

1. Optimize the performance of the network

The three optimizations I picked for this assignment (since I had already done all of the others in the former assignments) were the following.

(b) Do a more exhaustive random search to find **good** values for the amount of regularization, the learning rate.

For this experiment I wasn't really sure on where or how to look. Thus I used the methods from this and the former assignment to do a more extensive coarse and fine search. The method can be seen in the code, but basically I created a broad range of all values for the network such as momentum and weight decay. I also searched for different values for the learning rate and the lambda value as well. After the coarse search had ran, I would pick the parameters of the top 10% of the networks on the testing set and search further within their range for another 40 loops to find the best results. After finishing that fine search, I did the same as before and kept on going like this for about 5 rounds, increasing the epochs of each run by 2. The number of data points used started at 4000 and another 1000 were added on every run. Then I went to sleep.

I started out with these ranges to search within.

Initial values

New momentum	Max:0.9	Min:0.5
New eta	Max:0.01	Min:0.00001
New lambda	Max:0.1	Min:0.0001
New decay	Max:0.99	Min:0.5

When I woke up the next day, the results were these. Note: The momentum shows the same value as the eta because I was printing out the wrong attribute. The final momentum is still the searched best one.

First run – got from 13% to 33%

New momentum	Max:0.00886130147304	Min:0.00496543201235
New eta	Max:0.00886130147304	Min:0.00496543201235
New lambda	Max:0.0765582212381	Min:0.0202011093053
New decay	Max:0.745389577052	Min:0.653847626828

Second run – got from 33% to 36%

New momentum	Max:0.0085850141985	Min:0.00678209022403
New eta	Max:0.0085850141985	Min:0.00678209022403
New lambda	Max:0.0606092439706	Min:0.0366519282252
New decay	Max:0.740287220143	Min:0.693201272473

Third run – got from 36% to 38%

New momentum	Max:0.00849596298794	Min:0.00769374610716
New eta	Max:0.00849596298794	Min:0.00769374610716
New lambda	Max:0.0498395220942	Min:0.0374307744506
New decay	Max:0.738484791511	Min:0.711145010173

Fourth run – got from 38% to 39%

New momentum	Max:0.00846025058374	Min:0.00810650251179
New eta	Max:0.00846025058374	Min:0.00810650251179
New lambda	Max:0.048269431085	Min:0.0393471571397
New decay	Max:0.737252863107	Min:0.715980529622

Fifth run – got from 39% to 39.9%

New momentum	Max:0.00840180167037	Min:0.00815798105238
New eta	Max:0.00840180167037	Min:0.00815798105238
New lambda	Max:0.044207720211	Min:0.0402050897734
New decay	Max:0.733660595632	Min:0.721867325012

So the top networks parameters of this 4 hour long run (5 * 40 trainings) were the following

```
accuracy: 0.3992
momentum: 0.855267369989
eta: 0.00815934255035
lambda: 0.0402050897734
decay: 0.731936477927
```

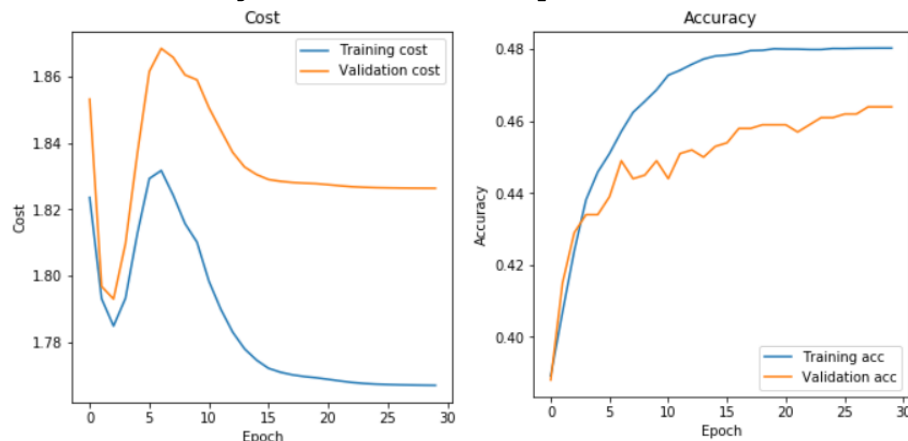
Reaching 39.92% accuracy on the testing set. Thus, comparing the best results with my initial parameters trained on all of the data gave me this outcome

```
Network Eta:0.00815934255035 epoch: 30 batch: 500 lambdaVal: 0.0402050897734 momentum: 0.855267369989 decay:0.731936477927
```

```
Info on Training data: Accuracy: 48.03% and Cost: 1.77
```

```
Info on Validation data: Accuracy: 46.40% and Cost: 1.83
```

```
Info on Testing data: Accuracy: 44.38% and Cost: 1.84
```



A big surprise though, giving these best parameters access to all of the batches seemed over fit it to some degree. Training it for a longer time might increase the accuracy though since it seems to be climbing even though the cost had function had a rough start early on. Would it have made a difference if I searched for the best parameters on all of the data? Maybe, I think so. But I don't have the computational resources to test it out at the moment so I leave these further thoughts with myself for future projects.

The training log can be seen in Appendix 1.

(c) Do a more thorough search to find a good network architecture. Does making the network deeper improve performance?

For this experiment I constructed 9 different architectures to see and compare the different accuracy achieved. I used 5000 data points on the training and 1000 for validation with these initial settings

```
Network Eta:0.010062184458341922 epoch: 5 batch: 500 lambdaVal: 0.0014561487876284364 momentum: 0.9
```

The networks that I constructed had 4, 5 and 6 layers with different amount of nodes in them

- 4 Layer Networks
 - Layers 3072 -> 50 -> 30 -> 20 -> 10
 - Layers 3072 -> 100 -> 50 -> 30 -> 10
 - Layers 3072 -> 200 -> 100 -> 50 -> 10
- 5 Layer Networks
 - Layers 3072 -> 50 -> 40 -> 30 -> 20 -> 10
 - Layers 3072 -> 100 -> 50 -> 30 -> 20 -> 10
 - Layers 3072 -> 400 -> 200 -> 50 -> 30 -> 10
- 6 Layer Networks
 - Layers 3072 -> 50 -> 40 -> 30 -> 20 -> 15 -> 10
 - Layers 3072 -> 200 -> 100 -> 50 -> 30 -> 20 -> 10
 - Layers 3072 -> 500 -> 200 -> 100 -> 50 -> 30 -> 10

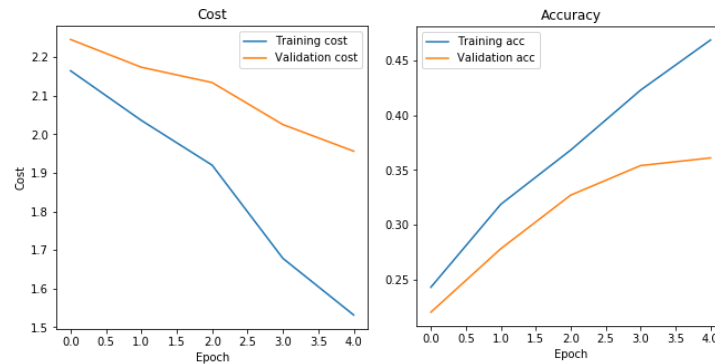
After creating a loop that went through all of them for the initial settings, it seemed like going deeper and changing the node structure surely had different results and varied a lot. The most accuracy I got on the training set and the testing set was a really deep layer

(3072,500) -> (500,200) -> (200,100) -> (100,50) -> (50,30) -> (30,10)

Info on Training data: Accuracy: 46.88% and Cost: 1.53

Info on Validation data: Accuracy: 36.10% and Cost: 1.96

Info on Testing data: Accuracy: 35.12% and Cost: 1.90



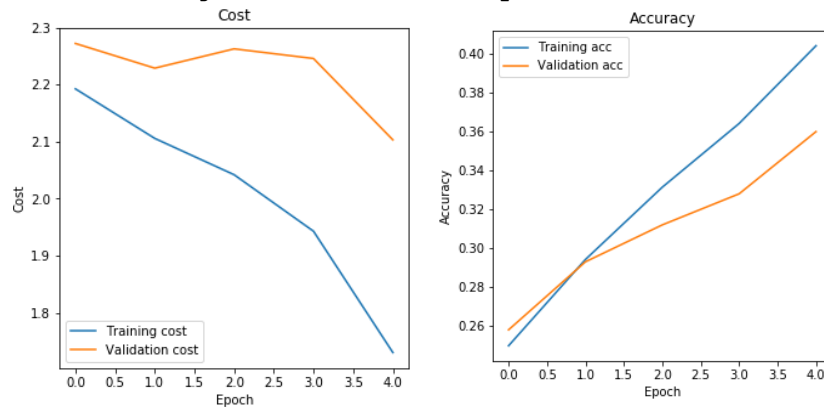
While the most accuracy I got on the validation set was way smaller

(3072,100) -> (100,50) -> (50,30) -> (30,10)

Info on Training data: Accuracy: 40.42% and Cost: 1.73

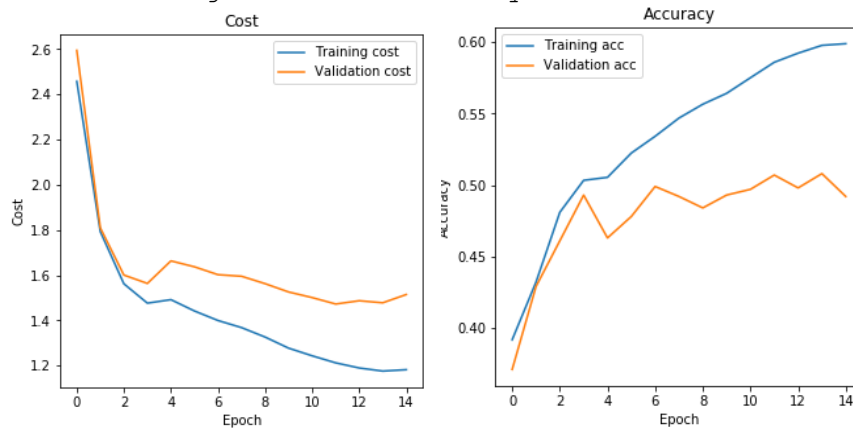
Info on Validation data: Accuracy: 36.00% and Cost: 2.10

