In [92]:
```
import warnings
warnings.filterwarnings("ignore")
from sklearn.datasets import load_boston
from random import seed
from random import randrange
from csv import reader
from math import sqrt
from sklearn import preprocessing
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from prettytable import PrettyTable
from sklearn.linear_model import SGDRegressor
from sklearn import preprocessing
from sklearn.metrics import mean_squared_error
```

In [93]:
```
data = load_boston().data
target_data = load_boston().target
```

In [94]:
```
boston_data = pd.DataFrame(load_boston().data,columns=load_boston().fea
ture_names)
```

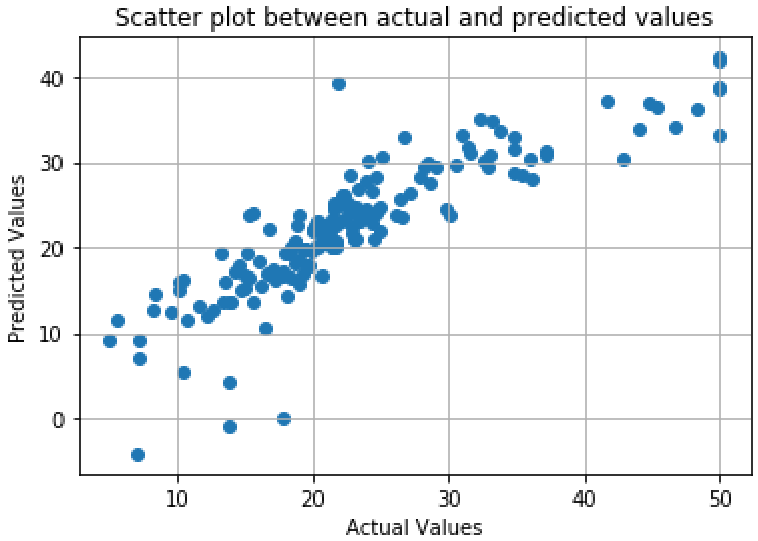
In [95]:
```
boston_data.head(5)
```

Out[95]:

	CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	RAD	TAX	PTRATIO	B
0	0.00632	18.0	2.31	0.0	0.538	6.575	65.2	4.0900	1.0	296.0	15.3	396.90
1	0.02731	0.0	7.07	0.0	0.469	6.421	78.9	4.9671	2.0	242.0	17.8	396.90
2	0.02729	0.0	7.07	0.0	0.469	7.185	61.1	4.9671	2.0	242.0	17.8	392.83
3	0.03237	0.0	2.18	0.0	0.458	6.998	45.8	6.0622	3.0	222.0	18.7	394.63
4	0.06905	0.0	2.18	0.0	0.458	7.147	54.2	6.0622	3.0	222.0	18.7	396.90

In [96]:
```
boston_data.shape
```
Out[96]:
```
(506, 13)
```
In [97]:
```
boston_data['PRICE'] = target_data

data = boston_data.drop('PRICE', axis = 1)
target = boston_data['PRICE']
```
In [98]:
```
# Data splitting

from sklearn.model_selection import train_test_split

# Splitting in train and test
X_train, X_test, y_train, y_test = train_test_split(data, target_data,
test_size=0.33)
```
In [99]:
```
# Data Standardization

scaler = preprocessing.StandardScaler().fit(X_train)

X_train = scaler.transform(X_train)
X_test = scaler.transform(X_test)
```
In [100]:
```
# shape of test and train data

print(X_train.shape)
print(X_test.shape)
print(y_train.shape)
print(y_test.shape)
```
```
(339, 13)
(167, 13)
(339,)
(167,)
```

In [101]:
```
# SGD Classifier with sklearn implementation
# https://www.kaggle.com/premvardhan/stocasticgradientdescent-implement
ation-lr-python

clf = SGDRegressor()
clf.fit(X_train, y_train)
plt.scatter(y_test, clf.predict(X_test))
plt.grid()
plt.xlabel('Actual Values')
plt.ylabel('Predicted Values')
plt.title('Scatter plot between actual and predicted values')
plt.show()
```



