Assignment12

December 13, 2018

1 Assignment12

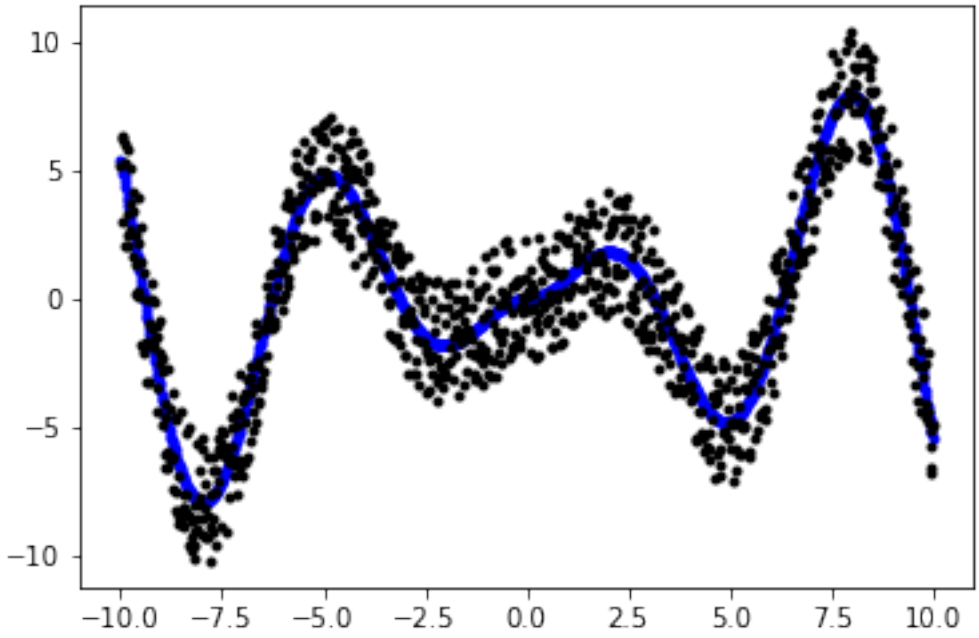
1.1 Name : ChoiBowon

1.2 Student ID : 20155212

1.3 GitHub : https://github.com/ChoiBowon/Assignment

In [47]:
```
import numpy as np
import matplotlib.pyplot as plt
import numpy.linalg as lin
```

In [48]:
```
num     = 1001
std     = 5

# x  : x-coordinate data
# y1 : (clean) y-coordinate data
# y2 : (noisy) y-coordinate data


plt.plot(x, y1, 'b.', x, y2, 'k.')
plt.show()
```



1.4 Define function for generating coordinates

```
In [49]: def fun(x):

                 # f = np.sin(x) * (1 / (1 + np.exp(-x)))
                 f = np.abs(x) * np.sin(x)
                 return f
```

1.5 Define n, nn, x, y1, y2

```
In [50]: n       = np.random.rand(num)
         nn      = n - np.mean(n)
         x       = np.linspace(-10,10,num)
         y1      = fun(x)                          # clean points
         y2      = y1 + nn * std                  # noisy points
```

1.6 Define lamda

```
In [51]: lamb_val = [2**(-3), 2**(-2), 2**(-1), 2**(0), 2**1, 2**2, 2**3]
         print(lamb_val)
```

