CS 498 AML HW2

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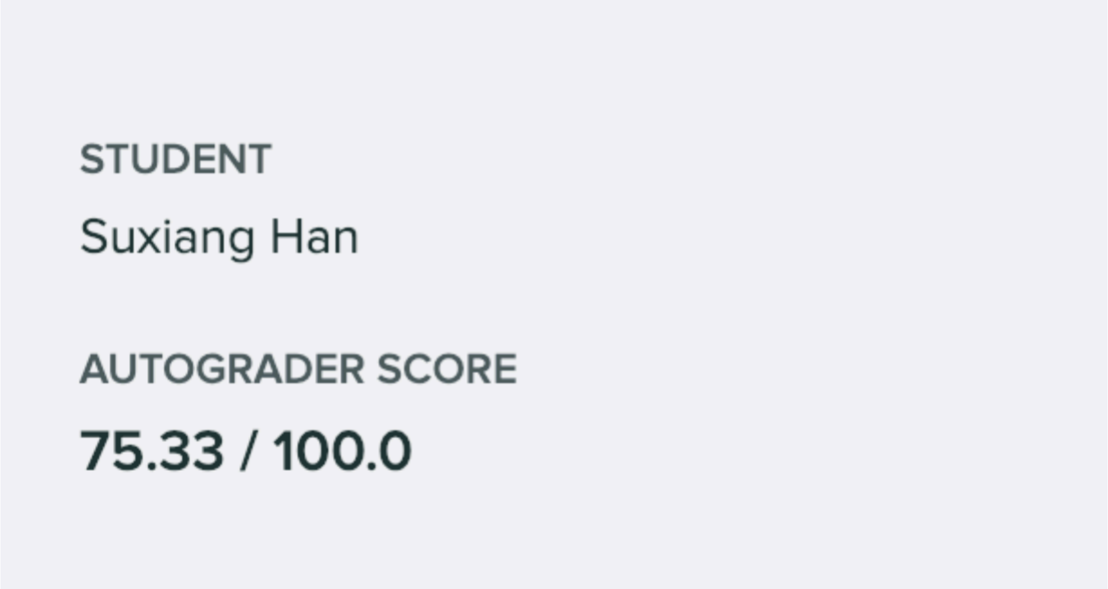


STUDENT

Suxiang Han

AUTOGRADER SCORE

75.33 / 100.0

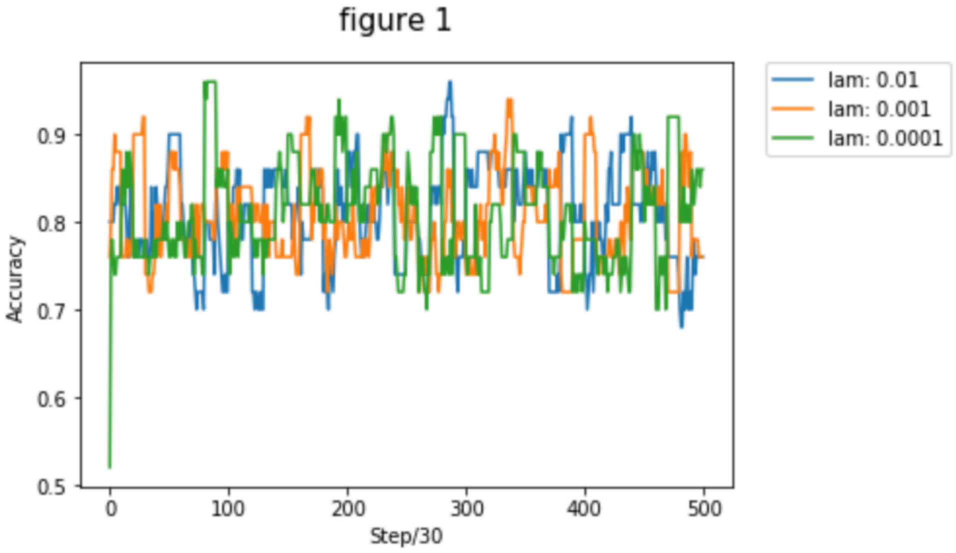
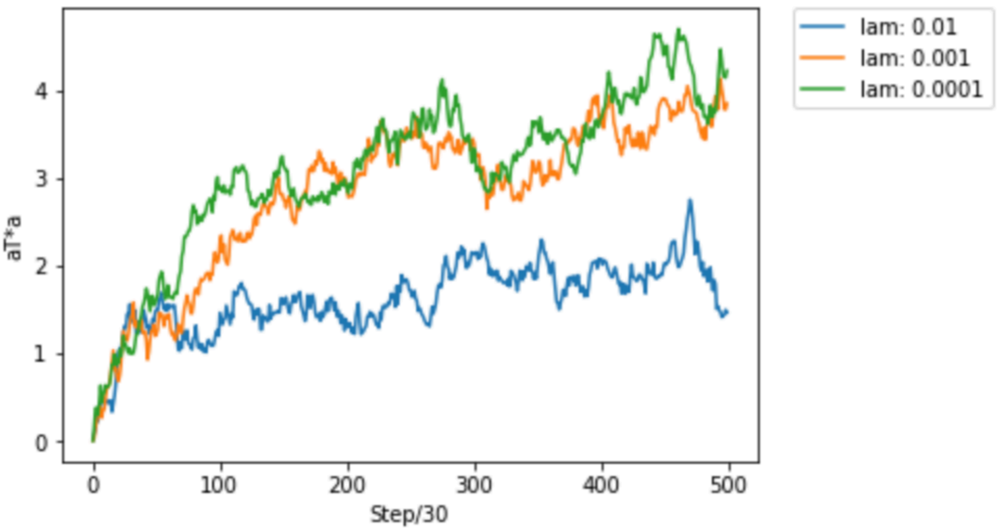


