Polynominal fitiing

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Major: **Software Engineering**

Name: **Kim Young Min** [Polynomial fitting]

Solve a least square problem to find an optimal polynomial curve for a given set of two dimensional points.

Demonstrate the effect of the degree of polynomial in fitting a given set of points.

- choose a polynomial curve and generate points along the curve with random noise
- plot the generated noisy points along with its original polynomial without noise
- plot the approximating polynomial curve obtained by solving a least square problem
- plot the approximating polynomial curve with varying polynomial degree

0.0.1 Start!

```
In [279]: import matplotlib.pyplot as plt
          from random import *
          import numpy as np
          from numpy.linalg import inv

          %matplotlib inline

          import pylab as pl
```

0.1 choose a polynomial curve and generate points along the curve with random noise

0.2 plot the generated noisy points along with its original polynomial without noise

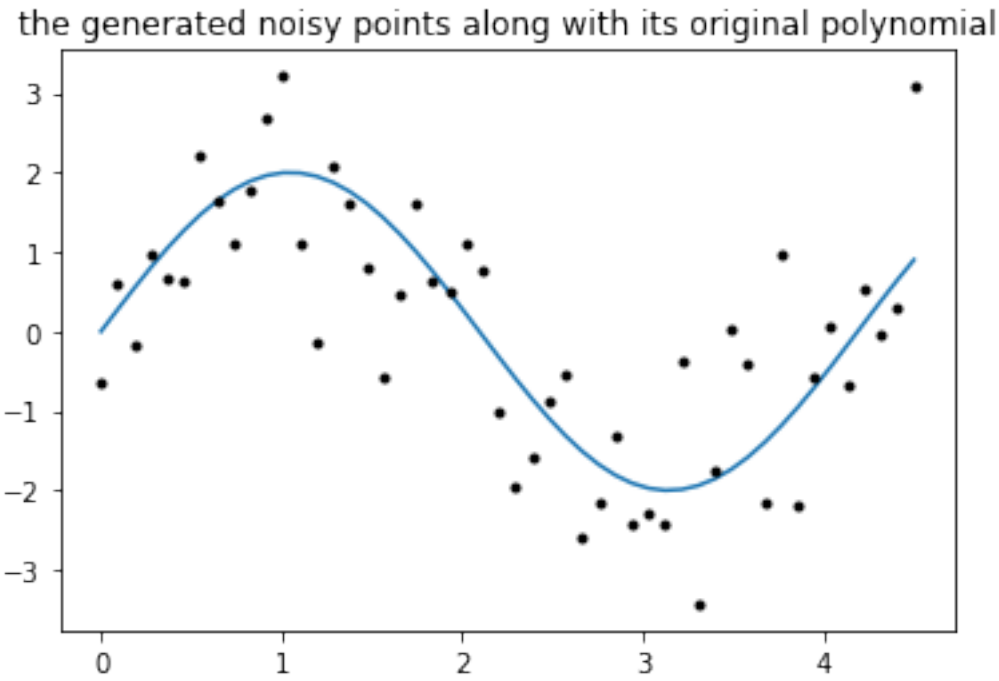
I chose random noise points from 'Sin(x) curve'

In [434]:
```
def f(size):
    x = np.linspace(0, 4.5, size)
    y = 2 * np.sin(x * 1.5)
    return (x,y)

def sample(size):
    x = np.linspace(0, 4.5, size)
    y = 2 * np.sin(x * 1.5) + pl.randn(x.size)
    return (x,y)

pl.clf()
f_x, f_y = f(50)
pl.plot(f_x, f_y)
x, y = sample(50)
pl.title("the generated noisy points along with its original polynomial")
pl.plot(x, y, 'k.')
```

Out[434]: [<matplotlib.lines.Line2D at 0x23821307f28>]



0.2.1 Define Functions: pseudo_inverse(using matrix) and least_square_energy(using L2-Norm)

In [417]:
```
def pseudo_inverse(x,order,y):
    A=np.array([[0.0]*(order+1)]*50)
```

```
        for j in range(50):
            for i in range(order+1):
                A[j][order-i]=x[j]**i

        Apinv = inv(A.T @ A) @ (A.T@y)

        def polynominal_func(x):
            polynominal=0.0
            for i in range(order+1):
                polynominal+=Apinv[order-i]*(x**i)
            return polynominal

        plt.xlim(0,4.5)
        plt.ylim(-4,5)
        plt.grid()
        plt.plot(x,polynominal_func(x))
        plt.plot(x, y, 'k.')
        return polynominal_func(x)

    def least_square_ener(polynominal_list,y):
        d = (polynominal_list - y) ** 2
        s = np.sum(d)
        return s
```

