Q3.2 Quadratic Least Square Fitting

Importing Libraries

In [1]:
```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
from prettytable import PrettyTable as ptbl
```

Importing database

In [2]:
```
data = pd.read_csv('Quadratic_curve_fitting_dataset.csv')
```

Visualizing database

In [3]:
```
data.head()
```

Out[3]:

	x	y
0	2	5
1	5	140
2	8	455
3	11	950
4	14	1625

Extracing Dependent and independent variables from database in X and y variables respectively

In [4]:
```
X = data.iloc[:,0].values
y = data.iloc[:,1].values
```

Quadratic Least square fitting function

y = c1*x*^2 + *c2*x + c3

In [5]:
```
def QuadraticFitting(x,y):

    x_four_sum = sum(x**4)
    x_three_sum = sum(x**3)
    x_sq_sum = sum(x**2)
    x_sum = sum(x)
    n = len(x)

    y_xsq_sum = sum(y*(x**2))
    yx_sum = sum(x*y)
    y_sum = sum(y)

    A = np.array([
        [x_four_sum,  x_three_sum,  x_sq_sum],
        [x_three_sum, x_sq_sum,     x_sum],
        [x_sq_sum,    x_sum,        n],
        ])

    b = np.array([
        [y_xsq_sum],
        [yx_sum],
        [y_sum]
        ])

    invA = np.linalg.inv(A)
    M = np.matmul(invA,b)

    return M
```

Calling Quadratic least square fitting function on given database

In [6]:
```
c1, c2, c3 = QuadraticFitting(X,y)
```

Visualizing coefficients and constants

In [7]:
```
print(f"c1 = {c1}\tc2 = {c2}\tc3 = {c3}")
```

```
c1 = [10.]      c2 = [-25.]     c3 = [15.]
```

Calculating Approximate Values

In [8]:
```
y_pred = c1*(X**2) + c2*X + c3
```

Table of actual values and predicted values

In [9]:
```
table = ptbl(['X','y','y-predicted'])
for i in range(len(X)):
    table.add_row([X[i],y[i],y_pred[i]])
print(table)
```