Info on Testing data: Accuracy: 34.80% and Cost: 1.99

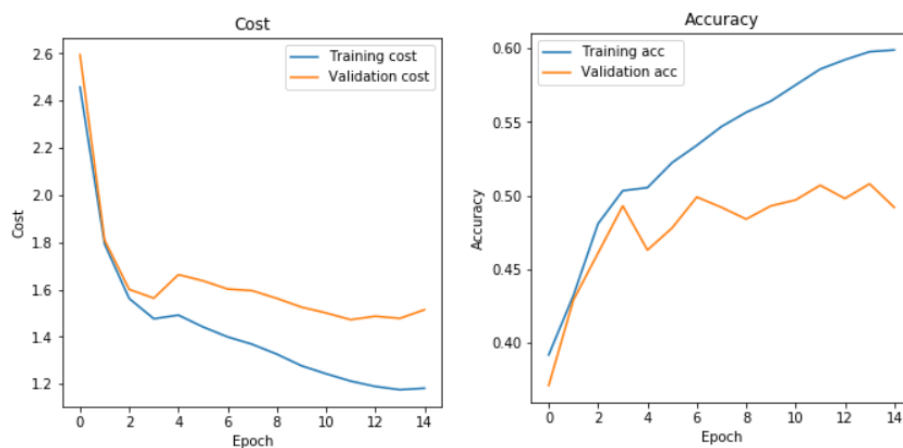


So, indeed, going deeper gave me a little bit of boost on the validation set but not as much as I had hoped for. Thus I tested both of those networks on all of the data and for a longer training time to see the effects. So training on all the data and for 15 epochs gave me these results.

(3072,100) -> (100,50) -> (50,30) -> (30,10)
 Network Eta:0.010062184458341922 epoch: 15 batch: 500 lambdaVal: 0.0014
 561487876284364 momentum: 0.9
 Info on Training data: Accuracy: 59.89% and Cost: 1.18
 Info on Validation data: Accuracy: 49.20% and Cost: 1.51
 Info on Testing data: Accuracy: 50.75% and Cost: 1.55



(3072,500) -> (500,200) -> (200,100) -> (100,50) -> (50,30) -> (30,10)
 Network Eta:0.010062184458341922 epoch: 15 batch: 500 lambdaVal: 0.0014
 561487876284364 momentum: 0.9
 Info on Training data: Accuracy: 61.47% and Cost: 1.17
 Info on Validation data: Accuracy: 46.10% and Cost: 1.75
 Info on Testing data: Accuracy: 46.89% and Cost: 1.79



So according to my research, going deeper didn't really change that much for this architecture. We can see that the 6 layer version did not perform as good as the original three layer while the 4 layer one with 100 nodes in the first hidden layer boosted up my results by 2%. So it might be good to add one layer extra but picking the correct number of nodes is a little bit trickier (bias/variance dilemma). I'll leave that to my wonders.

All of my network printings can be seen in Appendix 2.

(f) Augment your training data by applying small random geometric and photometric jitter to the original training data. You can do this on the fly by applying a random jitter to each image in the mini-batch before doing the forward and backward pass.

For this experiment, I created 3 different types of functions that could be applied to any size of a batch. The functions that I worked with were the following

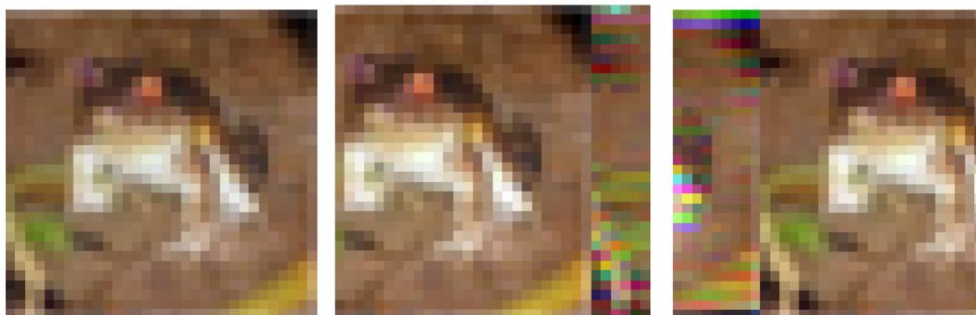
addBrightnessToHue:

This function selected a random array of the red, green or blue values of an image and tweaked its brightness/hue by adding or subtracting a maximum of 0.1. These effects can be seen here



moveAround:

This function panned the image a little bit to the left or right, creating a moving frame or a small corruption to the dataset. These effects can be seen here



jitterAndNoise:

This function distorted the image a little bit by adding a random sampling of noise and small rotation to a random red, green or blue array. These effects can be seen here



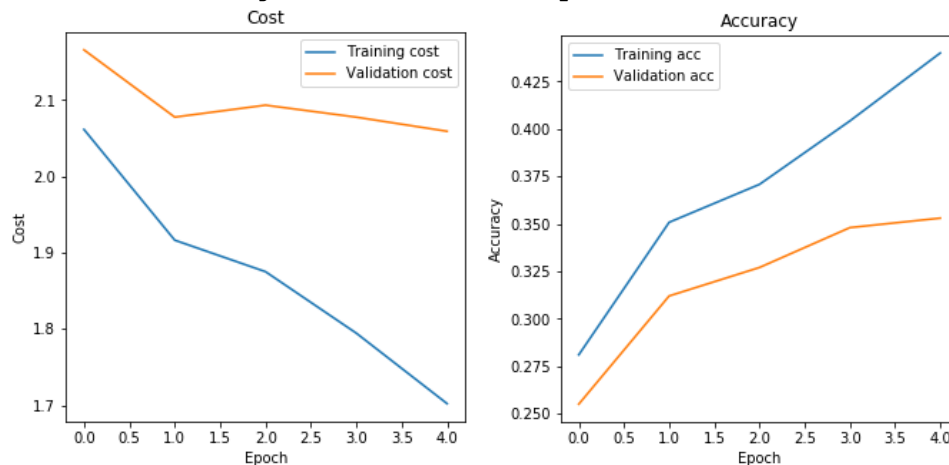
So with all of these effects combined, here are different variations



Since the data used in training is now endless (new data augmentation is added to each batch in the training) we could train forever. Thus, when using augmentation the data trained on was multiplied by 4 if the augmentation was active by creating an extra loop within the epoch. So without using the augmentation we get

```
Network Eta:0.010062184458341922 epoch: 5 batch: 500 lambdaVal: 0.00145
61487876284364 momentum: 0.9
```

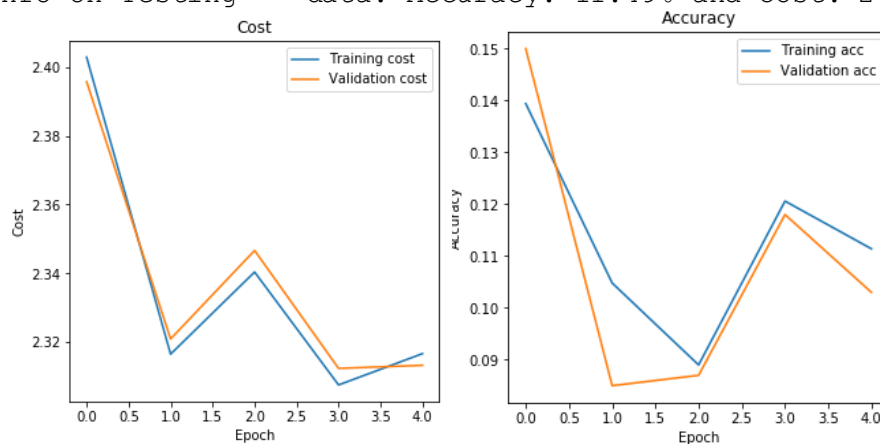
```
Info on Training data: Accuracy: 44.00% and Cost: 1.70
Info on Validation data: Accuracy: 35.30% and Cost: 2.06
Info on Testing data: Accuracy: 36.22% and Cost: 1.97
```



Using my data augmentation methods

```
Network Eta:0.010062184458341922 epoch: 5 batch: 500 lambdaVal: 0.00145
61487876284364 momentum: 0.9
```

```
Info on Training data: Accuracy: 11.14% and Cost: 2.32
Info on Validation data: Accuracy: 10.30% and Cost: 2.31
Info on Testing data: Accuracy: 11.49% and Cost: 2.32
```



It seems like my data augmentation methods were not successful at all. Even after lowering the amount of noise and placement of the images it didn't help that much. This makes a lot of sense since the CIFAR-10 dataset is built with images being placed in the center and having similar color schemes. My theory is that the fully connected structure doesn't handle the placement and noise so well, while a convolutional might do since it can see the patterns that it is looking for. Thus, this structure doesn't really handle noise or corruption that well.

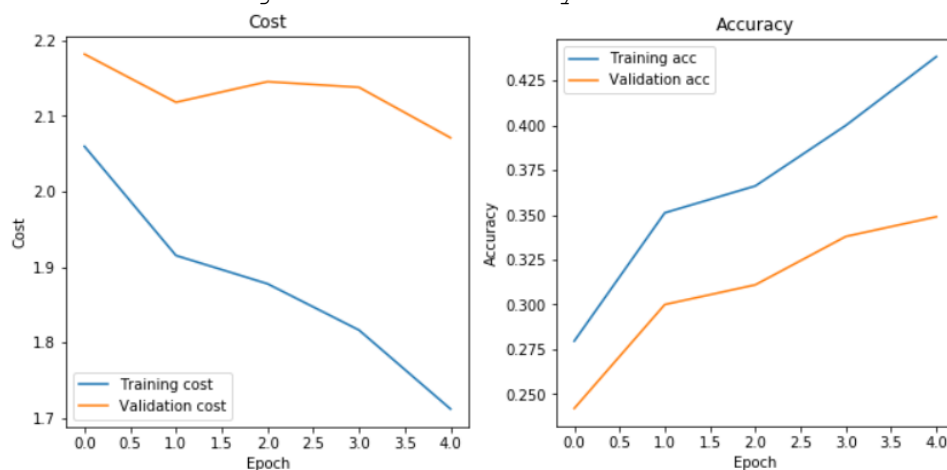
2. Train network using a different activation to ReLu

So for this assignment I decided to try out using **Leaky ReLu** after my miserable **ArcTan** function in the former assignment. The implementation was straightforward but required a little bit of extra calculations since I need to create another copy of the input array multiplied by 0.1. To my surprise, the first initial test came out quite good. Training on only the first 5000 data points with the same parameters as in the basic assignment these were my outcomes.