This is list for Least Square Energy.

```
In [418]: ener_list=np.array([])
```

0.3 Plot the approximating polynomial curve obtained by solving a least square problem.

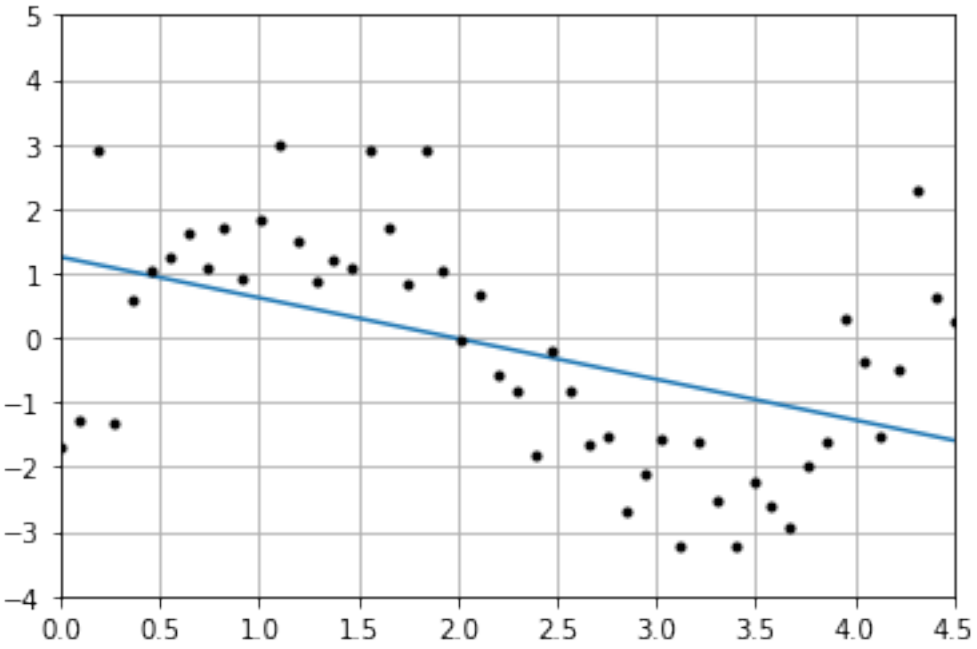
When Polynominal Order =1.

```
In [419]: order1=1

          polynominal_list1=pseudo_inverse(x,order1,y)

          ener_list=np.array([])
          ener_list=np.append(ener_list,least_square_ener(polynominal_list1,y))
          print(ener_list)
```

```
[118.24915715]
```