figure 1
Accuracy
0.5
0.6
0.7
0.8
0.9
0
100
200
300
400
500
Step/30
lam: 0.01
lam: 0.001
lam: 0.0001

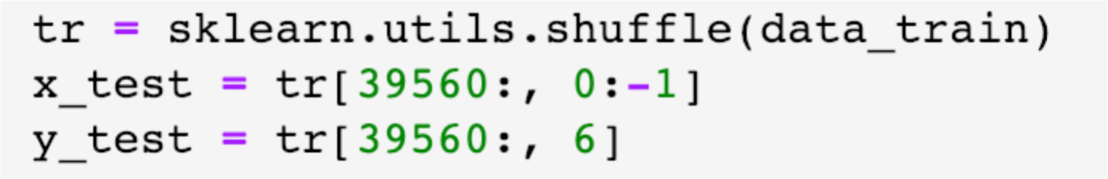
figure 2


lam: 0.01
lam: 0.001
lam: 0.0001
aT*a
0
1
2
3
4
0
100
200
300
400
500
Step/30

I chose 0.001 as the regularization constant. By looking at figure 2, we know 0.01 is not a good choice since it does not converge. However, 0.001 converges nicely in both figures, and by testing, 0.001 had the highest accuracy in the validation set among the three numbers. So I chose 0.001.

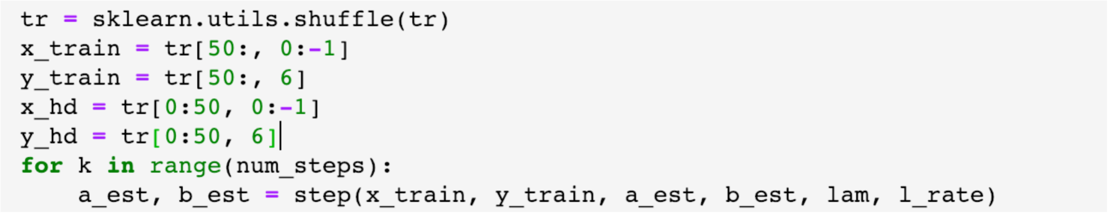
I chose 1/(50+0.01*s) as learning rate. From the beginning, it has 0.02 learning rate, which is fast enough at the beginning. And as season increases, learning rate will decrease for convergence. Such properties make it a good choice.