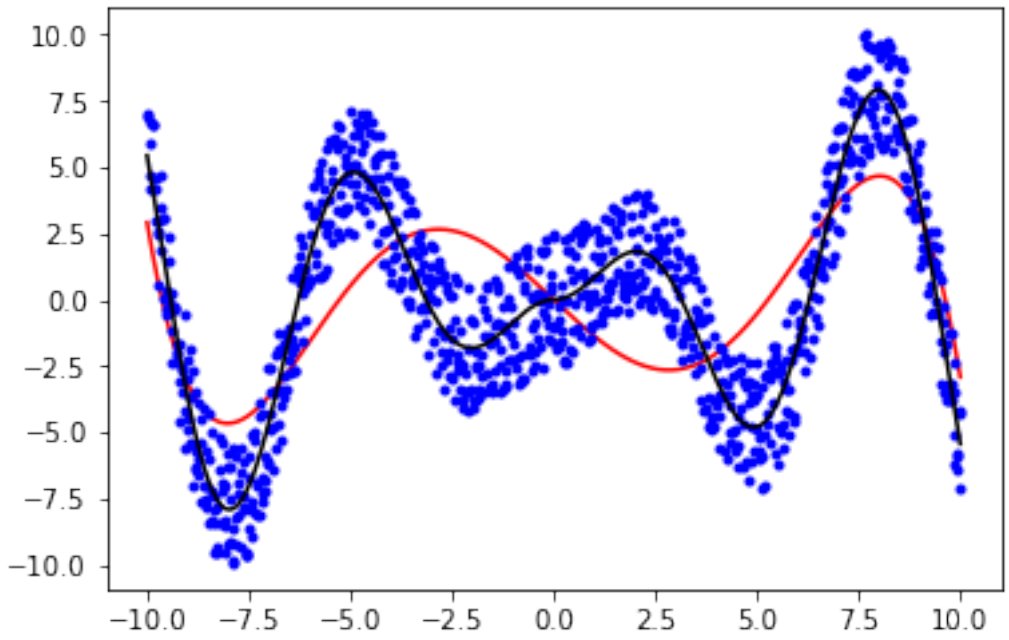
```
[0.125, 0.25, 0.5, 1, 2, 4, 8]
```

1.7 Define function for getting approximation

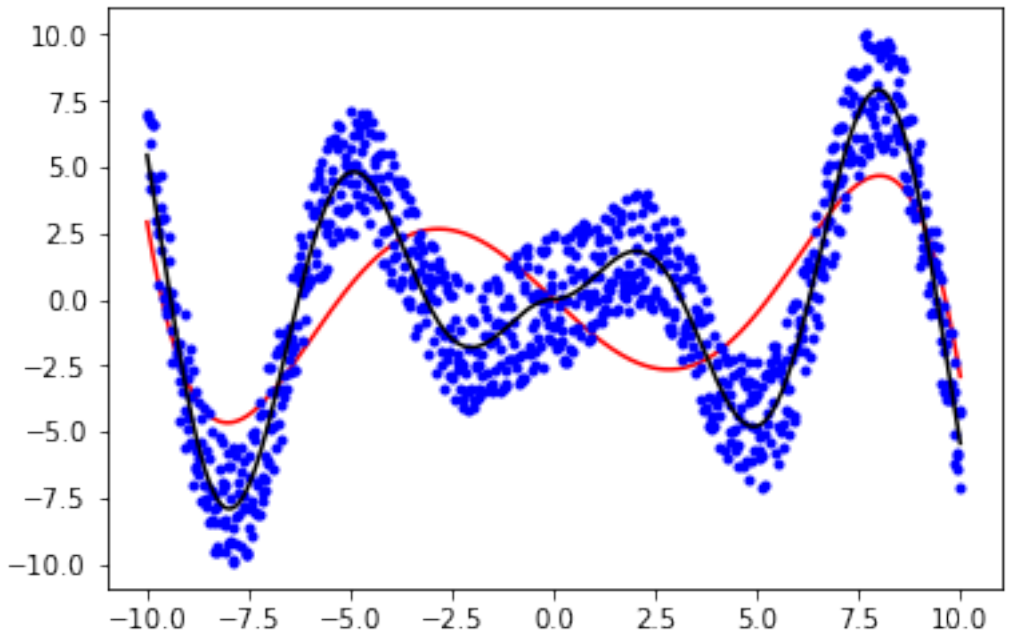
```
In [54]: def approx(x,y,p, lamb):
             iden = np.identity(p)
             zero = np.zeros((p,1))
             arr = np.ones((x.shape[0],p))

             for i in range(p):
                 arr.T[i] = x**i;

             iden = (2**int(lamb))*iden

             arr_con = np.concatenate((arr, iden), axis=0)
             y1 = np.concatenate((y.reshape(-1),zero.reshape(-1)), axis=0)

             result = np.dot(np.dot(lin.inv(np.dot(arr_con.T,arr_con)),arr_con.T),y1)

             energy = ((np.dot(arr, result) - y)**2).sum() - lamb*((arr*2).sum())

             return np.dot(arr,result), energy
```

```
In [55]: print('\nBlack: clean data / Blue: noise data / Red: least square curve\n')

         for i in range(6,16):
             error_val = np.empty(0)
             for j in lamb_val:
                 y3, energy = approx(x, y1, p=i, lamb=j)
                 error_val = np.append(error_val, energy)
                 plt.plot(x, y3,'r', x, y2,'b.', x, y1,'k')
                 plt.show()
                 print('p :',i)
                 print('lambda',j)

             print('\n<Energy graph When p =', i,'>')
             plt.plot(lamb_val, error_val)
             plt.show()
```