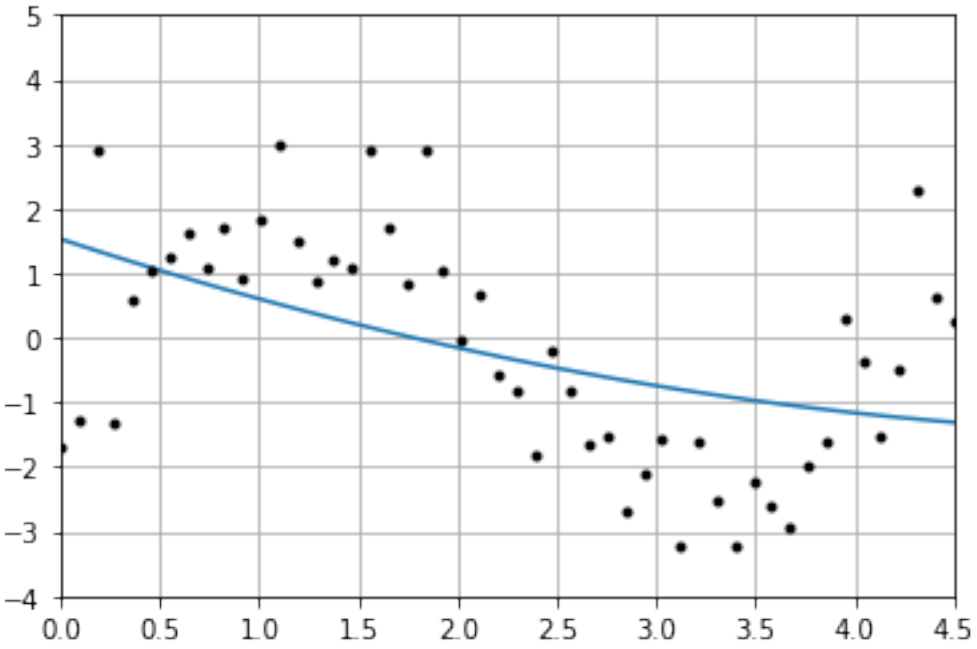


When Polynominal Order =2.

```
In [420]: order2=2

          polynominal_list2=pseudo_inverse(x,order2,y)
          ener_list=np.append(ener_list,least_square_ener(polynominal_list2,y))
          print(ener_list)
```

```
[118.24915715 117.37334049]
```

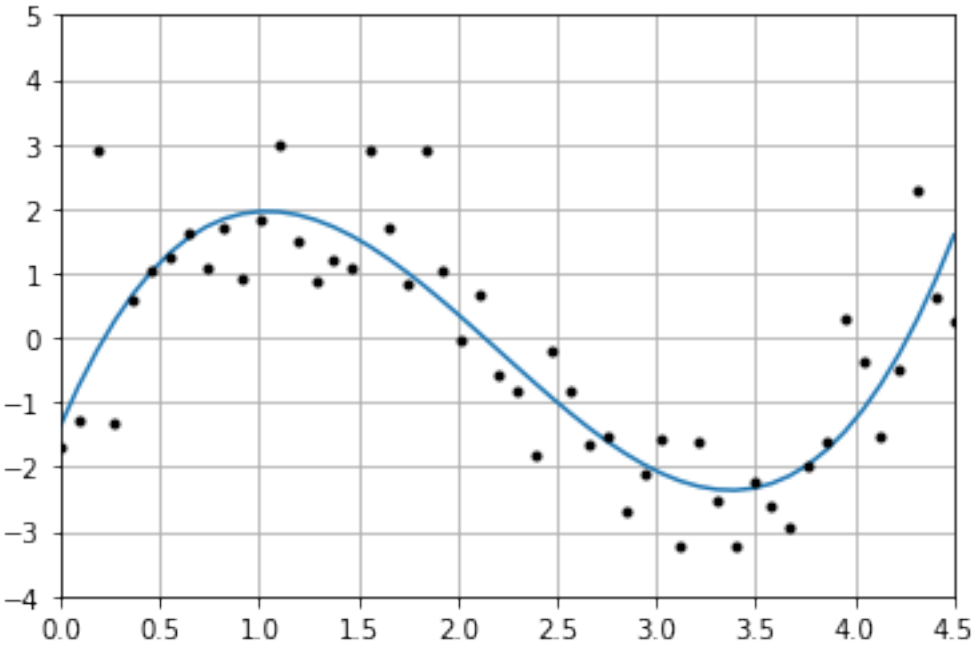


When Polynominal Order =3.

```
In [421]: order3=3

          polynominal_list3=pseudo_inverse(x,order3,y)
          ener_list=np.append(ener_list,least_square_ener(polynominal_list3,y))
          print(ener_list)
```

```
[118.24915715 117.37334049  41.25225445]
```

