

RemoveNodeMAB-Different_bandit

March 22, 2017

Compute the performance of MAB methods

```
In [1]: import numpy as np
import time
import sys
from numpy import *
import matplotlib.pyplot as plt
from sklearn import metrics
%matplotlib inline
plt.rcParams['figure.figsize'] = (15, 6)
```

0.1 Load BOKEH lib.

```
In [2]: from bokeh.layouts import row, gridplot
from bokeh.plotting import figure, output_notebook, show
from bokeh.models import Legend
```

```
#####
TOOLS = 'box_zoom,box_select,crosshair,resize,reset,lasso_select,pan,save,poly_select,tap
output_notebook()
#####
```

1 Load the data

```
In [3]: X_train = np.load('/Users/saleemameen/Desktop/banditsbook/python_Titanic/titanc/X_train.npy')
y_train = np.load('/Users/saleemameen/Desktop/banditsbook/python_Titanic/titanc/y_train.npy')
X_test = np.load('/Users/saleemameen/Desktop/banditsbook/python_Titanic/titanc/X_test.npy')
y_test = np.load('/Users/saleemameen/Desktop/banditsbook/python_Titanic/titanc/y_test.npy')
X_deploy = np.load('/Users/saleemameen/Desktop/banditsbook/python_Titanic/titanc/X_deploy.npy')

print('Number of training examples',len(X_train))
print('Number of validation examples',len(X_test))
print('Number of testing examples',len(X_deploy))
```

```
Number of training examples 712
Number of validation examples 179
Number of testing examples 418
```

```
In [4]: exec(open("core.py").read()) # python 3x
        #exec(compile(open('core.py', "rb").read(), 'core.py', 'exec'))

        #execfile("./core.py") # python 2.7
```

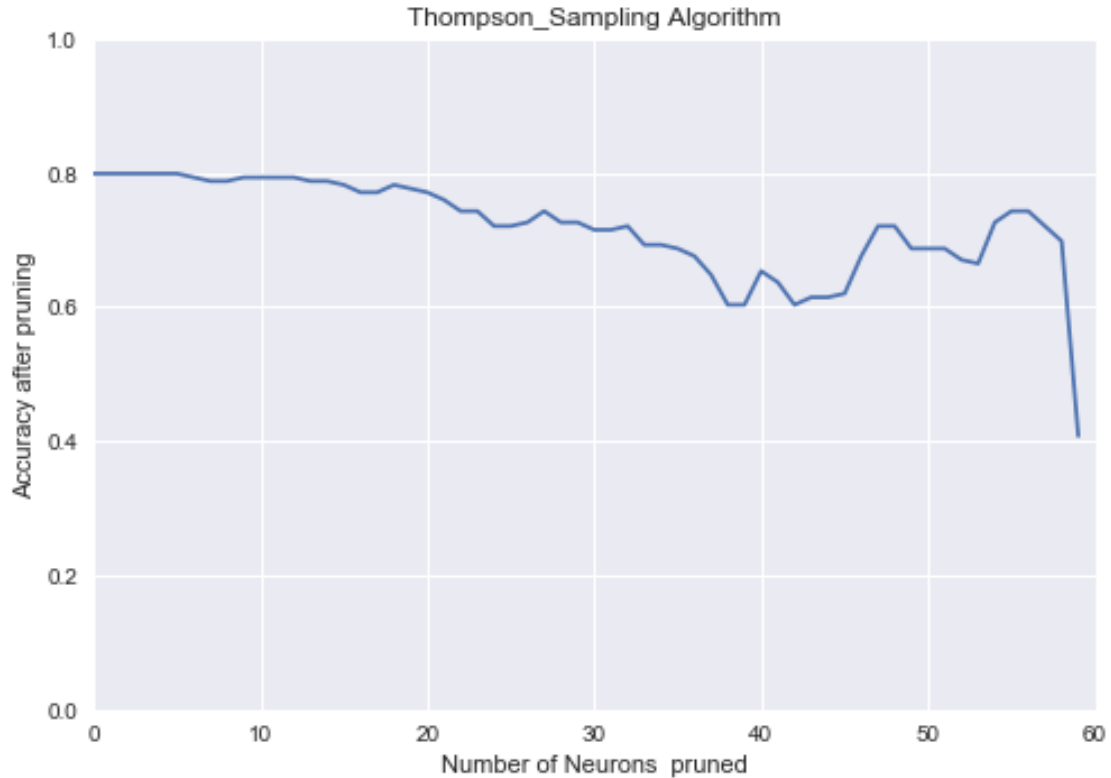
1.1 Run Thompson Sampling pruning Algorithm

```
In [5]: algo = Thompson_Sampling([], [])
        Alg_name = 'Thompson_Sampling Algorithm'
        path = './Thompson_Sampling/'
        sys.path.append("./Thompson_Sampling")
        exec(open("mnist_cnnFORTESTING.py").read())
```

```
/Library/Frameworks/Python.framework/Versions/3.6/lib/python3.6/site-packages/sklearn/cross_vali
"This module will be removed in 0.20.", DeprecationWarning)
Using Theano backend.
```

```
Test fraction correct (NN-Score) = 0.51
Test fraction correct (NN-Accuracy) = 0.80
The time for running this method is 0.46561193466186523 seconds
Finsh playing start pruning:
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.79
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Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.78
Test after pruning= 0.77
Test after pruning= 0.77
Test after pruning= 0.78
Test after pruning= 0.78
Test after pruning= 0.77
Test after pruning= 0.76
Test after pruning= 0.74
Test after pruning= 0.74
Test after pruning= 0.72
Test after pruning= 0.72
```

Test after pruning= 0.73
Test after pruning= 0.74
Test after pruning= 0.73
Test after pruning= 0.73
Test after pruning= 0.72
Test after pruning= 0.72
Test after pruning= 0.72
Test after pruning= 0.69
Test after pruning= 0.69
Test after pruning= 0.69
Test after pruning= 0.68
Test after pruning= 0.65
Test after pruning= 0.60
Test after pruning= 0.60
Test after pruning= 0.65
Test after pruning= 0.64
Test after pruning= 0.60
Test after pruning= 0.61
Test after pruning= 0.61
Test after pruning= 0.62
Test after pruning= 0.68
Test after pruning= 0.72
Test after pruning= 0.72
Test after pruning= 0.69
Test after pruning= 0.69
Test after pruning= 0.69
Test after pruning= 0.67
Test after pruning= 0.66
Test after pruning= 0.73
Test after pruning= 0.74
Test after pruning= 0.74
Test after pruning= 0.72
Test after pruning= 0.70
Test after pruning= 0.41



1.2 Run UCB1 pruning Algorithm

```
In [6]: algo = UCB1([], [])
        Alg_name = 'UCB1 Algorithm'
        path = './UCB1/'
        sys.path.append("./UCB1")
        exec(open("mnist_cnnFORTESTING.py").read())
```

Test fraction correct (NN-Score) = 0.51

Test fraction correct (NN-Accuracy) = 0.80

The time for running this method is 0.4200592041015625 seconds

Finsh playing start pruning:

