

類神經網路 程式作業二 報告

隱藏層與輸出層的 Weight 與 Biases 皆使用亂數生成。而可自行設定的參數包含以下：

1. Learning Rate
2. 隱藏層所使用的神經元個數 (最多 20 個)
3. 結束訓練的最大世代數
4. 結束訓練的最大錯誤值

透過改變上述的變數，可得到不同的結果。此處討論以下幾項

1. 隱藏層使用相同的神經元數 (5 個)，且以上自行設定的參數皆為相同的狀況下，利用亂數初始 Weight 及 Biases 時，做了四次的測試可得不同的 training accuracies 及 testing accuracies，因此可知其精確度與 Weight 和 Biases 的初始化有關。於終端機輸出結果如圖(1)至圖(4)

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Test 1 Inital Matrix and Biases

Layer_1_Martix
0.453797 0.965682 0.210219 0.152676
0.018697 0.245772 0.683251 0.394522
0.736714 0.949142 0.224181 0.804186
0.949616 0.201912 0.533152 0.678743
0.627387 0.488935 0.535734 0.086479

Layer_1_Baises
0.434795
0.600525
0.028988
0.204799
0.057690

Layer_2_Martix
0.186259 0.449514 0.984176 0.053641 0.544825
0.404713 0.004087 0.693749 0.841770 0.634866
0.751288 0.890308 0.409759 0.812839 0.391263

Layer_1_Baises
0.178982
0.156789
0.153392

-----
Number of hidden neurons = 5
Learning rates = 1.000000
Epoch: 50000
training accuracies = 93%
testing accuracies = 90%

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Test 2 Inital Matrix and Biases

Layer_1_Martix
0.058064 0.877575 0.395226 0.561661
0.840163 0.617144 0.333660 0.829062
0.045086 0.761281 0.846971 0.039226
0.267034 0.043137 0.996616 0.131488
0.916149 0.715494 0.305909 0.405809

Layer_1_Baises
0.033209
0.151502
0.287920
0.063444
0.307256

Layer_2_Martix
0.548872 0.898409 0.558053 0.197619 0.381094
0.797664 0.338043 0.496171 0.152785 0.865400
0.186945 0.990380 0.316564 0.484619 0.991811

Layer_1_Baises
0.837107
0.249340
0.663441

-----
Number of hidden neurons = 5
Learning rates = 1.000000
Epoch: 50000
training accuracies = 95%
testing accuracies = 96%

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圖 (1)

圖 (2)

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Test 3 Inital Matrix and Biases

Layer_1_Martix
0.456023 0.385666 0.890534 0.211527
0.134959 0.254993 0.672066 0.406690
0.241535 0.475476 0.326756 0.782226
0.866894 0.882319 0.128053 0.190532
0.270774 0.904542 0.642520 0.834964

Layer_1_Baises
0.328055
0.623713
0.738381
0.968866
0.735619

Layer_2_Martix
0.999871 0.828777 0.260662 0.949095 0.445801
0.359099 0.371022 0.767046 0.743832 0.585887
0.284613 0.484201 0.969397 0.660975 0.010835

Layer_1_Baises
0.001994
0.520512
0.240449

-----
Number of hidden neurons = 5
Learning rates = 1.000000
Epoch: 50000
training accuracies = 97%
testing accuracies = 90%

=====
Test 4 Inital Matrix and Biases

Layer_1_Martix
0.218278 0.605331 0.798716 0.012145
0.126228 0.517371 0.450719 0.236558
0.834935 0.748727 0.858637 0.109976
0.359052 0.581459 0.577289 0.500902
0.667328 0.773821 0.613294 0.636040

Layer_1_Baises
0.713643
0.201021
0.566747
0.308788
0.791727

Layer_2_Martix
0.905782 0.479148 0.043680 0.131218 0.381684
0.356885 0.161168 0.744805 0.932276 0.767017
0.146867 0.400034 0.363524 0.741667 0.201135

Layer_1_Baises
0.153784
0.654996
0.526116

-----
Number of hidden neurons = 5
Learning rates = 1.000000
Epoch: 50000
training accuracies = 93%
testing accuracies = 90%

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圖 (3)

圖 (4)