Choosing validation set randomly



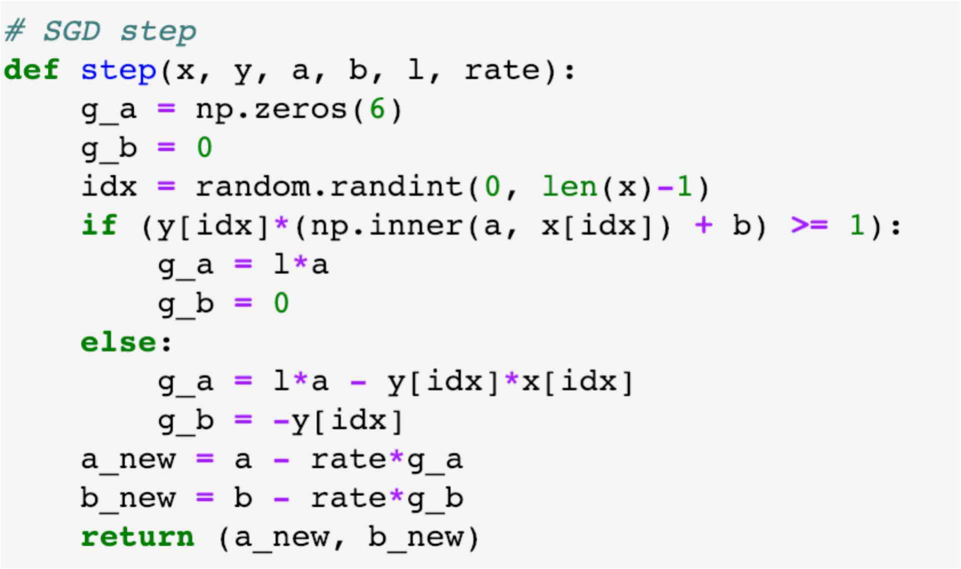
```
tr = sklearn.utils.shuffle(data_train)
x_test = tr[39560:, 0:-1]
y_test = tr[39560:, 6]
```

Separate 50 examples for plotting



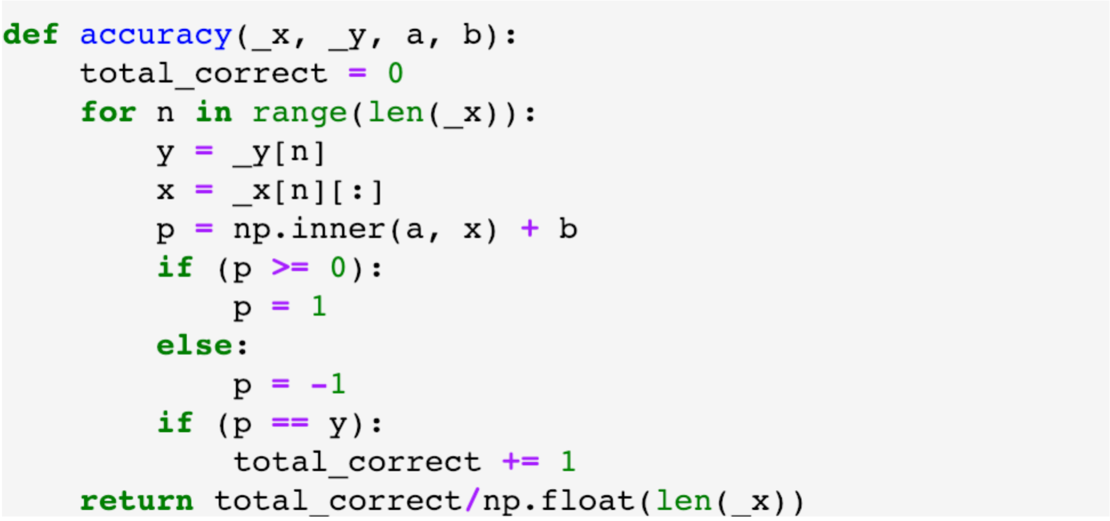
```
tr = sklearn.utils.shuffle(tr)
x_train = tr[50:, 0:-1]
y_train = tr[50:, 6]
x_hd = tr[0:50, 0:-1]
y_hd = tr[0:50, 6]
for k in range(num_steps):
    a_est, b_est = step(x_train, y_train, a_est, b_est, lam, l_rate)
```

SGD process



```
# SGD step
def step(x, y, a, b, l, rate):
    g_a = np.zeros(6)
    g_b = 0
    idx = random.randint(0, len(x)-1)
    if (y[idx]*(np.inner(a, x[idx]) + b) >= 1):
        g_a = l*a
        g_b = 0
    else:
        g_a = l*a - y[idx]*x[idx]
        g_b = -y[idx]
    a_new = a - rate*g_a
    b_new = b - rate*g_b
    return (a_new, b_new)
```

Testing by calculating accuracy with validation set



```
def accuracy(_x, _y, a, b):
    total_correct = 0
    for n in range(len(_x)):
        y = _y[n]
        x = _x[n][:]
        p = np.inner(a, x) + b
        if (p >= 0):
            p = 1
        else:
            p = -1
        if (p == y):
            total_correct += 1
    return total_correct/np.float(len(_x))
```