Test after pruning= 0.80

Test after pruning= 0.80

Test after pruning= 0.80

Test after pruning= 0.80

Test after pruning= 0.80

Test after pruning= 0.80

Test after pruning= 0.79

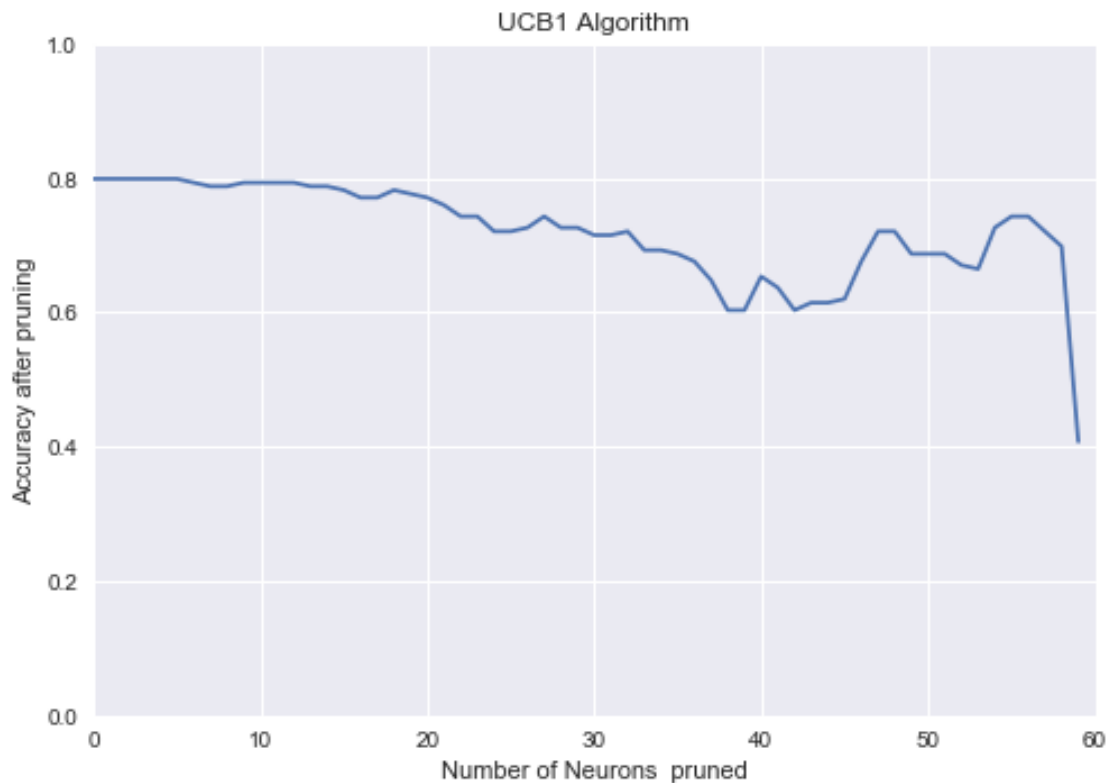
Test after pruning= 0.79

Test after pruning= 0.79

Test after pruning= 0.79

Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
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Test after pruning= 0.77
Test after pruning= 0.77
Test after pruning= 0.78
Test after pruning= 0.78
Test after pruning= 0.77
Test after pruning= 0.76
Test after pruning= 0.74
Test after pruning= 0.74
Test after pruning= 0.72
Test after pruning= 0.72
Test after pruning= 0.73
Test after pruning= 0.74
Test after pruning= 0.73
Test after pruning= 0.73
Test after pruning= 0.72
Test after pruning= 0.72
Test after pruning= 0.72
Test after pruning= 0.69
Test after pruning= 0.69
Test after pruning= 0.69
Test after pruning= 0.68
Test after pruning= 0.65
Test after pruning= 0.60
Test after pruning= 0.60
Test after pruning= 0.65
Test after pruning= 0.64
Test after pruning= 0.60
Test after pruning= 0.61
Test after pruning= 0.61
Test after pruning= 0.62
Test after pruning= 0.68
Test after pruning= 0.72
Test after pruning= 0.72
Test after pruning= 0.69
Test after pruning= 0.69
Test after pruning= 0.69
Test after pruning= 0.67
Test after pruning= 0.66
Test after pruning= 0.73
Test after pruning= 0.74
Test after pruning= 0.74
Test after pruning= 0.72

Test after pruning= 0.70
Test after pruning= 0.41



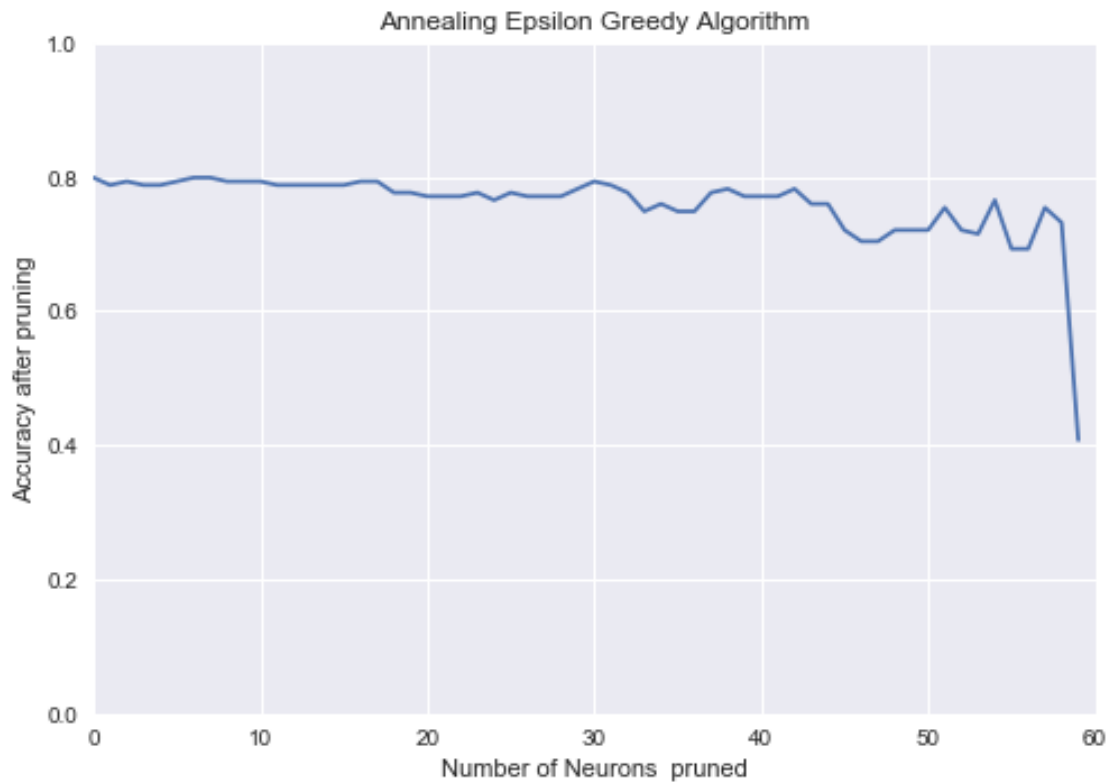
2 Run Annealing Epsilon Greedy pruning Algorithm

```
In [7]: algo = AnnealingEpsilonGreedy([], [])  
        Alg_name = 'Annealing Epsilon Greedy Algorithm'  
        path = './AnnealingEpsilonGreedy/'  
        sys.path.append("./AnnealingEpsilonGreedy")  
        exec(open("mnist_cnnFORTESTING.py").read())
```

Test fraction correct (NN-Score) = 0.51
Test fraction correct (NN-Accuracy) = 0.80
The time for running this method is 0.43750500679016113 seconds
Finsh playing start pruning:
Test after pruning= 0.80
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79

Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.78
Test after pruning= 0.78
Test after pruning= 0.77
Test after pruning= 0.77
Test after pruning= 0.77
Test after pruning= 0.78
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Test after pruning= 0.77
Test after pruning= 0.77
Test after pruning= 0.77
Test after pruning= 0.78
Test after pruning= 0.78
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.78
Test after pruning= 0.75
Test after pruning= 0.76
Test after pruning= 0.75
Test after pruning= 0.75
Test after pruning= 0.75
Test after pruning= 0.78
Test after pruning= 0.78
Test after pruning= 0.77
Test after pruning= 0.77
Test after pruning= 0.77
Test after pruning= 0.78
Test after pruning= 0.76
Test after pruning= 0.76
Test after pruning= 0.72
Test after pruning= 0.70
Test after pruning= 0.70
Test after pruning= 0.72
Test after pruning= 0.72
Test after pruning= 0.72
Test after pruning= 0.75
Test after pruning= 0.72
Test after pruning= 0.72

Test after pruning= 0.77
 Test after pruning= 0.69
 Test after pruning= 0.69
 Test after pruning= 0.75
 Test after pruning= 0.73
 Test after pruning= 0.41



