

▼ Curve Fitting

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```
1 import pandas as pd
2 import numpy as np
3 import matplotlib.pyplot as plt
4 import seaborn as sns
5 from sklearn.model_selection import train_test_split
6 from sklearn import datasets
7 from sklearn.linear_model import LinearRegression
8 from sklearn import metrics
```

```
1 # Data Preparation
2 # importing data set from sklearn diabetes
3 db_data = datasets.load_diabetes()
```

```
1 diabetes_data = pd.DataFrame(db_data.data, columns=db_data.feature_names)
2 diabetes_data.describe()
```

	age	sex	bmi	bp	s1	s2
count	4.420000e+02	4.420000e+02	4.420000e+02	4.420000e+02	4.420000e+02	4.420000e+02
mean	-3.634285e-16	1.308343e-16	-8.045349e-16	1.281655e-16	-8.835316e-17	1.327024e-16
std	4.761905e-02	4.761905e-02	4.761905e-02	4.761905e-02	4.761905e-02	4.761905e-02
min	-1.072256e-01	-4.464164e-02	-9.027530e-02	-1.123996e-01	-1.267807e-01	-1.156131e-01
25%	-3.729927e-02	-4.464164e-02	-3.422907e-02	-3.665645e-02	-3.424784e-02	-3.035840e-02
50%	5.383060e-03	-4.464164e-02	-7.283766e-03	-5.670611e-03	-4.320866e-03	-3.819065e-03

```
1 # checking its rows and columns
2 diabetes_data.shape
```

(442, 10)

```
1 # target refers to y-axis. setting target as the data of disease progression
2 diabetes_data['disease progression'] = db_data.target
3 diabetes_data['disease progression'].head()
```

```
0    151.0
1     75.0
2    141.0
3    206.0
4    135.0
Name: disease progression, dtype: float64
```

```
1 #cheking the updated rows and columns of the data
2 diabetes_data.shape
```

(442, 11)

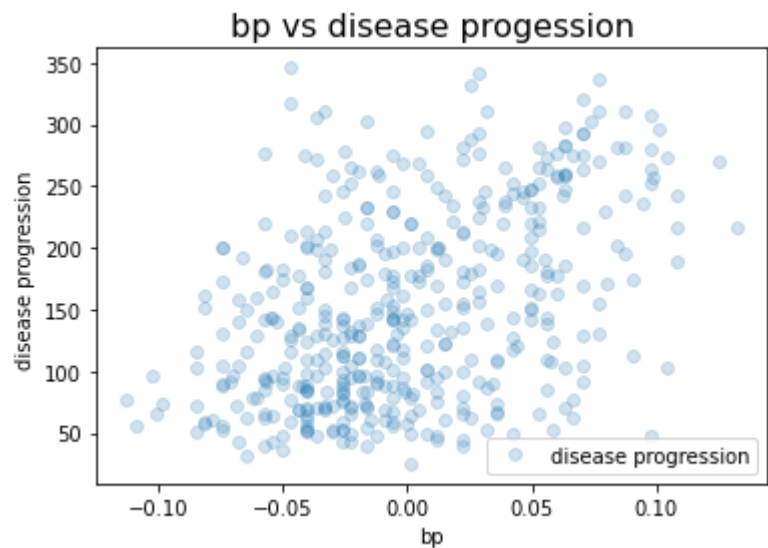
Visualization of percentage related on the following bp = average blood pressure

s4= total cholesterol / HDL (tch)

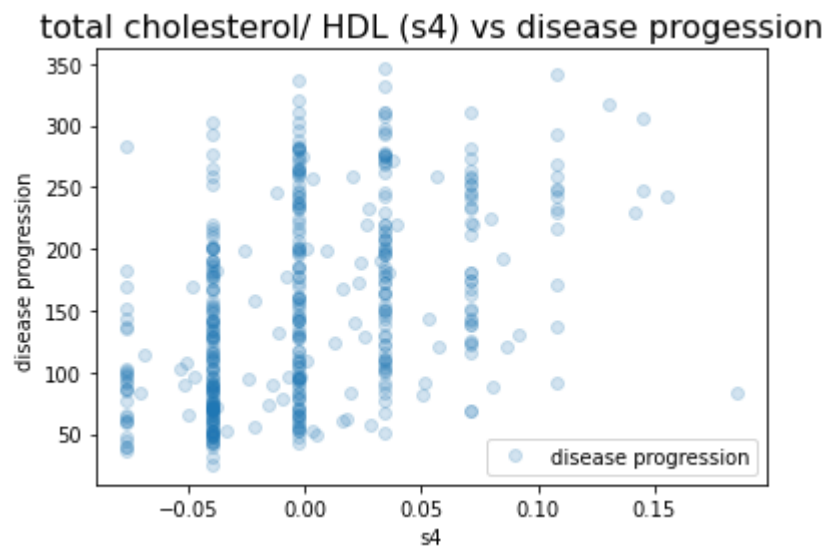
s6 = blood sugar level

which measure of disease progression one year after baseline [1]

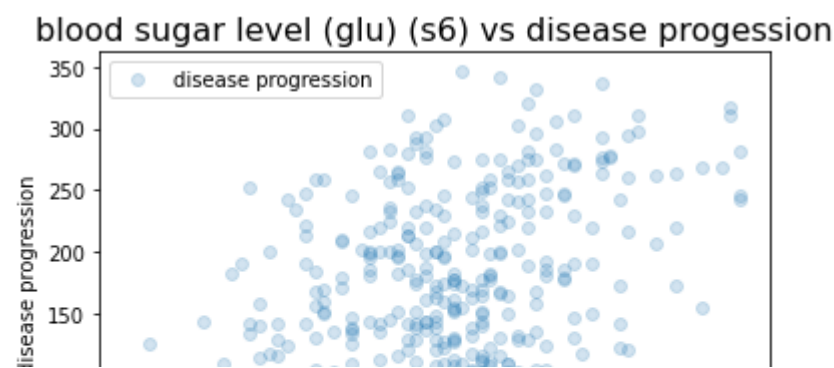
```
1 # Visualizing the average blood pressure and disease progression
2 diabetes_data.plot(x='bp', y='disease progression', style='o', alpha=0.2)
3 plt.title('bp vs disease progression', fontsize=16)
4 plt.xlabel('bp')
5 plt.ylabel('disease progression ')
6 plt.show()
```



