

week_1_solution_15

March 15, 2018

```
In [2]: import mnist_loader
import numpy as np
import pandas as pd
```

```
training_data, validation_data, test_data = mnist_loader.load_data_wrapper()
print("Training data, validation data and test data loaded.")
```

Training data, validation data and test data loaded.

```
In [3]: print("15. Repeat 12 for a deep network with four hidden layers, with 30 neuron in each")
```

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```
In [4]: import network2
net2_all_train = network2.Network([784, 30, 30, 30, 30, 10], cost=network2.CrossEntropy,
net2_all_train.large_weight_initializer()

epochs = 30

evaluation_cost_all_train, evaluation_accuracy_all_train, training_cost_all_train, tra
    training_data,
    epochs,
    10,
    0.5,
    evaluation_data=test_data,
    lmbda=5.0,
    monitor_evaluation_cost=True,
    monitor_evaluation_accuracy=True,
    monitor_training_cost=True,
    monitor_training_accuracy=True
)
```

Epoch 0 training complete

Cost on training data: 1.44657434606

Accuracy on training data: 45579 / 50000

Cost on evaluation data: 5.07364038108

Accuracy on evaluation data: 9138 / 10000

Epoch 1 training complete

Cost on training data: 1.08592073967

Accuracy on training data: 46323 / 50000

Cost on evaluation data: 3.62337116737

Accuracy on evaluation data: 9219 / 10000

Epoch 2 training complete

Cost on training data: 0.825739990345

Accuracy on training data: 47043 / 50000

Cost on evaluation data: 2.69165018341

Accuracy on evaluation data: 9390 / 10000

Epoch 3 training complete

Cost on training data: 0.692453820495

Accuracy on training data: 47379 / 50000

Cost on evaluation data: 2.16554209789

Accuracy on evaluation data: 9419 / 10000

Epoch 4 training complete

Cost on training data: 0.601228547243

Accuracy on training data: 47575 / 50000

Cost on evaluation data: 1.84981541158

Accuracy on evaluation data: 9454 / 10000

Epoch 5 training complete

Cost on training data: 0.550159724657

Accuracy on training data: 47734 / 50000

Cost on evaluation data: 1.66239914358

Accuracy on evaluation data: 9465 / 10000

Epoch 6 training complete

Cost on training data: 0.501271190217

Accuracy on training data: 47930 / 50000

Cost on evaluation data: 1.52239506956

Accuracy on evaluation data: 9500 / 10000

Epoch 7 training complete

Cost on training data: 0.518429976985

Accuracy on training data: 47800 / 50000

Cost on evaluation data: 1.50856877644

Accuracy on evaluation data: 9491 / 10000

Epoch 8 training complete

Cost on training data: 0.54855359401

Accuracy on training data: 47357 / 50000

Cost on evaluation data: 1.498837195

Accuracy on evaluation data: 9429 / 10000

Epoch 9 training complete

Cost on training data: 0.550150830471

Accuracy on training data: 47309 / 50000

Cost on evaluation data: 1.49457924808

Accuracy on evaluation data: 9403 / 10000

Epoch 10 training complete

Cost on training data: 0.489974953908

Accuracy on training data: 47844 / 50000

Cost on evaluation data: 1.39647648275

Accuracy on evaluation data: 9517 / 10000

Epoch 11 training complete

Cost on training data: 0.481178063442

Accuracy on training data: 47885 / 50000

Cost on evaluation data: 1.40231636253

Accuracy on evaluation data: 9518 / 10000

Epoch 12 training complete

Cost on training data: 0.490345815979

Accuracy on training data: 47906 / 50000

Cost on evaluation data: 1.4139500828

Accuracy on evaluation data: 9497 / 10000

Epoch 13 training complete

Cost on training data: 0.429120010084

Accuracy on training data: 48296 / 50000

Cost on evaluation data: 1.35483185191