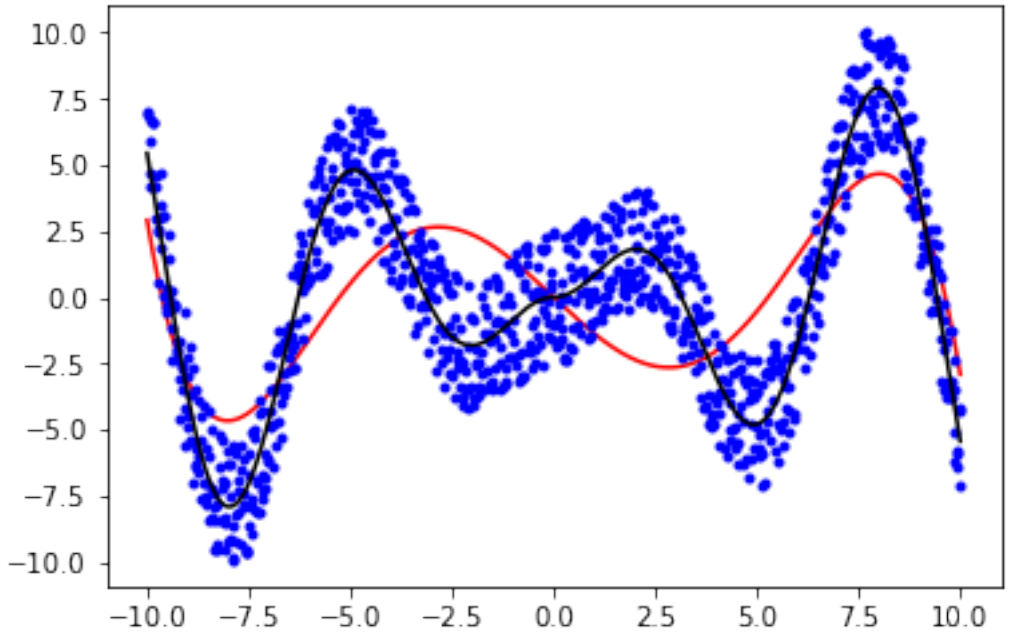
```
Black: clean data / Blue: noise data / Red: least square curve
```