```
1 diabetes_data.plot(x='s4', y='disease progression', style='o', alpha=0.2)
2 plt.title('total cholesterol/ HDL (s4) vs disease progression', fontsize=16)
3 plt.xlabel('s4')
4 plt.ylabel('disease progression ')
5 plt.show()
```



```
1 diabetes_data.plot(x='s6', y='disease progression', style='o', alpha=0.2)
2 plt.title('blood sugar level (glu) (s6) vs disease progression', fontsize=16)
3 plt.xlabel('s6')
4 plt.ylabel('disease progression ')
5 plt.show()
```



▼ Multiple Linear Regression

```
-0.15  -0.10  -0.05   0.00   0.05   0.10
1 # Multiple Regreesion
2 X = pd.DataFrame(np.c_[diabetes_data['s4'], diabetes_data['bp'], diabetes_data['s6']], col
3 y = diabetes_data['disease progression']
4 X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.2, random_state=1)
```

```
1 # Fitting a Multiple Linear Model
2 l_reg= LinearRegression()
3 l_reg.fit(X_train, y_train)
```

```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None, normalize=False)
```

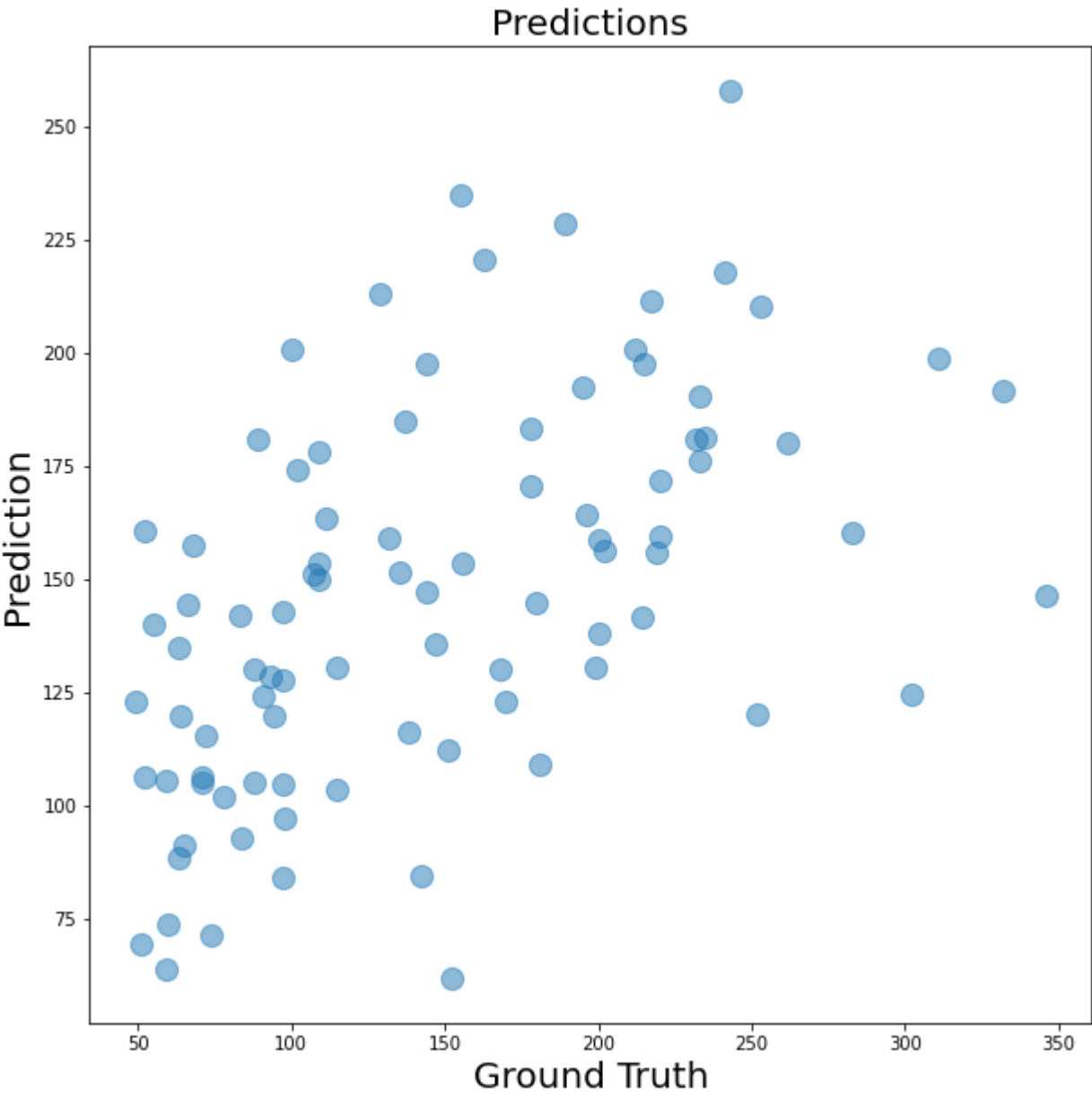
```
1 # Summary of modelling
2 l_reg_sum = pd.DataFrame(X.columns, columns=['Features'])
3 l_reg_sum['Weights Raw'] = l_reg.coef_.reshape(3,1)