3 Run Epsilon Greedy pruning Algorithm

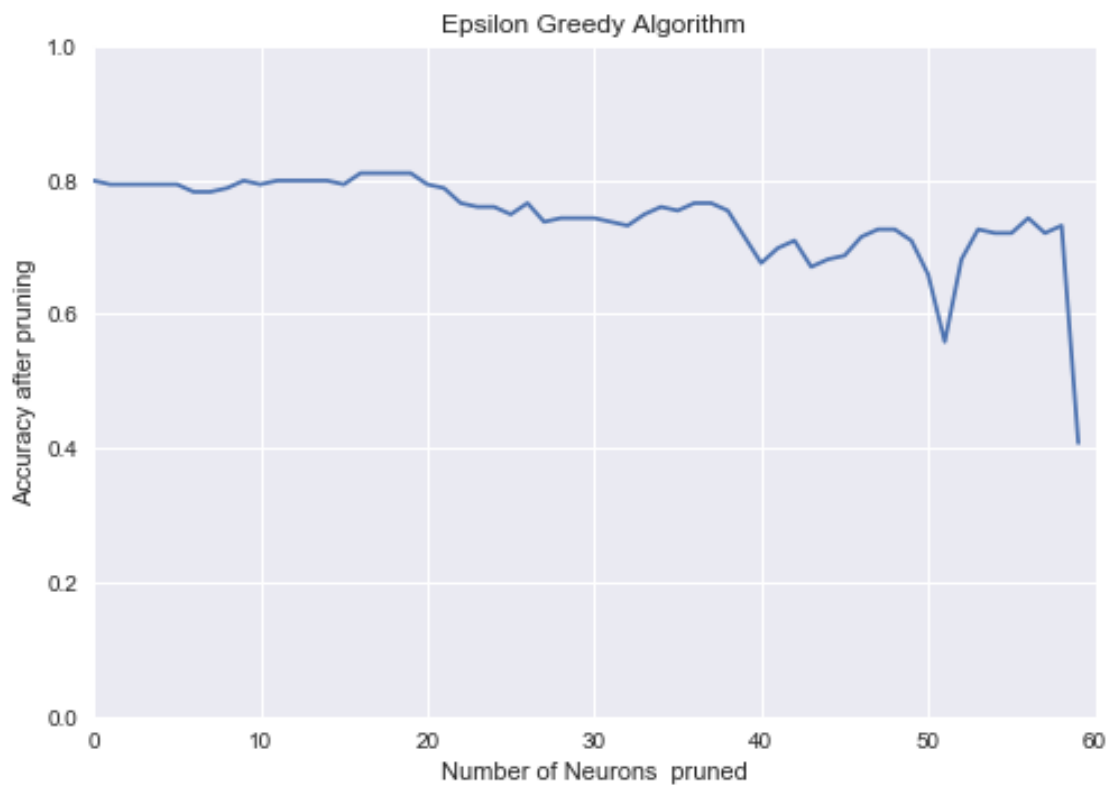
```

In [8]: epsilon = 0.9 # epsilon = (0,1)
        algo = EpsilonGreedy(epsilon, [], [])
        Alg_name = 'Epsilon Greedy Algorithm'
        path = './EpsilonGreedy/'
        sys.path.append('./AnnealingEpsilonGreedy')
        exec(open("mnist_cnnFORTESTING.py").read())
  
```

Test fraction correct (NN-Score) = 0.51
 Test fraction correct (NN-Accuracy) = 0.80
 The time for running this method is 0.44070887565612793 seconds
 Finish playing start pruning:
 Test after pruning= 0.80

Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.78
Test after pruning= 0.78
Test after pruning= 0.79
Test after pruning= 0.80
Test after pruning= 0.79
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.79
Test after pruning= 0.81
Test after pruning= 0.81
Test after pruning= 0.81
Test after pruning= 0.81
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.77
Test after pruning= 0.76
Test after pruning= 0.76
Test after pruning= 0.75
Test after pruning= 0.77
Test after pruning= 0.74
Test after pruning= 0.74
Test after pruning= 0.74
Test after pruning= 0.74
Test after pruning= 0.74
Test after pruning= 0.73
Test after pruning= 0.75
Test after pruning= 0.76
Test after pruning= 0.75
Test after pruning= 0.77
Test after pruning= 0.77
Test after pruning= 0.75
Test after pruning= 0.72
Test after pruning= 0.68
Test after pruning= 0.70
Test after pruning= 0.71
Test after pruning= 0.67
Test after pruning= 0.68
Test after pruning= 0.69
Test after pruning= 0.72
Test after pruning= 0.73
Test after pruning= 0.73

Test after pruning= 0.71
 Test after pruning= 0.66
 Test after pruning= 0.56
 Test after pruning= 0.68
 Test after pruning= 0.73
 Test after pruning= 0.72
 Test after pruning= 0.72
 Test after pruning= 0.74
 Test after pruning= 0.72
 Test after pruning= 0.73
 Test after pruning= 0.41



4 Run Exp3 pruning Algorithm

```

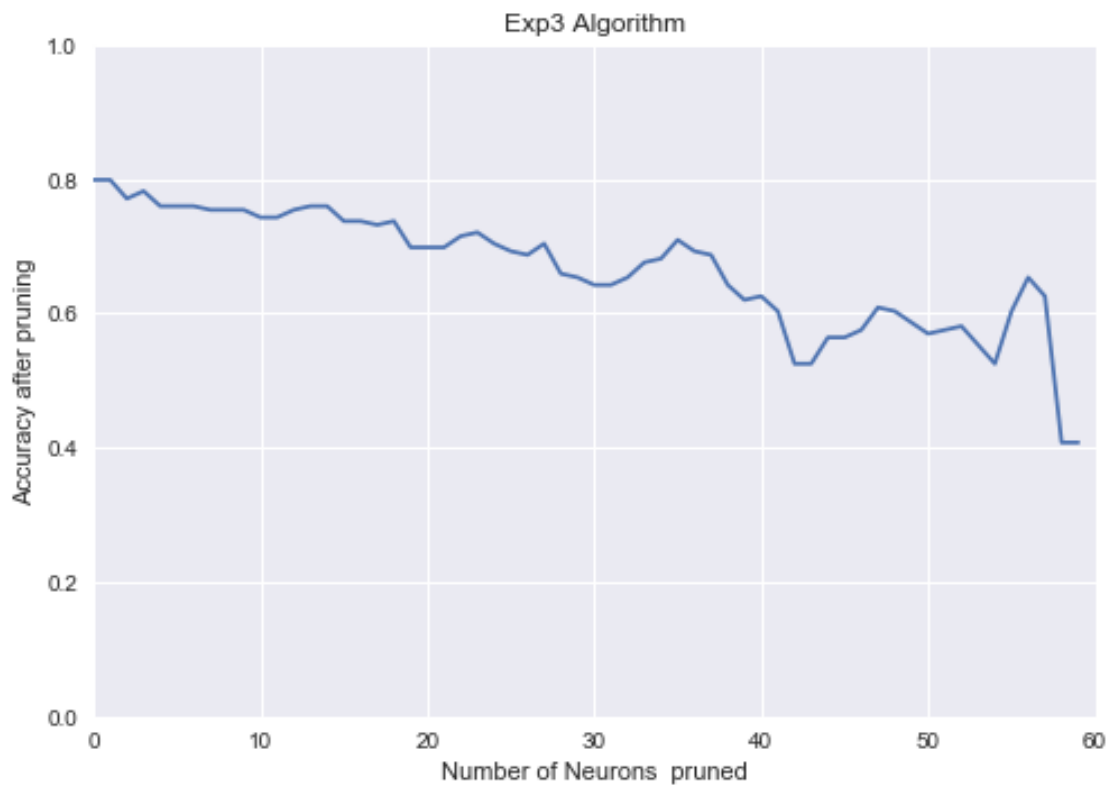
In [9]: exp3_gamma = 0.2 #exp3_gamma in [0.1, 0.2, 0.3, 0.4, 0.5]
        algo = Exp3(exp3_gamma, [])
        Alg_name = 'Exp3 Algorithm'
        path = './Exp3/'
        sys.path.append("./EpsilonGreedy")
        exec(open("mnist_cnnFORTESTING.py").read())
  
```

Test fraction correct (NN-Score) = 0.51
Test fraction correct (NN-Accuracy) = 0.80
The time for running this method is 0.4300537109375 seconds
Finsh playing start pruning:
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.77
Test after pruning= 0.78
Test after pruning= 0.76
Test after pruning= 0.76
Test after pruning= 0.76
Test after pruning= 0.75
Test after pruning= 0.75
Test after pruning= 0.75
Test after pruning= 0.74
Test after pruning= 0.74
Test after pruning= 0.75
Test after pruning= 0.76
Test after pruning= 0.76
Test after pruning= 0.74
Test after pruning= 0.74
Test after pruning= 0.73
Test after pruning= 0.74
Test after pruning= 0.70
Test after pruning= 0.70
Test after pruning= 0.70
Test after pruning= 0.72
Test after pruning= 0.72
Test after pruning= 0.70
Test after pruning= 0.69
Test after pruning= 0.69
Test after pruning= 0.70
Test after pruning= 0.66
Test after pruning= 0.65
Test after pruning= 0.64
Test after pruning= 0.64
Test after pruning= 0.65
Test after pruning= 0.68
Test after pruning= 0.68
Test after pruning= 0.71
Test after pruning= 0.69
Test after pruning= 0.69
Test after pruning= 0.64
Test after pruning= 0.62
Test after pruning= 0.63
Test after pruning= 0.60
Test after pruning= 0.53
Test after pruning= 0.53

```

Test after pruning= 0.56
Test after pruning= 0.56
Test after pruning= 0.58
Test after pruning= 0.61
Test after pruning= 0.60
Test after pruning= 0.59
Test after pruning= 0.57
Test after pruning= 0.58
Test after pruning= 0.58
Test after pruning= 0.55
Test after pruning= 0.53
Test after pruning= 0.60
Test after pruning= 0.65
Test after pruning= 0.63
Test after pruning= 0.41
Test after pruning= 0.41