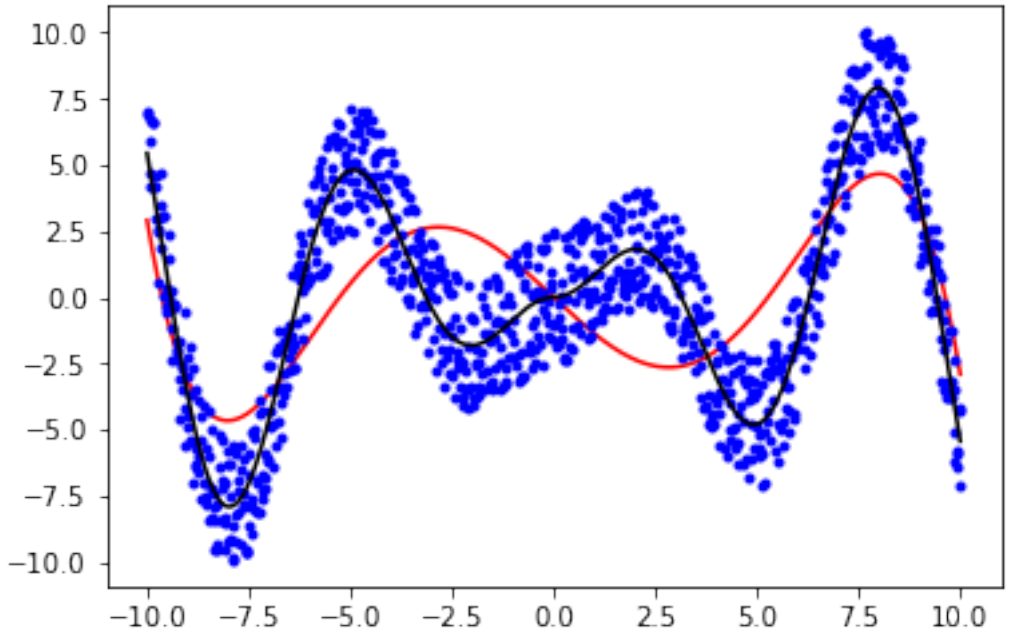

```
p : 6
lambda 0.125
```



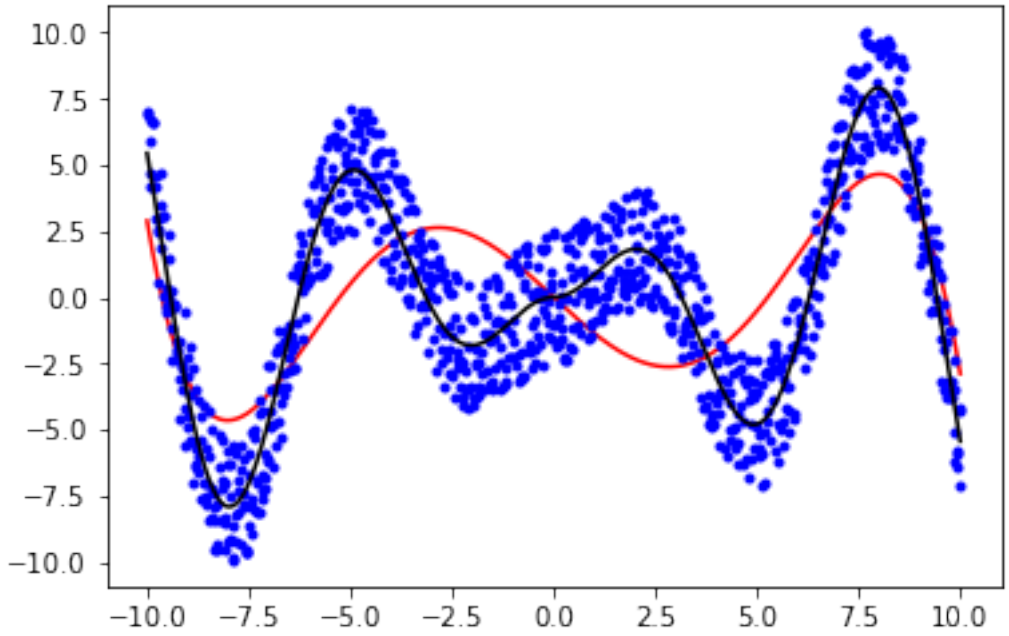
p : 6
lambda 0.25



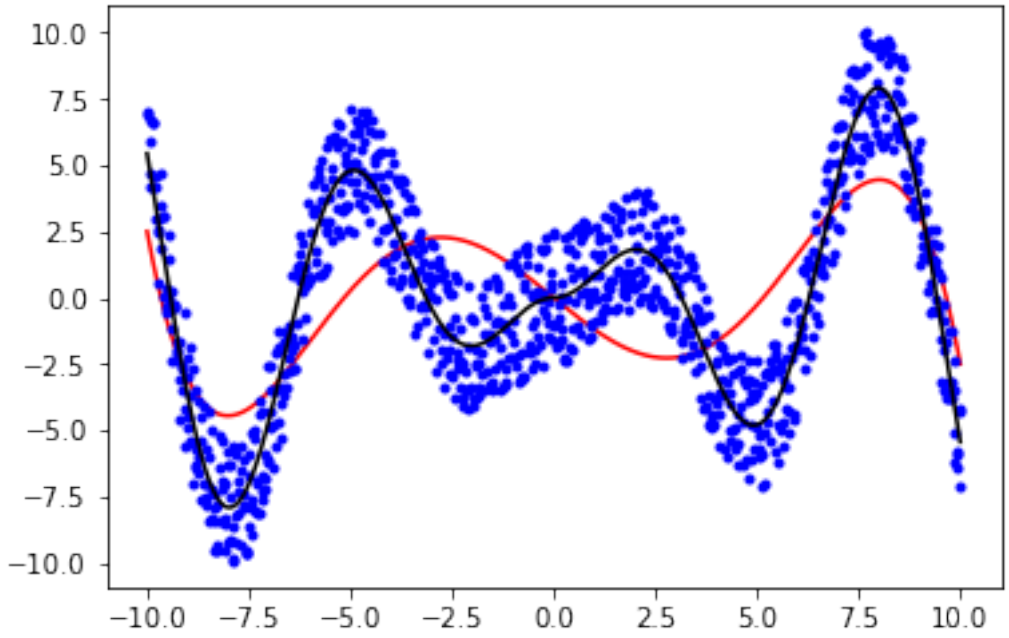
p : 6
lambda 0.5



p : 6
lambda 1