4 l_reg_sum = l_reg_sum.append({'Features':'Intercept', 'Weights Raw':float(l_reg.intercept_
5 l_reg_sum
```

	Features	Weights Raw
0	s4	476.371697
1	bp	520.717573
2	s6	223.540217
3	Intercept	152.003079

```
1 # prediction model
2 preds = l_reg.predict(X_test)
3 res = pd.DataFrame({'Actual': y_test, 'Predicted': preds})
4 res
```

Actual Predicted

```
1 plt.figure(figsize=(10,10))
2 plt.title('Predictions', fontsize=20)
3 plt.scatter(y_test, preds, s = 150, alpha=0.5)
4 plt.xlabel('Ground Truth', fontsize=20)
5 plt.ylabel('Prediction', fontsize=20)
6 plt.show()
```



```
1 # Metrics
2 # adjusted r squared as per lecture
3
4 def adjr2(r2,x):
5     n = x.shape[0]
6     p = x.shape[1]
7     adjusted_r2 = 1-(1-r2)*(n-1)/(n-p-1)
8     return adjusted_r2
9
10
11 MSE = metrics.mean_squared_error(y_test, preds)
12 RMSE = np.sqrt(MSE)
13 R2 = metrics.r2_score(y_test, preds)
14 AR2 = adjr2(R2,X_train)
15 model_metrics = pd.DataFrame([['MSE'],['RMSE'],['R^2'],
16                                ['Adjusted R^2']],
17                                columns=['Metrics'])
18 model_metrics['Multiple Regression'] = MSE, RMSE, R2, AR2
19 model_metrics
```

	Metrics	Multiple Regression
0	MSE	3834.449487
1	RMSE	61.922932

▼ Polynomial Regression

