In [0]:

```
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 [0]:

```
X = load_boston().data
Y = load_boston().target
```

In [0]:

```
scaler = preprocessing.StandardScaler().fit(X)
X = scaler.transform(X)
```

In [12]:

```
clf = SGDRegressor()
clf.fit(X, Y)
print(mean_squared_error(Y, clf.predict(X)))
```

```
22.713026681360155
```

Assignment 6: Implement SGD for linear regression

Objective:

To implement Manual stochastic gradient descent(SGD) for linear Regression and implementing SKLEARN's SGD Regression on Bostan House Prices dataset and Comparing the results of both Manual SGD and Sklearn's SGD

In [58]:

```
import warnings
warnings.filterwarnings('ignore')
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import math
from math import sqrt
from sklearn import preprocessing
from random import randrange
from sklearn.datasets import load_boston
from sklearn.model_selection import train_test_split
from sklearn.model_selection import learning_curve
from sklearn.model_selection import ShuffleSplit
from sklearn.linear_model import LinearRegression
from sklearn.linear_model import SGDRegressor
from sklearn.utils.extmath import safe_sparse_dot
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import mean_squared_error , r2_score
```

1.Loading the boston dataset

In [59]:

```
import numpy as np
import pandas as pd

from sklearn.datasets import load_boston
boston = load_boston()


print(boston.data.shape)
```

```
(506, 13)
```

In [63]:

```
print(boston.feature_names)
```

```
['CRIM' 'ZN' 'INDUS' 'CHAS' 'NOX' 'RM' 'AGE' 'DIS' 'RAD' 'TAX' 'PTRATIO'
 'B' 'LSTAT']
```

In [64]:

```
print(boston.target.shape)
```

```
(506,)
```

In [65]:

```
print(boston.target)
```

```
[24.  21.6 34.7 33.4 36.2 28.7 22.9 27.1 16.5 18.9 15.  18.9 21.7 20.4
 18.2 19.9 23.1 17.5 20.2 18.2 13.6 19.6 15.2 14.5 15.6 13.9 16.6 14.8
 18.4 21.  12.7 14.5 13.2 13.1 13.5 18.9 20.  21.  24.7 30.8 34.9 26.6
 25.3 24.7 21.2 19.3 20.  16.6 14.4 19.4 19.7 20.5 25.  23.4 18.9 35.4
 24.7 31.6 23.3 19.6 18.7 16.  22.2 25.  33.  23.5 19.4 22.  17.4 20.9
 24.2 21.7 22.8 23.4 24.1 21.4 20.  20.8 21.2 20.3 28.  23.9 24.8 22.9
 23.9 26.6 22.5 22.2 23.6 28.7 22.6 22.  22.9 25.  20.6 28.4 21.4 38.7
 43.8 33.2 27.5 26.5 18.6 19.3 20.1 19.5 19.5 20.4 19.8 19.4 21.7 22.8
 18.8 18.7 18.5 18.3 21.2 19.2 20.4 19.3 22.  20.3 20.5 17.3 18.8 21.4
 15.7 16.2 18.  14.3 19.2 19.6 23.  18.4 15.6 18.1 17.4 17.1 13.3 17.8
 14.  14.4 13.4 15.6 11.8 13.8 15.6 14.6 17.8 15.4 21.5 19.6 15.3 19.4
 17.  15.6 13.1 41.3 24.3 23.3 27.  50.  50.  50.  22.7 25.  50.  23.8
 23.8 22.3 17.4 19.1 23.1 23.6 22.6 29.4 23.2 24.6 29.9 37.2 39.8 36.2
 37.9 32.5 26.4 29.6 50.  32.  29.8 34.9 37.  30.5 36.4 31.1 29.1 50.
 33.3 30.3 34.6 34.9 32.9 24.1 42.3 48.5 50.  22.6 24.4 22.5 24.4 20.
 21.7 19.3 22.4 28.1 23.7 25.  23.3 28.7 21.5 23.  26.7 21.7 27.5 30.1
 44.8 50.  37.6 31.6 46.7 31.5 24.3 31.7 41.7 48.3 29.  24.  25.1 31.5
 23.7 23.3 22.  20.1 22.2 23.7 17.6 18.5 24.3 20.5 24.5 26.2 24.4 24.8
 29.6 42.8 21.9 20.9 44.  50.  36.  30.1 33.8 43.1 48.8 31.  36.5 22.8
 30.7 50.  43.5 20.7 21.1 25.2 24.4 35.2 32.4 32.  33.2 33.1 29.1 35.1
 45.4 35.4 46.  50.  32.2 22.  20.1 23.2 22.3 24.8 28.5 37.3 27.9 23.9
 21.7 28.6 27.1 20.3 22.5 29.  24.8 22.  26.4 33.1 36.1 28.4 33.4 28.2
 22.8 20.3 16.1 22.1 19.4 21.6 23.8 16.2 17.8 19.8 23.1 21.  23.8 23.1
 20.4 18.5 25.  24.6 23.  22.2 19.3 22.6 19.8 17.1 19.4 22.2 20.7 21.1
 19.5 18.5 20.6 19.  18.7 32.7 16.5 23.9 31.2 17.5 17.2 23.1 24.5 26.6
 22.9 24.1 18.6 30.1 18.2 20.6 17.8 21.7 22.7 22.6 25.  19.9 20.8 16.8
 21.9 27.5 21.9 23.1 50.  50.  50.  50.  50.  13.8 13.8 15.  13.9 13.3
 13.1 10.2 10.4 10.9 11.3 12.3  8.8  7.2 10.5  7.4 10.2 11.5 15.1 23.2
  9.7 13.8 12.7 13.1 12.5  8.5  5.   6.3  5.6  7.2 12.1  8.3  8.5  5.
 11.9 27.9 17.2 27.5 15.  17.2 17.9 16.3  7.   7.2  7.5 10.4  8.8  8.4
 16.7 14.2 20.8 13.4 11.7  8.3 10.2 10.9 11.   9.5 14.5 14.1 16.1 14.3
 11.7 13.4  9.6  8.7  8.4 12.8 10.5 17.1 18.4 15.4 10.8 11.8 14.9 12.6
 14.1 13.  13.4 15.2 16.1 17.8 14.9 14.1 12.7 13.5 14.9 20.  16.4 17.7
 19.5 20.2 21.4 19.9 19.  19.1 19.1 20.1 19.9 19.6 23.2 29.8 13.8 13.3
 16.7 12.  14.6 21.4 23.  23.7 25.  21.8 20.6 21.2 19.1 20.6 15.2  7.
  8.1 13.6 20.1 21.8 24.5 23.1 19.7 18.3 21.2 17.5 16.8 22.4 20.6 23.9
 22.  11.9]
```