p : 6
lambda 2


10.0
7.5
5.0
2.5
0.0
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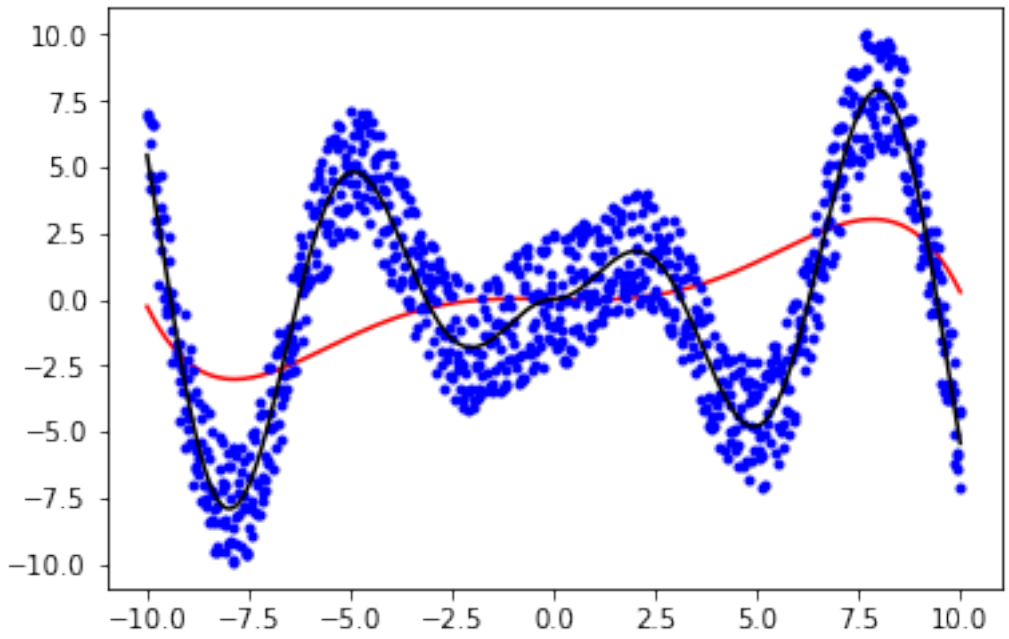
−5.0
−7.5
−10.0
−10.0
−7.5
−5.0
−2.5
0.0
2.5
5.0
7.5
10.0

```
p : 6
lambda 4
```