```
1 # POLYNOMIAL REGRESSION
2 from sklearn.preprocessing import PolynomialFeatures
3 X = pd.DataFrame(np.c_[diabetes_data['s4'], diabetes_data['bp'], diabetes_data['s6'],diabe
4 y = diabetes_data['disease progression']
5 X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.2, random_state=1)
```

```
1 poly_reg = PolynomialFeatures(degree=2)
2 X_poly = poly_reg.fit_transform(X_train)
```

```
1 print(X_poly)

[[ 1.00000000e+00  3.43088589e-02 -6.76422830e-02 ...  1.97895780e-03
   2.19497116e-03  2.43456348e-03]
 [ 1.00000000e+00  5.60805202e-02 -1.14087284e-02 ...  1.02778960e-03
   1.27305716e-03  1.57685439e-03]
 [ 1.00000000e+00 -2.59226200e-03  4.25295792e-02 ...  2.72463581e-05
  -3.72467191e-04  5.09175604e-03]
 ...
 [ 1.00000000e+00 -3.94933829e-02 -2.28849640e-02 ...  1.17063562e-03
   2.17217379e-03  4.03057866e-03]
 [ 1.00000000e+00  1.29062088e-02  5.85963092e-02 ...  2.36464207e-03
  -2.88648387e-03  3.52348849e-03]
 [ 1.00000000e+00 -3.94933829e-02 -5.73136710e-02 ...  2.72463581e-05
   1.30287145e-04  6.23009508e-04]]
```

```
1 # Fitting a Multiple Linear Model
2 l_reg2 = LinearRegression()
3 l_reg2.fit(X_poly, y_train)

LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None, normalize=False)
```

```
1 preds = l_reg2.predict(poly_reg.fit_transform(X_test))
```

```
1 poly_MSE = metrics.mean_squared_error(y_test,preds)
2 poly_RMSE = np.sqrt(poly_MSE)
3 poly_R2 = metrics.r2_score(y_test,preds)
4 poly_AR2 = adjr2(poly_R2,X_train)
5 model_metrics = pd.DataFrame(['MSE'],['RMSE'],['R^2'],
6                               ['Adjusted R^2']],
7                               columns=['Metrics'])
8 model_metrics['Polynomial Regression'] = poly_MSE, poly_RMSE, poly_R2, poly_AR2
9 model_metrics
```

	Metrics	Polynomial Regression
0	MSE	4219.197941
1	RMSE	64.955353
2	R^2	0.208253
3	Adjusted R^2	0.199152

▼ Normal Equation

```
1 X = diabetes_data['s4'].values.reshape(-1,1)
2 y = diabetes_data['disease progression'].values.reshape(-1,1)
3
4 n = len(diabetes_data['s4']) #no. rows
5 bias = np.ones((n,1)) #column-1 of Matrix X
6 xnew = np.reshape(X,(n,1)) #reshaping the data
7 xnew1 =np.append(bias,xnew,axis=1) #forming Matrix X
8 xnew1_t = np.transpose(xnew1) #transpose
9 xnew_t_dot_x_new = xnew1_t.dot(xnew1) #matrix multiplication
10 temp_1 = np.linalg.inv(xnew_t_dot_x_new) #inverse of a matrix
11 temp_2 = xnew1_t.dot(y)
```