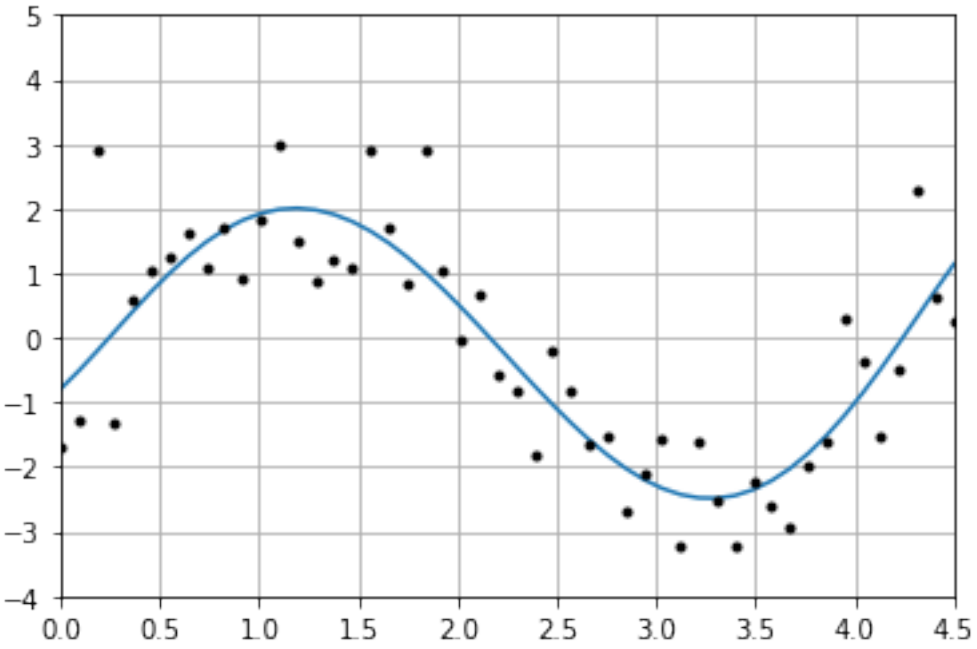


When Polynominal Order =5.

```
In [422]: order5=5

          polynominal_list5=pseudo_inverse(x,order5,y)
          ener_list=np.append(ener_list,least_square_ener(polynominal_list5,y))
          print(ener_list)
```

```
[118.24915715 117.37334049  41.25225445  39.08030955]
```

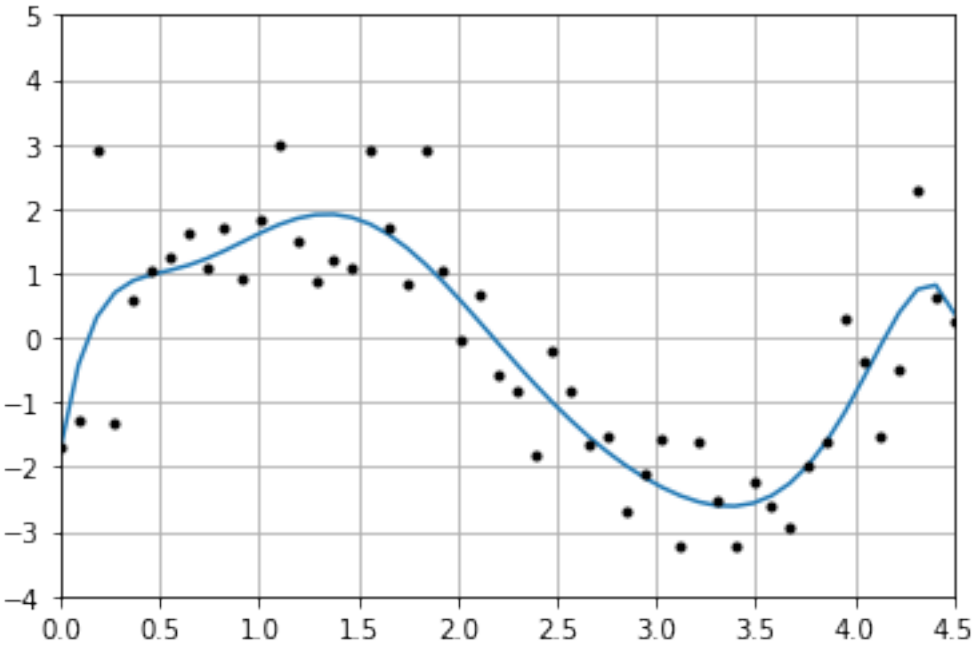


When Polynominal Order =8.

```
In [423]: order8=8

          polynominal_list8=pseudo_inverse(x,order8,y)
          ener_list=np.append(ener_list,least_square_ener(polynominal_list8,y))
          print(ener_list)
```

```
[118.24915715 117.37334049  41.25225445  39.08030955  35.29489651]
```