10.0
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2.5
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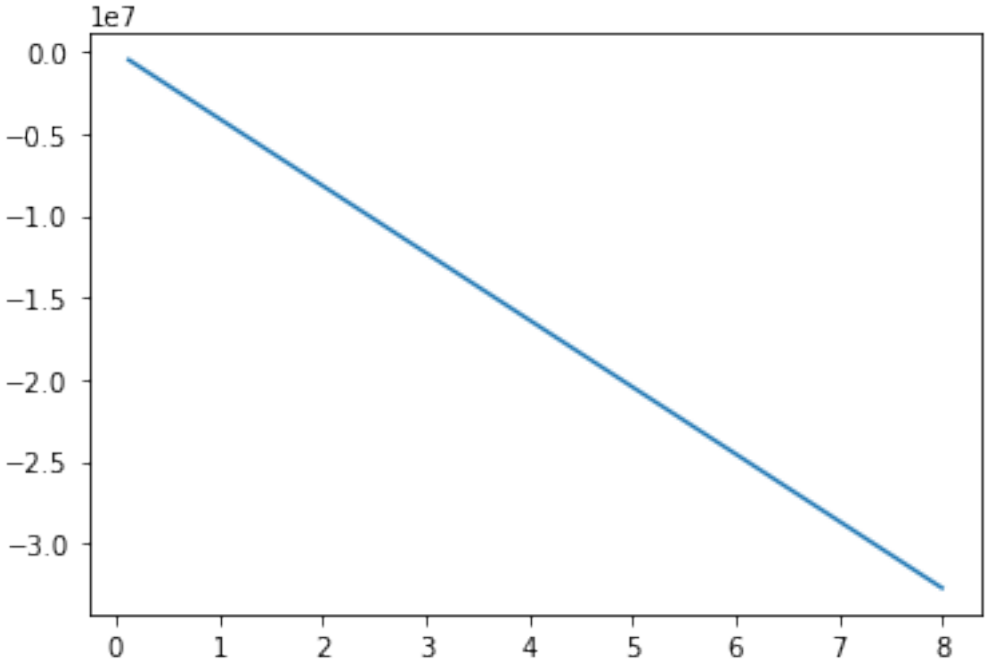
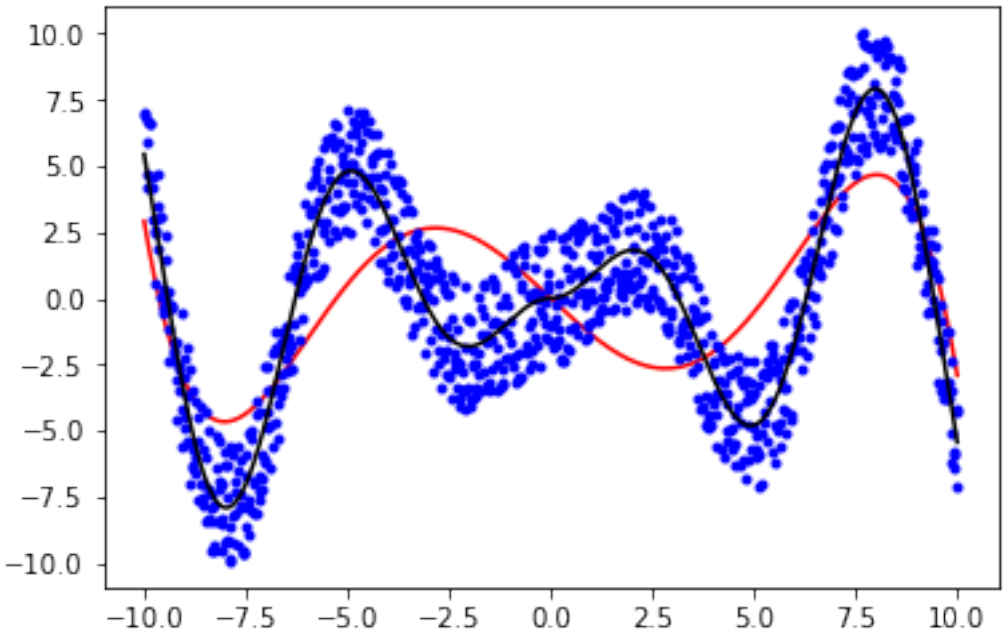
−5.0
−7.5
−10.0
−10.0
−7.5
−5.0
−2.5
0.0
2.5
5.0
7.5
10.0