```



5 Run Softmax pruning Algorithm

```

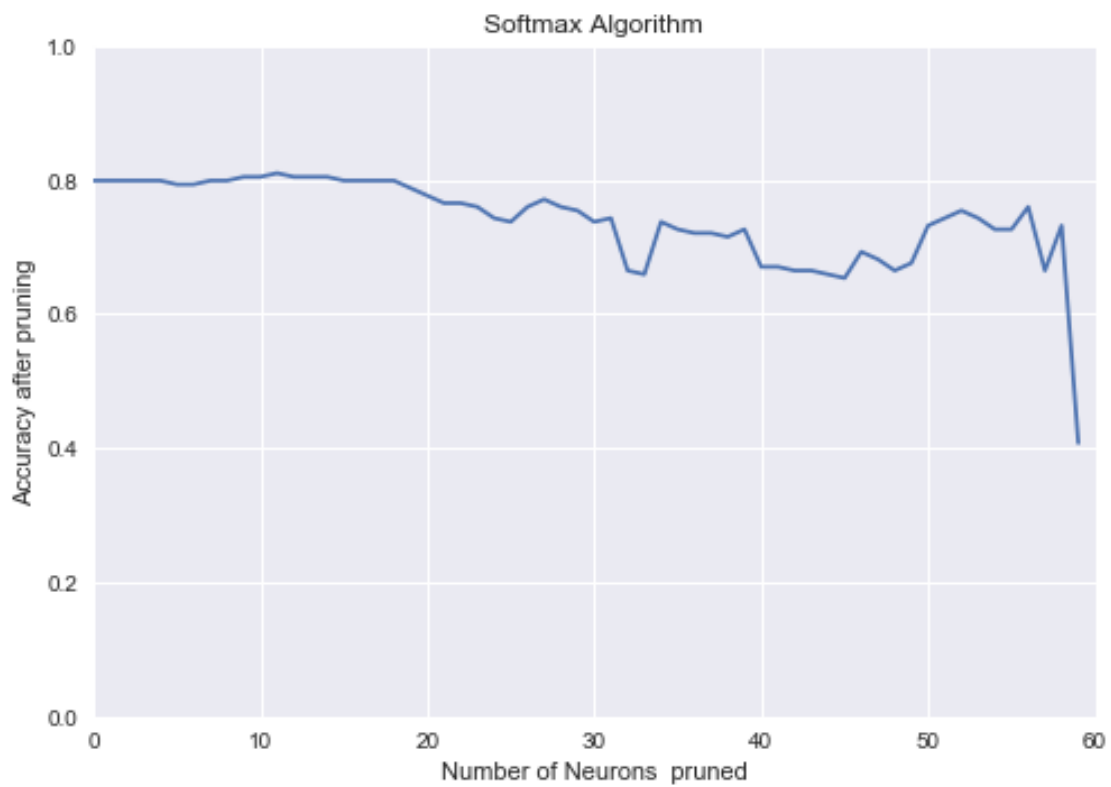
In [10]: temperature = 0.9
         algo = Softmax(temperature, [], [])

```

```
Alg_name = 'Softmax Algorithm'
path = './Softmax/'
sys.path.append("./Softmax")
exec(open("mnist_cnnFORTESTING.py").read())
```

```
Test fraction correct (NN-Score) = 0.51
Test fraction correct (NN-Accuracy) = 0.80
The time for running this method is 0.4435570240020752 seconds
Finsh playing start pruning:
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.79
Test after pruning= 0.79
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.81
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.79
Test after pruning= 0.78
Test after pruning= 0.77
Test after pruning= 0.77
Test after pruning= 0.76
Test after pruning= 0.74
Test after pruning= 0.74
Test after pruning= 0.76
Test after pruning= 0.77
Test after pruning= 0.76
Test after pruning= 0.75
Test after pruning= 0.74
Test after pruning= 0.74
Test after pruning= 0.66
Test after pruning= 0.66
Test after pruning= 0.74
Test after pruning= 0.73
Test after pruning= 0.72
Test after pruning= 0.72
Test after pruning= 0.72
```

Test after pruning= 0.73
Test after pruning= 0.67
Test after pruning= 0.67
Test after pruning= 0.66
Test after pruning= 0.66
Test after pruning= 0.66
Test after pruning= 0.65
Test after pruning= 0.69
Test after pruning= 0.68
Test after pruning= 0.66
Test after pruning= 0.68
Test after pruning= 0.73
Test after pruning= 0.74
Test after pruning= 0.75
Test after pruning= 0.74
Test after pruning= 0.73
Test after pruning= 0.73
Test after pruning= 0.76
Test after pruning= 0.66
Test after pruning= 0.73
Test after pruning= 0.41

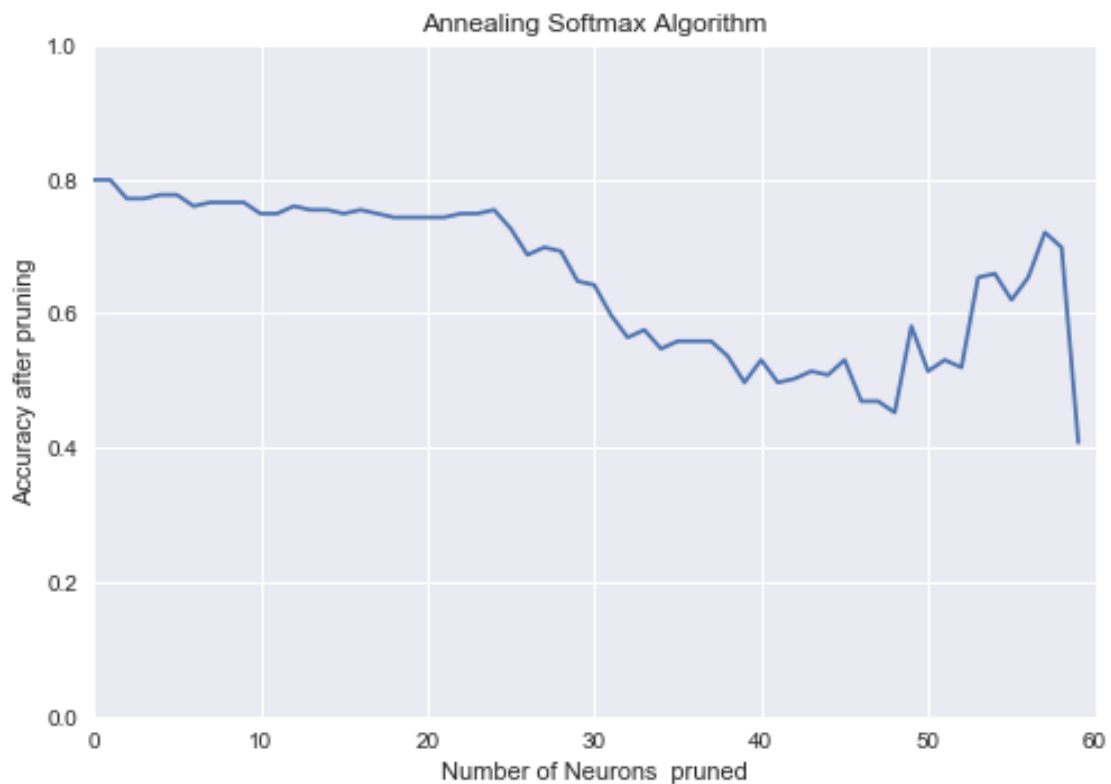


6 Run Annealing Softmax pruning Algorithm

```
In [11]: algo = AnnealingSoftmax([], [])
         Alg_name = 'Annealing Softmax Algorithm'
         path = './AnnealingSoftmax/'
         sys.path.append("./AnnealingSoftmax")
         exec(open("mnist_cnnFORTESTING.py").read())

Test fraction correct (NN-Score) = 0.51
Test fraction correct (NN-Accuracy) = 0.80
The time for running this method is 0.4275703430175781 seconds
Finsh playing start pruning:
Test after pruning= 0.80
Test after pruning= 0.80
Test after pruning= 0.77
Test after pruning= 0.77
Test after pruning= 0.78
Test after pruning= 0.78
Test after pruning= 0.76
Test after pruning= 0.77
Test after pruning= 0.77
Test after pruning= 0.77
Test after pruning= 0.75
Test after pruning= 0.75
Test after pruning= 0.76
Test after pruning= 0.75
Test after pruning= 0.75
Test after pruning= 0.75
Test after pruning= 0.75
Test after pruning= 0.75
Test after pruning= 0.75
Test after pruning= 0.74
Test after pruning= 0.74
Test after pruning= 0.74
Test after pruning= 0.74
Test after pruning= 0.75
Test after pruning= 0.75
Test after pruning= 0.73
Test after pruning= 0.69
Test after pruning= 0.70
Test after pruning= 0.69
Test after pruning= 0.65
Test after pruning= 0.64
Test after pruning= 0.60
Test after pruning= 0.56
Test after pruning= 0.58
Test after pruning= 0.55
Test after pruning= 0.56
```