```
22.  11.9]
```

In [66]:

```python
print(boston.DESCR)
```

```
.. _boston_dataset:

Boston house prices dataset
---------------------------

**Data Set Characteristics:**

    :Number of Instances: 506

    :Number of Attributes: 13 numeric/categorical predictive. Median Value (attribute 14) is usually the target.

    :Attribute Information (in order):
        - CRIM     per capita crime rate by town
        - ZN       proportion of residential land zoned for lots over 25,000 sq.ft.
        - INDUS    proportion of non-retail business acres per town
        - CHAS     Charles River dummy variable (= 1 if tract bounds river; 0 otherwise)
        - NOX      nitric oxides concentration (parts per 10 million)
        - RM       average number of rooms per dwelling
        - AGE      proportion of owner-occupied units built prior to 1940
        - DIS      weighted distances to five Boston employment centres
        - RAD      index of accessibility to radial highways
        - TAX      full-value property-tax rate per $10,000
        - PTRATIO  pupil-teacher ratio by town
        - B        1000(Bk - 0.63)^2 where Bk is the proportion of blacks by town
        - LSTAT    % lower status of the population
        - MEDV     Median value of owner-occupied homes in $1000's

    :Missing Attribute Values: None

    :Creator: Harrison, D. and Rubinfeld, D.L.

This is a copy of UCI ML housing dataset.
https://archive.ics.uci.edu/ml/machine-learning-databases/housing/


This dataset was taken from the StatLib library which is maintained at Carnegie Mellon University.

The Boston house-price data of Harrison, D. and Rubinfeld, D.L. 'Hedonic
prices and the demand for clean air', J. Environ. Economics & Management,
vol.5, 81-102, 1978.   Used in Belsley, Kuh & Welsch, 'Regression diagnostics
...', Wiley, 1980.   N.B. Various transformations are used in the table on
pages 244-261 of the latter.

The Boston house-price data has been used in many machine learning papers that address regression problems.

.. topic:: References

   - Belsley, Kuh & Welsch, 'Regression diagnostics: Identifying Influential Data and Sources of Collinearity', Wiley, 1980. 244-261.
   - Quinlan,R. (1993). Combining Instance-Based and Model-Based Learning. In Proceedings on the Tenth International Conference of Machine Learning, 236-243, University of Massachusetts, Amherst. Morgan Kaufmann.
```

1.1 Splitting the dataset into train-data and test-data

In [67]:

```python
feature_data=pd.DataFrame(data=boston.data)
target_price=boston.target
X_train, X_test, Y_train, Y_test=train_test_split(feature_data, target_price, test_size=0.3, random_state=5)
```

1.2 Applying column standardization on train and test data

In [68]:

```
ss=StandardScaler()
X_train=ss.fit_transform(np.array(X_train))
X_test=ss.transform(np.array(X_test))
```

In [69]:

```
manual_sgd=pd.DataFrame(data=X_train)
manual_sgd['price']=Y_train
```

In [70]:

```
X_test=np.array(X_test)
Y_test=np.array(Y_test)
```

In [71]:

```
diff=[]
num=[]
```

Set 1: Manual SGD and SGDRegressor for iteration=1000, learning rate=0.01 and batch_size=10

In [ ]:

```
# A) Implementing Manual SGD on LINEAR REGRESSION
```

In [72]:

```
import seaborn as sns
import numpy as np
from sklearn.linear_model import SGDRegressor
from sklearn.metrics import mean_squared_error
import matplotlib.pyplot as plt
%matplotlib inline
```

In [96]:

```
#https://scikit-learn.org/stable/modules/generated/sklearn.linear_model.SGDClassifier.html
#https://stackoverflow.com/questions/48843721/python-gd-and-sgd-implementation-on-linear-regressio
n
def manual_fit(X, lr_rate_variation, alpha=0.0001, lr_rate=0.01, power_t=0.25, n_iter=1000):
    a=np.zeros(shape=(1,13))
    b=0
    t=1
    r=lr_rate

    while(t<=n_iter):
        a_1=a
        b_1=b
        a_=np.zeros(shape=(1,13))
        b_=0
        x_data=X.sample(10)
        x=np.array(x_data.drop('price',axis=1))
        y=np.array(x_data['price'])


        for i in range(10):
            y_curr=np.dot(a_1,x[i])+b_1
            a_+=x[i] * (y[i] - y_curr)
            b_+=(y[i]-y_curr)

        a_*=(-2/x.shape[0])
        b_*=(-2/x.shape[0])
```

```
        a=(a_1-r*a_)
        b=(b_1-r*b_)

        if(lr_rate_variation=='invscaling'):
            r = lr_rate / pow(t, power_t)
        t+=1

    return a,b
```

In [98]:

