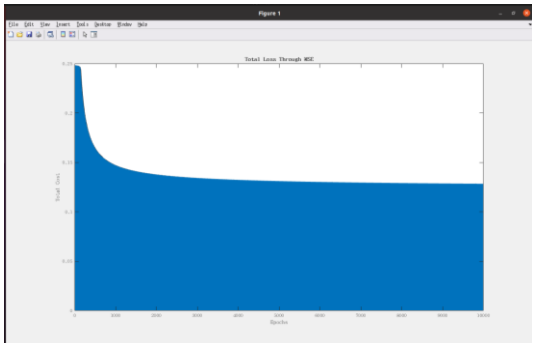
3.分析

底下的表格是我用 4bit 運算 XOR 訓練後的結果，很巧的是 run 三次竟然都一樣，旁邊的圖是我寫檔紀錄 total cost 在 epoch 數的變化，並以 matlab 作圖呈現。三次的 run 都是參考開源的訓練方式(2 hidden layers, 4 neurons per hidden layer, lr=0.15, 10000 epochs)

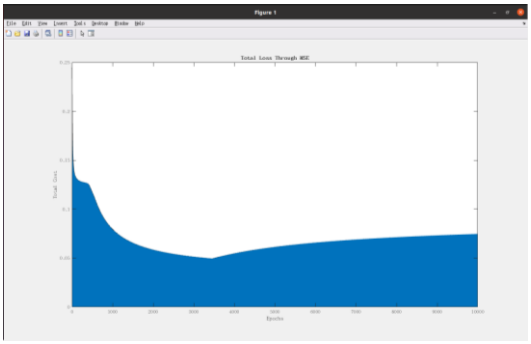
4-bit XOR operation with 2 hidden layers, 4 neurons per hidden layer, lr=0.15, 10000 epochs					
input	XOR	1st test	2nd test	3rd test	
0	0	0	0	0	
1	1	1	1	1	
2	1	1	1	1	
3	0	0	0	0	
4	1	1	1	1	
5	0	0	0	0	
6	0	0	0	0	
7	1	1	1	1	
8	1	1	1	1	
9	0	0	0	0	
10	0	0	0	0	
11	1	1	1	1	
12	0	0	0	0	
13	1	1	1	1	
14	1	1	1	1	
15	0	1	1	1	
Accuracy(%)	X	93.75	93.75	93.75	



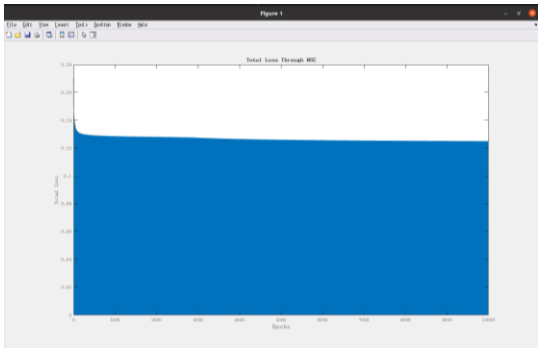
上圖為對照組，底下為實驗組，六張 loss function 作圖是改變不同條件所做的 total cost 的圖，第一組為 learning rate 改變，第二組為 hidden layer 的 neuron 數比較，第三組為 hidden layer 的層數改變，具體改變均標示在圖下方。