Test after pruning= 0.56
Test after pruning= 0.56
Test after pruning= 0.54
Test after pruning= 0.50
Test after pruning= 0.53
Test after pruning= 0.50
Test after pruning= 0.50
Test after pruning= 0.51
Test after pruning= 0.51
Test after pruning= 0.53
Test after pruning= 0.47
Test after pruning= 0.47
Test after pruning= 0.45
Test after pruning= 0.58
Test after pruning= 0.51
Test after pruning= 0.53
Test after pruning= 0.52
Test after pruning= 0.65
Test after pruning= 0.66
Test after pruning= 0.62
Test after pruning= 0.65
Test after pruning= 0.72
Test after pruning= 0.70
Test after pruning= 0.41



7 Run Hedge pruning Algorithm

```
In [12]: eta = 0.9 # eta in [.5, .8, .9, 1, 2]
        algo = Hedge(eta, [], [])
        Alg_name = 'Hedge Algorithm'
        path = './Hedge/'
        sys.path.append("./Hedge")
        exec(open("mnist_cnnFORTESTING.py").read())
```

Test fraction correct (NN-Score) = 0.51

Test fraction correct (NN-Accuracy) = 0.80

The time for running this method is 0.43310117721557617 seconds

Finsh playing start pruning:

Test after pruning= 0.80

Test after pruning= 0.79

Test after pruning= 0.80

Test after pruning= 0.80

Test after pruning= 0.78

Test after pruning= 0.78

Test after pruning= 0.79

Test after pruning= 0.78

Test after pruning= 0.79

Test after pruning= 0.79

Test after pruning= 0.79

Test after pruning= 0.79

Test after pruning= 0.79

Test after pruning= 0.79

Test after pruning= 0.79

Test after pruning= 0.79

Test after pruning= 0.79

Test after pruning= 0.79

Test after pruning= 0.79

Test after pruning= 0.79

Test after pruning= 0.78

Test after pruning= 0.79

Test after pruning= 0.78

Test after pruning= 0.78

Test after pruning= 0.78

Test after pruning= 0.78

Test after pruning= 0.78

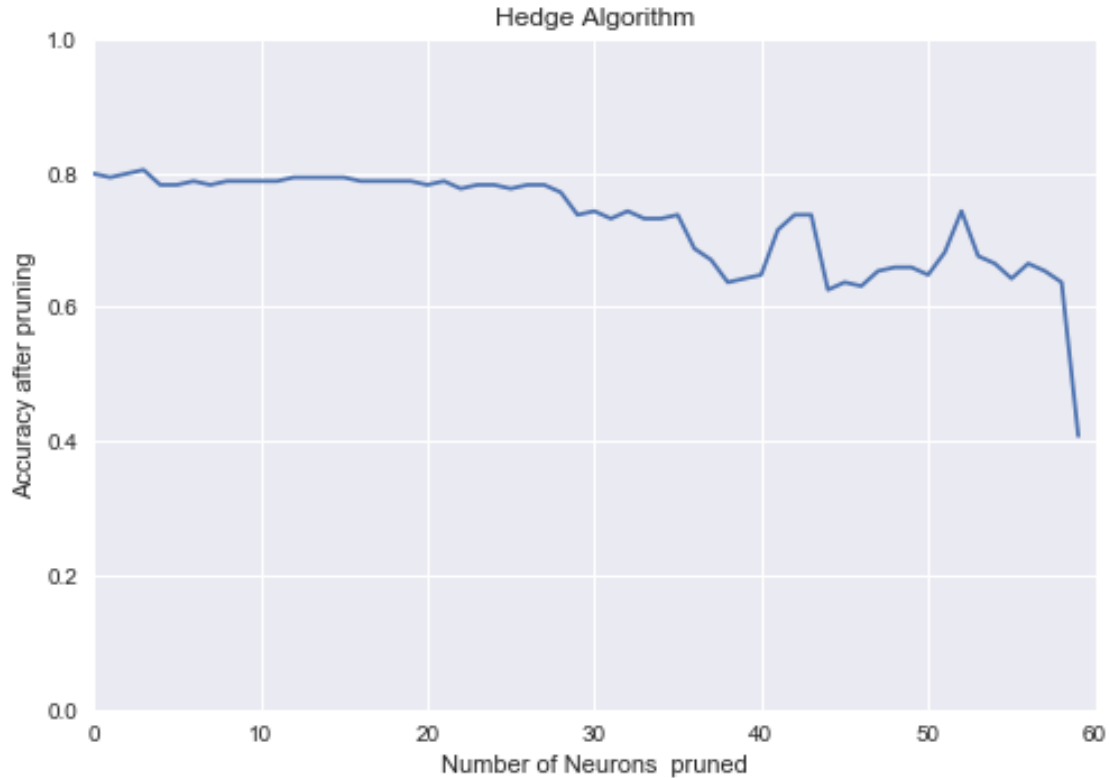
Test after pruning= 0.78

Test after pruning= 0.77

Test after pruning= 0.74

Test after pruning= 0.74

Test after pruning= 0.73
Test after pruning= 0.74
Test after pruning= 0.73
Test after pruning= 0.73
Test after pruning= 0.74
Test after pruning= 0.69
Test after pruning= 0.67
Test after pruning= 0.64
Test after pruning= 0.64
Test after pruning= 0.65
Test after pruning= 0.72
Test after pruning= 0.74
Test after pruning= 0.74
Test after pruning= 0.63
Test after pruning= 0.64
Test after pruning= 0.63
Test after pruning= 0.65
Test after pruning= 0.66
Test after pruning= 0.66
Test after pruning= 0.65
Test after pruning= 0.68
Test after pruning= 0.74
Test after pruning= 0.68
Test after pruning= 0.66
Test after pruning= 0.64
Test after pruning= 0.66
Test after pruning= 0.65
Test after pruning= 0.64
Test after pruning= 0.41



8 Compare the accuracy of the models

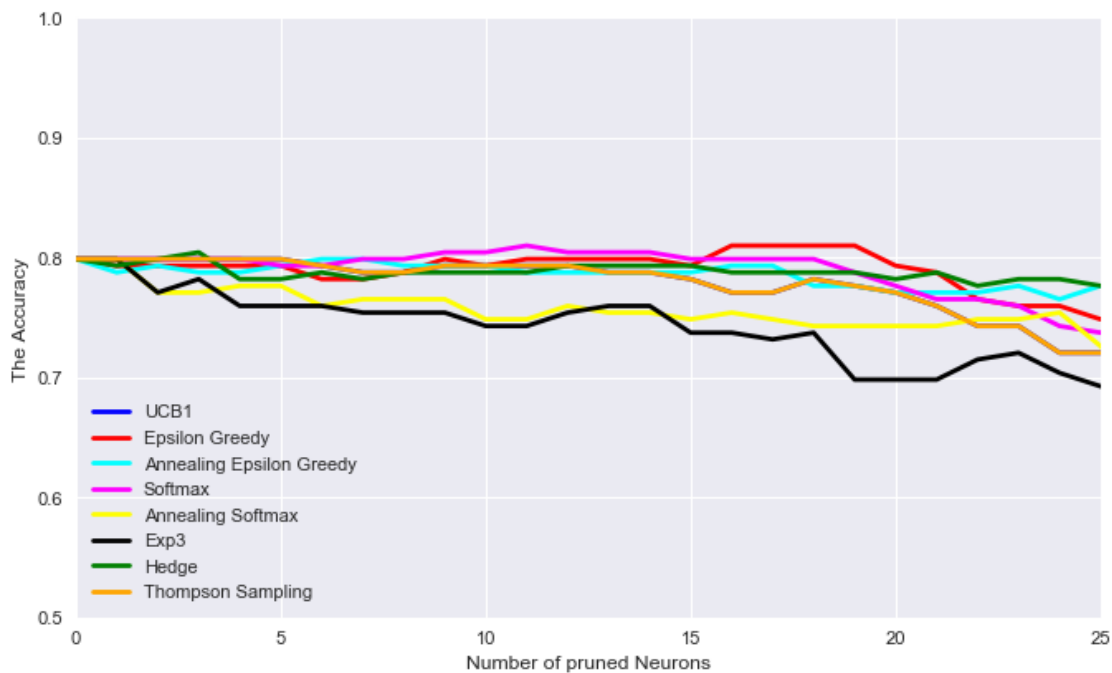
```
In [13]: ucb1 = np.load('./UCB1/AccuracyAfterPrune.npy')
        EpsilonGreedy = np.load('./EpsilonGreedy/AccuracyAfterPrune.npy')
        AnnealingEpsilonGreedy = np.load('./AnnealingEpsilonGreedy/AccuracyAfterPrune.npy')
        Softmax = np.load('./Softmax/AccuracyAfterPrune.npy')
        AnnealingSoftmax = np.load('./AnnealingSoftmax/AccuracyAfterPrune.npy')
        Exp3 = np.load('./Exp3/AccuracyAfterPrune.npy')
        Hedge = np.load('./Hedge/AccuracyAfterPrune.npy')
        ThompsonSampling = np.load('./Thompson_Sampling/AccuracyAfterPrune.npy')
        Accuracy = np.load('AccuracyBeforePruning.npy')

In [14]: fig = plt.figure(figsize=(10, 6), dpi=80)
        ax = fig.add_subplot(111)
        N = len(ucb1)
        ## necessary variables
        ind = np.arange(N)                                # the x locations for the groups
        plt.plot(ind, ucb1, color="blue", linewidth=2.5, linestyle="-", label="UCB1")
        plt.plot(ind, EpsilonGreedy, color="red", linewidth=2.5, linestyle="-", label="Epsilon")
        plt.plot(ind, AnnealingEpsilonGreedy, color="cyan", linewidth=2.5, linestyle="-", label="Annealing")
        plt.plot(ind, Softmax, color="magenta", linewidth=2.5, linestyle="-", label="Softmax")
```

```

plt.plot(ind , AnnealingSoftmax, color="yellow", linewidth=2.5, linestyle="-", label="A
plt.plot(ind , Exp3, color="black", linewidth=2.5, linestyle="-", label="Exp3")
plt.plot(ind , Hedge, color="green", linewidth=2.5, linestyle="-", label="Hedge")
plt.plot(ind , ThompsonSampling, color="orange", linewidth=2.5, linestyle="-", label="T
plt.legend(loc = 3)
plt.axis([0, 25, 0.5, 1])
plt.xlabel('Number of pruned Neurons')
plt.ylabel('The Accuracy')
plt.grid(True)
plt.show()