```
def pred(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)

#https://scikit-learn.org/stable/modules/generated/sklearn.linear_model.SGDClassifier.html
#https://www.m-asim.com/2018/10/19/how-to-implement-linear-regression-with-stochastic-gradient-des
cent-from-scratch-with-python/
def plot_(X_test,y_pred):

    plt.scatter(Y_test,y_pred)
    plt.grid(b=True, linewidth=0.3)
    plt.title("Actual Prices vs Predicted Prices: $Y_i$ vs $\hat{Y}_i$",size=18)
    plt.xlabel("Actual Prices: $Y_i$",size=14)
    plt.ylabel("Predicted prices: $\hat{Y}_i$",size=14)
    plt.show()
    print('*******************************************************************')



    manual_sgd_predictions=mean_squared_error(Y_test,y_pred)
    print('Mean Squared Error for SGD  is=', manual_sgd_predictions)

    return manual_sgd_predictions
```

B) Actual Prices vs Predicted Prices - Manual SGD

In [99]:

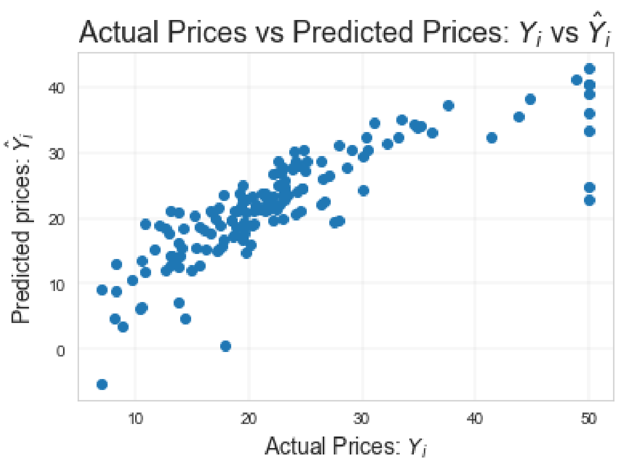
```
w, b=manual_fit(X=manual_sgd, lr_rate_variation='constant' , n_iter=1000)
```

In [100]:

```
y_pred=pred(X_test, w=w, b=b)
```

In [101]:

```
manual_sgd_predictions=plot_(X_test,y_pred)
```

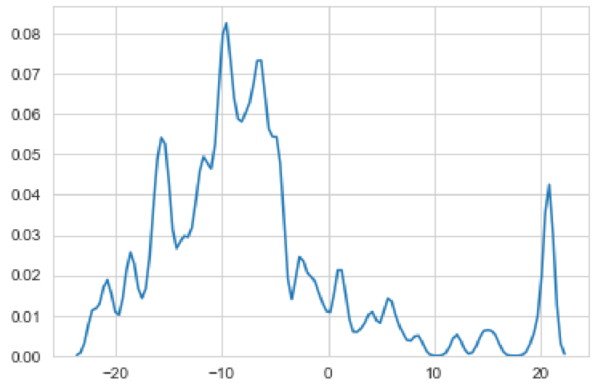


```
****************************************************************
Mean Squared Error for SGD  is= 29.190348582305024
```

C) Delta calculation

In [102]:

```
delta_y = Y_test - manual_sgd_predictions;

import seaborn as sns;
import numpy as np;
sns.set_style('whitegrid')
sns.kdeplot(np.array(delta_y), bw=0.5)
plt.show()
```



In [19]:

```
print('manual sgd weight---\n',w)
```

```
manual sgd weight---
 [[-1.26180209  0.97661208 -0.46747528  0.03543625 -1.47907354  2.24727871
  -0.20324435 -2.66972307  2.21848987 -1.60168014 -2.06784397  0.95997343
  -3.31828759]]
```

2. SKLEARN's SGD

In [ ]:

```
# A) Implementing SKLEARN's SGD Regression
```

In [20]:

```
def sklearn_sgd(alpha, lr_rate_variation, eta0=0.01, power_t=0.25, n_iter=1000, X_train=X_train, X_
test=X_test, Y_train=Y_train, Y_test=Y_test):
    clf=SGDRegressor(alpha=alpha, penalty=None, learning_rate=lr_rate_variation, eta0=eta0, power_t
=power_t, n_iter=n_iter)
    clf.fit(X_train, Y_train)
    y_pred=clf.predict(X_test)