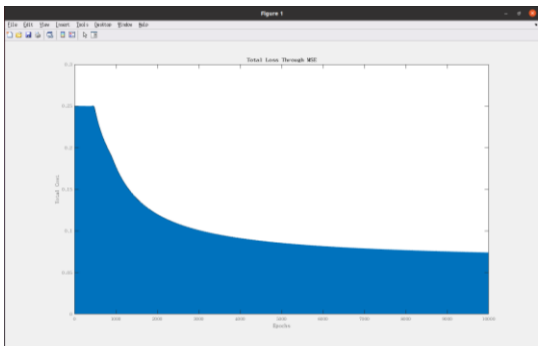
Learning rate = 0.01



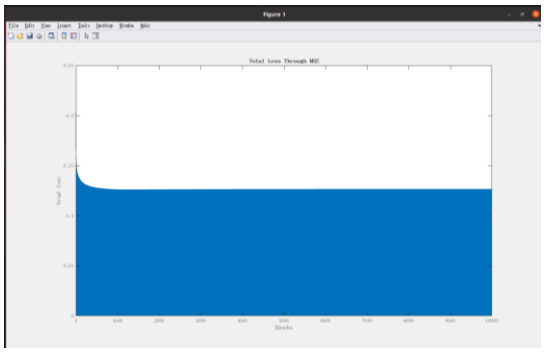
Learning rate = 0.3



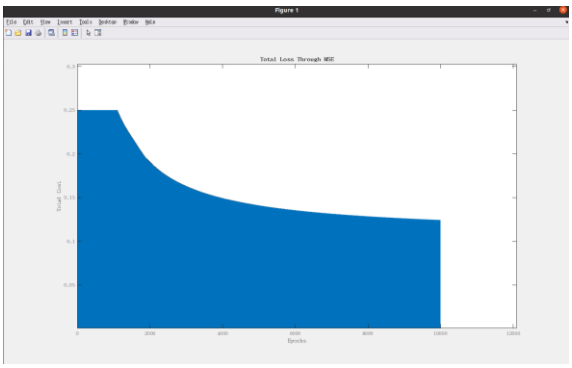
Number of neuron = 2 per hidden layer



Number of neuron = 8 per hidden layer



1 hidden layer



4 hidden layers

透過上方的實驗組，驗證了我所學到的 deep learning 的知識，像是適當的 learning rate 是很重要的，不然 loss 反而會更大。又像是 neuron 數越多會讓降低 loss 的效率更好。

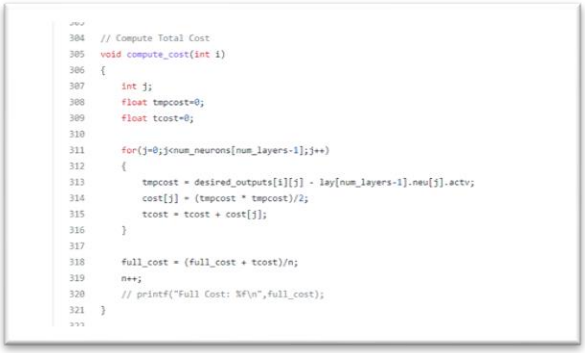
4.問題探討

(1)Linux 指令的運用

平常不常使用 Linux 的環境，等於是重新複習終端機的使用。對於指令的使用也爬了很多文，至少 10 幾個分頁是必須的(install gcc, vim, matlab, compiling .c … and more)。

(2)學習程式的架構

這次的程式碼是來自 open source，看懂程式碼就算是把程式語法抓一點感覺回來，而且比較特別的是因為是做 neural network，剛好跟我專題在看的東西幾乎一樣，就憑著 deep learning 的知識去拆解他的函式，搭配網站的解說分析，讓我能快速了解程式的運行並給予註解，甚至我修復了一個他的 cost function 的 bug，他使用 Mean Squared Error 來算 total cost，但他在疊代的過程忘了把前面的 mean 消掉，如下圖第 315 行。這讓我覺得蠻有成就感的，感覺學到的東西派上用場了。



```
304  // Compute Total Cost
305  void compute_cost(int i)
306  {
307      int j;
308      float tmpcost=0;
309      float tcost=0;
310
311      for(j=0;j<num_neurons[num_layers-1];j++)
312      {
313          tmpcost = desired_outputs[i][j] - lay[num_layers-1].neu[j].actv;
314          cost[j] = (tmpcost * tmpcost)/2;
315          tcost = tcost + cost[j];
316      }
317
318      full_cost = (full_cost + tcost)/n;
319      n++;
320      // printf("Full Cost: %f\n",full_cost);
321  }
```

(3)訓練的不穩定性

從我的分析部分中可以看到使用開源的範例的運算效率是最好的，大部分測試 MSE 都能壓在 0.05 以內。但浮動的狀況仍然會有至 0.1 附近就開始收斂，這我並不確定式甚麼原因造成的，但根據我微薄的知識推測是在 gradient descent 遇到 local minimum 或 saddle point 而跑不出來嗎?但收斂區只要根據原本開源的 instruction 就都能在 0.15 以下收斂，算是還可以接受的結果吧。