In [102]:
```
# MSE and MAE of sklearn implementation

from sklearn.metrics import mean_absolute_error

print('Mean Squared Error after sklearn implementation :', mean_squared
_error(y_test, clf.predict(X_test)))
print('Mean Absolute Error after sklearn implementation :', mean_absolu
te_error(y_test, clf.predict(X_test)))
```

```
Mean Squared Error after sklearn implementation : 23.191790394
Mean Absolute Error after sklearn implementation : 3.26583123241
```

In [103]:

```
# Weight of sklearn implementation

print('Weight after sklearn implementation :', clf.coef_)
```

```
Weight after sklearn implementation : [-0.52380409  0.32545145 -0.29677
791  1.02042997 -0.75370784  2.65470476
  0.05639033 -2.07758715  0.77030698 -0.44860918 -1.85116231  0.7589835
1
 -3.88445001]
```

In [104]:

```
# Defining Custom SGD Classifier

# https://www.kaggle.com/arpandas65/simple-sgd-implementation-of-linear
-regression
# https://www.kaggle.com/premvardhan/stocasticgradientdescent-implement
ation-lr-python

# SGD Regressor processor
def CustomSGD(train_data, learning_rate=0.001, n_itr=1000, k=10):

    current_weight =np.zeros(shape=(1,train_data.shape[1]-1))      # In
itializing array for weight vector
    current_intercept = 0                                           # In
itializing intercept
    current_itr = 1                                                 # in
tilaizing Iteration

    while(current_itr <= n_itr):
# Loop for all the iteration which is 1000

        old_weight = current_weight
        old_intercept = current_intercept

        temp_weight = np.zeros(shape=(1,train_data.shape[1]-1))
        temp_intercept = 0
```

```
        temp = train_data.sample(k)                                    # cr
eate k random points data Sample from train data where k = 10


        y = np.array(temp['price'])
        x = np.array(temp.drop('price',axis=1))

        for i in range(k):                                             # Lo
op through k random points

            temp_weight += x[i] * (y[i] - (np.dot(old_weight, x[i]) + o
ld_intercept)) * (-2/k)  # Calculate (dl/dw = Summation of (-2x(i) * (y
(i)-w(transpose)*x(i) - b)/ k
            temp_intercept += (y[i] - (np.dot(old_weight, x[i]) + old_i
ntercept)) * (-2/k)      # Calculate (dl/db = Summation of (-2/k) (y(i)
 - w(transpose)*x(i) - b)

        current_weight = old_weight - learning_rate * temp_weight
                         # Calculate w(next iteration) = w(previous ite
ration)-r(learning rate)(dl/dw)
        current_intercept = old_intercept - learning_rate * temp_interc
ept                      # Calculate b(next iteration) = b(previous ite
ration)-r(learning rate)(dl/db)

        if(old_weight == current_weight).all():                         #
 if previous and current values are same finalize w and b


            break

        current_itr += 1          # If previous and current values are
 different loop it untill we get the same value


    return current_weight, current_intercept

def predict(x, w, b):

    y_pred=[]
```

```
    for i in range(len(x)):

        y = np.asscalar(np.dot(w, x[i]) + b)

        y_pred.append(y)

    return np.array(y_pred)


def plot(test_data, y_pred):

    #scatter plot
    plt.scatter(test_data, y_pred)
    plt.grid()
    plt.title('scatter plot between actual and predicted value')
    plt.xlabel('actual value')
    plt.ylabel('predicted value')
    plt.show()
```

In [105]:
```
# Data splitting for custom SGD

from sklearn.model_selection import train_test_split

# Splitting in train and test
X1_train, X1_test, y1_train, y1_test = train_test_split(data, target_da
ta, test_size=0.33)

# Splitting in Train Test and Cross Validation
X1_train, X1_cv, y1_train, y1_cv = train_test_split(X1_train, y1_train,
 test_size=0.33)
```