    #https://scikit-learn.org/stable/modules/generated/sklearn.linear_model.SGDClassifier.html
    plt.scatter(Y_test,y_pred)
    plt.title("Actual Prices vs Predicted Prices: $Y_i$ vs $\hat{Y}_i$",size=18)
    plt.xlabel("Actual Prices: $Y_i$",size=14)
    plt.ylabel("Predicted prices: $\hat{Y}_i$",size=14)
    plt.grid(b=True, linewidth=0.5)
    plt.show()
    print('****************************************************************')



    sklearn_sgd_predictions=mean_squared_error(Y_test,y_pred)
```

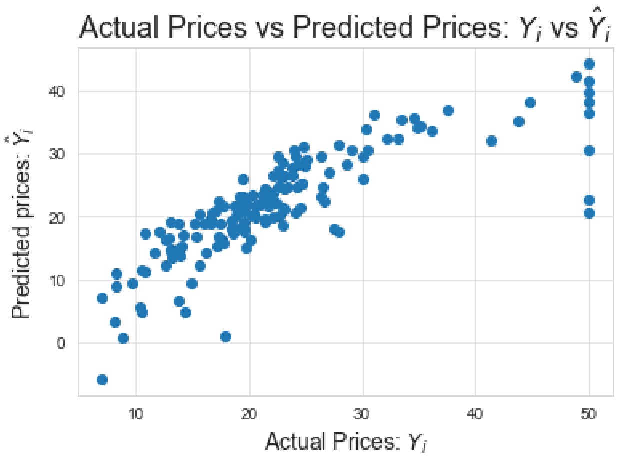
```
    sklearn_sgd_predictions=mean_squared_error(Y_test,y_pred)
    print('Mean Squared Error for sklearn SGD  is=', sklearn_sgd_predictions)
    return clf.coef_, clf.intercept_, sklearn_sgd_predictions
```

B) Actual Prices vs Predicted Prices - Sklearn's SGD

In [21]:

```
w_sgd, b_sgd, sklearn_sgd_predictions=sklearn_sgd(alpha=0.0001, lr_rate_variation='constant', eta0=
0.01, n_iter=1000)
```

```
C:\Users\myuri\Anaconda3\lib\site-packages\sklearn\linear_model\stochastic_gradient.py:152:
DeprecationWarning: n_iter parameter is deprecated in 0.19 and will be removed in 0.21. Use
max_iter and tol instead.
  DeprecationWarning)
```




```
************************************************************
Mean Squared Error for sklearn SGD  is= 31.723818064357136
```

In [22]:

```
print('sklearn sgd weight---\n',w_sgd)
```

```
sklearn sgd weight---
 [-1.4482362   0.96933109 -0.36207034  0.37129718 -1.40204542  2.793824
 -0.38061007 -2.83415396  2.62028983 -2.42494435 -2.33486942  0.87483608
 -2.84720086]
```

Set 2: Manual SGD and SGDRegressor for iteration=100,learning rate=0.01 and batch_size=10

1.Manual SGD

In [ ]:

```
# A) Implementing Manual SGD on LINEAR REGRESSION
```

In [23]:

```
def manual_fit(X, lr_rate_variation, alpha=0.0001, lr_rate=0.01, power_t=0.25, n_iter=100):
    a=np.zeros(shape=(1,13))
    b=0
    t=1
    r=lr_rate

    while(t<=n_iter):
        a_1=a
```

```
        b_1=b
        a_=np.zeros(shape=(1,13))
        b_=0
        x_data=X.sample(10)
        x=np.array(x_data.drop('price',axis=1))
        y=np.array(x_data['price'])


        for i in range(10):
            y_curr=np.dot(a_1,x[i])+b_1
            a_+=x[i] * (y[i] - y_curr)
            b_+=(y[i]-y_curr)


        a_*=(-2/x.shape[0])
        b_*=(-2/x.shape[0])


        a=(a_1-r*a_)
        b=(b_1-r*b_)


        if(lr_rate_variation=='invscaling'):
            r = lr_rate / pow(t, power_t)
        t+=1

    return a,b
```

In [24]:

```
# https://scikit-learn.org/stable/modules/generated/sklearn.linear_model.SGDClassifier.html
def pred(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_(X_test,y_pred):
    #scatter plot
    plt.scatter(Y_test,y_pred)
    plt.grid(b=True, linewidth=0.3)
    plt.title("Actual Prices vs Predicted Prices: $Y_i$ vs $\hat{Y}_i$",size=18)
    plt.xlabel("Actual Prices: $Y_i$",size=14)
    plt.ylabel("Predicted prices: $\hat{Y}_i$",size=14)
    plt.show()
    print('****************************************************************')



    manual_sgd_predictions=mean_squared_error(Y_test,y_pred)
    print('Mean Squared Error for SGD  is=', manual_sgd_predictions)

    return manual_sgd_predictions
```

B) Actual Prices vs Predicted Prices - Manual SGD

In [25]:

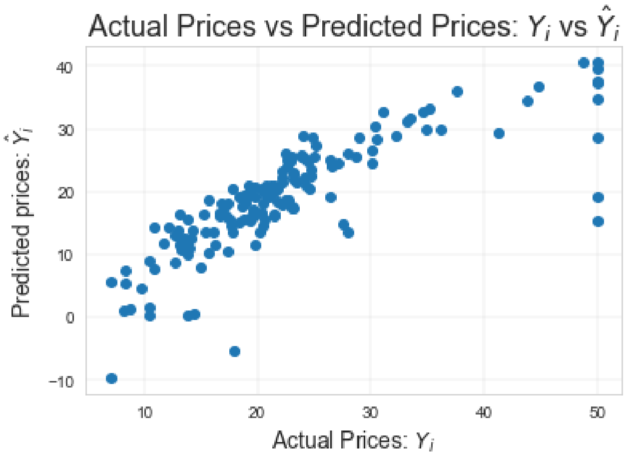
```
w, b=manual_fit(X=manual_sgd, lr_rate_variation='constant' , n_iter=100)
```

In [26]:

```
y_pred=pred(X_test, w=w, b=b)
```

In [27]:

```
manual_sgd_predictions=plot_(X_test,y_pred)
```

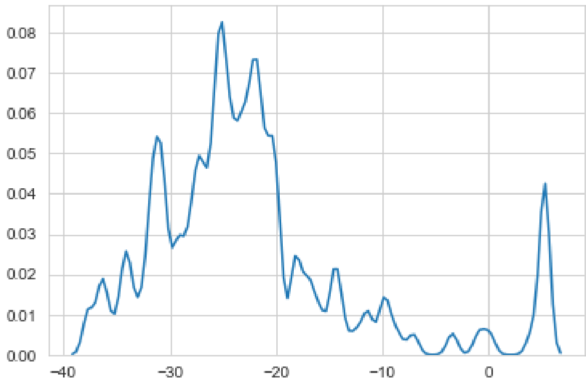



```
************************************************************
Mean Squared Error for SGD  is= 44.68717378241439
```

C) Delta calculation

In [28]:

```
delta_y = Y_test - manual_sgd_predictions;

import seaborn as sns;
import numpy as np;
sns.set_style('whitegrid')
sns.kdeplot(np.array(delta_y), bw=0.5)
plt.show()
```



In [29]:

```
print('manual sgd weight---\n',w)
```

```
manual sgd weight---
 [[-0.87219783  0.09280404 -1.07240255  0.5372507  -0.48505819  3.62350434
   0.11505545 -1.31915466  0.48481747 -0.63682064 -1.75182607  0.90823022
  -3.21287437]]
```

2. SKLEARN's SGD

A) Implementing SKLEARN's SGD Regression

In [30]:

```
def sklearn_sgd(alpha, lr_rate_variation, eta0=0.01, power_t=0.25, n_iter=100, X_train=X_train, X_t
est=X_test, Y_train=Y_train, Y_test=Y_test):
    clf=SGDRegressor(alpha=alpha, penalty=None, learning_rate=lr_rate_variation, eta0=eta0, power_t
```

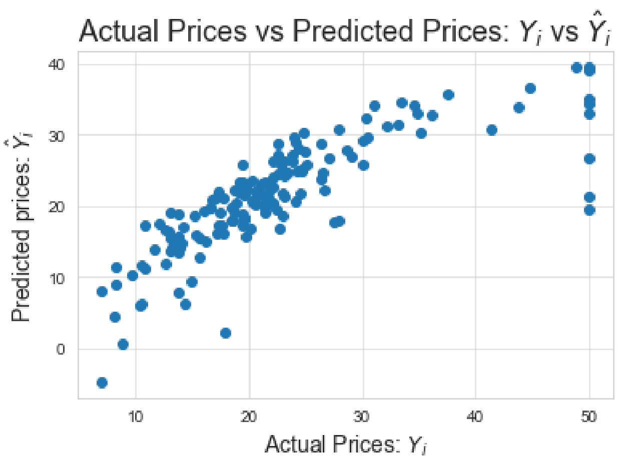
```
=power_t, n_iter=n_iter)
    clf.fit(X_train, Y_train)
    y_pred=clf.predict(X_test)


    plt.scatter(Y_test,y_pred)
    plt.title("Actual Prices vs Predicted Prices: $Y_i$ vs $\hat{Y}_i$",size=18)
    plt.xlabel("Actual Prices: $Y_i$",size=14)
    plt.ylabel("Predicted prices: $\hat{Y}_i$",size=14)
    plt.grid(b=True, linewidth=0.5)
    plt.show()
    print('************************************************************')



    sklearn_sgd_predictions=mean_squared_error(Y_test,y_pred)
    print('Mean Squared Error for sklearn SGD  is=', sklearn_sgd_predictions)
    return clf.coef_, clf.intercept_, sklearn_sgd_predictions
```

B) Actual Prices vs Predicted Prices - Sklearn's SGD

In [31]:

```
w_sgd, b_sgd, sklearn_sgd_predictions=sklearn_sgd(alpha=0.0001, lr_rate_variation='constant', eta0=
0.01, n_iter=100)
```

```
C:\Users\myuri\Anaconda3\lib\site-packages\sklearn\linear_model\stochastic_gradient.py:152:
DeprecationWarning: n_iter parameter is deprecated in 0.19 and will be removed in 0.21. Use
max_iter and tol instead.
  DeprecationWarning)
```




```
************************************************************
Mean Squared Error for sklearn SGD  is= 35.9310287384534
```

In [32]:

```
print('sklearn sgd weight---\n',w_sgd)
```

```
sklearn sgd weight---
 [-1.46650869  0.85241943 -0.34573313 -0.36656426 -1.721017    2.33378017
 -0.18405754 -2.62373484  2.636995   -2.40623034 -2.02920351  0.97542525
 -2.70858207]
```

Set 3: Manual SGD and SGDRegressor for iteration=10000,learning rate=0.01 and batch_size=20

In [ ]:

```
#1 Manual SGD
```

```
#1.Manual SGD
```

In [ ]:

```
#A) Implementing Manual SGD on LINEAR REGRESSION
```

In [33]:

```
def manual_fit(X, lr_rate_variation, alpha=0.0001, lr_rate=0.01, power_t=0.25, n_iter=10000):
    a=np.zeros(shape=(1,13))
    b=0
    t=1
    r=lr_rate

    while(t<=n_iter):
        a_1=a
        b_1=b
        a_=np.zeros(shape=(1,13))
        b_=0
        x_data=X.sample(20)
        x=np.array(x_data.drop('price',axis=1))
        y=np.array(x_data['price'])


        for i in range(10):
            y_curr=np.dot(a_1,x[i])+b_1
            a_+=x[i] * (y[i] - y_curr)
            b_+=(y[i]-y_curr)


        a_*=(-2/x.shape[0])
        b_*=(-2/x.shape[0])


        a=(a_1-r*a_)
        b=(b_1-r*b_)


        if(lr_rate_variation=='invscaling'):
            r = lr_rate / pow(t, power_t)
        t+=1

    return a,b
```

In [34]:

```
def pred(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_(X_test,y_pred):
    #scatter plot
    plt.scatter(Y_test,y_pred)
    plt.grid(b=True, linewidth=0.3)
    plt.title("Actual Prices vs Predicted Prices: $Y_i$ vs $\hat{Y}_i$",size=18)
    plt.xlabel("Actual Prices: $Y_i$",size=14)
    plt.ylabel("Predicted prices: $\hat{Y}_i$",size=14)
    plt.show()
    print('*****************************************************************')



    manual_sgd_predictions=mean_squared_error(Y_test,y_pred)
    print('Mean Squared Error for SGD  is=', manual_sgd_predictions)

    return manual_sgd_predictions
```

B) Actual Prices vs Predicted Prices - Manual SGD

In [35]:

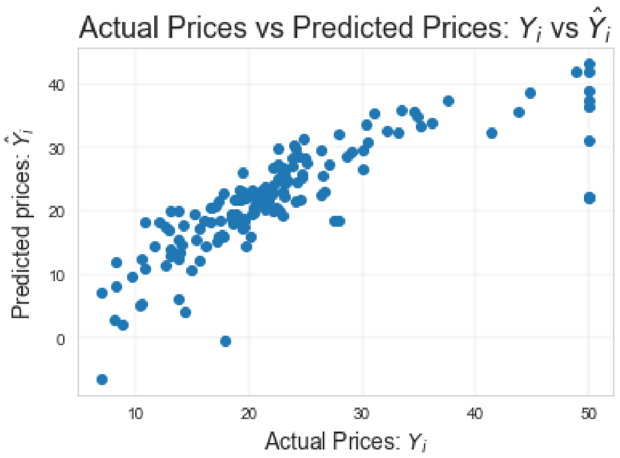
```
w, b=manual_fit(X=manual_sgd, lr_rate_variation='constant' , n_iter=10000)
```

In [36]:

```
y_pred=pred(X_test, w=w, b=b)
```

In [37]:

```
manual_sgd_predictions=plot_(X_test,y_pred)
```

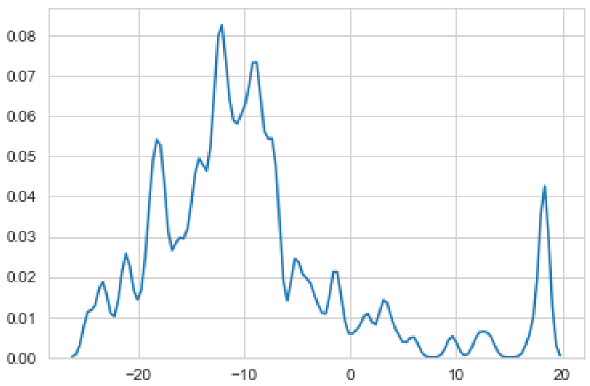



```
************************************************************************
Mean Squared Error for SGD  is= 31.720432090621838
```

C) Delta calculation

In [38]:

```
delta_y = Y_test - manual_sgd_predictions;

import seaborn as sns;
import numpy as np;
sns.set_style('whitegrid')
sns.kdeplot(np.array(delta_y), bw=0.5)
plt.show()
```



In [39]:

```
print('manual sgd weight---\n',w)
```

```
manual sgd weight---
 [[-1.19805521  1.07186743 -0.18415063  0.03677539 -1.5120233   2.89647951
```

```
 -0.42811747 -2.79927493  2.72217074 -2.13396224 -2.0969396   1.22362042
 -3.31214515]]
```

2. SKLEARN's SGD

In [ ]:

```
A) Implementing SKLEARN's SGD Regression
```

In [40]:

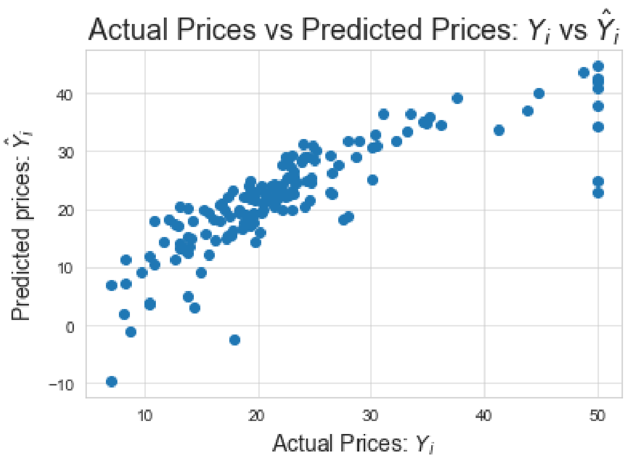
```
def sklearn_sgd(alpha, lr_rate_variation, eta0=0.01, power_t=0.25, n_iter=10000, X_train=X_train, X_test=X_test, Y_train=Y_train, Y_test=Y_test):
    clf=SGDRegressor(alpha=alpha, penalty=None, learning_rate=lr_rate_variation, eta0=eta0, power_t=power_t, n_iter=n_iter)
    clf.fit(X_train, Y_train)
    y_pred=clf.predict(X_test)


