29.13.implement_SGD_1.0

August 1, 2018

1 Implement SGD on bston dataset

Dataset from sklearn load_boston

The GD is theta=theta-alpha*derivative(cost function) equ=y=wtx+b; cost = (y-wtx-b)ˆ2 determinant wrt w=> -2(y-wtx-b)x determinant wrt b => -2(y-wtx-b); in general : loss* These are in vec notation

h=np.dot(x,theta); loss=h-y; cost=np.sum(loss**2)/(2*m); gradient=np.dot(xt,loss)/m; theta=theta-alpha*gradient

2 Objective

Implement the model and compare the intercept and weights with sklearn

3 Import data and libraries and split train and test by 80:20

```
In [139]: from sklearn.datasets import load_boston
          import numpy as np
          import matplotlib.pyplot as plt

          boston = load_boston()
          print(boston.data.shape)
          boston.data[0:1]

          y=np.array(boston.target)
          x=np.array(boston.data)
          from sklearn.preprocessing import normalize, StandardScaler
          x = normalize(x, norm='l1', axis=0)
          #y = normalize(y.reshape(-1, 1), norm='l1', axis=0)
          #y=y.ravel()
          #print("shape of y",y.shape)

          x_train=x[0:450]
          x_test=x[451:505]
          y_train=y[0:450]
          y_test=y[451:505]
```

```
(506, 13)
```

4 Create my model and cost function to calculate cost

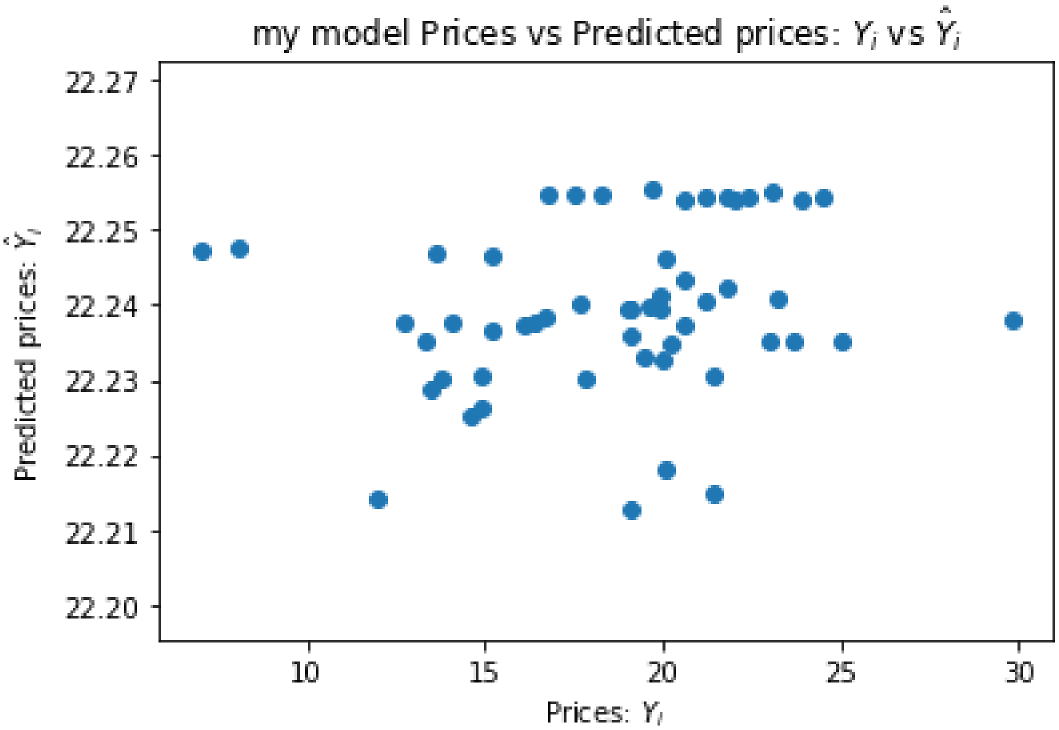
```
In [140]: # Create all functions

          #m=no of obs,n=no of features
          def grad(x,y,theta,alpha=.0001,iteration=1000,k=200):

            #for SGD
            m=x.shape[0]

            idx=np.random.randint(m,size=k)
            x=x[idx,:]
            y=np.random.choice(y,k)
            #print('for SGD new size',x.shape,y.shape)

            m,n=np.shape(x)
            xt=x.transpose()
            #print("x y, theta , m,n,shape before multiply",x.shape,y.shape,theta.shape,m,n)
            oldcost=0
            bold=0
            l=0
            thetaprev=theta
            prevalpha=alpha
            optimumcost=0
            ind=0
            for i in range(0,iteration):
               l=l+1
               h=np.dot(x,theta)
               #print("\nbefore loss h and y",h.shape,y.shape)
               loss=h-y
               #print('loss',loss)
               cost=np.sum(loss**2)/(2*k)
               #if (oldcost~=0 & cost-oldcost<20):
               #       break;
               #if change is very slow increase alpha
               b=(cost-oldcost)/oldcost
               #print("At iteration %d Cost : %f oldcost : %f alpha %f cost compare %f" %(i,co
               #if ((b>0 & bold<0) | (b<0 & bold>0)):
               if((cost>oldcost) & (oldcost>0) & (ind==0)):
                   #set optimumcost only one time
                      ind=1
                      optimumcost=oldcost
                      alpha=alpha/2
                      print("opt cost,ind",optimumcost,ind)
                      theta=thetaprev
                      print('new alpha',alpha,'cost',cost,'old cost',oldcost)
                      continue
               elif ((b>-.05) & (ind==0)):
```

```
            alpha=alpha*2
     #elif (ind==1):
     #       alpha=alpha*1.15
     #       ind=2

     gradient=np.dot(xt,loss)/k
     #print("\ngradient\n",gradient)
     theta=theta-alpha*gradient
     aa=alpha*gradient
     b=(cost-oldcost)/oldcost
     oldcost=cost
     thetaprev=theta
     prevalpha=alpha
  return theta,cost

def data(x,y,k=10):
  x=np.append(x, np.ones([x.shape[0], 1]), axis=1)  #with intercept
  #without intercept
  n1=np.shape(x)[1]

  theta=np.random.randn(n1)
  print("theta passed shaped",theta.shape,theta)
  newtheta,cost=grad(x,y,theta)
  print('coefficient of mymodel',newtheta)
  return newtheta,cost

def predictcost(x,newtheta):
    x=np.append(x, np.ones([x.shape[0], 1]), axis=1) #with intercept
    #without intercept
    y=np.dot(x,newtheta)
    return y

def cost1(y_pred,y_test):
    loss=-y_pred+y_test
    cost=np.sum(loss**2)/(2*y_test.shape[0])
    return cost
```