```
1 #Finding coefficients:
2
3 theta = temp_1.dot(temp_2)
4 Intercept = theta[0]
5 Slope = theta[1]
6 print("Intercept:",Intercept)
7 print("Slope:",Slope)
```

Intercept: [152.13348416]
Slope: [696.88303009]

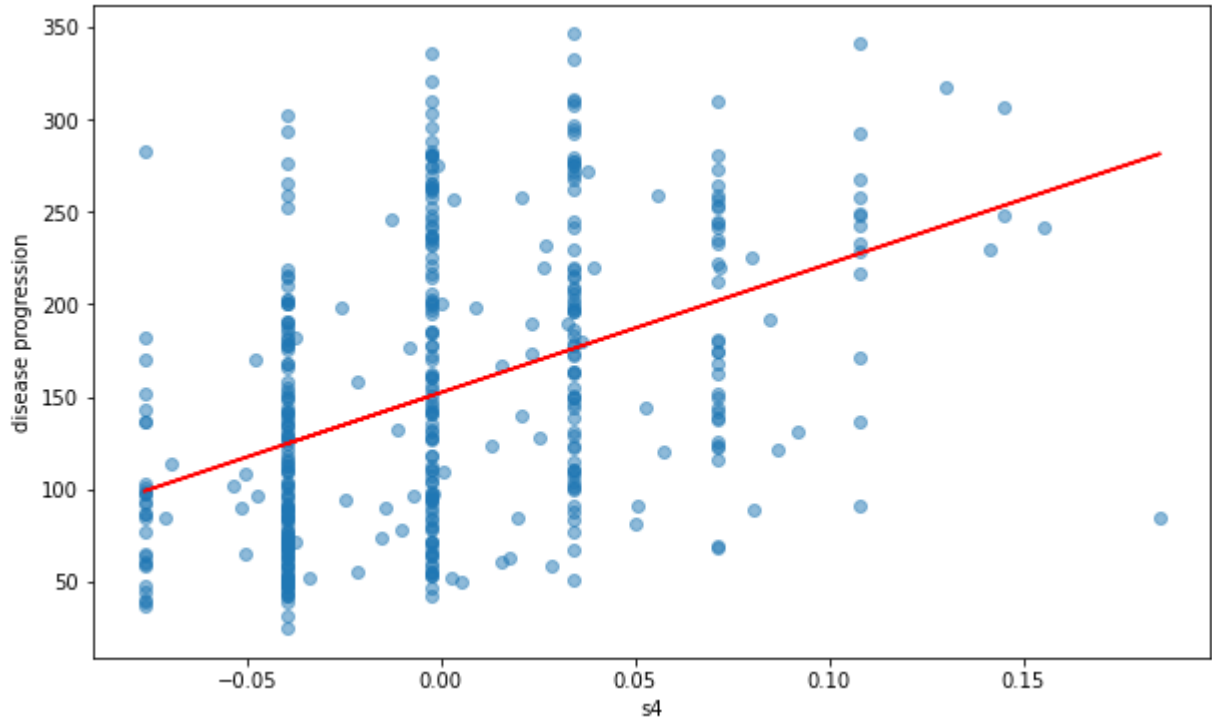
```
1 #Predicting values:
2 def predict_value(input_feature,slope,intercept):
3     return slope*input_feature+intercept
```

```
1 bmi =3
2 prediction =predict_value(bmi,Slope,Intercept)
3 print(prediction)
```

[2242.78257444]

```
1 #Plotting the regression Line:
2 plt.figure(figsize=(5*2,3*2))
3 plt.scatter(X,y, alpha=0.5)
4 plt.xlabel('s4')
5 plt.ylabel('disease progression')
6 plt.plot(X,Slope*X+Intercept, color="red")
```

[<matplotlib.lines.Line2D at 0x7f5c3d289bd0>]



▼ Polynomial Curve

```

1 def linear_regressor(X,y):
2     X = np.array(X)
3     y = np.array(y)
4     n = X.size
5     w0 = (y.mean()*np.sum(X**2)-X.mean()*np.sum(X*y)) / (np.sum(X**2) - n*X.mean()**2)
6     w1 = (np.sum(X*y) - X.mean()*np.sum(y)) / (np.sum(X**2) - n*X.mean()**2)
7     return w0,w1
8 w0,w1 = linear_regressor(X,y)
9 print("Linear Regression Equation: y = {:.3f}x + {:.3f}".format(w1, w0))

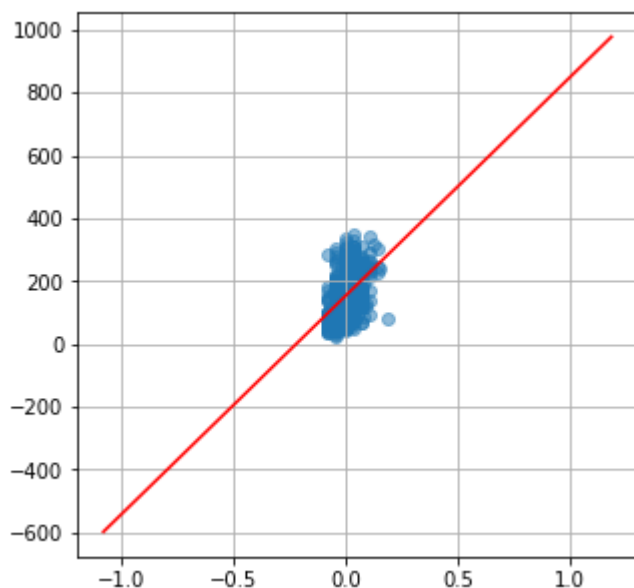
```

Linear Regression Equation: y = 696.883x + 152.133