In [7]:

```python
import numpy as np
import pandas as pd
import scipy as sp
import matplotlib.pyplot as plt
import random
import sklearn
import sklearn.preprocessing
import sklearn.utils

# Import data
train = pd.read_csv('train.txt')
test = pd.read_csv('test.txt')

train.columns = ["age", "workclass", "fnlwgt", "education", "education-num", "marital-status", "occupation",
                 "relationship", "race", "sex", "capital-gain", "capital-loss", "hours-per-week", "native-country",
                 "label"]
test.columns = ["age", "workclass", "fnlwgt", "education", "education-num", "marital-status", "occupation",
                "relationship", "race", "sex", "capital-gain", "capital-loss", "hours-per-week", "native-country"]
tokens = ["age", "fnlwgt", "education-num", "capital-gain", "capital-loss", "hours-per-week"]

data_train = train.loc[:, tokens].values
data_test = test.loc[:, tokens].values
data_label = train.loc[:, "label"].values

# Standardization
data_train = sklearn.preprocessing.scale(data_train.astype(float))
data_test = sklearn.preprocessing.scale(data_test.astype(float))
# data_train = (data_train - np.mean(data_train, axis=0)) / np.std(data_train, axis=0)
# data_test = (data_test - np.mean(data_test, axis=0)) / np.std(data_test, axis=0)

for i in range(len(data_label)):
    if (data_label[i] == " >50K"):
        data_label[i] = 1
    else:
        data_label[i] = -1

data_train = np.hstack((data_train, np.reshape(data_label, (43956, 1))))
# Cost function
def cost_function(x, y, a, b, l):
    s = 0
    for i in range(len(x)):
        s += max(0, 1-y[i]*(np.dot(a, x[i])+b))
    return s/len(x)+l*np.dot(a, a)/2

# SGD step
def step(x, y, a, b, l, rate):
    g_a = np.zeros(6)
    g_b = 0
    idx = random.randint(0, len(x)-1)
    if (y[idx]*(np.inner(a, x[idx]) + b) >= 1):
        g_a = l*a
        g_b = 0
    else:
        g_a = l*a - y[idx]*x[idx]
        g_b = -y[idx]
    a_new = a - rate*g_a
    b_new = b - rate*g_b
    return (a_new, b_new)

def accuracy(_x, _y, a, b):
    total_correct = 0
    for n in range(len(_x)):
        y = _y[n]
        x = _x[n][:]
        p = np.inner(a, x) + b
        if (p >= 0):
            p = 1
        else:
            p = -1
        if (p == y):
            total_correct += 1
    return total_correct/np.float(len(_x))
```

In [8]:

```
#global variable
a_init = np.zeros(6)
b_init = 0
num_seasons = 50
num_steps = 300
lam = 0.001
```

In [9]:

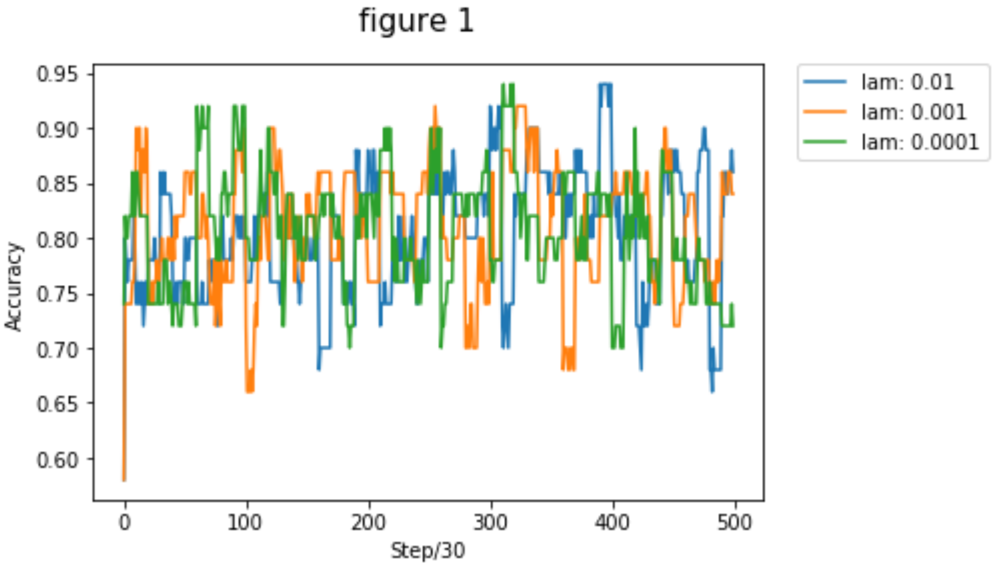
```
# Start iteration
def run(a = 1):
    a_est = a_init
    b_est = b_init

    tr = sklearn.utils.shuffle(data_train)
    x_test = tr[39560:, 0:-1]
    y_test = tr[39560:, 6]

    val_accuracy_arr = []
    val_coefficient = []
    for s in range(num_seasons):
        # Update learning rate
        l_rate = 1/(50+0.01*s)
        # Shuffle data
        tr = sklearn.utils.shuffle(tr)
        x_train = tr[50:, 0:-1]
        y_train = tr[50:, 6]
        x_hd = tr[0:50, 0:-1]
        y_hd = tr[0:50, 6]
        for k in range(num_steps):
            a_est, b_est = step(x_train, y_train, a_est, b_est, lam, l_rate)
            if (k%30 == 0):
                temp = accuracy(x_hd, y_hd, a_est, b_est)
                temp2 = np.dot(a_est, a_est)
                val_accuracy_arr.append(temp)
                val_coefficient.append(temp2)
                # print(accuracy(x_hd, y_hd, a_est, b_est))
    if (a == 0):
        print(accuracy(x_test, y_test, a_est, b_est))
    return val_accuracy_arr, val_coefficient, a_est, b_est
# print(val_accuracy_arr)
# print(accuracy(x_test, y_test, a_est, b_est))
```