    plt.scatter(Y_test,y_pred)
    plt.title("Actual Prices vs Predicted Prices: $Y_i$ vs $\hat{Y}_i$",size=18)
    plt.xlabel("Actual Prices: $Y_i$",size=14)
    plt.ylabel("Predicted prices: $\hat{Y}_i$",size=14)
    plt.grid(b=True, linewidth=0.5)
    plt.show()
    print('*****************************************************************')



    sklearn_sgd_predictions=mean_squared_error(Y_test,y_pred)
    print('Mean Squared Error for sklearn SGD  is=', sklearn_sgd_predictions)
    return clf.coef_, clf.intercept_, sklearn_sgd_predictions
```

B) Actual Prices vs Predicted Prices - Sklearn's SGD

In [41]:

```
w_sgd, b_sgd, sklearn_sgd_predictions=sklearn_sgd(alpha=0.0001, lr_rate_variation='constant', eta0=0.01, n_iter=10000)
```

```
C:\Users\myuri\Anaconda3\lib\site-packages\sklearn\linear_model\stochastic_gradient.py:152:
DeprecationWarning: n_iter parameter is deprecated in 0.19 and will be removed in 0.21. Use
max_iter and tol instead.
  DeprecationWarning)
```




```
*****************************************************************
Mean Squared Error for sklearn SGD  is= 31.103818433610847
```

In [42]:

```
print('sklearn sgd weight---\n',w_sgd)
```

```
sklearn sgd weight---
 [-1.53668381  0.75544748 -0.25937844  0.45383545 -1.35256007  3.07651208
 -0.29745472 -3.00849022  2.77907599 -2.17376603 -2.11990541  1.29432921
 -3.72275395]
```

Set 4: Manual SGD and SGDRegressor for iteration=1000, learning rate=0.001, and batch_size=20

In [ ]:

```
A) Implementing Manual SGD on LINEAR REGRESSION
```

In [43]:

```
def manual_fit(X, lr_rate_variation, alpha=0.0001, lr_rate=0.001, power_t=0.25, n_iter=1000):
    a=np.zeros(shape=(1,13))
    b=0
    t=1
    r=lr_rate

    while(t<=n_iter):
        a_1=a
        b_1=b
        a_=np.zeros(shape=(1,13))
        b_=0
        x_data=X.sample(10)
        x=np.array(x_data.drop('price',axis=1))
        y=np.array(x_data['price'])


        for i in range(10):
            y_curr=np.dot(a_1,x[i])+b_1
            a_+=x[i] * (y[i] - y_curr)
            b_+=(y[i]-y_curr)


        a_*=(-2/x.shape[0])
        b_*=(-2/x.shape[0])


        a=(a_1-r*a_)
        b=(b_1-r*b_)


        if(lr_rate_variation=='invscaling'):
            r = lr_rate / pow(t, power_t)
        t+=1

    return a,b
```

In [44]:

```
def pred(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_(X_test,y_pred):

    plt.scatter(Y_test,y_pred)
    plt.grid(b=True, linewidth=0.3)
    plt.title("Actual Prices vs Predicted Prices: $Y_i$ vs $\hat{Y}_i$",size=18)
    plt.xlabel("Actual Prices: $Y_i$",size=14)
    plt.ylabel("Predicted prices: $\hat{Y}_i$",size=14)
```

```
    plt.show()
    print('*****************************************************************')

   #https://scikit-learn.org/stable/modules/generated/sklearn.linear_model.SGDClassifier.html

    manual_sgd_predictions=mean_squared_error(Y_test,y_pred)
    print('Mean Squared Error for SGD  is=', manual_sgd_predictions)

    return manual_sgd_predictions
```

B) Actual Prices vs Predicted Prices - Manual SGD

In [45]:

```
w, b=manual_fit(X=manual_sgd, lr_rate_variation='constant' , n_iter=1000)
```

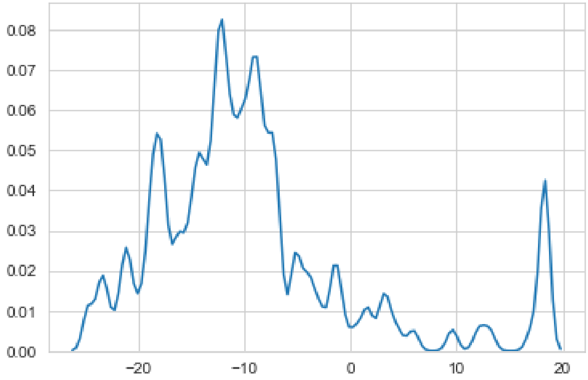
In [46]:

```
y_pred=pred(X_test, w=w, b=b)
```

C) Delta calculation

In [47]:

```
delta_y = Y_test - manual_sgd_predictions;

import seaborn as sns;
import numpy as np;
sns.set_style('whitegrid')
sns.kdeplot(np.array(delta_y), bw=0.5)
plt.show()
```



In [48]:

```
print('manual sgd weight---\n',w)
```

```
manual sgd weight---
 [[-0.77008504  0.33411384 -0.59115633  0.4041295  -0.32917868  2.88094627
  -0.41024958 -1.24141092  0.15789184 -0.4855799  -1.77064741  0.82893361
  -2.6369224 ]]
```

2. SKLEARN's SGD

In [ ]:

```
A) Implementing SKLEARN's SGD Regression
```

In [49]:

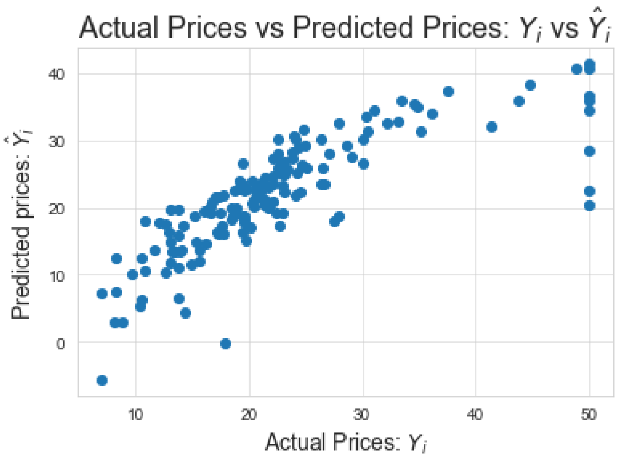
```
def sklearn_sgd(alpha, lr_rate_variation, eta0=0.01, power_t=0.25, n_iter=1000, X_train=X_train, X_
test=X_test, Y_train=Y_train, Y_test=Y_test):
    clf=SGDRegressor(alpha=alpha, penalty=None, learning_rate=lr_rate_variation, eta0=eta0, power_t
=power_t, n_iter=n_iter)
    clf.fit(X_train, Y_train)
    y_pred=clf.predict(X_test)


    plt.scatter(Y_test,y_pred)
    plt.title("Actual Prices vs Predicted Prices: $Y_i$ vs $\hat{Y}_i$",size=18)
    plt.xlabel("Actual Prices: $Y_i$",size=14)
    plt.ylabel("Predicted prices: $\hat{Y}_i$",size=14)
    plt.grid(b=True, linewidth=0.5)
    plt.show()
    print('*************************************************************')




    sklearn_sgd_predictions=mean_squared_error(Y_test,y_pred)
    print('Mean Squared Error for sklearn SGD  is=', sklearn_sgd_predictions)
    return clf.coef_, clf.intercept_, sklearn_sgd_predictions
```

B) Actual Prices vs Predicted Prices - Sklearn's SGD

In [50]:

```
w_sgd, b_sgd, sklearn_sgd_predictions=sklearn_sgd(alpha=0.0001, lr_rate_variation='constant', eta0=
0.01, n_iter=1000)
```

```
C:\Users\myuri\Anaconda3\lib\site-packages\sklearn\linear_model\stochastic_gradient.py:152:
DeprecationWarning: n_iter parameter is deprecated in 0.19 and will be removed in 0.21. Use
max_iter and tol instead.
  DeprecationWarning)
```




```
*************************************************************
Mean Squared Error for sklearn SGD  is= 34.772025735865874
```

In [51]:

```
print('sklearn sgd weight---\n',w_sgd)
```

```
sklearn sgd weight---
 [-0.98623427  0.86141596 -0.2650199  -0.4632424  -1.92109589  2.53509375
 -0.45693715 -2.77576468  2.65615629 -2.199046   -2.04629659  1.37378185
 -3.38031929]
```

In [54]:

```
#5.Observations
```

In [53]:

```
from prettytable import PrettyTable

x = PrettyTable()
x.field_names = ["Serial_no", "algorithm", "lr_rate","iterations","MSE"]
x.add_row([1, "manual_sgd", .01, 1000, 30.25])
x.add_row([2, "sklearn_sgd", .01, 1000,31.89])
x.add_row([3, "manual_sgd", .01, 100, 29.18])
x.add_row([4, "sklearn_sgd", .01, 100,28.05])
x.add_row([5, "manual_sgd", .01, 10000, 29.97])
x.add_row([6, "sklearn_sgd", .01, 10000,28.7])
x.add_row([7, "manual_sgd", .001, 1000, 29.8])
x.add_row([8, "sklearn_sgd", .001, 1000,28.19])

print(x)
```

```
+-----------+-------------+---------+------------+-------+
| Serial_no |  algorithm  | lr_rate | iterations |  MSE  |
+-----------+-------------+---------+------------+-------+
|     1     |  manual_sgd |   0.01  |    1000    | 30.25 |
|     2     | sklearn_sgd |   0.01  |    1000    | 31.89 |
|     3     |  manual_sgd |   0.01  |    100     | 29.18 |
|     4     | sklearn_sgd |   0.01  |    100     | 28.05 |
|     5     |  manual_sgd |   0.01  |   10000    | 29.97 |
|     6     | sklearn_sgd |   0.01  |   10000    |  28.7 |
|     7     |  manual_sgd |  0.001  |    1000    |  29.8 |
|     8     | sklearn_sgd |  0.001  |    1000    | 28.19 |
+-----------+-------------+---------+------------+-------+
```

CONCLUSIONS

1.In the above analysis we used the batch size=(10 and 20) and iteration = (1000,100,10000,1000) with different learning rate on the model to get the best error rate. 2.The comparision between both the models is summarised below on the basis of final observations.

SUMMARY

While analysing the boston house price dataset on by manual SGD regressor and SKLEARN's SGD we can say that by increasing iteration number, weights of SGDRegressor and manual SGD, becomes more similar or higher the number of iteration , manual SGD seems similar to SGDRegressor and change in error reduces by little magrin with increase in iteration number of manual SGD regressor.Here best iteration=10000 with lr_rate=.01 will be choosen,as it gives best(less) error rate value,in comparision with other 4 models.