```



```

In [15]: p1 = figure(title="The Performance over the number of neurons' pruned", tools=TOOLS)

```

```

#p1.circle(ind, ucb1, legend="ucb1", color="orange")
p1.line(ind, ucb1, legend="ucb1", line_color="orange", line_width=2)

#p1.square(ind, EpsilonGreedy, legend="Epsilon Greedy", fill_color=None, line_color="red")
p1.line(ind, EpsilonGreedy, legend="Epsilon Greedy", line_color="red", line_width=2)

#p1.ellipse(ind, AnnealingEpsilonGreedy, legend="Annealing Epsilon Greedy", line_color="blue")
p1.line(ind, AnnealingEpsilonGreedy, legend="Annealing Epsilon Greedy", line_color="blue", line_width=2)

#p1.diamond(ind, Softmax, legend="Softmax", line_color="green")
p1.line(ind, Softmax, legend="Softmax", line_color="green", line_width=2)

```

```

#p1.arc(ind, AnnealingSoftmax, legend="Annealing Softmax", line_color="grey", end_angle
p1.line(ind, AnnealingSoftmax, legend="Annealing Softmax", line_color="grey", line_widt

#p1.oval(ind, Exp3, legend="Exp3", line_color="black", height=0.01, width=0.01)
p1.line(ind, Exp3, legend="Exp3", line_color="black", line_width=2)

#p1.arc(ind, Hedge, legend="Hedge", line_color="yellow")
#p1.triangle(ind, Hedge, legend="Hedge", line_color="yellow")
p1.line(ind, Hedge, legend="Hedge", line_color="yellow", line_width=2)

#p1.square_cross(ind, ThompsonSampling, legend="Thompson Sampling", line_color="pink")
p1.line(ind, ThompsonSampling, legend="Thompson Sampling", line_color="pink", line_widt

#p1.line(ind, Exp3, legend="2*sin(x)", line_dash=(4, 4), line_color="orange", line_widt
#p1.square(ind, Hedge, legend="3*sin(x)", fill_color=None, line_color="brown")
p1.title.align = "center"

show(p1)
#show(gridplot(p1, p2, ncols=2, plot_width=400, plot_height=400)) # open a browser

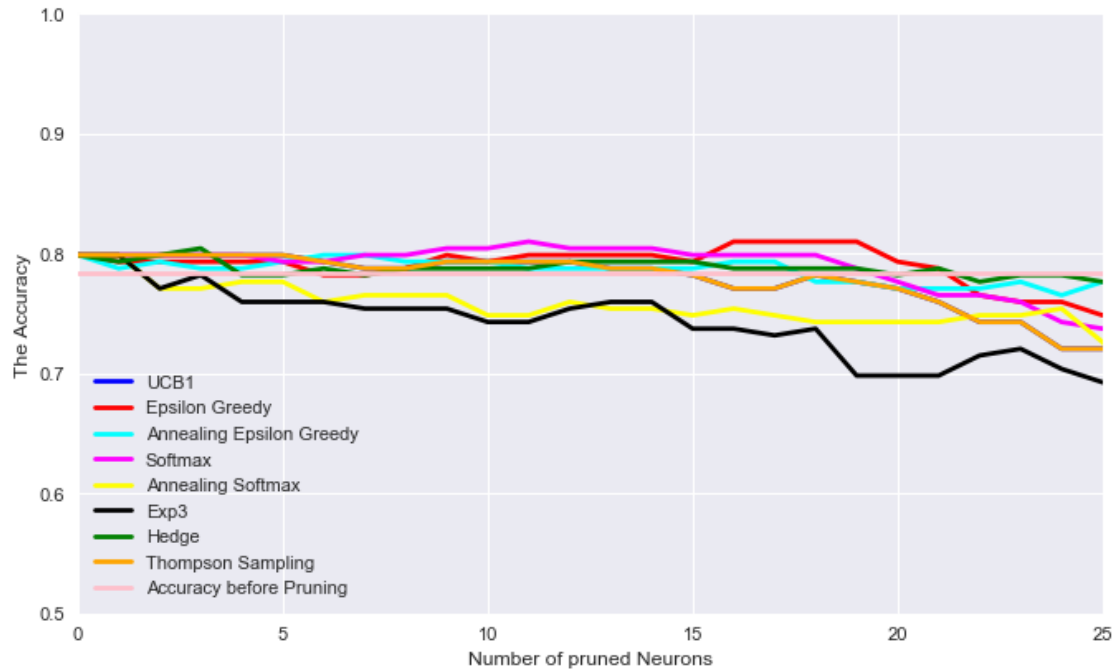
```

8.1 Comparing All algorithms with the model before pruning

```

In [16]: fig = plt.figure(figsize=(10, 6), dpi=80)
ax = fig.add_subplot(111)
N = len(ucb1)
Acc = [Accuracy for col in range(N)]
## necessary variables
ind = np.arange(N) # the x locations for the groups
plt.plot(ind , ucb1 , color="blue", linewidth=2.5, linestyle="-", label="UCB1")
plt.plot(ind , EpsilonGreedy, color="red", linewidth=2.5, linestyle="-", label="Epsilon")
plt.plot(ind , AnnealingEpsilonGreedy, color="cyan", linewidth=2.5, linestyle="-", label="AnnealingEpsilonGreedy")
plt.plot(ind , Softmax, color="magenta", linewidth=2.5, linestyle="-", label="Softmax")
plt.plot(ind , AnnealingSoftmax, color="yellow", linewidth=2.5, linestyle="-", label="AnnealingSoftmax")
plt.plot(ind , Exp3, color="black", linewidth=2.5, linestyle="-", label="Exp3")
plt.plot(ind , Hedge, color="green", linewidth=2.5, linestyle="-", label="Hedge")
plt.plot(ind , ThompsonSampling, color="orange", linewidth=2.5, linestyle="-", label="ThompsonSampling")
plt.plot(ind , Acc, color="pink", linewidth=2.5, linestyle="-", label="Accuracy before pruning")
plt.legend(loc = 3)
plt.axis([0, 25, 0.5, 1])
plt.xlabel('Number of pruned Neurons')
plt.ylabel('The Accuracy')
plt.grid(True)
plt.show()