2. 一開始使用亂數生成 Weight 及 Biases，並將其值儲存起來，等到每一次訓練及測試完後，恢復初始的 Weight 和 Biases，使得以下 10 次皆於相同的 Weight 與 Biase 下測試，且隱藏層使用相同 5 個神經元，最大世代數 50000，及可接受的最大錯誤值 (0.01) 相同時。每做一次測試就將 Learning Rate 減 0.1，可得以下結果，越到後面由於 Learning Rate 越低，收斂得較慢，因此在同為無法在最大世代數前收斂的情況下，最後的精確度較 Learning Rate 高的低許多。終端機輸出結果為圖(5)與圖(6)，數據整理於表(1)。

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Number of hidden neurons = 5
Learning rates = 1.000000
Epoch: 50000
training accuracies = 93%
testing accuracies = 90%

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Number of hidden neurons = 5
Learning rates = 0.900000
Epoch: 50000
training accuracies = 96%
testing accuracies = 96%

-----
Number of hidden neurons = 5
Learning rates = 0.800000
Epoch: 50000
training accuracies = 97%
testing accuracies = 96%

-----
Number of hidden neurons = 5
Learning rates = 0.700000
Epoch: 50000
training accuracies = 96%
testing accuracies = 93%

-----
Number of hidden neurons = 5
Learning rates = 0.600000
Epoch: 50000
training accuracies = 97%
testing accuracies = 96%

-----
Number of hidden neurons = 5
Learning rates = 0.500000
Epoch: 50000
training accuracies = 98%
testing accuracies = 96%

-----
Number of hidden neurons = 5
Learning rates = 0.400000
Epoch: 50000
training accuracies = 97%
testing accuracies = 93%

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Number of hidden neurons = 5
Learning rates = 0.300000
Epoch: 50000
training accuracies = 97%
testing accuracies = 93%

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Number of hidden neurons = 5
Learning rates = 0.200000
Epoch: 50000
training accuracies = 66%
testing accuracies = 66%

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Number of hidden neurons = 5
Learning rates = 0.100000
Epoch: 50000
training accuracies = 68%
testing accuracies = 66%

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圖 (5)

圖 (6)

Learning Rate	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
Training accuracies	93%	96%	97%	96%	97%	98%	97%	97%	66%	68%
Testing accuracies	90%	96%	96%	93%	96%	96%	93%	93%	66%	66%

表 (1) 不同 Learning Rate 時的精準度差異

3. 利用亂數產生 Weight 及 Biases，並將最大的 ERMSE 值設置成 0.1，最大世代數設置為 500000，測試神經元數為 1 至 20 個，並利用迴圈每種神經元個數測試五次並計算出平均花費的世代數與其 Training accuracies 和 Testing accuracies。(結果輸出至 ANN2_Test_Output10.txt 檔案中)

神經元個數	1	2	3	4	5
平均世代數	500000	500000	457170	229542	177503
Training accuracies	67%	90.8%	97.2%	97.8%	97.4%
Testing accuracies	66.8%	87.6%	94.2%	95%	93.6%
神經元個數	6	7	8	9	10
平均世代數	115549	78125	170871	42586	149474
Training accuracies	97.6%	98%	98%	98.2%	98.2%
Testing accuracies	93.6%	93.6%	94.4%	94.2%	93.6%
神經元個數	11	12	13	14	15
平均世代數	138585	72090	122393	59436	67254
Training accuracies	98.2%	98.2%	98.4%	97.6%	98.2%
Testing accuracies	92.2%	95.6%	91%	93%	93.6%
神經元個數	16	17	18	19	20
平均世代數	147191	127183	66248	63821	111927
Training accuracies	98.2%	98%	98.4%	98.6%	98.45
Testing accuracies	92.4%	93.6%	94.2%	93.6%	94.4%

表 (2) 神經元數 1~20 個的平均是代數、Training / Testing accuracies 差異

可透過表 2 觀察出此 Training Data 在此狀況下大約花 3 個三個神經元就可以訓練達準確度約 97% - 98% 上下。而 Testing Data 的準確度則都約於 93% - 94% 左右，表現最優異落在神經元數 4 和 12 個的時候，其皆有 95 (含) 以上的準確度。