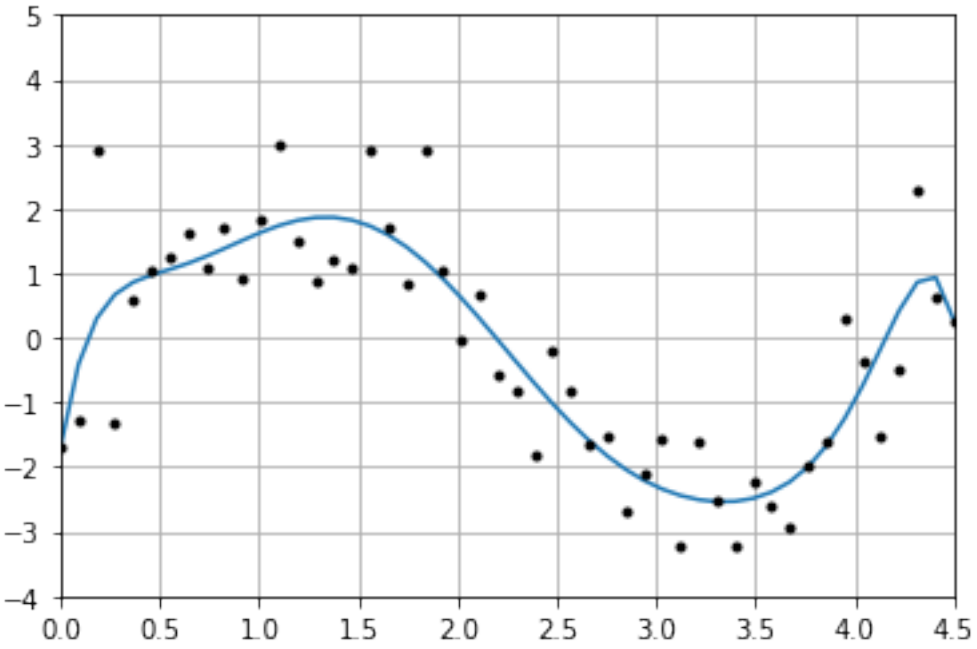
When Polynominal Order =10.

```
In [424]: order10=10

          polynominal_list10=pseudo_inverse(x,order10,y)

          ener_list=np.append(ener_list,least_square_ener(polynominal_list10,y))
          print(ener_list)
```

```
[118.24915715 117.37334049  41.25225445  39.08030955  35.29489651
  35.16845174]
```