5 Use my model on boston data

```
In [141]: import warnings
          warnings.filterwarnings('ignore')

          import pandas as pd
          #print("train test split",x_train.shape,x_test.shape,y_train.shape,y_test.shape)
          #scale=StandardScaler(with_mean=True)
          #x_train=scale.fit_transform(x_train)
          #x_test=scale.transform(x_test)
          newtheta,cost=data(x_train,y_train)
          print("mymodel cost from the train",cost)
          #predict
          y_pred=predictcost(x_train,newtheta)
          cost=cost1(y_pred,y_train)

          y_pred=predictcost(x_test,newtheta)
          c=cost1(y_pred,y_test)

          #print(y_pred.shape,y_test.shape)
          print("my model cost from the test",c)
          aa=pd.DataFrame({'type':['mymodel'],'train_cost':[cost],'test_cost':[c],'Coeff':[new
          #print(aa)

          plt.scatter(y_test, y_pred)
          plt.xlabel("Prices: $Y_i$")
          plt.ylabel("Predicted prices: $\hat{Y}_i$")
          plt.title("my model Prices vs Predicted prices: $Y_i$ vs $\hat{Y}_i$")
          plt.show()
```

```
theta passed shaped (14,) [ 0.84181168  0.28353384 -1.65890218  0.67759257 -0.23250494  1.55153
  0.95602726 -0.60950194  1.19612826  0.36614641  0.18908912  0.16858242
  1.53765322  0.13158901]
opt cost,ind 36.6582077629 1
new alpha 1.6384 cost 36.7077999525 old cost 36.6582077629
coefficient of mymodel [ -4.30642126e+00   4.82291220e+00  -2.55874326e+00  -1.06998034e+01
  -6.13320333e-01   1.74705492e+00  -1.84281057e-03   5.26956375e-01
  -5.46160077e-01  -2.90538283e-01   2.86636557e-01   4.13640841e-01
   9.42275633e-01   2.22545481e+01]
mymodel cost from the train 36.529936717
my model cost from the test 15.2824107048
```