```

1 def show_regline(X,y,w1,w0):
2     x_min, x_max = X.min() - 1, X.max() + 1
3     linex = np.linspace(x_min, x_max)
4     liney = w1*linex+w0
5     plt.figure(figsize=(5,5))
6     plt.grid()
7     plt.scatter(X,y, alpha=0.5)
8     plt.plot(linex, liney, c='red')
9     plt.show()
10 show_regline(X,y,w1,w0)

```

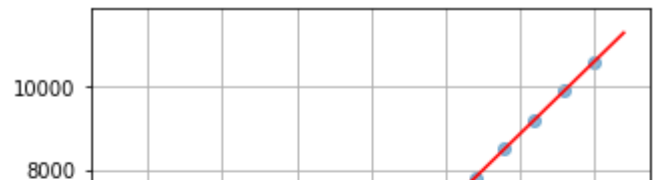


```

1 def lin_reg(val,w0,w1):
2     return w1*val + w0 #model
3 print(lin_reg(10, w0, w1))
4 X_new, y_new = X.copy(), y.copy()
5 for i in range(10,16):
6     X_new = np.insert(X_new,-1, i)
7     y_new = np.insert(y_new,-1, lin_reg(i,w0,w1))
8 show_regline(X_new, y_new, w1, w0)

```

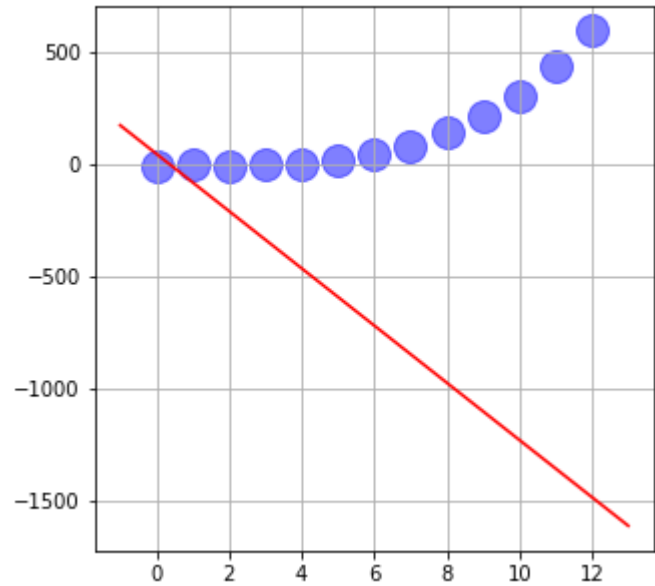
7120.963785085329



```
1 X_1 = np.arange(0, 13,1)
2 y_1 = X_1 - 2 * (X_1 ** 2) + 0.5 * (X_1 ** 3) + np.random.normal(-3, 3, 13)
    |   |   |   |   |   |   |   |   |   |   |
1 def show_regline(X,y,w1,w0):
2     x_min, x_max = X.min() - 1, X.max() + 1
3     linex = np.linspace(x_min, x_max)
4     liney = w1*linex+w0
5     plt.figure(figsize=(5,5))
6     plt.grid()
7     plt.scatter(X_1,y_1, s = 256, color='blue', alpha=0.5)
8     plt.plot(linex, liney, c='red')
9     plt.show()

1 def linear_regressor(X,y):
2     X = np.array(X)
3     y = np.array(y)
4     n = X.size
5     w0 = (y.mean()*np.sum(X**2)-X.mean()*np.sum(X*y)) / (np.sum(X**2) - n*X.mean()**2)
6     w1 = (np.sum(X*y) - X.mean()*np.sum(y)) / (np.sum(X**2) - n*X.mean()**2)
7     return w0,w1
8 w0,w1 = linear_regressor(X,y)

1 w0_q,w1_q = linear_regressor(X_1, y_1)
2 show_regline(X_1,y_1,w0_q,w1_q)
```



1

References:

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[3] "numeth2021/NuMeth_4_Curve_Fitting.ipynb at main · dyjdllopez/numeth2021 · GitHub."

[https://github.com/dyjdllopez/numeth2021/blob/main/Week%209-13%20-](https://github.com/dyjdllopez/numeth2021/blob/main/Week%209-13%20-%20Curve%20Fitting%20Techniques/NuMeth_4_Curve_Fitting.ipynb)

[%20Curve%20Fitting%20Techniques/NuMeth_4_Curve_Fitting.ipynb](https://github.com/dyjdllopez/numeth2021/blob/main/Week%209-13%20-%20Curve%20Fitting%20Techniques/NuMeth_4_Curve_Fitting.ipynb) (accessed May 05, 2021).

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