In [106]:
```
# Data Standardization for custom SGD
X1_train = scaler.transform(X1_train)
X1_cv=scaler.transform(X1_cv)

X1_train=np.array(X1_train)
```

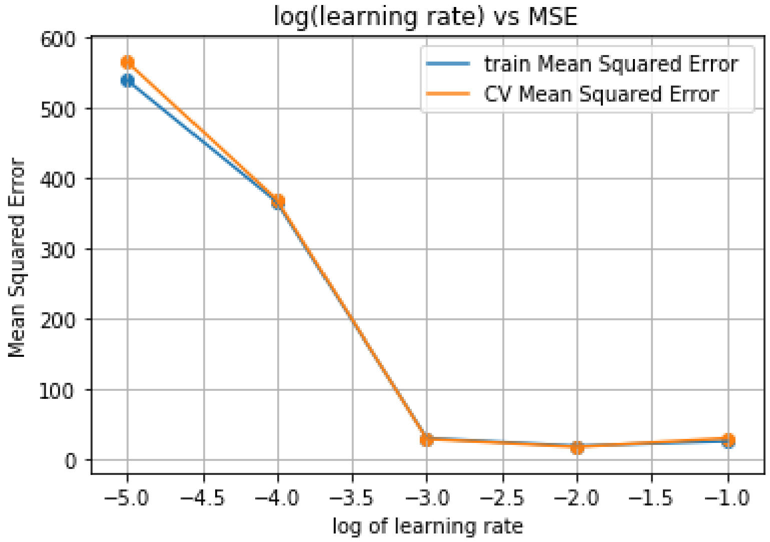
```
X1_train_data=pd.DataFrame(X1_train)
X1_train_data['price']=y1_train

X1_cv_data=pd.DataFrame(X1_cv)
X1_cv_data['price']=y1_cv

y1_train_=np.array(y1_train)
y1_cv=np.array(y1_cv)
```

In [107]:
```
def tuneParams_learning_rate():

    train_error = []
    cv_error = []
    r = [0.00001, 0.0001, 0.001, 0.01, 0.1]

    for itr in r:

        w, b = CustomSGD(X1_train_data, learning_rate = itr, n_itr = 10
00)
        y1_pred_train = predict(X1_train, w, b)
        train_error.append(mean_squared_error(y1_train, y1_pred_train))

        w, b = CustomSGD(X1_cv_data, learning_rate = itr, n_itr = 1000)
        y1_pred_cv = predict(X1_cv, w, b)
        cv_error.append(mean_squared_error(y1_cv, y1_pred_cv))

    return train_error,cv_error
```

In [108]:
```
train_error,cv_error=tuneParams_learning_rate()
```

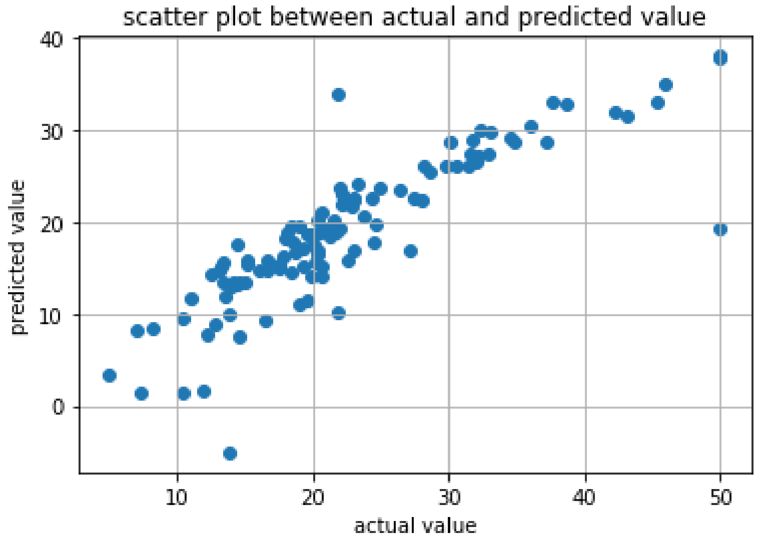
In [109]:
```
# plotting obtained values

import math
r = [0.00001,0.0001,0.001,0.01,0.1]

x1 = [math.log10(i) for i in r]

plt.plot(x1,train_error,label='train Mean Squared Error ')
```

```
plt.plot(x1,cv_error,label='CV Mean Squared Error')
plt.scatter(x1,train_error)
plt.scatter(x1,cv_error)
plt.legend()
plt.xlabel('log of learning rate')
plt.ylabel('Mean Squared Error')
plt.title('log(learning rate) vs MSE')
plt.grid()
plt.show()
```