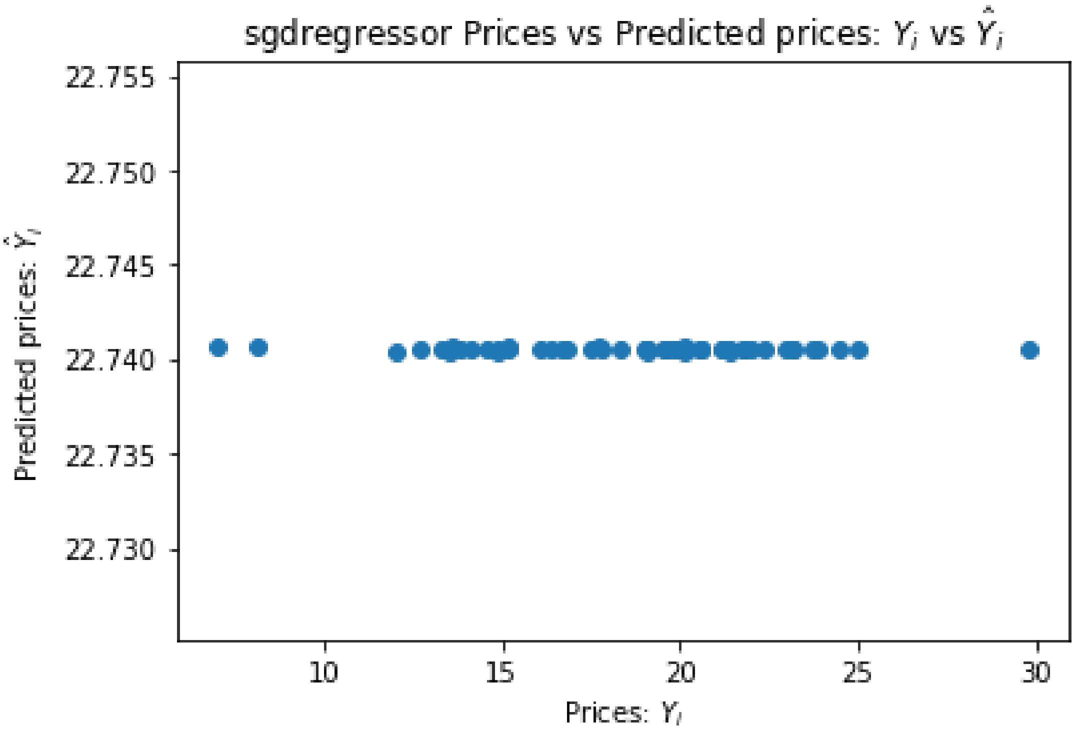


6 Use SGDREGRESSOR model on boston data

```
In [142]: import warnings
          warnings.filterwarnings('ignore')

          # Use sklearn
          import pandas as pd
          from sklearn.linear_model import SGDRegressor
          x_train=pd.DataFrame(x_train)
          x_test=pd.DataFrame(x_test)
          y_train=pd.DataFrame(y_train)
          y_test=pd.DataFrame(y_test)
          #print(x_train)
          #print(y_train)

          print(y_train.shape,y_test.shape,x_train.shape,x_test.shape)
          lm = SGDRegressor(fit_intercept=True)
          lm.fit(x_train, y_train)
          #print(lm.coef_)
          print(lm)
          #y_test.reshape(-1,1)
          #np.reshape(y_test,54)
```

```
#print(y_test.shape)
y_pred = lm.predict(x_train)
print('coefficient of sgdregressor model',lm.intercept_,lm.coef_)

#c=cost1(y_pred,y_train)
y_predtrain = lm.predict(x_train)
print("sklearn Cost from train")
print(lm.score(x_train,y_train))

#c1=cost1(y_pred,y_test)
y_predtest = lm.predict(x_test)
print("shape",y_predtrain.shape,y_train.shape)
print(type(cost1(y_predtrain.reshape(450,1),y_train)))
print("train cost :",cost1(y_predtrain.reshape(450,1),y_train)[0])

print("test cost",cost1(y_predtest.reshape(54,1),y_test)[0])
#print(y_predtrain)
#print(y_train)
#print("sklearn Cost from test",lm.score(y_predtest,y_test))
#bb=pd.DataFrame({'type':['sgdregressor'],'train_cost':[lm.score(x_train,y_train)],'
bb=pd.DataFrame({'type':['sgdregressor'],'train_cost':[cost1(y_predtrain.reshape(450
aa=aa.append(bb)

plt.scatter(y_test, y_predtest)
plt.xlabel("Prices: $Y_i$")
plt.ylabel("Predicted prices: $\hat{Y}_i$")
plt.title("sgdregressor Prices vs Predicted prices: $Y_i$ vs $\hat{Y}_i$")
plt.show()

print(aa)
```

```
(450, 1) (54, 1) (450, 13) (54, 13)
SGDRegressor(alpha=0.0001, average=False, epsilon=0.1, eta0=0.01,
       fit_intercept=True, l1_ratio=0.15, learning_rate='invscaling',
       loss='squared_loss', max_iter=None, n_iter=None, penalty='l2',
       power_t=0.25, random_state=None, shuffle=True, tol=None, verbose=0,
       warm_start=False)
coefficient of sgdregressor model [ 22.73990766] [-0.03697114  0.10995223  0.01883134  0.102066
  0.03142505  0.0571567   0.01386032  0.0279774   0.03979366  0.05169953
  0.00950983]
sklearn Cost from train
-0.000943380226666
shape (450,) (450, 1)
<class 'pandas.core.series.Series'>
train cost : 45.1897757515
test cost 17.2183729505
```