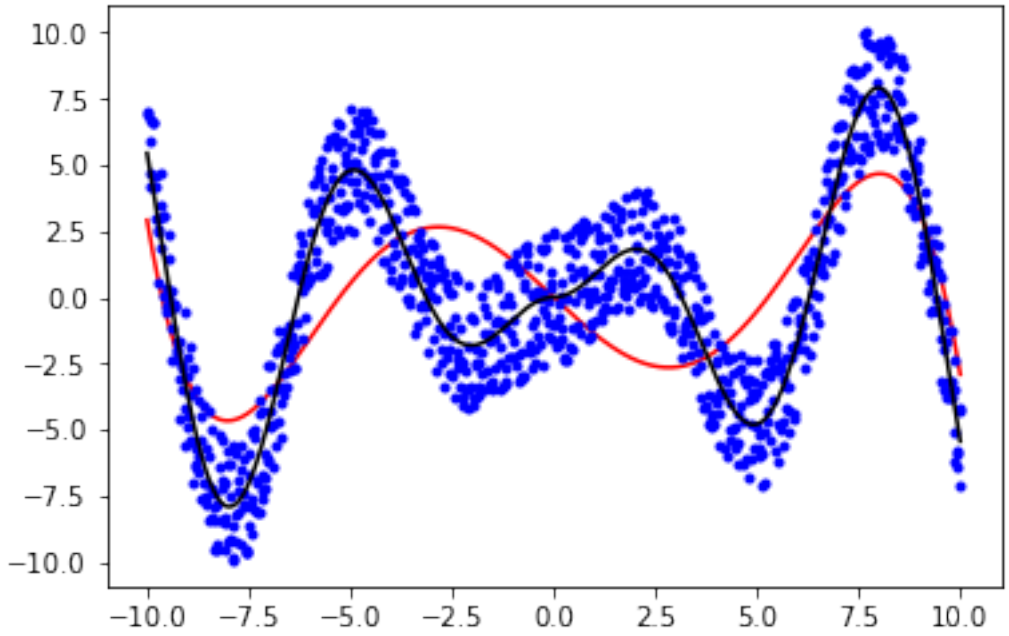
p : 6
lambda 8

<Energy graph When p = 6 >

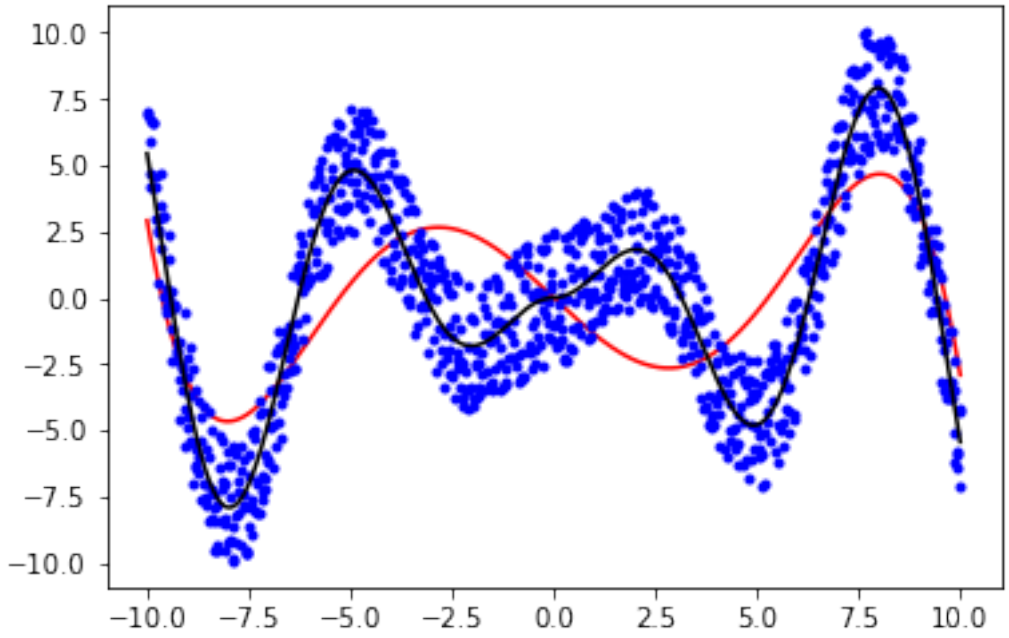




p : 7
lambda 0.125



p : 7
lambda 0.25


10.0
7.5
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2.5
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−5.0
−7.5
−10.0
−10.0