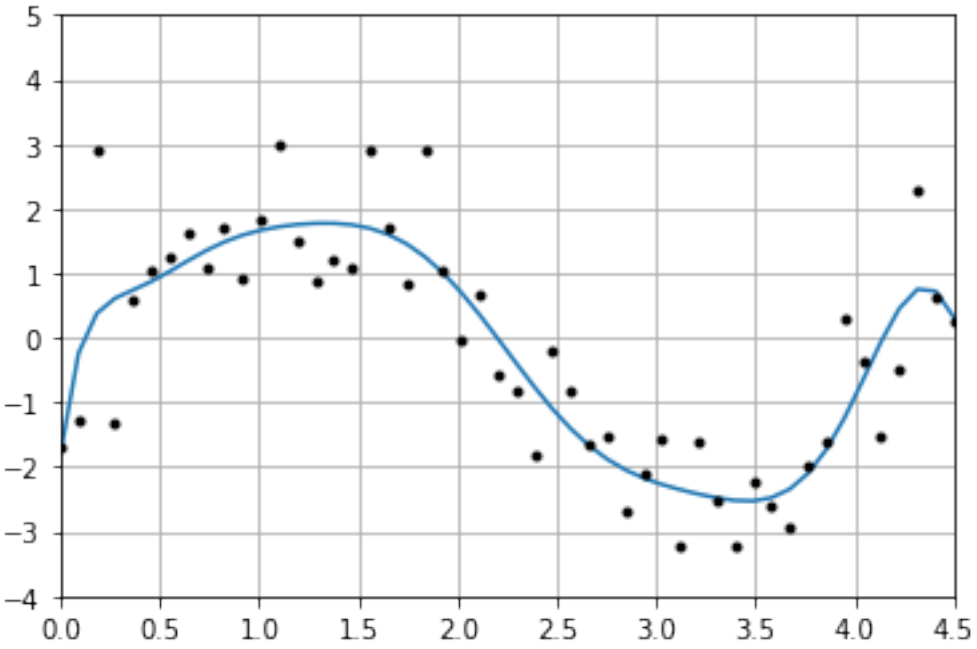


When Polynominal Order =11.

```
In [425]: order11=11

          polynominal_list11=pseudo_inverse(x,order11,y)
          ener_list=np.append(ener_list,least_square_ener(polynominal_list11,y))
          print(ener_list)
```

```
[118.24915715 117.37334049  41.25225445  39.08030955  35.29489651
  35.16845174  34.87362018]
```

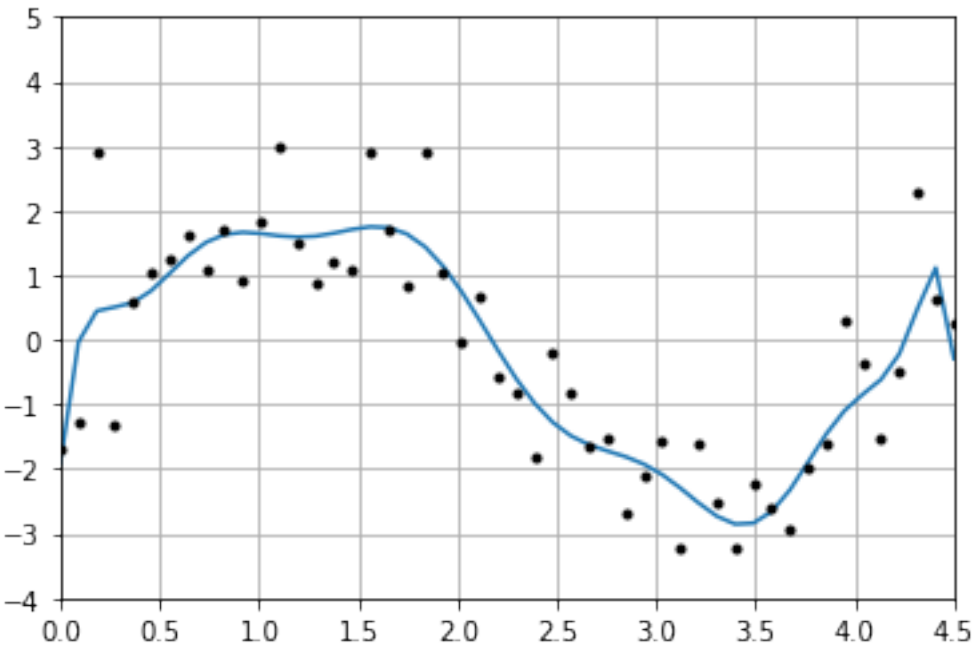


When Polynominal Order =15.

```
In [426]: order15=15

          polynominal_list15=pseudo_inverse(x,order15,y)
          ener_list=np.append(ener_list,least_square_ener(polynominal_list15,y))
          print(ener_list)
```

```
[118.24915715 117.37334049  41.25225445  39.08030955  35.29489651
  35.16845174  34.87362018  33.23546773]
```