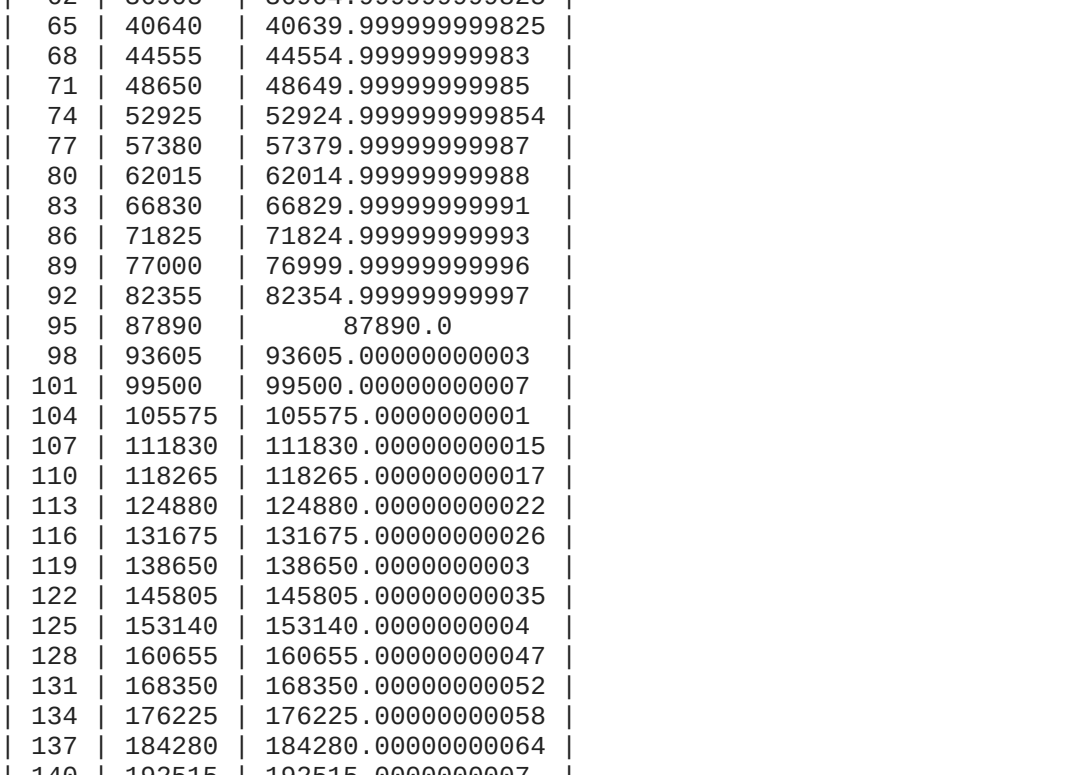
```
+-----+--------+--------------------+
|  X  |   y    |    y-predicted     |
+-----+--------+--------------------+
|  2  |   5    | 5.000000000204238  |
|  5  |  140   | 140.00000000016325 |
|  8  |  455   | 455.0000000001246  |
|  11 |  950   | 950.0000000000882  |
|  14 |  1625  | 1625.0000000000541 |
|  17 |  2480  | 2480.0000000000223 |
|  20 |  3515  | 3514.9999999999927 |
|  23 |  4730  | 4729.999999999965  |
|  26 |  6125  | 6124.999999999941  |
|  29 |  7700  | 7699.999999999918  |
|  32 |  9455  | 9454.999999999898  |
|  35 | 11390  | 11389.99999999988  |
|  38 | 13505  | 13504.999999999865 |
|  41 | 15800  | 15799.99999999985  |
|  44 | 18275  | 18274.99999999984  |
|  47 | 20930  | 20929.999999999833 |
|  50 | 23765  | 23764.999999999825 |
|  53 | 26780  | 26779.99999999982  |
|  56 | 29975  | 29974.999999999818 |
|  59 | 33350  | 33349.99999999982  |
|  62 | 36905  | 36904.999999999825 |
|  65 | 40640  | 40639.999999999825 |
|  68 | 44555  | 44554.99999999983  |
|  71 | 48650  | 48649.99999999985  |
|  74 | 52925  | 52924.999999999854 |
|  77 | 57380  | 57379.99999999987  |
|  80 | 62015  | 62014.99999999988  |
|  83 | 66830  | 66829.99999999991  |
|  86 | 71825  | 71824.99999999993  |
|  89 | 77000  | 76999.99999999996  |
|  92 | 82355  | 82354.99999999997  |
|  95 | 87890  |      87890.0       |
|  98 | 93605  | 93605.00000000003  |
| 101 | 99500  | 99500.00000000007  |
| 104 | 105575 | 105575.0000000001  |
| 107 | 111830 | 111830.00000000015 |
| 110 | 118265 | 118265.00000000017 |
| 113 | 124880 | 124880.00000000022 |
| 116 | 131675 | 131675.00000000026 |
| 119 | 138650 | 138650.0000000003  |
| 122 | 145805 | 145805.00000000035 |
| 125 | 153140 | 153140.0000000004  |
| 128 | 160655 | 160655.00000000047 |
| 131 | 168350 | 168350.00000000052 |
| 134 | 176225 | 176225.00000000058 |
| 137 | 184280 | 184280.00000000064 |
| 140 | 192515 | 192515.0000000007  |
| 143 | 200930 | 200930.00000000076 |
| 146 | 209525 | 209525.00000000084 |
| 149 | 218300 | 218300.00000000093 |
+-----+--------+--------------------+
```

Visualizing Best Fit Curve

Note: The database used here was generated by me using Microsoft EXCEL

that's why the actual points are perfectly overlapping with approximate line

In [10]:
```
plt.scatter(X,y, marker = '.')
plt.plot(X,y_pred,color = 'red',linewidth = 0.5)
plt.title('Quadratic Least Square Fitting')
plt.xlabel('X')
plt.ylabel('Y')
plt.show()
```



Evaluating Error in reconstruction

In [11]:
```
max_error = max(abs(y-y_pred)/y)
print(max_error)
```

```
4.084768079337664e-11
```

Error is less because the data was generate using excel

In [12]:
```
for i in range(5):
    print(f"y[{i}] = {y[i]}\ty_predict[{i}] = {y_pred[i]}")
```

```
y[0] = 5        y_predict[0] = 5.000000000204238
y[1] = 140      y_predict[1] = 140.00000000016325
y[2] = 455      y_predict[2] = 455.0000000001246
y[3] = 950      y_predict[3] = 950.0000000000882
y[4] = 1625     y_predict[4] = 1625.0000000000541
```