```



```
In [17]: p1 = figure(title="The Performance over the number of neurons' pruned", tools=TOOLS)

#p1.circle(ind, ucb1, legend="ucb1", color="orange")
p1.line(ind, ucb1, legend="ucb1", line_color="orange", line_width=2)

#p1.square(ind, EpsilonGreedy, legend="Epsilon Greedy", fill_color=None, line_color="red")
p1.line(ind, EpsilonGreedy, legend="Epsilon Greedy", line_color="red", line_width=2)

#p1.ellipse(ind, AnnealingEpsilonGreedy, legend="Annealing Epsilon Greedy", line_color="blue")
p1.line(ind, AnnealingEpsilonGreedy, legend="Annealing Epsilon Greedy", line_color="blue", line_width=2)

#p1.diamond(ind, Softmax, legend="Softmax", line_color="green")
p1.line(ind, Softmax, legend="Softmax", line_color="green", line_width=2)

#p1.arc(ind, AnnealingSoftmax, legend="Annealing Softmax", line_color="grey", end_angle=0.5)
p1.line(ind, AnnealingSoftmax, legend="Annealing Softmax", line_color="grey", line_width=2)

#p1.oval(ind, Exp3, legend="Exp3", line_color="black", height=0.01, width=0.01)
p1.line(ind, Exp3, legend="Exp3", line_color="black", line_width=2)

#p1.arc(ind, Hedge, legend="Hedge", line_color="yellow")
#p1.triangle(ind, Hedge, legend="Hedge", line_color="yellow")
p1.line(ind, Hedge, legend="Hedge", line_color="yellow", line_width=2)
```

```

#p1.square_cross(ind, ThompsonSampling, legend="Thompson Sampling", line_color="pink")
p1.line(ind, ThompsonSampling, legend="Thompson Sampling", line_color="pink", line_widt

p1.line(ind, Acc, legend="Accuracy", line_dash=(4, 4), line_color="orange", line_width=
#p1.square(ind, Hedge, legend="3*sin(x)", fill_color=None, line_color="brown")
p1.title.align = "center"

show(p1)
#show(gridplot(p1, p2, ncols=2, plot_width=400, plot_height=400)) # open a browser

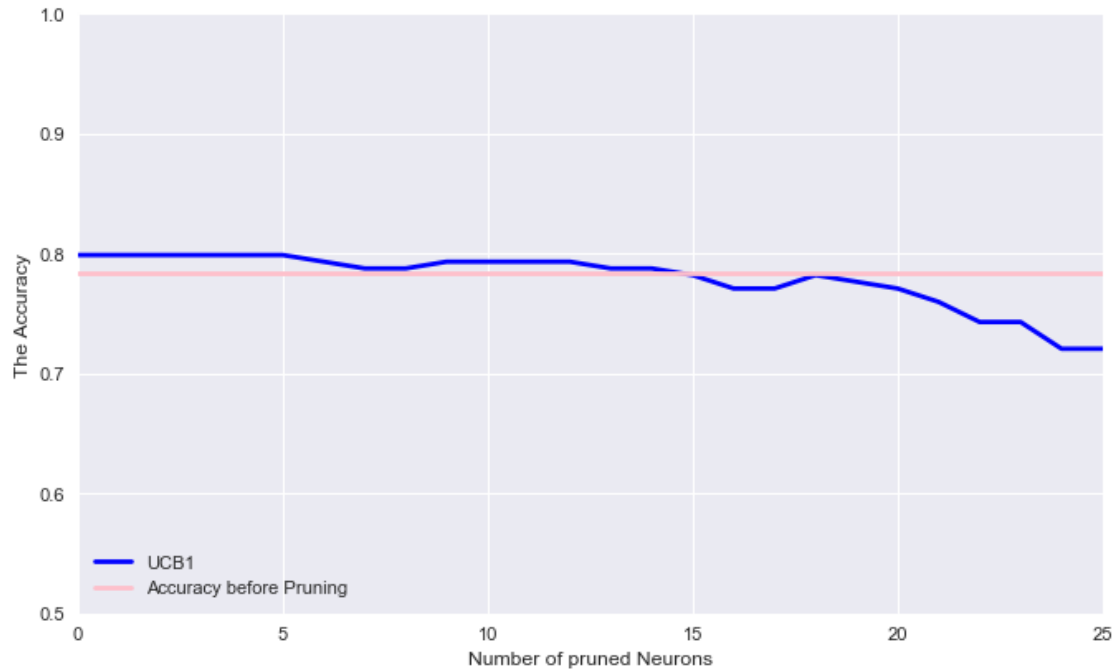
```

8.2 UCB1

```

In [18]: fig = plt.figure(figsize=(10, 6), dpi=80)
ax = fig.add_subplot(111)
N = len(ucb1)
Acc = [Accuracy for col in range(N)]
## necessary variables
ind = np.arange(N) # the x locations for the groups
plt.plot(ind, ucb1, color="blue", linewidth=2.5, linestyle="-", label="UCB1")
plt.plot(ind, Acc, color="pink", linewidth=2.5, linestyle="-", label="Accuracy before
plt.legend(loc = 3)
plt.axis([0, 25, 0.5, 1])
plt.xlabel('Number of pruned Neurons')
plt.ylabel('The Accuracy')
plt.grid(True)
plt.show()

```



```
In [19]: p1 = figure(title="The Performance over the number of neurons' pruned", tools=TOOLS)

#p1.circle(ind, ucb1, legend="ucb1", color="orange")
p1.line(ind, ucb1, legend="ucb1", line_color="orange", line_width=2)
p1.line(ind, Acc, legend="Accuracy", line_dash=(4, 4), line_color="orange", line_width=2)
#p1.square(ind, Hedge, legend="3*sin(x)", fill_color=None, line_color="brown")
p1.title.align = "center"

show(p1)
#show(gridplot(p1, p2, ncols=2, plot_width=400, plot_height=400)) # open a browser
```

8.3 Epsilon greedy and Softmax

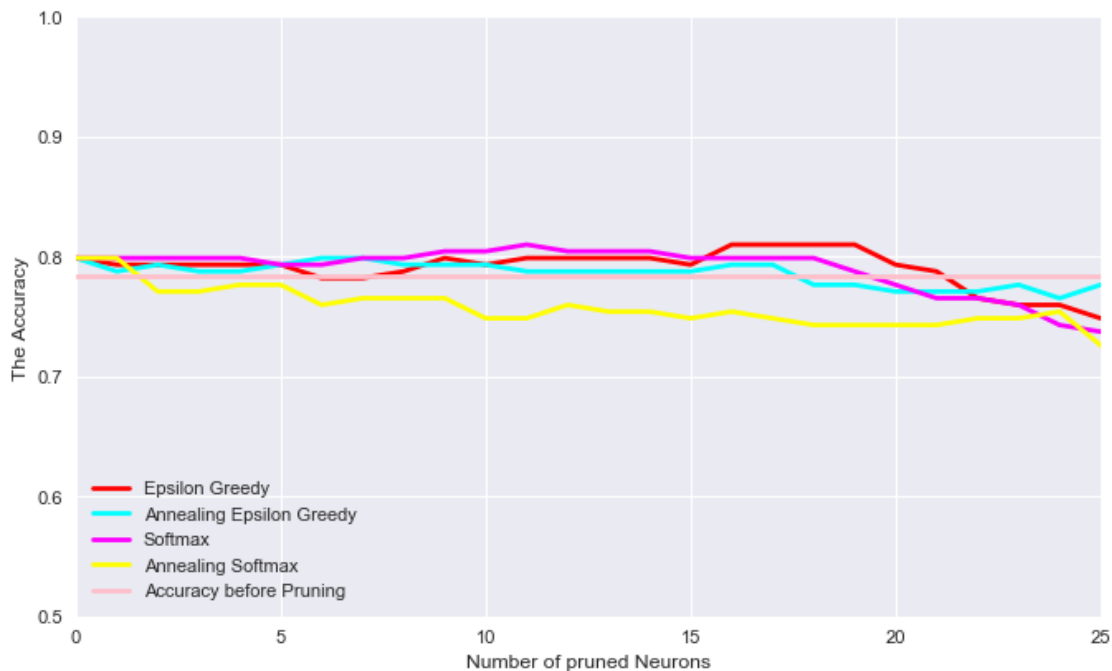
```
In [20]: fig = plt.figure(figsize=(10, 6), dpi=80)
ax = fig.add_subplot(111)
N = len(EpsilonGreedy)
Acc = [Accuracy for col in range(N)]
## necessary variables
ind = np.arange(N) # the x locations for the groups
plt.plot(ind, EpsilonGreedy, color="red", linewidth=2.5, linestyle="-", label="EpsilonGreedy")
plt.plot(ind, AnnealingEpsilonGreedy, color="cyan", linewidth=2.5, linestyle="-", label="AnnealingEpsilonGreedy")
plt.plot(ind, Softmax, color="magenta", linewidth=2.5, linestyle="-", label="Softmax")
plt.plot(ind, AnnealingSoftmax, color="yellow", linewidth=2.5, linestyle="-", label="AnnealingSoftmax")
```



```

plt.plot(ind , Acc, color="pink", linewidth=2.5, linestyle="--", label="Accuracy before
plt.legend(loc = 3)
plt.axis([0, 25, 0.5, 1])
plt.xlabel('Number of pruned Neurons')
plt.ylabel('The Accuracy')
plt.grid(True)
plt.show()