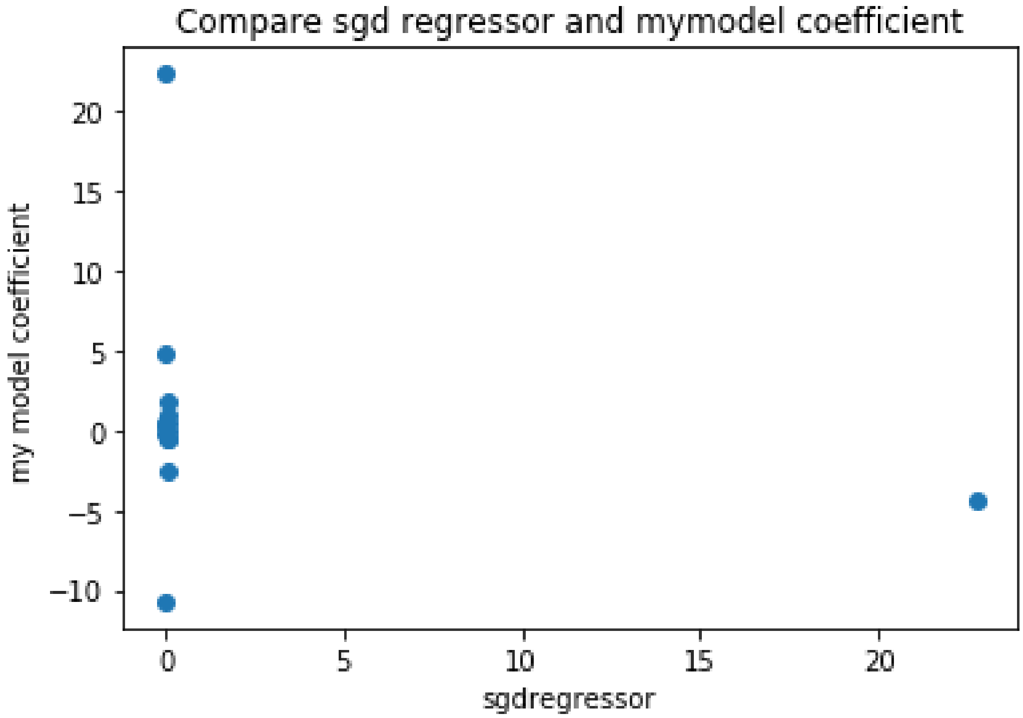


```
                                               Coeff  test_cost  train_cost  \
0  [-4.30642126306, 4.82291219613, -2.55874326256...  15.282411   45.445280
0  [-0.0369711351004, 0.109952233902, 0.018831339...  17.218373   45.189776

          type
0      mymodel
0  sgdregressor
```

7 Score comparision of mymodel and SGDregressor

```
In [143]: print('sklearn coeff',lm.intercept_,lm.coef_)
          print('mymodel theta including intercept',newtheta[0],newtheta[1:])
          x1=lm.intercept_.tolist()
          x2=lm.coef_.tolist()
          x1.extend(x2)
          y=newtheta.tolist()
          import matplotlib.pyplot as plt
          plt.title("Compare sgd regressor and mymodel coefficient")
          plt.xlabel("sgdregressor")
          plt.ylabel("my model coefficient")
          plt.scatter(np.array(x1),np.array(y))
          plt.show()
```

```
sklearn coeff [ 22.73990766] [-0.03697114  0.10995223  0.01883134  0.10206679  0.03709152  0.05
  0.03142505  0.0571567   0.01386032  0.0279774   0.03979366  0.05169953
  0.00950983]
mymodel theta including intercept -4.30642126306 [  4.82291220e+00  -2.55874326e+00  -1.069980
   1.74705492e+00  -1.84281057e-03   5.26956375e-01  -5.46160077e-01
  -2.90538283e-01   2.86636557e-01   4.13640841e-01   9.42275633e-01
   2.22545481e+01]
```



8 Observation

1. While trying learning rate of different value sometimes cost is going towards very hogh value, so tried with higher value
2. After trying more iteration cost is going down with a very small alpha value
3. sklearn model is performing better with cost close to 0 but my model cost is close to 30
4. Best cost is achieved by different trial cost function
5. theta are not changing much from initial random value (when alpha like .000005)
6. when alpha taken like .05 , gradient is becoming too high. cost function is becoming inf, theta are becoming very high
7. sklearn model is always getting global minimum but my model doesnot