In [110]:

```
# running implemented SGD Classifier with obtained optimal learning rat
e

w,b = CustomSGD(X1_train_data,learning_rate=0.001,n_itr=1000)
y_pred=predict(X1_cv, w, b)
plot(y1_cv, y_pred)
```



In [111]:
```
# Errors in implemeted model

print('Mean Squared Error after sklearn implementation :', mean_squared
_error(y1_cv,y_pred))
print('Mean Absolute Error after sklearn implementation :', mean_absolu
te_error(y1_cv,y_pred))
```

```
Mean Squared Error after sklearn implementation : 35.5011353896
Mean Absolute Error after sklearn implementation : 4.09106210882
```

In [112]:
```
# Weight of implemented model

print('Weight after custom implementation :', w)
```

```
Weight after custom implementation : [[-0.25636454  0.16867572 -0.02128
325  0.57903203 -0.08315041  3.04927617
  -0.08005042 -0.86034177 -0.39381752 -1.01818641 -0.93491511  0.161907
89
  -3.29345498]]
```

In [113]:
```
# Comparing MSE and MAE of custom and Sklearn models

from prettytable import PrettyTable

prettytable = PrettyTable()

prettytable.field_names=['SGD Implementation type', 'Mean Squared Erro
r','Mean Absolute Error']

prettytable.add_row(['Custom', mean_squared_error(y1_cv,y_pred), mean_a
bsolute_error(y1_cv,y_pred)])
prettytable.add_row(['Sklearn', mean_squared_error(y_test, clf.predict(
X_test)), mean_absolute_error(y_test, clf.predict(X_test))])

print(prettytable)
```

```
+-------------------------+--------------------+---------------------+
| SGD Implementation type | Mean Squared Error | Mean Absolute Error |
+-------------------------+--------------------+---------------------+
|          Custom         |   35.5011353896    |    4.09106210882    |
|         Sklearn         |    23.191790394    |    3.26583123241    |
+-------------------------+--------------------+---------------------+
```

In [114]:
```
# Comparing weight vector of custom and Sklearn models

from prettytable import PrettyTable

prettytable = PrettyTable()

prettytable.field_names=['SGD Implementation type', 'Weight Vector']

prettytable.add_row(['Custom', w])
prettytable.add_row(['Sklearn', clf.coef_])

print(prettytable)
```

```
+-------------------------+------------------------------------------
-------------------------------+
| SGD Implementation type |                                Weight Vector
                               |
```

```
+-------------------------+-------------------------------------------
------------------------------+
|          Custom         | [[-0.25636454  0.16867572 -0.02128325  0.57
903203 -0.08315041  3.04927617 |
|                         |   -0.08005042 -0.86034177 -0.39381752 -1.01
818641 -0.93491511  0.16190789 |
|                         |                                -3.2934549
8]]                             |
|         Sklearn         |  [-0.52380409  0.32545145 -0.29677791  1.02
042997 -0.75370784  2.65470476 |
|                         |    0.05639033 -2.07758715  0.77030698 -0.44
860918 -1.85116231  0.75898351 |
|                         |                                -3.88445001]
                               |
+-------------------------+-------------------------------------------
------------------------------+
```