Network Eta:0.010062184458341922 epoch: 5 batch: 500 lambdaVal: 0.00145
61487876284364 momentum: 0.9 decay:0.95

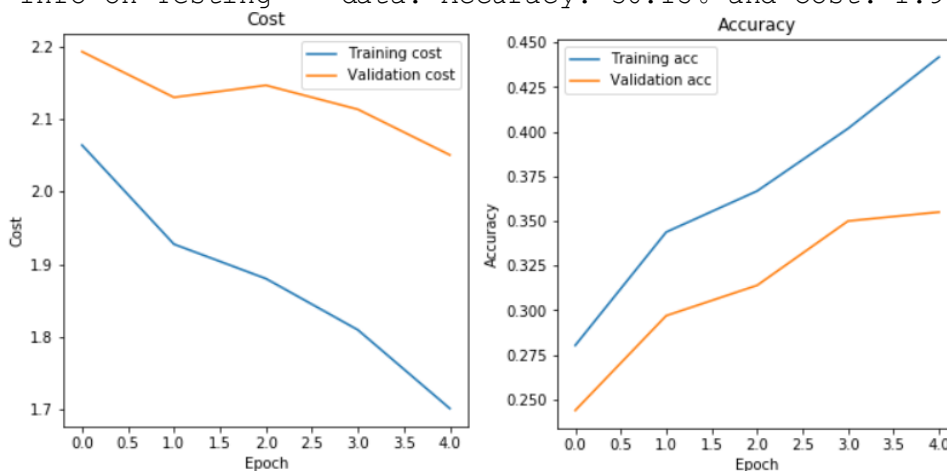
Not using Leaky Relu

Info on Training data: Accuracy: 43.84% and Cost: 1.71
Info on Validation data: Accuracy: 34.90% and Cost: 2.07
Info on Testing data: Accuracy: 36.05% and Cost: 1.98



Using Leaky ReLu

Info on Training data: Accuracy: 44.18% and Cost: 1.70
Info on Validation data: Accuracy: 35.50% and Cost: 2.05
Info on Testing data: Accuracy: 36.15% and Cost: 1.97

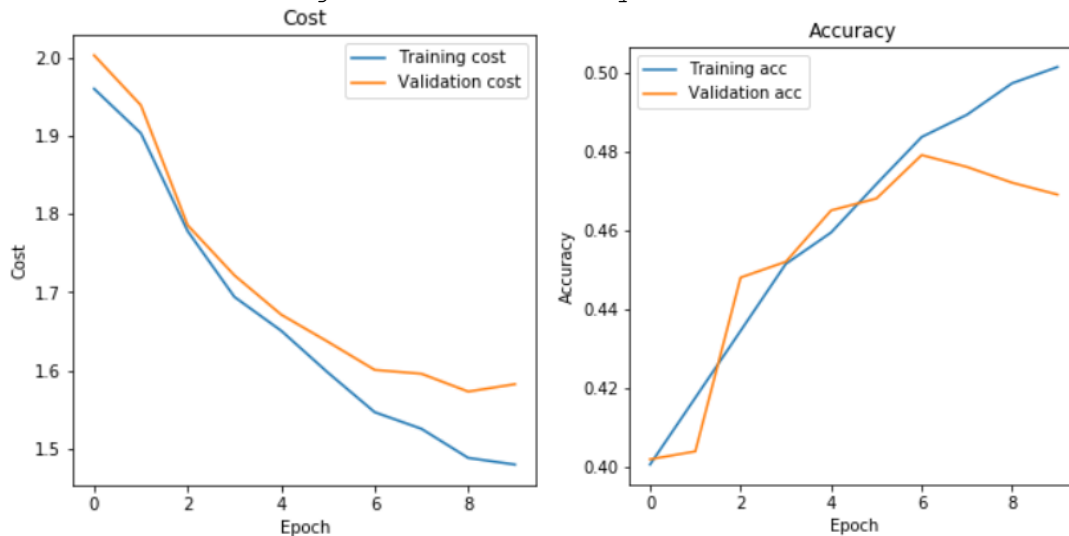


So it wasn't really a much improvement but did bump up the accuracy by a half percent on both the validation set and the testing set.

I then tried to train on all the data for 10 epochs with the original parameters to see the outcome.

```
Network Eta:0.010062184458341922 epoch: 10 batch: 500 lambdaVal: 0.0014
561487876284364 momentum: 0.9 decay:0.95
```

```
Info on Training data: Accuracy: 50.13% and Cost: 1.48
Info on Validation data: Accuracy: 46.90% and Cost: 1.58
Info on Testing data: Accuracy: 46.82% and Cost: 1.61
```

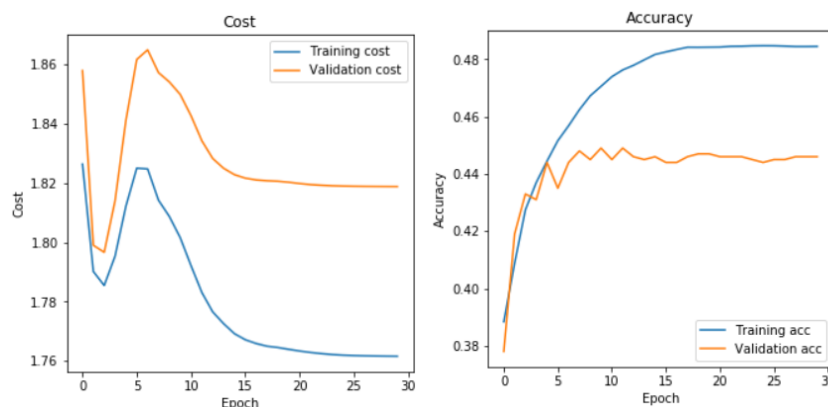


This actually came out pretty great as you can see. An early stopping method would have been really good here since we see that the validation accuracy reaches 48% but drops down to 46% at the end of the 6th epoch.

I also tested out the best parameters found from the optional part here above to see if the accuracy would improve.

```
Network Eta:0.00815934255035 epoch: 30 batch: 500 lambdaVal: 0.04020508
97734 momentum: 0.855267369989 decay:0.731936477927
```

```
Info on Training data: Accuracy: 48.45% and Cost: 1.76
Info on Validation data: Accuracy: 44.60% and Cost: 1.82
Info on Testing data: Accuracy: 44.74% and Cost: 1.83
```



It did not, so I guess that searching for better parameters to a different architecture of networks is always needed. Which is what I did. I ran the same depth search as I did in the optional part and narrowed my search down like this.

Initial values

New momentum	Max:0.9	Min:0.5
New eta	Max:0.01	Min:0.00001
New lambda	Max:0.1	Min:0.0001
New decay	Max:0.99	Min:0.5

First run – got from 10% to 34%

New momentum	Max:0.00978510294471	Min:0.00445161612533
New eta	Max:0.00978510294471	Min:0.00445161612533
New lambda	Max:0.0943205792876	Min:0.0140726931839
New decay	Max:0.926654873461	Min:0.627890451932

Second run – got from 33% to 37%

New momentum	Max:0.00966186331961	Min:0.00620612117744
New eta	Max:0.00966186331961	Min:0.00620612117744
New lambda	Max:0.0465029752588	Min:0.0187848169605
New decay	Max:0.901497264331	Min:0.800071850992

Third run – got from 37% to 39%

New momentum	Max:0.0096288793137	Min:0.00795575277882
New eta	Max:0.0096288793137	Min:0.00795575277882
New lambda	Max:0.0248219291291	Min:0.0194824032864
New decay	Max:0.900225185582	Min:0.818953859944

Fourth run – got from 39% to 40.5%

New momentum	Max:0.00944098264466	Min:0.00822637210839
New eta	Max:0.00944098264466	Min:0.00822637210839
New lambda	Max:0.0243145633584	Min:0.0204144545863
New decay	Max:0.883431120965	Min:0.855845982966

Fifth run – got from 40.5% to

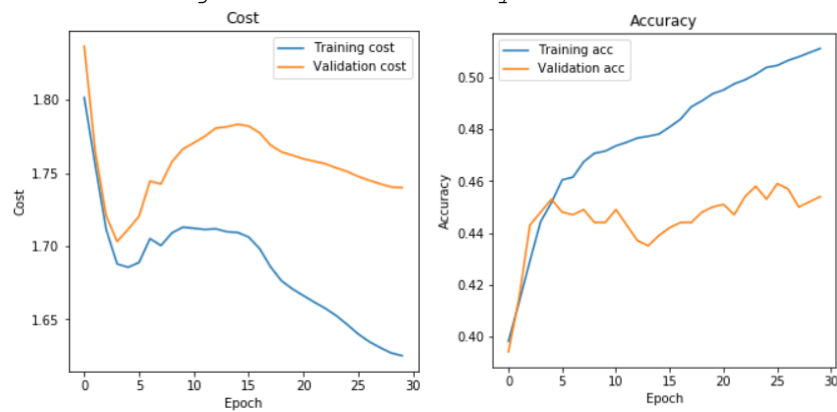
New momentum	Max:0.00936187213673	Min:0.00839591394551
New eta	Max:0.00936187213673	Min:0.00839591394551
New lambda	Max:0.0231651269512	Min:0.0217890632654
New decay	Max:0.874448836071	Min:0.858505933723

So the top networks parameters of this 4 hour long run (5 * 40 trainings) were the following

accuracy:	0.4102
momentum:	0.868630862338
eta:	0.00936187213673
lambda:	0.0218014476467
decay:	0.874448836071

Reaching 41.02% accuracy on the testing set which is nearly 1.5% improvement. Thus, comparing the best results with these parameters trained on all of the data for a longer time gave me this outcome

Network Eta:0.00936187213673 epoch: 30 batch: 500 lambdaVal: 0.02180144
76467 momentum: 0.868630862338 decay:0.874448836071
Info on Training data: Accuracy: 51.12% and Cost: 1.63
Info on Validation data: Accuracy: 45.40% and Cost: 1.74
Info on Testing data: Accuracy: 44.82% and Cost: 1.76



It didn't seem that I would have to modify my batch normalization forward and backward functions at all. I'm not really sure if it's needed or not but the network managed to train without overflowing or dividing somewhere by zero. It was nice testing another function from the course. Just like the lecture said, you should always use leaky ReLU. Guess I'll start to do that from now on.

Appendix 1

Network Eta:0.005982033717286888 epoch: 5 batch: 500 lambdaVal: 0.090255137
30337084 momentum: 0.8368276492473308 decay:0.6540404252472586
Info on Testing data: Accuracy: 32.78% and Cost: 2.1

Network Eta:0.005482991609536066 epoch: 5 batch: 500 lambdaVal: 0.081443443
77818279 momentum: 0.8370073454076632 decay:0.5334994823451803
Info on Testing data: Accuracy: 31.8% and Cost: 2.12

Network Eta:0.000887524214793747 epoch: 5 batch: 500 lambdaVal: 0.037887165
67306188 momentum: 0.6790311884684053 decay:0.5881189493381831
Info on Testing data: Accuracy: 19.24% and Cost: 2.26

Network Eta:0.006136844205940584 epoch: 5 batch: 500 lambdaVal: 0.017782295
693419096 momentum: 0.7084633737818811 decay:0.6120207529261874
Info on Testing data: Accuracy: 30.87% and Cost: 2.06

Network Eta:0.0029891306976687526 epoch: 5 batch: 500 lambdaVal: 0.08211634
91021087 momentum: 0.7148512556948481 decay:0.50937099572507
Info on Testing data: Accuracy: 26.84% and Cost: 2.23

Network Eta:0.005383005194262174 epoch: 5 batch: 500 lambdaVal: 0.090790584
44254212 momentum: 0.5661414553854128 decay:0.918751372274822
Info on Testing data: Accuracy: 30.8% and Cost: 2.15

Network Eta:0.0031035823415946546 epoch: 5 batch: 500 lambdaVal: 0.09496098
443855017 momentum: 0.8353786677137496 decay:0.6015326871287596
Info on Testing data: Accuracy: 30.1% and Cost: 2.18

Network Eta:0.004091308939334367 epoch: 5 batch: 500 lambdaVal: 0.086873567
6425313 momentum: 0.6798041071182137 decay:0.5640784922245567
Info on Testing data: Accuracy: 28.11% and Cost: 2.21

Network Eta:0.00011545243396466634 epoch: 5 batch: 500 lambdaVal: 0.0288951
1624640674 momentum: 0.7332174793276357 decay:0.970649270760658
Info on Testing data: Accuracy: 13.75% and Cost: 2.31

Network Eta:0.0022216933734067698 epoch: 5 batch: 500 lambdaVal: 0.05498140
448913434 momentum: 0.8095460162868424 decay:0.5402940353616323
Info on Testing data: Accuracy: 27.6% and Cost: 2.18

Network Eta:0.006719167684915128 epoch: 5 batch: 500 lambdaVal: 0.022390977
06279861 momentum: 0.6557785802886773 decay:0.9568685235840855
Info on Testing data: Accuracy: 32.75% and Cost: 2.0

Network Eta:0.00867813428247571 epoch: 5 batch: 500 lambdaVal: 0.0012440488
150250665 momentum: 0.5186104433890824 decay:0.8381918510379468
Info on Testing data: Accuracy: 31.9% and Cost: 2.0

Network Eta:0.007614287100698044 epoch: 5 batch: 500 lambdaVal: 0.040984892
11891453 momentum: 0.7006756655173106 decay:0.6878203115045355
Info on Testing data: Accuracy: 32.25% and Cost: 2.06

Network Eta:0.005188044539930002 epoch: 5 batch: 500 lambdaVal: 0.013417118
15690953 momentum: 0.7739735653124978 decay:0.8864065610258071
Info on Testing data: Accuracy: 32.65% and Cost: 1.98

Network Eta:0.0008438750902546269 epoch: 5 batch: 500 lambdaVal: 0.07923478
429190897 momentum: 0.6481091222965342 decay:0.6805786891936552
Info on Testing data: Accuracy: 19.34% and Cost: 2.31

Network Eta:0.009003018561949343 epoch: 5 batch: 500 lambdaVal: 0.033011316
252088314 momentum: 0.5888460970078978 decay:0.9800305614708666
Info on Testing data: Accuracy: 33.08% and Cost: 2.0
Network Eta:0.009831311435594597 epoch: 5 batch: 500 lambdaVal: 0.013376009
775079661 momentum: 0.6003682876136467 decay:0.7981580984069084
Info on Testing data: Accuracy: 32.53% and Cost: 1.99
Network Eta:0.004091718981206272 epoch: 5 batch: 500 lambdaVal: 0.048549813
95108678 momentum: 0.6548899893905784 decay:0.8642736371167614
Info on Testing data: Accuracy: 30.23% and Cost: 2.11
Network Eta:0.0036438630575376333 epoch: 5 batch: 500 lambdaVal: 0.06446411
935157362 momentum: 0.6978974875296589 decay:0.8590537285999167
Info on Testing data: Accuracy: 30.11% and Cost: 2.14
Network Eta:0.00678377073519768 epoch: 5 batch: 500 lambdaVal: 0.0886593979
7976871 momentum: 0.5802786573389176 decay:0.5968327124819279
Info on Testing data: Accuracy: 29.44% and Cost: 2.19
Network Eta:0.004676764019733329 epoch: 5 batch: 500 lambdaVal: 0.052582494
99762393 momentum: 0.7180712913903282 decay:0.6097427533122783
Info on Testing data: Accuracy: 29.7% and Cost: 2.14
Network Eta:0.007222805587663954 epoch: 5 batch: 500 lambdaVal: 0.045443825
747765475 momentum: 0.6355375527389548 decay:0.7006695854548239
Info on Testing data: Accuracy: 31.46% and Cost: 2.09
Network Eta:0.00035189098131331283 epoch: 5 batch: 500 lambdaVal: 0.0365352
21546325936 momentum: 0.810295390994072 decay:0.5079132288465932
Info on Testing data: Accuracy: 16.25% and Cost: 2.29
Network Eta:0.0041054181351213095 epoch: 5 batch: 500 lambdaVal: 0.08471945
59301918 momentum: 0.8128348648889048 decay:0.9543479032995759
Info on Testing data: Accuracy: 32.67% and Cost: 2.09
Network Eta:0.004965432012350911 epoch: 5 batch: 500 lambdaVal: 0.028611018
908741327 momentum: 0.865512820499367 decay:0.7273894019261704
Info on Testing data: Accuracy: 33.21% and Cost: 1.99
Network Eta:0.007658884718390507 epoch: 5 batch: 500 lambdaVal: 0.020201109
30527043 momentum: 0.8412043520007809 decay:0.6538476268276949
Info on Testing data: Accuracy: 33.49% and Cost: 1.96
Network Eta:0.0031275697250164377 epoch: 5 batch: 500 lambdaVal: 0.09817192
537296271 momentum: 0.8504211533690332 decay:0.9671678464104362
Info on Testing data: Accuracy: 32.9% and Cost: 2.11
Network Eta:0.008557488686744417 epoch: 5 batch: 500 lambdaVal: 0.028182691
352958675 momentum: 0.7465927304073596 decay:0.5843009891959605
Info on Testing data: Accuracy: 32.42% and Cost: 2.03
Network Eta:0.004761352528841065 epoch: 5 batch: 500 lambdaVal: 0.003286596
6188583644 momentum: 0.5180598141050909 decay:0.5027121969266894
Info on Testing data: Accuracy: 26.2% and Cost: 2.13
Network Eta:0.0015292062588448533 epoch: 5 batch: 500 lambdaVal: 0.04299089
7238127546 momentum: 0.5433948149213479 decay:0.8401463690392814
Info on Testing data: Accuracy: 23.84% and Cost: 2.22
Network Eta:0.006438915945035841 epoch: 5 batch: 500 lambdaVal: 0.097434439
170897 momentum: 0.525464385504815 decay:0.5934324618475754
Info on Testing data: Accuracy: 28.62% and Cost: 2.21

Network Eta:0.00733901377706133 epoch: 5 batch: 500 lambdaVal: 0.0345608802
0952493 momentum: 0.6308081237512424 decay:0.521601460828923
Info on Testing data: Accuracy: 29.52% and Cost: 2.11
Network Eta:0.005997894335854846 epoch: 5 batch: 500 lambdaVal: 0.041988843
71933696 momentum: 0.7016385543884059 decay:0.8665107194530436
Info on Testing data: Accuracy: 32.45% and Cost: 2.05
Network Eta:0.004644415431594807 epoch: 5 batch: 500 lambdaVal: 0.068882053
26869501 momentum: 0.8134603870218959 decay:0.717580694543963
Info on Testing data: Accuracy: 31.78% and Cost: 2.1
Network Eta:0.006335548467049469 epoch: 5 batch: 500 lambdaVal: 0.083856813
67801322 momentum: 0.5154835842102908 decay:0.9408516088964096
Info on Testing data: Accuracy: 31.37% and Cost: 2.14
Network Eta:0.007026602002375065 epoch: 5 batch: 500 lambdaVal: 0.020078470
59658279 momentum: 0.5717652193874221 decay:0.9371359417571609
Info on Testing data: Accuracy: 31.94% and Cost: 2.02
Network Eta:0.008756471924105566 epoch: 5 batch: 500 lambdaVal: 0.015547509
975124888 momentum: 0.6643928030553395 decay:0.9269184861261712
Info on Testing data: Accuracy: 33.01% and Cost: 1.96
Network Eta:0.0011895705422808847 epoch: 5 batch: 500 lambdaVal: 0.08965872
918298672 momentum: 0.7007601523118918 decay:0.5915250493230628
Info on Testing data: Accuracy: 21.6% and Cost: 2.3
Network Eta:0.0088613014730374 epoch: 5 batch: 500 lambdaVal: 0.02901555861
0714264 momentum: 0.8461212934126991 decay:0.6834562119603272
Info on Testing data: Accuracy: 34.53% and Cost: 1.95
Network Eta:0.007730561314203823 epoch: 5 batch: 500 lambdaVal: 0.076558221
2380536 momentum: 0.7940123717060301 decay:0.745389577052012
Info on Testing data: Accuracy: 33.78% and Cost: 2.07
New momentum Max:0.00886130147304 Min:0.00496543201235
New eta Max:0.00886130147304 Min:0.00496543201235
New lambda Max:0.0765582212381 Min:0.0202011093053
New decay Max:0.745389577052 Min:0.653847626828
Network Eta:0.00805674635907 epoch: 7 batch: 500 lambdaVal: 0.0459079835498
momentum: 0.836867977278 decay:0.738706043929
Info on Testing data: Accuracy: 35.95% and Cost: 1.98
Network Eta:0.00561187651745 epoch: 7 batch: 500 lambdaVal: 0.0246638327065
momentum: 0.83145746186 decay:0.678024238473
Info on Testing data: Accuracy: 34.72% and Cost: 2.0
Network Eta:0.00499177712649 epoch: 7 batch: 500 lambdaVal: 0.028215082379
momentum: 0.84882530052 decay:0.659375364944
Info on Testing data: Accuracy: 33.94% and Cost: 2.01
Network Eta:0.00801133226171 epoch: 7 batch: 500 lambdaVal: 0.0404163358621
momentum: 0.864421848575 decay:0.697095468506
Info on Testing data: Accuracy: 36.15% and Cost: 1.96
Network Eta:0.00608200503038 epoch: 7 batch: 500 lambdaVal: 0.0527562697376
momentum: 0.808104090587 decay:0.725364175995
Info on Testing data: Accuracy: 35.08% and Cost: 2.04
Network Eta:0.0072886390378 epoch: 7 batch: 500 lambdaVal: 0.0580792917582
momentum: 0.862360913431 decay:0.678873338073

Info on Testing data: Accuracy: 35.6% and Cost: 2.02
Network Eta:0.00800890176691 epoch: 7 batch: 500 lambdaVal: 0.035625219508
momentum: 0.847243809986 decay:0.701972366917
Info on Testing data: Accuracy: 35.85% and Cost: 1.96
Network Eta:0.00678209022403 epoch: 7 batch: 500 lambdaVal: 0.0437622057196
momentum: 0.863428821935 decay:0.740287220143
Info on Testing data: Accuracy: 36.23% and Cost: 1.98
Network Eta:0.00732306206781 epoch: 7 batch: 500 lambdaVal: 0.0714700723332
momentum: 0.819914999751 decay:0.679278650892
Info on Testing data: Accuracy: 35.41% and Cost: 2.06
Network Eta:0.00762472340836 epoch: 7 batch: 500 lambdaVal: 0.0206785545465
momentum: 0.813404844835 decay:0.66705225997
Info on Testing data: Accuracy: 35.24% and Cost: 1.97
Network Eta:0.0075515897808 epoch: 7 batch: 500 lambdaVal: 0.0516859661542
momentum: 0.798281855051 decay:0.660385873057
Info on Testing data: Accuracy: 35.28% and Cost: 2.04
Network Eta:0.00729338898196 epoch: 7 batch: 500 lambdaVal: 0.0653797925069
momentum: 0.82645438001 decay:0.719978341174
Info on Testing data: Accuracy: 35.31% and Cost: 2.04
Network Eta:0.0064244935926 epoch: 7 batch: 500 lambdaVal: 0.0365572670921
momentum: 0.859692394573 decay:0.667714746515
Info on Testing data: Accuracy: 35.13% and Cost: 1.99
Network Eta:0.00501431232081 epoch: 7 batch: 500 lambdaVal: 0.0709698121279
momentum: 0.824206548057 decay:0.720701320492
Info on Testing data: Accuracy: 34.06% and Cost: 2.08
Network Eta:0.00637640140613 epoch: 7 batch: 500 lambdaVal: 0.0407685650103
momentum: 0.811835672644 decay:0.72265206316
Info on Testing data: Accuracy: 34.98% and Cost: 2.01
Network Eta:0.00497099932251 epoch: 7 batch: 500 lambdaVal: 0.0645117277479
momentum: 0.828825521446 decay:0.715954682935
Info on Testing data: Accuracy: 34.24% and Cost: 2.07
Network Eta:0.00707427244024 epoch: 7 batch: 500 lambdaVal: 0.0654791343131
momentum: 0.824893330473 decay:0.663384636402
Info on Testing data: Accuracy: 35.07% and Cost: 2.06
Network Eta:0.00568403094949 epoch: 7 batch: 500 lambdaVal: 0.0681380140331
momentum: 0.829080093593 decay:0.744515335843
Info on Testing data: Accuracy: 35.0% and Cost: 2.06
Network Eta:0.00708771729312 epoch: 7 batch: 500 lambdaVal: 0.056831235674
momentum: 0.81635104978 decay:0.659516972807
Info on Testing data: Accuracy: 34.97% and Cost: 2.05
Network Eta:0.0085850141985 epoch: 7 batch: 500 lambdaVal: 0.0606092439706
momentum: 0.847521103599 decay:0.705340309406
Info on Testing data: Accuracy: 36.26% and Cost: 2.01
Network Eta:0.00561317416592 epoch: 7 batch: 500 lambdaVal: 0.0226326453865
momentum: 0.852768932859 decay:0.741505226629
Info on Testing data: Accuracy: 35.71% and Cost: 1.96
Network Eta:0.00724933686702 epoch: 7 batch: 500 lambdaVal: 0.0444541177201
momentum: 0.835395096398 decay:0.669819015118

Info on Testing data: Accuracy: 35.27% and Cost: 2.01
Network Eta:0.00751995386086 epoch: 7 batch: 500 lambdaVal: 0.0325359248501
momentum: 0.821616719445 decay:0.667267032495
Info on Testing data: Accuracy: 35.66% and Cost: 1.99
Network Eta:0.00742182471478 epoch: 7 batch: 500 lambdaVal: 0.0646954166872
momentum: 0.833954903662 decay:0.684580594991
Info on Testing data: Accuracy: 35.6% and Cost: 2.04
Network Eta:0.00667441803023 epoch: 7 batch: 500 lambdaVal: 0.058467460831
momentum: 0.84260589209 decay:0.734709762656
Info on Testing data: Accuracy: 35.39% and Cost: 2.03
Network Eta:0.00820111150002 epoch: 7 batch: 500 lambdaVal: 0.0366519282252
momentum: 0.845929625246 decay:0.693201272473
Info on Testing data: Accuracy: 35.96% and Cost: 1.96
Network Eta:0.00735832578451 epoch: 7 batch: 500 lambdaVal: 0.0669635385264
momentum: 0.829971936665 decay:0.737599214131
Info on Testing data: Accuracy: 35.37% and Cost: 2.04
Network Eta:0.00544826792311 epoch: 7 batch: 500 lambdaVal: 0.0260614092474
momentum: 0.835852036603 decay:0.672310315475
Info on Testing data: Accuracy: 34.49% and Cost: 2.0
Network Eta:0.00579567590209 epoch: 7 batch: 500 lambdaVal: 0.0687066306951
momentum: 0.832505757836 decay:0.676114488744
Info on Testing data: Accuracy: 34.9% and Cost: 2.07
Network Eta:0.00571287010879 epoch: 7 batch: 500 lambdaVal: 0.0612932271658
momentum: 0.859562866364 decay:0.683048299149
Info on Testing data: Accuracy: 35.1% and Cost: 2.04
Network Eta:0.00567909586032 epoch: 7 batch: 500 lambdaVal: 0.0211450014718
momentum: 0.831723783743 decay:0.690885585935
Info on Testing data: Accuracy: 34.61% and Cost: 1.99
Network Eta:0.00501565637137 epoch: 7 batch: 500 lambdaVal: 0.0367891967706
momentum: 0.801091738359 decay:0.66618519209
Info on Testing data: Accuracy: 33.29% and Cost: 2.05
Network Eta:0.00776985063716 epoch: 7 batch: 500 lambdaVal: 0.0472115713814
momentum: 0.826111732262 decay:0.66461775767
Info on Testing data: Accuracy: 35.33% and Cost: 2.01
Network Eta:0.00622909356332 epoch: 7 batch: 500 lambdaVal: 0.0291770053613
momentum: 0.804800080787 decay:0.725109790629
Info on Testing data: Accuracy: 35.17% and Cost: 2.0
Network Eta:0.00547136273305 epoch: 7 batch: 500 lambdaVal: 0.0533502714283
momentum: 0.850214978589 decay:0.733157716518
Info on Testing data: Accuracy: 35.31% and Cost: 2.03
Network Eta:0.0069059019981 epoch: 7 batch: 500 lambdaVal: 0.0439491646551
momentum: 0.831850354647 decay:0.688347129337
Info on Testing data: Accuracy: 35.22% and Cost: 2.01
Network Eta:0.0075596415963 epoch: 7 batch: 500 lambdaVal: 0.0465627926062
momentum: 0.834934873653 decay:0.720656542277
Info on Testing data: Accuracy: 35.82% and Cost: 2.0
Network Eta:0.00635477050176 epoch: 7 batch: 500 lambdaVal: 0.0744169540897
momentum: 0.798976504878 decay:0.660735377943

Info on Testing data: Accuracy: 34.37% and Cost: 2.09
Network Eta:0.00532612067573 epoch: 7 batch: 500 lambdaVal: 0.055896718483
momentum: 0.812337744799 decay:0.725012774996
Info on Testing data: Accuracy: 34.37% and Cost: 2.06
Network Eta:0.00739528505 epoch: 7 batch: 500 lambdaVal: 0.0372246996004 mo
mentum: 0.811629681754 decay:0.668470506655
Info on Testing data: Accuracy: 35.17% and Cost: 2.01
New momentum Max:0.0085850141985 Min:0.00678209022403
New eta Max:0.0085850141985 Min:0.00678209022403
New lambda Max:0.0606092439706 Min:0.0366519282252
New decay Max:0.740287220143 Min:0.693201272473
Network Eta:0.00687857871455 epoch: 9 batch: 500 lambdaVal: 0.0581449171658
momentum: 0.856079179676 decay:0.732114746169
Info on Testing data: Accuracy: 37.26% and Cost: 2.01
Network Eta:0.00699917227791 epoch: 9 batch: 500 lambdaVal: 0.0520948852938
momentum: 0.851846240449 decay:0.7312810686
Info on Testing data: Accuracy: 37.16% and Cost: 2.0
Network Eta:0.00793814738957 epoch: 9 batch: 500 lambdaVal: 0.0452782425891
momentum: 0.848669215054 decay:0.708057337668
Info on Testing data: Accuracy: 37.69% and Cost: 1.98
Network Eta:0.007950115569 epoch: 9 batch: 500 lambdaVal: 0.045144873835 mo
mentum: 0.848809341073 decay:0.698059117491
Info on Testing data: Accuracy: 37.34% and Cost: 1.98
Network Eta:0.00766260656058 epoch: 9 batch: 500 lambdaVal: 0.0384390756346
momentum: 0.860798505714 decay:0.701290509276
Info on Testing data: Accuracy: 37.5% and Cost: 1.96
Network Eta:0.00809758080723 epoch: 9 batch: 500 lambdaVal: 0.0529568464871
momentum: 0.859229844446 decay:0.737954223532
Info on Testing data: Accuracy: 37.76% and Cost: 1.98
Network Eta:0.00793784640163 epoch: 9 batch: 500 lambdaVal: 0.0466240822558
momentum: 0.857957668204 decay:0.704703512512
Info on Testing data: Accuracy: 37.48% and Cost: 1.98
Network Eta:0.00771761315317 epoch: 9 batch: 500 lambdaVal: 0.0432625820717
momentum: 0.8616283243 decay:0.716662913269
Info on Testing data: Accuracy: 37.65% and Cost: 1.96
Network Eta:0.00790307739421 epoch: 9 batch: 500 lambdaVal: 0.050394697598
momentum: 0.856080378996 decay:0.71595356098
Info on Testing data: Accuracy: 37.71% and Cost: 1.98
Network Eta:0.00794297305711 epoch: 9 batch: 500 lambdaVal: 0.050304374254
momentum: 0.853966094532 decay:0.725105407812
Info on Testing data: Accuracy: 37.74% and Cost: 1.98
Network Eta:0.00823332984918 epoch: 9 batch: 500 lambdaVal: 0.0464122452789
momentum: 0.857101225159 decay:0.711944904793
Info on Testing data: Accuracy: 37.7% and Cost: 1.97
Network Eta:0.00778154407518 epoch: 9 batch: 500 lambdaVal: 0.060185223237
momentum: 0.852395389631 decay:0.718448373471
Info on Testing data: Accuracy: 37.43% and Cost: 2.01

Network Eta:0.00746215968148 epoch: 9 batch: 500 lambdaVal: 0.0557294843873
momentum: 0.861421346523 decay:0.729784591358
Info on Testing data: Accuracy: 37.44% and Cost: 2.0
Network Eta:0.00798418835007 epoch: 9 batch: 500 lambdaVal: 0.0451226158398
momentum: 0.854206829171 decay:0.738484791511
Info on Testing data: Accuracy: 37.93% and Cost: 1.97
Network Eta:0.00825116176947 epoch: 9 batch: 500 lambdaVal: 0.0513563605616
momentum: 0.860886850403 decay:0.739852447149
Info on Testing data: Accuracy: 37.84% and Cost: 1.98
Network Eta:0.00832032621212 epoch: 9 batch: 500 lambdaVal: 0.0568861638241
momentum: 0.849619198069 decay:0.694390331077
Info on Testing data: Accuracy: 37.34% and Cost: 2.0
Network Eta:0.00702575396287 epoch: 9 batch: 500 lambdaVal: 0.0441228343457
momentum: 0.857481640228 decay:0.718748749876
Info on Testing data: Accuracy: 37.23% and Cost: 1.98
Network Eta:0.00801648649215 epoch: 9 batch: 500 lambdaVal: 0.0419396441827
momentum: 0.851912255221 decay:0.728508465004
Info on Testing data: Accuracy: 37.73% and Cost: 1.96
Network Eta:0.00762984788789 epoch: 9 batch: 500 lambdaVal: 0.0568893383276
momentum: 0.862394108222 decay:0.739956960552
Info on Testing data: Accuracy: 37.7% and Cost: 1.99
Network Eta:0.00816631732204 epoch: 9 batch: 500 lambdaVal: 0.043936265342
momentum: 0.847087014258 decay:0.705323962234
Info on Testing data: Accuracy: 37.64% and Cost: 1.97
Network Eta:0.00688121616484 epoch: 9 batch: 500 lambdaVal: 0.0372330380251
momentum: 0.846232987736 decay:0.737803386556
Info on Testing data: Accuracy: 37.22% and Cost: 1.97
Network Eta:0.00710873778655 epoch: 9 batch: 500 lambdaVal: 0.0416358534494
momentum: 0.85480727926 decay:0.700587237564
Info on Testing data: Accuracy: 36.98% and Cost: 1.98
Network Eta:0.00694144268291 epoch: 9 batch: 500 lambdaVal: 0.0391466519803
momentum: 0.862353061529 decay:0.732016273802
Info on Testing data: Accuracy: 37.55% and Cost: 1.96
Network Eta:0.00711510142387 epoch: 9 batch: 500 lambdaVal: 0.051202311396
momentum: 0.850120592215 decay:0.716152219781
Info on Testing data: Accuracy: 36.96% and Cost: 2.0
Network Eta:0.0072630505333 epoch: 9 batch: 500 lambdaVal: 0.0398765233946
momentum: 0.854632040239 decay:0.725419035983
Info on Testing data: Accuracy: 37.17% and Cost: 1.97
Network Eta:0.00692796135591 epoch: 9 batch: 500 lambdaVal: 0.0522077409746
momentum: 0.862385101986 decay:0.70736597821
Info on Testing data: Accuracy: 37.15% and Cost: 2.0
Network Eta:0.00809871762673 epoch: 9 batch: 500 lambdaVal: 0.0463208062162
momentum: 0.853920688668 decay:0.737231786448
Info on Testing data: Accuracy: 37.9% and Cost: 1.97
Network Eta:0.00799181954407 epoch: 9 batch: 500 lambdaVal: 0.0479326282613
momentum: 0.857825902809 decay:0.70125068738
Info on Testing data: Accuracy: 37.48% and Cost: 1.98

Network Eta:0.00788944686561 epoch: 9 batch: 500 lambdaVal: 0.0586665764214
momentum: 0.861435530831 decay:0.731614685983
Info on Testing data: Accuracy: 37.63% and Cost: 2.0
Network Eta:0.00714396085833 epoch: 9 batch: 500 lambdaVal: 0.0366653679479
momentum: 0.847406354622 decay:0.734518025157
Info on Testing data: Accuracy: 37.06% and Cost: 1.96
Network Eta:0.00755264095871 epoch: 9 batch: 500 lambdaVal: 0.0446804576873
momentum: 0.856269361552 decay:0.693736640951
Info on Testing data: Accuracy: 37.22% and Cost: 1.98
Network Eta:0.00819373836274 epoch: 9 batch: 500 lambdaVal: 0.0593811401504
momentum: 0.85329028747 decay:0.718915022316
Info on Testing data: Accuracy: 37.74% and Cost: 2.0
Network Eta:0.0076786508311 epoch: 9 batch: 500 lambdaVal: 0.0494296082896
momentum: 0.861447231646 decay:0.70138354727
Info on Testing data: Accuracy: 37.48% and Cost: 1.98
Network Eta:0.00788297589817 epoch: 9 batch: 500 lambdaVal: 0.0435422478774
momentum: 0.847966550978 decay:0.702757607037
Info on Testing data: Accuracy: 37.32% and Cost: 1.98
Network Eta:0.0068153935935 epoch: 9 batch: 500 lambdaVal: 0.0574356574532
momentum: 0.862147233698 decay:0.716559241809
Info on Testing data: Accuracy: 37.01% and Cost: 2.01
Network Eta:0.0068618533519 epoch: 9 batch: 500 lambdaVal: 0.0509550275031
momentum: 0.849629737862 decay:0.70747027504
Info on Testing data: Accuracy: 36.76% and Cost: 2.0
Network Eta:0.00742195357772 epoch: 9 batch: 500 lambdaVal: 0.0547377530483
momentum: 0.851525857164 decay:0.721397689093
Info on Testing data: Accuracy: 37.47% and Cost: 2.0
Network Eta:0.00849596298794 epoch: 9 batch: 500 lambdaVal: 0.0498395220942
momentum: 0.861510248434 decay:0.711145010173
Info on Testing data: Accuracy: 37.91% and Cost: 1.97
Network Eta:0.00769374610716 epoch: 9 batch: 500 lambdaVal: 0.0374307744506
momentum: 0.861865039934 decay:0.737324221627
Info on Testing data: Accuracy: 38.13% and Cost: 1.94
Network Eta:0.00835733202786 epoch: 9 batch: 500 lambdaVal: 0.0594562731419
momentum: 0.859675361364 decay:0.72201384173
Info on Testing data: Accuracy: 37.67% and Cost: 2.0
New momentum Max:0.00849596298794 Min:0.00769374610716
New eta Max:0.00849596298794 Min:0.00769374610716
New lambda Max:0.0498395220942 Min:0.0374307744506
New decay Max:0.738484791511 Min:0.711145010173
Network Eta:0.0083407932259 epoch: 11 batch: 500 lambdaVal: 0.0377313821069
momentum: 0.855259081168 decay:0.711986385977
Info on Testing data: Accuracy: 38.59% and Cost: 1.95
Network Eta:0.00833327677726 epoch: 11 batch: 500 lambdaVal: 0.041160398821
7 momentum: 0.861775246057 decay:0.737252863107
Info on Testing data: Accuracy: 39.14% and Cost: 1.95
Network Eta:0.00812623371897 epoch: 11 batch: 500 lambdaVal: 0.045419248679
momentum: 0.85949779206 decay:0.719428516759

Info on Testing data: Accuracy: 38.87% and Cost: 1.96
Network Eta:0.00781538125753 epoch: 11 batch: 500 lambdaVal: 0.043251544375
momentum: 0.858921073492 decay:0.72159884591
Info on Testing data: Accuracy: 38.69% and Cost: 1.96
Network Eta:0.00783829199618 epoch: 11 batch: 500 lambdaVal: 0.040065395961
5 momentum: 0.854055323628 decay:0.730360307282
Info on Testing data: Accuracy: 38.82% and Cost: 1.95
Network Eta:0.00806498863525 epoch: 11 batch: 500 lambdaVal: 0.049333851561
4 momentum: 0.855368112233 decay:0.72899265391
Info on Testing data: Accuracy: 38.69% and Cost: 1.98
Network Eta:0.00810650251179 epoch: 11 batch: 500 lambdaVal: 0.040328588987
8 momentum: 0.854143296717 decay:0.726542015639
Info on Testing data: Accuracy: 39.13% and Cost: 1.95
Network Eta:0.0084538653445 epoch: 11 batch: 500 lambdaVal: 0.0396225293678
momentum: 0.856566738462 decay:0.732930672875
Info on Testing data: Accuracy: 39.02% and Cost: 1.95
Network Eta:0.00786942570774 epoch: 11 batch: 500 lambdaVal: 0.041761625948
3 momentum: 0.85461138693 decay:0.730122339826
Info on Testing data: Accuracy: 38.73% and Cost: 1.96
Network Eta:0.00795558340964 epoch: 11 batch: 500 lambdaVal: 0.044049736403
8 momentum: 0.857827158988 decay:0.714831399453
Info on Testing data: Accuracy: 38.57% and Cost: 1.96
Network Eta:0.00785981789041 epoch: 11 batch: 500 lambdaVal: 0.037547907241
momentum: 0.858763249011 decay:0.711661799914
Info on Testing data: Accuracy: 38.63% and Cost: 1.95
Network Eta:0.00791321800304 epoch: 11 batch: 500 lambdaVal: 0.041661586882
7 momentum: 0.855244769321 decay:0.714102536666
Info on Testing data: Accuracy: 38.6% and Cost: 1.96
Network Eta:0.00844880593937 epoch: 11 batch: 500 lambdaVal: 0.043584851257
2 momentum: 0.859040683819 decay:0.725099511148
Info on Testing data: Accuracy: 38.94% and Cost: 1.96
Network Eta:0.00770338031815 epoch: 11 batch: 500 lambdaVal: 0.047782740528
3 momentum: 0.854256788188 decay:0.711390015293
Info on Testing data: Accuracy: 38.31% and Cost: 1.98
Network Eta:0.00844158388342 epoch: 11 batch: 500 lambdaVal: 0.043367476901
2 momentum: 0.861615936969 decay:0.730538958615
Info on Testing data: Accuracy: 38.95% and Cost: 1.95
Network Eta:0.00829422108861 epoch: 11 batch: 500 lambdaVal: 0.049576988400
5 momentum: 0.856347237789 decay:0.735999321851
Info on Testing data: Accuracy: 38.97% and Cost: 1.97
Network Eta:0.00840357579872 epoch: 11 batch: 500 lambdaVal: 0.044629746161
3 momentum: 0.86093193709 decay:0.725697591619
Info on Testing data: Accuracy: 39.02% and Cost: 1.96
Network Eta:0.00846025058374 epoch: 11 batch: 500 lambdaVal: 0.039347157139
7 momentum: 0.855011277546 decay:0.715980529622
Info on Testing data: Accuracy: 39.23% and Cost: 1.95
Network Eta:0.00833867156501 epoch: 11 batch: 500 lambdaVal: 0.045698755193
4 momentum: 0.860532575994 decay:0.712836584932

Info on Testing data: Accuracy: 38.96% and Cost: 1.96
Network Eta:0.00839137788311 epoch: 11 batch: 500 lambdaVal: 0.048269431085
momentum: 0.860043778516 decay:0.731631517041
Info on Testing data: Accuracy: 39.18% and Cost: 1.97
Network Eta:0.00798442692674 epoch: 11 batch: 500 lambdaVal: 0.042614451135
2 momentum: 0.854734694559 decay:0.713930754824
Info on Testing data: Accuracy: 38.69% and Cost: 1.96
Network Eta:0.0076938835804 epoch: 11 batch: 500 lambdaVal: 0.0464057630075
momentum: 0.861438777979 decay:0.713510869194
Info on Testing data: Accuracy: 38.47% and Cost: 1.97
Network Eta:0.00794317582865 epoch: 11 batch: 500 lambdaVal: 0.042273907718
2 momentum: 0.860284080677 decay:0.722942352429
Info on Testing data: Accuracy: 38.5% and Cost: 1.96
Network Eta:0.0079976270916 epoch: 11 batch: 500 lambdaVal: 0.0452945689898
momentum: 0.85761132225 decay:0.727340752737
Info on Testing data: Accuracy: 38.73% and Cost: 1.97
Network Eta:0.00832194621537 epoch: 11 batch: 500 lambdaVal: 0.042639934022
9 momentum: 0.858109884479 decay:0.712292617634
Info on Testing data: Accuracy: 38.74% and Cost: 1.96
Network Eta:0.00840312958124 epoch: 11 batch: 500 lambdaVal: 0.038220457064
5 momentum: 0.860924085845 decay:0.726799320429
Info on Testing data: Accuracy: 39.11% and Cost: 1.94
Network Eta:0.00805934323264 epoch: 11 batch: 500 lambdaVal: 0.049250889188
momentum: 0.858333009204 decay:0.712471382964
Info on Testing data: Accuracy: 38.52% and Cost: 1.98
Network Eta:0.0080344820817 epoch: 11 batch: 500 lambdaVal: 0.0421572139649
momentum: 0.857687492145 decay:0.736431629848
Info on Testing data: Accuracy: 38.73% and Cost: 1.96
Network Eta:0.00793719604395 epoch: 11 batch: 500 lambdaVal: 0.042521562404
1 momentum: 0.859315975985 decay:0.724915328607
Info on Testing data: Accuracy: 38.82% and Cost: 1.96
Network Eta:0.00812648476124 epoch: 11 batch: 500 lambdaVal: 0.040088824243
8 momentum: 0.854657696594 decay:0.711813747725
Info on Testing data: Accuracy: 38.68% and Cost: 1.95
Network Eta:0.00836418311167 epoch: 11 batch: 500 lambdaVal: 0.048091676188
5 momentum: 0.854645234547 decay:0.713778159278
Info on Testing data: Accuracy: 38.84% and Cost: 1.97
Network Eta:0.00790525442443 epoch: 11 batch: 500 lambdaVal: 0.042009791091
1 momentum: 0.854092709119 decay:0.719875442557
Info on Testing data: Accuracy: 38.66% and Cost: 1.96
Network Eta:0.00774550103563 epoch: 11 batch: 500 lambdaVal: 0.042713571014
8 momentum: 0.856048015689 decay:0.736098365173
Info on Testing data: Accuracy: 39.08% and Cost: 1.96
Network Eta:0.00822915235934 epoch: 11 batch: 500 lambdaVal: 0.044788375379
3 momentum: 0.855278822811 decay:0.721545064247
Info on Testing data: Accuracy: 38.79% and Cost: 1.96
Network Eta:0.00832377420118 epoch: 11 batch: 500 lambdaVal: 0.042161742024
7 momentum: 0.85647895651 decay:0.721273420836

Info on Testing data: Accuracy: 39.12% and Cost: 1.95
Network Eta:0.00831826005978 epoch: 11 batch: 500 lambdaVal: 0.046873943330
7 momentum: 0.855920679007 decay:0.717323530158
Info on Testing data: Accuracy: 38.96% and Cost: 1.97
Network Eta:0.00793012454626 epoch: 11 batch: 500 lambdaVal: 0.047858366201
4 momentum: 0.861509129323 decay:0.717340853653
Info on Testing data: Accuracy: 38.65% and Cost: 1.97
Network Eta:0.00780393147765 epoch: 11 batch: 500 lambdaVal: 0.041406278740
9 momentum: 0.855037057466 decay:0.737160369184
Info on Testing data: Accuracy: 38.81% and Cost: 1.96
Network Eta:0.00837056705654 epoch: 11 batch: 500 lambdaVal: 0.046906812896
5 momentum: 0.859484088024 decay:0.731886137029
Info on Testing data: Accuracy: 38.93% and Cost: 1.96
Network Eta:0.00829385264379 epoch: 11 batch: 500 lambdaVal: 0.040317896307
2 momentum: 0.860490590289 decay:0.723105996813
Info on Testing data: Accuracy: 38.97% and Cost: 1.95
New momentum Max:0.00846025058374 Min:0.00810650251179
New eta Max:0.00846025058374 Min:0.00810650251179
New lambda Max:0.048269431085 Min:0.0393471571397
New decay Max:0.737252863107 Min:0.715980529622
Network Eta:0.0082300847626 epoch: 13 batch: 500 lambdaVal: 0.04408696972 m
omentum: 0.854517372253 decay:0.729425004934
Info on Testing data: Accuracy: 39.71% and Cost: 1.96
Network Eta:0.00838436262055 epoch: 13 batch: 500 lambdaVal: 0.045002415942
3 momentum: 0.856683383566 decay:0.730876973067
Info on Testing data: Accuracy: 39.67% and Cost: 1.96
Network Eta:0.00812200601481 epoch: 13 batch: 500 lambdaVal: 0.047227102376
6 momentum: 0.858984593305 decay:0.721635712043
Info on Testing data: Accuracy: 39.64% and Cost: 1.97
Network Eta:0.00837591363832 epoch: 13 batch: 500 lambdaVal: 0.040042035713
5 momentum: 0.861045639357 decay:0.717379903529
Info on Testing data: Accuracy: 39.81% and Cost: 1.95
Network Eta:0.0084365792572 epoch: 13 batch: 500 lambdaVal: 0.0396580015108
momentum: 0.859429086751 decay:0.718197856683
Info on Testing data: Accuracy: 39.61% and Cost: 1.95
Network Eta:0.00822594213294 epoch: 13 batch: 500 lambdaVal: 0.045947939795
momentum: 0.856871649828 decay:0.716077878599
Info on Testing data: Accuracy: 39.45% and Cost: 1.97
Network Eta:0.00844619363303 epoch: 13 batch: 500 lambdaVal: 0.040505012768
2 momentum: 0.858735538336 decay:0.723965230947
Info on Testing data: Accuracy: 39.54% and Cost: 1.95
Network Eta:0.00842855906529 epoch: 13 batch: 500 lambdaVal: 0.045211863452
2 momentum: 0.854961122826 decay:0.721973651051
Info on Testing data: Accuracy: 39.59% and Cost: 1.97
Network Eta:0.0081958670159 epoch: 13 batch: 500 lambdaVal: 0.0406211979999
momentum: 0.857043088929 decay:0.734066926542
Info on Testing data: Accuracy: 39.51% and Cost: 1.96

Network Eta:0.00815919323893 epoch: 13 batch: 500 lambdaVal: 0.040592312713
9 momentum: 0.859427810252 decay:0.717024631396
Info on Testing data: Accuracy: 39.64% and Cost: 1.95
Network Eta:0.00840180167037 epoch: 13 batch: 500 lambdaVal: 0.042275279629
5 momentum: 0.857634707731 decay:0.721867325012
Info on Testing data: Accuracy: 39.85% and Cost: 1.96
Network Eta:0.00844086125065 epoch: 13 batch: 500 lambdaVal: 0.046096358142
7 momentum: 0.858884009059 decay:0.725891846945
Info on Testing data: Accuracy: 39.52% and Cost: 1.97
Network Eta:0.00825633069244 epoch: 13 batch: 500 lambdaVal: 0.045347530191
momentum: 0.858249636517 decay:0.732460002945
Info on Testing data: Accuracy: 39.73% and Cost: 1.96
Network Eta:0.00834933147231 epoch: 13 batch: 500 lambdaVal: 0.046799142150
7 momentum: 0.860065300671 decay:0.736544362401
Info on Testing data: Accuracy: 39.64% and Cost: 1.97
Network Eta:0.00813359884329 epoch: 13 batch: 500 lambdaVal: 0.047988798096
5 momentum: 0.859245478837 decay:0.730702861361
Info on Testing data: Accuracy: 39.71% and Cost: 1.97
Network Eta:0.00814387951679 epoch: 13 batch: 500 lambdaVal: 0.043684199169
3 momentum: 0.858024249031 decay:0.73699812196
Info on Testing data: Accuracy: 39.67% and Cost: 1.96
Network Eta:0.008337249088 epoch: 13 batch: 500 lambdaVal: 0.0402167815784
momentum: 0.855565249889 decay:0.716910375854
Info on Testing data: Accuracy: 39.68% and Cost: 1.95
Network Eta:0.00830723557846 epoch: 13 batch: 500 lambdaVal: 0.047464180686
2 momentum: 0.855298077507 decay:0.736873995448
Info on Testing data: Accuracy: 39.65% and Cost: 1.97
Network Eta:0.00827326747226 epoch: 13 batch: 500 lambdaVal: 0.043689987932
8 momentum: 0.860136171421 decay:0.727444459127
Info on Testing data: Accuracy: 39.79% and Cost: 1.96
Network Eta:0.0083284273307 epoch: 13 batch: 500 lambdaVal: 0.039851143066
momentum: 0.857198326081 decay:0.734541294241
Info on Testing data: Accuracy: 39.84% and Cost: 1.95
Network Eta:0.00815930240237 epoch: 13 batch: 500 lambdaVal: 0.044211856254
8 momentum: 0.859708603113 decay:0.730537911742
Info on Testing data: Accuracy: 39.71% and Cost: 1.96
Network Eta:0.00815798105238 epoch: 13 batch: 500 lambdaVal: 0.04348842618
momentum: 0.861613869412 decay:0.722066095142
Info on Testing data: Accuracy: 39.91% and Cost: 1.96
Network Eta:0.00834672282511 epoch: 13 batch: 500 lambdaVal: 0.047827406463
9 momentum: 0.85683359633 decay:0.722532647886
Info on Testing data: Accuracy: 39.63% and Cost: 1.97
Network Eta:0.00827828714708 epoch: 13 batch: 500 lambdaVal: 0.043721448776
2 momentum: 0.861552807261 decay:0.721658726404
Info on Testing data: Accuracy: 39.52% and Cost: 1.96
Network Eta:0.0082240373 epoch: 13 batch: 500 lambdaVal: 0.0469619200305 mo
mentum: 0.855033857724 decay:0.726457514993
Info on Testing data: Accuracy: 39.52% and Cost: 1.97

Network Eta:0.00840386337778 epoch: 13 batch: 500 lambdaVal: 0.039426351138
3 momentum: 0.855612360948 decay:0.730799332909
Info on Testing data: Accuracy: 39.74% and Cost: 1.95
Network Eta:0.00842095815754 epoch: 13 batch: 500 lambdaVal: 0.045676472079
9 momentum: 0.861164845048 decay:0.716461249085
Info on Testing data: Accuracy: 39.48% and Cost: 1.97
Network Eta:0.00827227605219 epoch: 13 batch: 500 lambdaVal: 0.044207720211
momentum: 0.858358555909 decay:0.733660595632
Info on Testing data: Accuracy: 39.91% and Cost: 1.96
Network Eta:0.00823023101846 epoch: 13 batch: 500 lambdaVal: 0.043549216806
6 momentum: 0.858433491803 decay:0.720621584321
Info on Testing data: Accuracy: 39.64% and Cost: 1.96
Network Eta:0.00830896337766 epoch: 13 batch: 500 lambdaVal: 0.041596663331
4 momentum: 0.857991775029 decay:0.724657085225
Info on Testing data: Accuracy: 39.71% and Cost: 1.95
Network Eta:0.00832902195441 epoch: 13 batch: 500 lambdaVal: 0.044321492046
2 momentum: 0.861609015458 decay:0.716110757436
Info on Testing data: Accuracy: 39.82% and Cost: 1.96
Network Eta:0.00813579518778 epoch: 13 batch: 500 lambdaVal: 0.041118096860
5 momentum: 0.856016263876 decay:0.734338584078
Info on Testing data: Accuracy: 39.72% and Cost: 1.96
Network Eta:0.00839463555354 epoch: 13 batch: 500 lambdaVal: 0.039532416585
5 momentum: 0.856907476191 decay:0.736427525932
Info on Testing data: Accuracy: 39.78% and Cost: 1.95
Network Eta:0.00838646676938 epoch: 13 batch: 500 lambdaVal: 0.040542931450
3 momentum: 0.861023522214 decay:0.731490128237
Info on Testing data: Accuracy: 39.73% and Cost: 1.95
Network Eta:0.00812019619948 epoch: 13 batch: 500 lambdaVal: 0.048185039575
3 momentum: 0.86095365494 decay:0.731311293992
Info on Testing data: Accuracy: 39.56% and Cost: 1.97
Network Eta:0.00818268786987 epoch: 13 batch: 500 lambdaVal: 0.041106215059
4 momentum: 0.861726506812 decay:0.736307885308
Info on Testing data: Accuracy: 39.63% and Cost: 1.95
Network Eta:0.00820013284511 epoch: 13 batch: 500 lambdaVal: 0.039586706315
2 momentum: 0.856747695868 decay:0.727514847359
Info on Testing data: Accuracy: 39.61% and Cost: 1.95
Network Eta:0.00812097822643 epoch: 13 batch: 500 lambdaVal: 0.040163246373
4 momentum: 0.855014769602 decay:0.731145641975
Info on Testing data: Accuracy: 39.73% and Cost: 1.95
Network Eta:0.00827044202003 epoch: 13 batch: 500 lambdaVal: 0.041390120228
8 momentum: 0.859755350699 decay:0.728278869991
Info on Testing data: Accuracy: 39.7% and Cost: 1.96
Network Eta:0.00815934255035 epoch: 13 batch: 500 lambdaVal: 0.040205089773
4 momentum: 0.855267369989 decay:0.731936477927
Info on Testing data: Accuracy: 39.92% and Cost: 1.95
Top 10% accuracies Networks found in this search
accuracy:0.3991
momenum:0.861613869412

```
eta:0.00815798105238
lambda:0.04348842618
decay:0.722066095142
accuracy:0.3992
momenum:0.855267369989
eta:0.00815934255035
lambda:0.0402050897734
decay:0.731936477927
accuracy:0.3985
momenum:0.857634707731
eta:0.00840180167037
lambda:0.0422752796295
decay:0.721867325012
accuracy:0.3991
momenum:0.858358555909
eta:0.00827227605219
lambda:0.044207720211
decay:0.733660595632
New momentum Max:0.00840180167037 Min:0.00815798105238
New eta Max:0.00840180167037 Min:0.00815798105238
New lambda Max:0.044207720211 Min:0.0402050897734
New decay Max:0.733660595632 Min:0.721867325012
```

Appendix 2

(3072,50) -> (50,30) -> (30,20) -> (20,10)

Info on Training data: Accuracy: 37.08% and Cost: 1.98

Info on Validation data: Accuracy: 33.4% and Cost: 2.28

Info on Testing data: Accuracy: 30.8% and Cost: 2.23

(3072,100) -> (100,50) -> (50,30) -> (30,10)

Info on Training data: Accuracy: 40.42% and Cost: 1.73

Info on Validation data: Accuracy: 36.0% and Cost: 2.1

Info on Testing data: Accuracy: 34.8% and Cost: 1.99

(3072,200) -> (200,100) -> (100,50) -> (50,10)

Info on Training data: Accuracy: 39.72% and Cost: 1.89

Info on Validation data: Accuracy: 35.8% and Cost: 2.3

Info on Testing data: Accuracy: 33.81% and Cost: 2.23

(3072,50) -> (50,40) -> (40,30) -> (30,20) -> (20,10)

Info on Training data: Accuracy: 33.7% and Cost: 2.08

Info on Validation data: Accuracy: 29.6% and Cost: 2.34

Info on Testing data: Accuracy: 28.62% and Cost: 2.3

(3072,100) -> (100,50) -> (50,30) -> (30,20) -> (20,10)
Info on Training data: Accuracy: 36.24% and Cost: 1.98
Info on Validation data: Accuracy: 34.0% and Cost: 2.26
Info on Testing data: Accuracy: 29.85% and Cost: 2.28

(3072,400) -> (400,200) -> (200,50) -> (50,30) -> (30,10)
Info on Training data: Accuracy: 44.88% and Cost: 1.53
Info on Validation data: Accuracy: 34.4% and Cost: 1.92
Info on Testing data: Accuracy: 34.42% and Cost: 1.87

(3072,50) -> (50,40) -> (40,30) -> (30,20) -> (20,15) -> (15,10)
Info on Training data: Accuracy: 31.02% and Cost: 1.99
Info on Validation data: Accuracy: 28.3% and Cost: 2.12
Info on Testing data: Accuracy: 26.46% and Cost: 2.15

(3072,200) -> (200,100) -> (100,50) -> (50,30) -> (30,20) -> (20,10)
Info on Training data: Accuracy: 38.76% and Cost: 1.84
Info on Validation data: Accuracy: 32.4% and Cost: 2.15
Info on Testing data: Accuracy: 32.02% and Cost: 2.1

(3072,500) -> (500,200) -> (200,100) -> (100,50) -> (50,30) -> (30,10)
Info on Training data: Accuracy: 46.88% and Cost: 1.53
Info on Validation data: Accuracy: 36.1% and Cost: 1.96
Info on Testing data: Accuracy: 35.12% and Cost: 1.9