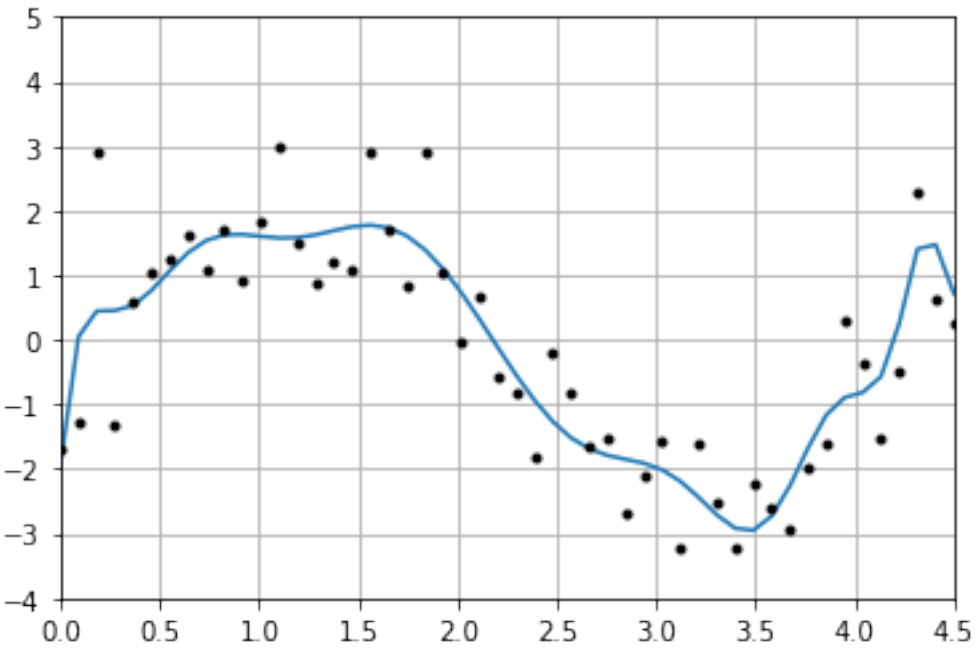


When Polynominal Order =25.

```
In [427]: order25=25

          polynominal_list25=pseudo_inverse(x,order25,y)
          ener_list=np.append(ener_list,least_square_ener(polynominal_list25,y))
          print(ener_list)
```

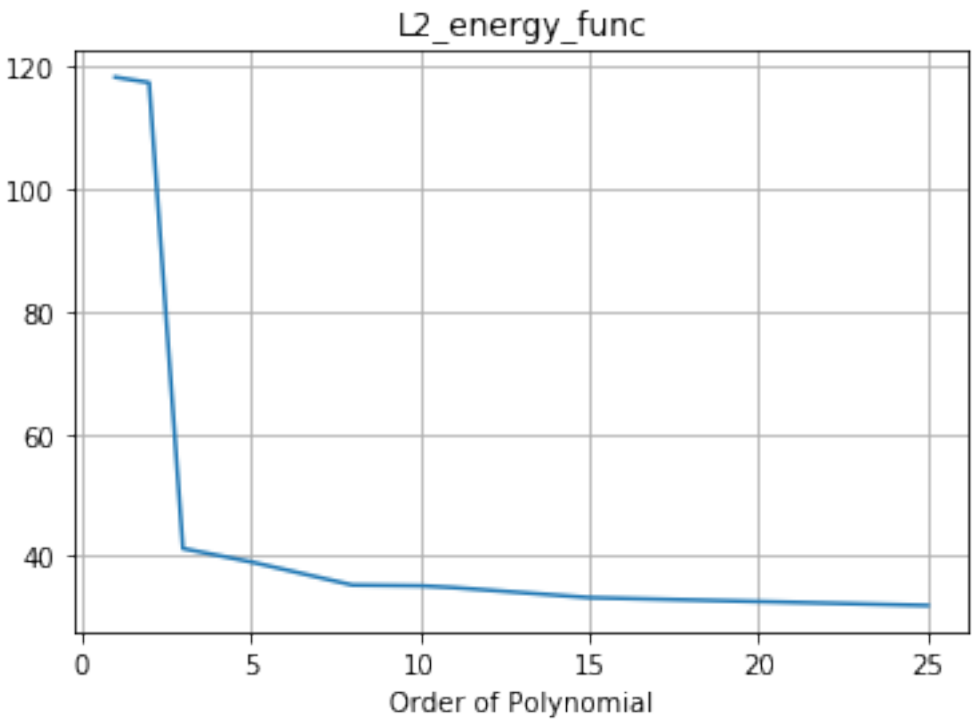
```
[118.24915715 117.37334049  41.25225445  39.08030955  35.29489651
  35.16845174  34.87362018  33.23546773  31.94936513]
```



0.4 Plot the approximating polynomial curve with varying polynomial degree.

```
In [433]: x_ener=[1,2,3,5,8,10,11,15,25]
          plt.title("L2_energy_func")
          plt.grid()
          plt.xlabel("Order of Polynomial")
          plt.plot(x_ener,ener_list)

Out[433]: [<matplotlib.lines.Line2D at 0x238213b7ac8>]
```


L2_energy_func
120
100
80
60
40
0
5
10
15
20
25
Order of Polynomial

In [ ]:

In [ ]:

In [ ]: