Report
on
Assignment 5
Backpropogation
using
Theano

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Initial Network Parameters

Parameter	Value
Number of Layers	3
Number of Outputs	10
Learning Rate	0.001
Image Vector size	3072
Epochs for Training	200
Epochs for Testing / Prediction	1
Minimum Initial Weight	-0.1
Maximum Initial Weight	0.1
Data Set Used	cifar_100

Scenarios

Task #	Case #	Regularization Lambda	Activation Functions	Number of Nodes in Hidden Layer	Number of Epochs
1	0	0.0	Relu and Softmax	100	100
2	1	0.0	Sigmoid and Sigmoid	100	100
3	2	0.0	Relu and Softmax	100	100
3	3	0.0	Relu and Softmax	200	100
3	4	0.0	Relu and Softmax	300	100
3	5	0.0	Relu and Softmax	400	100
3	6	0.0	Relu and Softmax	500	100
4	7	0.1	Relu and Softmax	500	50
4	8	0.2	Relu and Softmax	500	50
4	9	0.3	Relu and Softmax	500	50
4	10	0.4	Relu and Softmax	500	50
4	11	0.5	Relu and Softmax	500	50
5	12	0.1	Relu and Softmax	200	5

Output Task 1

Backpropogation using Theano

Backpropogation using Theano
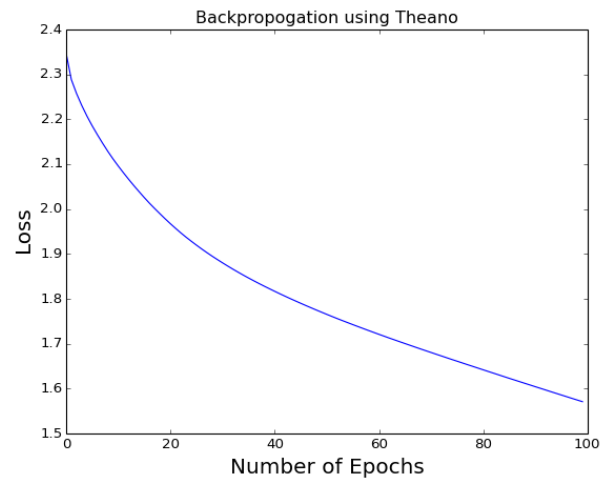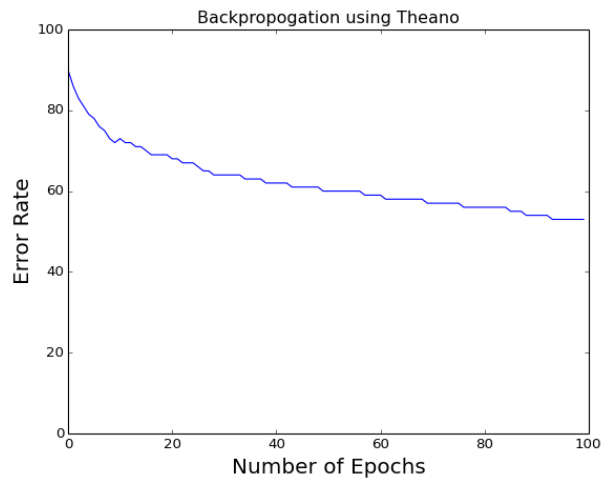
```
=======================================
Testing Epoch Error(misclassified) : 67 out of 100
=======================================
=================Confusion Matrix for Test Case #: 0====================
::Prediction X Actual::
[[ 1.  0.  1.  0.  1.  0.  0.  1.  0.  1.]
 [ 0.  4.  1.  0.  1.  2.  1.  1.  1.  0.]
 [ 1.  1.  4.  2.  0.  2.  1.  2.  0.  0.]
 [ 0.  1.  0.  3.  0.  0.  0.  1.  0.  0.]
 [ 0.  0.  0.  1.  1.  0.  3.  2.  0.  0.]
 [ 0.  0.  3.  1.  2.  2.  0.  0.  0.  1.]
 [ 1.  0.  0.  3.  1.  1.  5.  0.  0.  0.]
 [ 2.  1.  0.  0.  2.  2.  0.  1.  0.  0.]
 [ 4.  0.  1.  0.  1.  1.  0.  1.  5.  1.]
 [ 1.  3.  0.  0.  1.  0.  0.  1.  4.  7.]]

==============================================================================
```

Output Task 2

Backpropogation using Theano

Error Rate vs Number of Epochs

Backpropogation using Theano

Loss vs Number of Epochs
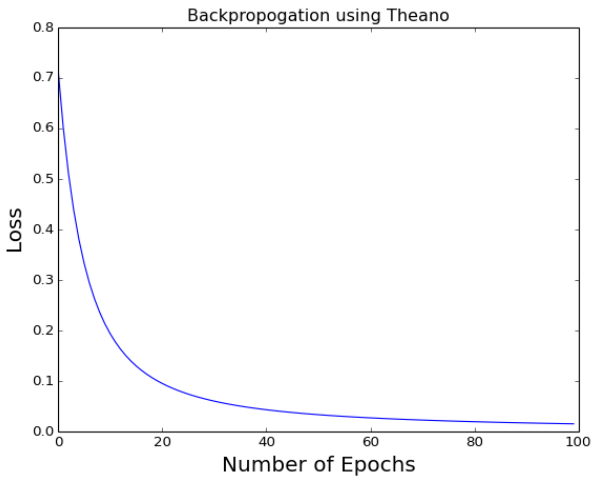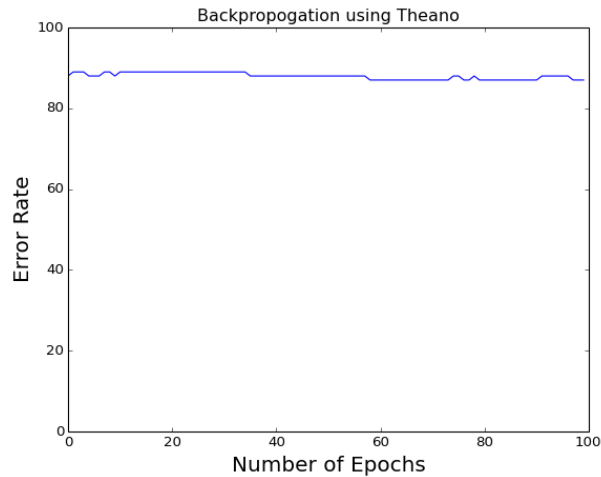
```
========================================
Testing Epoch Error(misclassified) : 89 out of 100
========================================
==================Confusion Matrix for Test Case #: 1====================
::Prediction X Actual::
[[ 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.]
 [ 2.  3.  0.  4.  3.  0.  1.  1.  3.  1.]
 [ 0.  0.  0.  0.  0.  1.  0.  0.  0.  0.]
 [ 0.  0.  1.  0.  0.  1.  0.  0.  0.  1.]
 [ 4.  5.  5.  2.  4.  6.  5.  4.  5.  2.]
 [ 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.]
 [ 3.  2.  4.  3.  3.  1.  4.  4.  2.  5.]
 [ 1.  0.  0.  1.  0.  0.  0.  0.  0.  1.]
 [ 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.]
 [ 0.  0.  0.  0.  0.  1.  0.  1.  0.  0.]]
================================================================================
```

Output Task 3

Backpropogation using Theano

Backpropogation using Theano
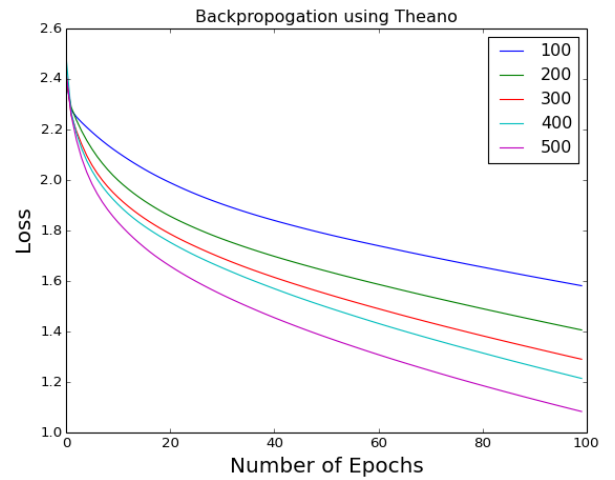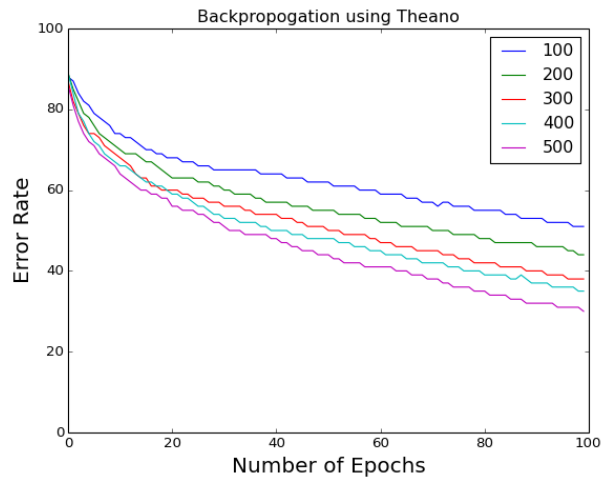
==
Testing Epoch Error(misclassified) : 68 out of 100
==
==================Confusion Matrix for Test Case #: 2=====================
::Prediction X Actual::
[[1. 1. 2. 0. 2. 0. 0. 0. 0. 0.]
 [0. 3. 0. 0. 0. 2. 0. 2. 0. 1.]
 [2. 0. 2. 1. 1. 1. 1. 2. 0. 0.]
 [0. 1. 0. 4. 2. 1. 0. 1. 0. 0.]
 [0. 0. 2. 1. 1. 1. 3. 1. 0. 0.]
 [0. 0. 1. 0. 1. 3. 0. 0. 0. 0.]
 [1. 1. 1. 3. 2. 1. 5. 0. 0. 0.]
 [1. 1. 0. 0. 0. 1. 1. 2. 1. 0.]
 [4. 0. 2. 0. 0. 0. 0. 1. 5. 3.]
 [1. 3. 0. 1. 1. 0. 0. 1. 4. 6.]]

==

```
========================================
Testing Epoch Error(misclassified) : 64 out of 100
========================================
==================Confusion Matrix for Test Case #: 3====================
::Prediction X Actual::
[[ 4.  1.  1.  0.  2.  1.  0.  2.  2.  1.]
 [ 0.  5.  0.  0.  0.  1.  0.  1.  0.  1.]
 [ 1.  1.  4.  3.  0.  3.  1.  3.  0.  0.]
 [ 0.  1.  0.  4.  2.  1.  2.  1.  0.  0.]
 [ 0.  0.  0.  0.  2.  1.  3.  1.  0.  0.]
 [ 0.  0.  2.  2.  1.  3.  0.  0.  0.  0.]
 [ 1.  0.  1.  1.  2.  0.  3.  0.  0.  0.]
 [ 0.  0.  1.  0.  0.  0.  1.  0.  0.  0.]
 [ 3.  0.  1.  0.  0.  0.  0.  1.  6.  3.]
 [ 1.  2.  0.  0.  1.  0.  0.  1.  2.  5.]]
========================================================================

========================================
Testing Epoch Error(misclassified) : 66 out of 100
========================================
==================Confusion Matrix for Test Case #: 4====================
::Prediction X Actual::
[[ 4.  0.  2.  0.  1.  0.  0.  0.  0.  1.]
 [ 0.  4.  0.  0.  0.  0.  0.  2.  0.  2.]
 [ 2.  0.  2.  3.  0.  0.  1.  1.  0.  0.]
 [ 1.  2.  0.  3.  1.  3.  1.  1.  1.  1.]
 [ 0.  0.  1.  0.  2.  1.  2.  3.  0.  0.]
 [ 0.  1.  2.  2.  2.  5.  0.  0.  0.  0.]
 [ 0.  1.  0.  2.  2.  0.  5.  0.  0.  1.]
 [ 0.  1.  1.  0.  0.  1.  1.  1.  1.  0.]
 [ 2.  0.  2.  0.  1.  0.  0.  1.  6.  3.]
 [ 1.  1.  0.  0.  1.  0.  0.  1.  2.  2.]]
========================================================================

========================================
Testing Epoch Error(misclassified) : 74 out of 100
========================================
==================Confusion Matrix for Test Case #: 5====================
::Prediction X Actual::
[[ 3.  1.  1.  0.  1.  0.  0.  0.  0.  0.]
 [ 0.  4.  0.  0.  0.  0.  1.  1.  0.  2.]
 [ 2.  1.  2.  3.  0.  0.  1.  2.  0.  0.]
 [ 0.  2.  0.  2.  0.  2.  2.  2.  1.  1.]
 [ 0.  0.  1.  0.  1.  2.  3.  1.  0.  0.]
 [ 0.  0.  2.  3.  1.  3.  0.  1.  0.  0.]
 [ 1.  0.  2.  2.  2.  0.  2.  1.  0.  0.]
 [ 1.  1.  1.  0.  2.  3.  1.  0.  1.  2.]
 [ 2.  0.  1.  0.  2.  0.  0.  1.  6.  2.]
 [ 1.  1.  0.  0.  1.  0.  0.  1.  2.  3.]]
========================================================================
```

==
Testing Epoch Error(misclassified) : 66 out of 100
==
==================Confusion Matrix for Test Case #: 6=====================
::Prediction X Actual::
[[6. 0. 2. 0. 2. 1. 0. 2. 1. 2.]
 [0. 5. 1. 0. 0. 1. 1. 2. 0. 2.]
 [2. 0. 1. 0. 0. 1. 1. 1. 0. 0.]
 [0. 2. 0. 5. 1. 1. 1. 0. 0. 0.]
 [0. 0. 3. 1. 3. 0. 6. 2. 0. 0.]
 [0. 0. 2. 0. 1. 4. 0. 0. 0. 0.]
 [1. 0. 1. 3. 1. 0. 1. 0. 0. 0.]
 [0. 0. 0. 0. 0. 2. 0. 1. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0. 0. 3. 1.]
 [1. 3. 0. 1. 2. 0. 0. 2. 6. 5.]]

==

Output Task 4


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=======================================
Testing Epoch Error(misclassified) : 70 out of 100
=======================================
==================Confusion Matrix for Test Case #: 7====================
::Prediction X Actual::
[[ 1.  0.  3.  0.  2.  0.  0.  1.  0.  1.]
 [ 0.  5.  1.  1.  1.  1.  0.  2.  1.  0.]
 [ 2.  0.  3.  2.  1.  2.  1.  2.  0.  0.]
 [ 0.  0.  0.  1.  0.  0.  0.  0.  0.  0.]
 [ 0.  1.  0.  1.  1.  1.  5.  2.  0.  0.]
 [ 0.  0.  2.  2.  3.  4.  1.  1.  0.  0.]
 [ 1.  1.  0.  2.  1.  0.  3.  0.  0.  1.]
 [ 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.]
 [ 4.  0.  0.  0.  0.  1.  0.  0.  6.  2.]
 [ 2.  3.  1.  1.  1.  1.  0.  2.  3.  6.]]
==============================================================================
```

==
Testing Epoch Error(misclassified) : 69 out of 100
==
==================Confusion Matrix for Test Case #: 8====================
::Prediction X Actual::
[[3. 0. 3. 0. 3. 0. 0. 2. 0. 0.]
 [0. 3. 0. 1. 0. 0. 0. 2. 0. 0.]
 [1. 0. 2. 0. 0. 2. 1. 1. 0. 0.]
 [0. 1. 0. 1. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 1. 0. 5. 1. 0. 0.]
 [1. 1. 3. 6. 2. 6. 3. 2. 0. 0.]
 [0. 1. 0. 1. 2. 0. 1. 0. 0. 1.]
 [0. 0. 1. 0. 0. 0. 0. 0. 0. 0.]
 [3. 1. 0. 0. 1. 0. 0. 1. 8. 3.]
 [2. 3. 1. 1. 1. 2. 0. 1. 2. 6.]]
===

==
Testing Epoch Error(misclassified) : 76 out of 100
==
==================Confusion Matrix for Test Case #: 9====================
::Prediction X Actual::
[[4. 0. 3. 1. 3. 0. 0. 2. 0. 2.]
 [0. 1. 0. 0. 0. 0. 0. 2. 0. 0.]
 [0. 0. 0. 0. 1. 2. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
 [0. 1. 1. 0. 1. 0. 3. 2. 0. 0.]
 [1. 2. 3. 7. 3. 6. 5. 2. 0. 0.]
 [0. 0. 0. 0. 0. 0. 2. 0. 0. 1.]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
 [3. 3. 3. 0. 1. 1. 0. 1. 8. 5.]
 [2. 3. 0. 2. 1. 1. 0. 1. 2. 2.]]
===

==================Confusion Matrix for Test Case #: 10====================
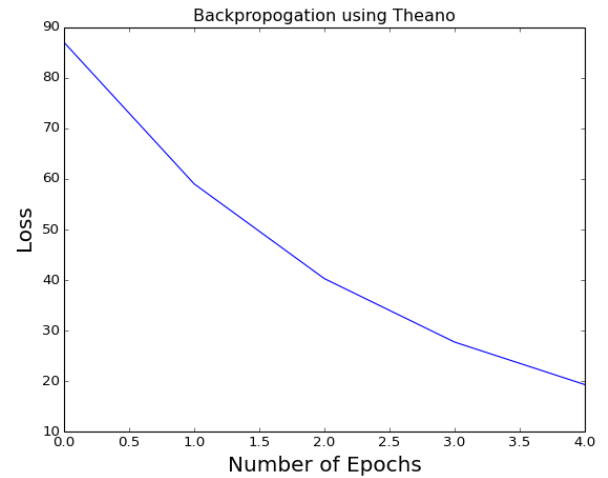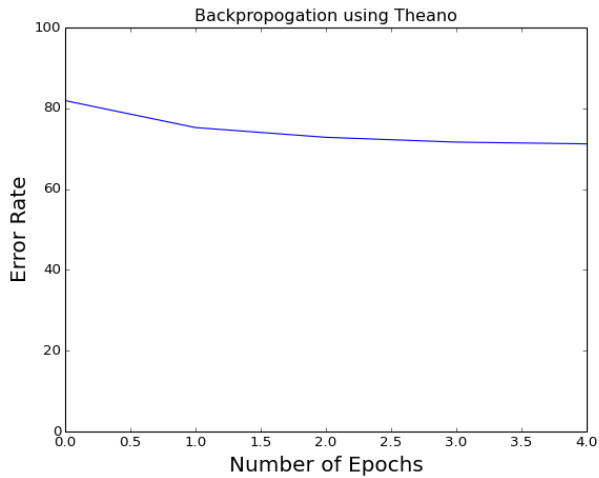::Prediction X Actual::
[[4. 0. 3. 1. 4. 2. 0. 2. 0. 1.]
 [0. 0. 0. 0. 0. 0. 0. 1. 0. 0.]
 [0. 0. 1. 0. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 1. 1. 0. 1.]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
 [1. 4. 3. 7. 4. 6. 9. 4. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
 [4. 4. 3. 0. 1. 1. 0. 1. 10. 7.]
 [1. 2. 0. 2. 1. 1. 0. 1. 0. 1.]]
===

==
Testing Epoch Error(misclassified) : 81 out of 100
==
==================Confusion Matrix for Test Case #: 11=====================
::Prediction X Actual::
[[4. 0. 3. 4. 2. 3. 1. 2. 0. 1.]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 1. 0. 0. 1.]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
 [1. 4. 3. 4. 4. 5. 8. 5. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
 [5. 5. 4. 0. 3. 1. 0. 2. 10. 8.]
 [0. 1. 0. 2. 1. 1. 0. 1. 0. 0.]]

===

Output Task 4

Backpropogation using Theano — Error Rate vs Number of Epochs

Backpropogation using Theano — Loss vs Number of Epochs

```
=======================================
Testing Epoch Error(misclassified) : -182 out of 10000
=======================================
==================Confusion Matrix for Test Case #: 12=====================
::Prediction X Actual::
[[ 39.   6.  28.   5.  14.  13.   5.  12.  18.   9.]
 [  0.   8.   0.   0.   1.   0.   0.   2.   1.   0.]
 [  2.   0.   6.   1.   2.   0.   0.   1.   0.   0.]
 [  0.   2.   0.   2.   1.   2.   1.   2.   1.   0.]
 [  0.   1.   1.   0.   3.   3.   0.   1.   0.   0.]
 [  7.  15.  25.  38.  27.  42.  18.  19.  10.   4.]
 [  5.  12.  18.  17.  26.  20.  48.  11.   0.   4.]
 [ 11.   6.  15.  20.  14.  13.  22.  28.   2.   7.]
 [ 17.  15.   2.   5.   4.   1.   0.   4.  42.  12.]
 [ 19.  35.   5.  12.   8.   6.   6.  20.  26.  64.]]
==============================================================================
```

Conclusion

Best Architecture and Best Hyper Parameters

Parameter	Value
Learning Rate	0.001
Minimum Initial Weight	-0.1
Maximum Initial Weight	0.1
Number of Nodes in Hidden Layer	500
L2 Regularization Lambda	0.2