

# HW1: Implement and train a neural network from scratch in Python for the MNIST dataset (no PyTorch).

## Implementation

I have introduced 3 dictionaries in this implemetation, which are `params` , `cache` , and `grads` . I learnt this from Coursera Deep Learning course. This implementation is very interesting. There is kind of "Dynamic Programming" in it. But it use a map to store corresponding variables. Besides, Python3 is not currently working on my laptop. So I have been dubugging for several hours and finally find `X_train = X_train / 255` will give a result of all zeros (only in Python2), which is painful.

For more details, please refer to the codes.

## Result

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```
1 $ python main.py
2 Epoch 1: training cost = 0.265081961482, test cost = 0.263101067507
3 Epoch 2: training cost = 0.192257499837, test cost = 0.192460479053
4 Epoch 3: training cost = 0.15334790917, test cost = 0.157792183161
5 Epoch 4: training cost = 0.129918472063, test cost = 0.137100690363
6 Epoch 5: training cost = 0.1105753254, test cost = 0.123208760518
7 Epoch 6: training cost = 0.101754493263, test cost = 0.118015495706
8 Epoch 7: training cost = 0.0895023220141, test cost = 0.107810720062
9 Epoch 8: training cost = 0.0802031525878, test cost = 0.0999057023506
10 Epoch 9: training cost = 0.0713123530575, test cost = 0.0966682614361
11 Epoch 10: training cost = 0.0707509095556, test cost = 0.0950335272556
12 Epoch 11: training cost = 0.0618889502614, test cost = 0.0902194327926
13 Epoch 12: training cost = 0.0594836700699, test cost = 0.0887112213609
14 Epoch 13: training cost = 0.0533482625207, test cost = 0.0858917731451
15 Epoch 14: training cost = 0.0497493878107, test cost = 0.0863620849658
16 Epoch 15: training cost = 0.0456300951972, test cost = 0.0812432592748
17 Epoch 16: training cost = 0.0433689077762, test cost = 0.0797903665373
18 Epoch 17: training cost = 0.0399626884096, test cost = 0.0794783895346
19 Epoch 18: training cost = 0.0384433169915, test cost = 0.0805901787306
20 Epoch 19: training cost = 0.0350620516271, test cost = 0.0787715005184
21 Epoch 20: training cost = 0.0325833753773, test cost = 0.0768358601798
22 Epoch 21: training cost = 0.034084911789, test cost = 0.0809462614759
23 Epoch 22: training cost = 0.0315315716914, test cost = 0.0805074821726
24 Epoch 23: training cost = 0.0275477067757, test cost = 0.0745879095451
25 Epoch 24: training cost = 0.0269855605018, test cost = 0.0789982725824
26 Epoch 25: training cost = 0.0252056303139, test cost = 0.0752948172436
27 Epoch 26: training cost = 0.0234739284611, test cost = 0.0744190776858
28 Epoch 27: training cost = 0.0223856684737, test cost = 0.0757207771773
29 Epoch 28: training cost = 0.0209431657586, test cost = 0.076040391821
30 Epoch 29: training cost = 0.0199311334505, test cost = 0.0749167133925
31 Epoch 30: training cost = 0.019578886791, test cost = 0.0771335701384
32 Epoch 31: training cost = 0.0187109933188, test cost = 0.0761018250375
33 Epoch 32: training cost = 0.0177614238517, test cost = 0.0758681809637
```

34	Epoch 33:	training cost = 0.0168390727148,	test cost = 0.0759259058483		
35	Epoch 34:	training cost = 0.0159508795507,	test cost = 0.0757620786415		
36	Epoch 35:	training cost = 0.0150691695975,	test cost = 0.0766713930889		
37	Epoch 36:	training cost = 0.0152976682857,	test cost = 0.0780594488272		
38	Epoch 37:	training cost = 0.0141206563319,	test cost = 0.076131049725		
39	Epoch 38:	training cost = 0.0132332484026,	test cost = 0.0756487528689		
40	Epoch 39:	training cost = 0.0129524321047,	test cost = 0.0773811524766		
41	Epoch 40:	training cost = 0.0122868058048,	test cost = 0.0773318415624		
42	Epoch 41:	training cost = 0.0124065134115,	test cost = 0.0783909511807		
43	Epoch 42:	training cost = 0.0117554454087,	test cost = 0.0806867460177		
44	Epoch 43:	training cost = 0.011807362872,	test cost = 0.0775934644233		
45	Epoch 44:	training cost = 0.0105890429278,	test cost = 0.0780540967234		
46	Epoch 45:	training cost = 0.0102032548453,	test cost = 0.0781684188151		
47	Epoch 46:	training cost = 0.00985393152382,	test cost = 0.0782410094465		
48	Epoch 47:	training cost = 0.00951154792944,	test cost = 0.0800757818157		
49	Epoch 48:	training cost = 0.00905277183778,	test cost = 0.0781992281772		
50	Epoch 49:	training cost = 0.00894101136169,	test cost = 0.0790644439324		
51	Epoch 50:	training cost = 0.0083409802008,	test cost = 0.0792101188431		
52		precision	recall	f1-score	support
53					
54		0	0.99	0.98	997
55		1	0.99	0.99	1138
56		2	0.98	0.98	1032
57		3	0.98	0.97	1019
58		4	0.98	0.98	984
59		5	0.97	0.98	883
60		6	0.98	0.98	953
61		7	0.97	0.98	1017
62		8	0.98	0.98	974
63		9	0.96	0.97	1003
64					
65	avg / total	0.98	0.98	0.98	10000