Accuracy on evaluation data: 9570 / 10000

Epoch 14 training complete

Cost on training data: 0.477667825781

Accuracy on training data: 47882 / 50000

Cost on evaluation data: 1.39309009387

Accuracy on evaluation data: 9508 / 10000

Epoch 15 training complete

Cost on training data: 0.423424653658

Accuracy on training data: 48323 / 50000

Cost on evaluation data: 1.34904405286

Accuracy on evaluation data: 9587 / 10000

Epoch 16 training complete

Cost on training data: 0.433961957357

Accuracy on training data: 48293 / 50000

Cost on evaluation data: 1.35496642652

Accuracy on evaluation data: 9559 / 10000

Epoch 17 training complete

Cost on training data: 0.49463828859

Accuracy on training data: 47771 / 50000

Cost on evaluation data: 1.40640661418

Accuracy on evaluation data: 9485 / 10000

Epoch 18 training complete

Cost on training data: 0.47418356412

Accuracy on training data: 47954 / 50000

Cost on evaluation data: 1.38230292131

Accuracy on evaluation data: 9509 / 10000

Epoch 19 training complete

Cost on training data: 0.434654964562

Accuracy on training data: 48299 / 50000

Cost on evaluation data: 1.35471332568

Accuracy on evaluation data: 9580 / 10000

Epoch 20 training complete

Cost on training data: 0.506512518681

Accuracy on training data: 47654 / 50000

Cost on evaluation data: 1.40626969239

Accuracy on evaluation data: 9488 / 10000

Epoch 21 training complete

Cost on training data: 0.510337314168

Accuracy on training data: 47596 / 50000

Cost on evaluation data: 1.40316408044

Accuracy on evaluation data: 9488 / 10000

Epoch 22 training complete

Cost on training data: 0.441234675356

Accuracy on training data: 48181 / 50000

Cost on evaluation data: 1.3548347108

Accuracy on evaluation data: 9580 / 10000

Epoch 23 training complete

Cost on training data: 0.448269893166

Accuracy on training data: 48153 / 50000

Cost on evaluation data: 1.37145518795

Accuracy on evaluation data: 9552 / 10000

Epoch 24 training complete

Cost on training data: 0.447195473394

Accuracy on training data: 48126 / 50000

Cost on evaluation data: 1.36927339388

Accuracy on evaluation data: 9566 / 10000

Epoch 25 training complete

Cost on training data: 0.509774110993

Accuracy on training data: 47637 / 50000

Cost on evaluation data: 1.41576545279

Accuracy on evaluation data: 9464 / 10000

Epoch 26 training complete

Cost on training data: 0.421152982337

Accuracy on training data: 48315 / 50000

Cost on evaluation data: 1.33600603477

Accuracy on evaluation data: 9593 / 10000

Epoch 27 training complete

Cost on training data: 0.454280588156

Accuracy on training data: 48066 / 50000

Cost on evaluation data: 1.3724223521

Accuracy on evaluation data: 9568 / 10000

Epoch 28 training complete

Cost on training data: 0.442168885164

Accuracy on training data: 48220 / 50000

Cost on evaluation data: 1.36025924121

Accuracy on evaluation data: 9573 / 10000

Epoch 29 training complete

Cost on training data: 0.450619561148

Accuracy on training data: 48118 / 50000

Cost on evaluation data: 1.37293766914

Accuracy on evaluation data: 9562 / 10000

```
In [6]: import plot_helper
```

```
plot_helper.plot_training_cost(num_epochs=epochs, training_cost=training_cost_all_train,
```

```
plot_helper.plot_training_accuracy(num_epochs=epochs, training_accuracy=training_accuracy_all_train,
```

```
plot_helper.plot_test_cost(num_epochs=epochs, test_cost=evaluation_cost_all_train, test_cost=evaluation_cost_all_test,
```

```
plot_helper.plot_test_accuracy(num_epochs=epochs, test_accuracy=evaluation_accuracy_all_train, test_accuracy=evaluation_accuracy_all_test,
```