```



```

In [21]: p1 = figure(title="The Performance over the number of neurons' pruned", tools=TOOLS)

#p1.square(ind, EpsilonGreedy, legend="Epsilon Greedy", fill_color=None, line_color="red", line_width=2)
p1.line(ind, EpsilonGreedy, legend="Epsilon Greedy", line_color="red", line_width=2)

#p1.ellipse(ind, AnnealingEpsilonGreedy, legend="Annealing Epsilon Greedy", line_color="blue", line_width=2)
p1.line(ind, AnnealingEpsilonGreedy, legend="Annealing Epsilon Greedy", line_color="blue", line_width=2)

#p1.diamond(ind, Softmax, legend="Softmax", line_color="green", line_width=2)
p1.line(ind, Softmax, legend="Softmax", line_color="green", line_width=2)

#p1.arc(ind, AnnealingSoftmax, legend="Annealing Softmax", line_color="grey", end_angle=90, line_width=2)
p1.line(ind, AnnealingSoftmax, legend="Annealing Softmax", line_color="grey", line_width=2)

p1.line(ind, Acc, legend="Accuracy", line_dash=(4, 4), line_color="orange", line_width=2)
#p1.square(ind, Hedge, legend="3*sin(x)", fill_color=None, line_color="brown")

```

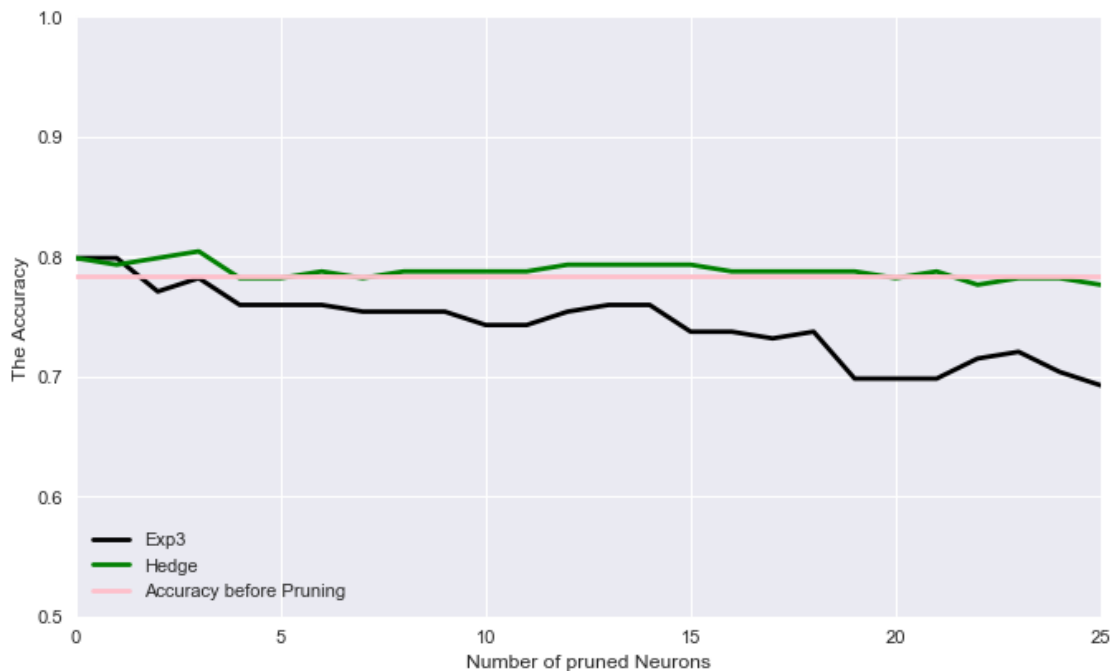
```
p1.title.align = "center"
```

```
show(p1)
```

```
#show(gridplot(p1, p2, ncols=2, plot_width=400, plot_height=400)) # open a browser
```

8.4 Adversial Bandits Hedge and EXP3

```
In [22]: fig = plt.figure(figsize=(10, 6), dpi=80)
ax = fig.add_subplot(111)
N = len(Exp3)
Acc = [Accuracy for col in range(N)]
## necessary variables
ind = np.arange(N) # the x locations for the groups
plt.plot(ind, Exp3, color="black", linewidth=2.5, linestyle="-", label="Exp3")
plt.plot(ind, Hedge, color="green", linewidth=2.5, linestyle="-", label="Hedge")
plt.plot(ind, Acc, color="pink", linewidth=2.5, linestyle="-", label="Accuracy before")
plt.legend(loc = 3)
plt.axis([0, 25, 0.5, 1])
plt.xlabel('Number of pruned Neurons')
plt.ylabel('The Accuracy')
plt.grid(True)
plt.show()
```



```
In [23]: p1 = figure(title="The Performance over the number of neurons' pruned", tools=TOOLS)
```

```

#p1.oval(ind, Exp3, legend="Exp3", line_color="black", height=0.01, width=0.01)
p1.line(ind, Exp3, legend="Exp3", line_color="black", line_width=2)

#p1.arc(ind, Hedge, legend="Hedge", line_color="yellow")
#p1.triangle(ind, Hedge, legend="Hedge", line_color="yellow")
p1.line(ind, Hedge, legend="Hedge", line_color="yellow", line_width=2)

p1.line(ind, Acc, legend="Accuracy", line_dash=(4, 4), line_color="orange", line_width=2)
#p1.square(ind, Hedge, legend="3*sin(x)", fill_color=None, line_color="brown")
p1.title.align = "center"

show(p1)
#show(gridplot(p1, p2, ncols=2, plot_width=400, plot_height=400)) # open a browser

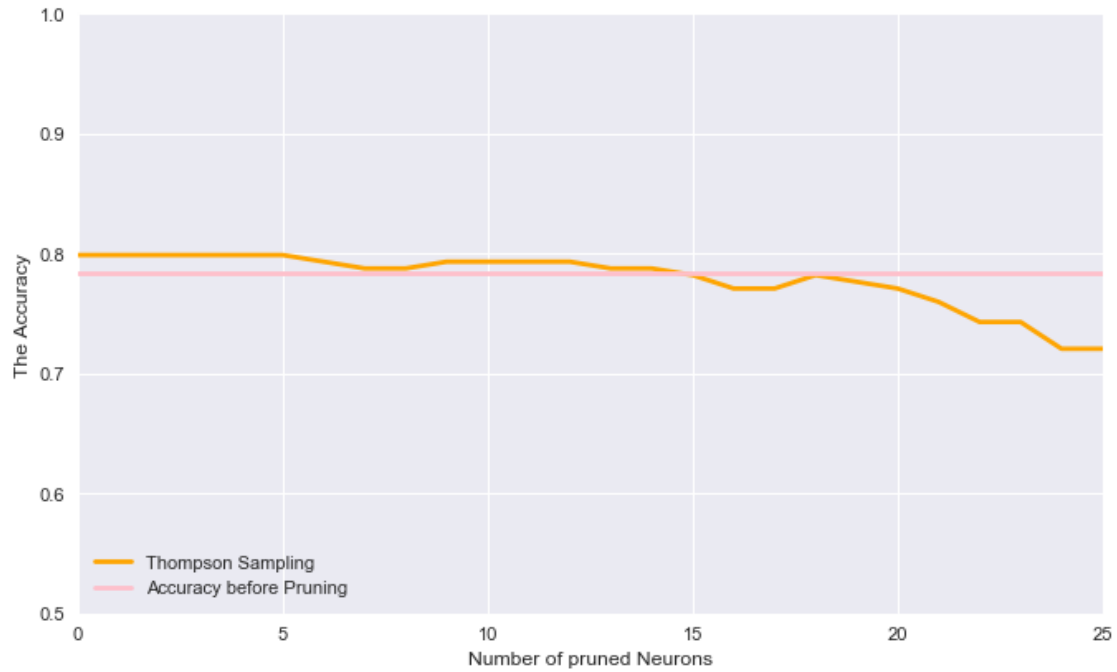
```

9 Thompson Sampling

```

In [24]: fig = plt.figure(figsize=(10, 6), dpi=80)
         ax = fig.add_subplot(111)
         N = len(ThompsonSampling)
         Acc = [Accuracy for col in range(N)]
         ## necessary variables
         ind = np.arange(N) # the x locations for the groups
         plt.plot(ind, ThompsonSampling, color="orange", linewidth=2.5, linestyle="-", label="Thompson Sampling")
         plt.plot(ind, Acc, color="pink", linewidth=2.5, linestyle="-", label="Accuracy before pruning")
         plt.legend(loc = 3)
         plt.axis([0, 25, 0.5, 1])
         plt.xlabel('Number of pruned Neurons')
         plt.ylabel('The Accuracy')
         plt.grid(True)
         plt.show()

```



```
In [25]: p1 = figure(title="The Performance over the number of neurons' pruned", tools=TOOLS)

#p1.square_cross(ind, ThompsonSampling, legend="Thompson Sampling", line_color="pink")
p1.line(ind, ThompsonSampling, legend="Thompson Sampling", line_color="pink", line_width=4)

p1.line(ind, Acc, legend="Accuracy", line_dash=(4, 4), line_color="orange", line_width=4)
#p1.square(ind, Hedge, legend="3*sin(x)", fill_color=None, line_color="brown")
p1.title.align = "center"

show(p1)
#show(gridplot(p1, p2, ncols=2, plot_width=400, plot_height=400)) # open a browser
```