In [10]:

```
ax = plt.figure()
ax.suptitle('figure 1', fontsize = 15)
a = ax.add_subplot(111)
a.set_xlabel('Step/30')
a.set_ylabel('Accuracy')
for testant in [0.01, 0.001, 0.0001]:
    lam = testant
    val_accuracy_arr, _, _, _ = run()
    a.plot(val_accuracy_arr, label="lam: " + str(testant))
a.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)
```

Out[10]:

```
<matplotlib.legend.Legend at 0x1a1a192710>
```

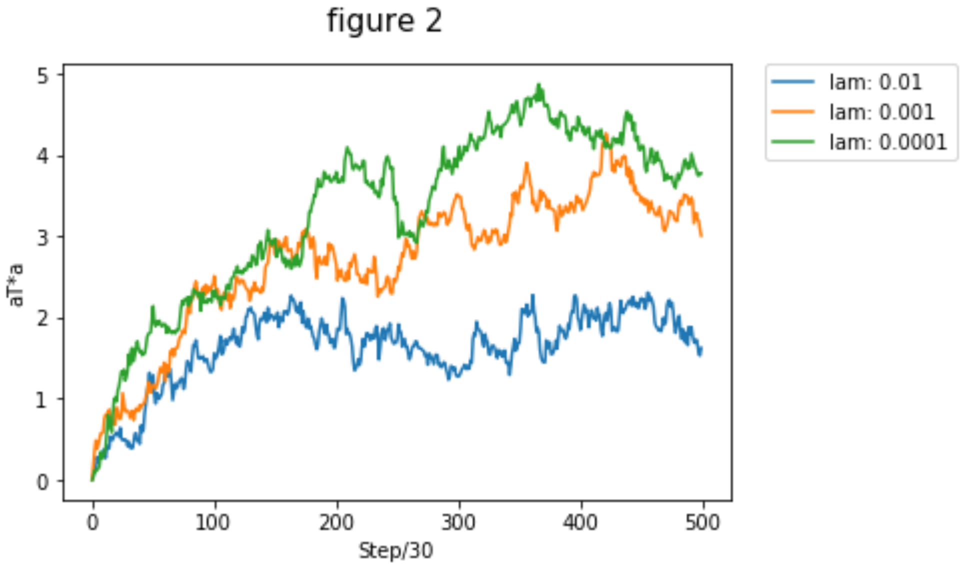


In [11]:

```
bx = plt.figure()
bx.suptitle('figure 2', fontsize = 15)
b = bx.add_subplot(111)
b.set_xlabel('Step/30')
b.set_ylabel('aT*a')
for testant in [0.01, 0.001, 0.0001]:
    lam = testant
    _, val_coefficient, _, _ = run()
    b.plot(val_coefficient, label="lam: " + str(testant))
b.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)
```

Out[11]:

```
<matplotlib.legend.Legend at 0x1a188d51d0>
```



In [12]:

```
#configure
b_init = 0
num_seasons = 50
num_steps = 300
lam = 0.001

_, _, a_est, b_est = run(0)
```

```
0.802547770700637
```