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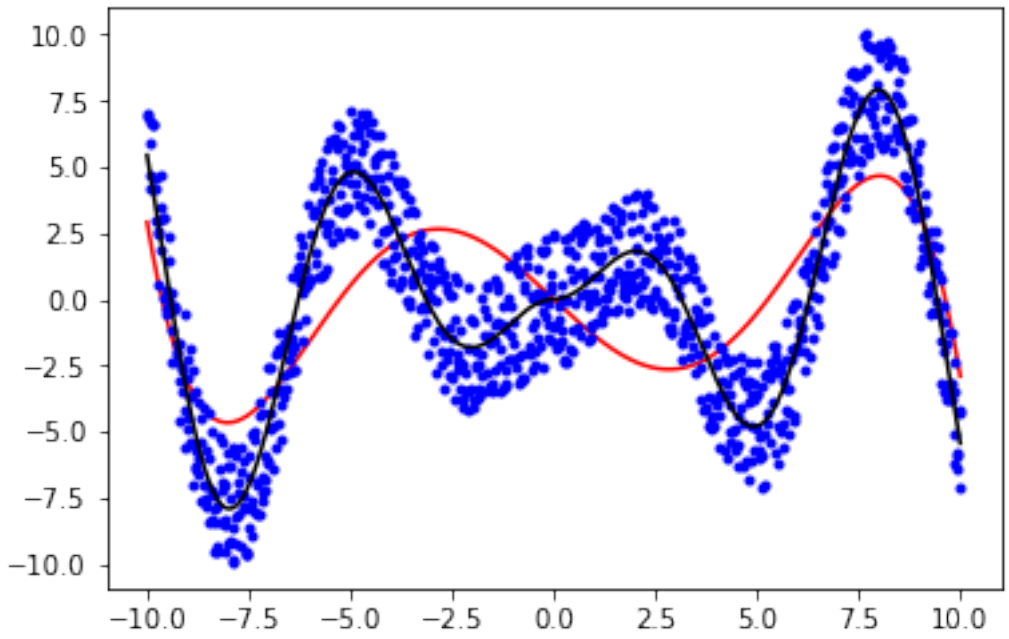
−2.5
0.0
2.5
5.0
7.5
10.0

```
p : 7
lambda 0.5
```


10.0
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−2.5
−5.0
−7.5
−10.0
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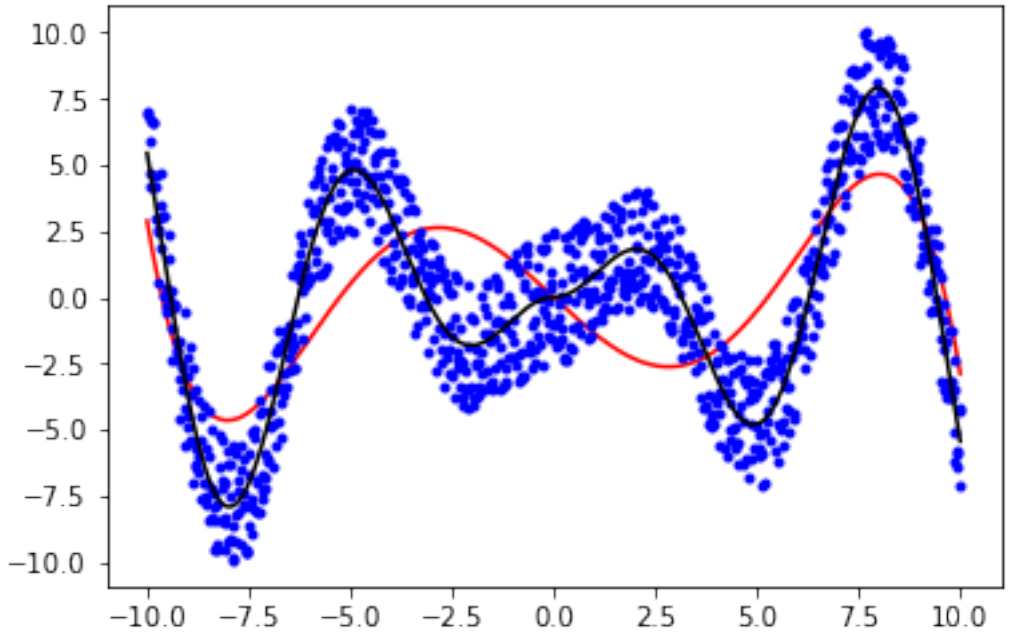
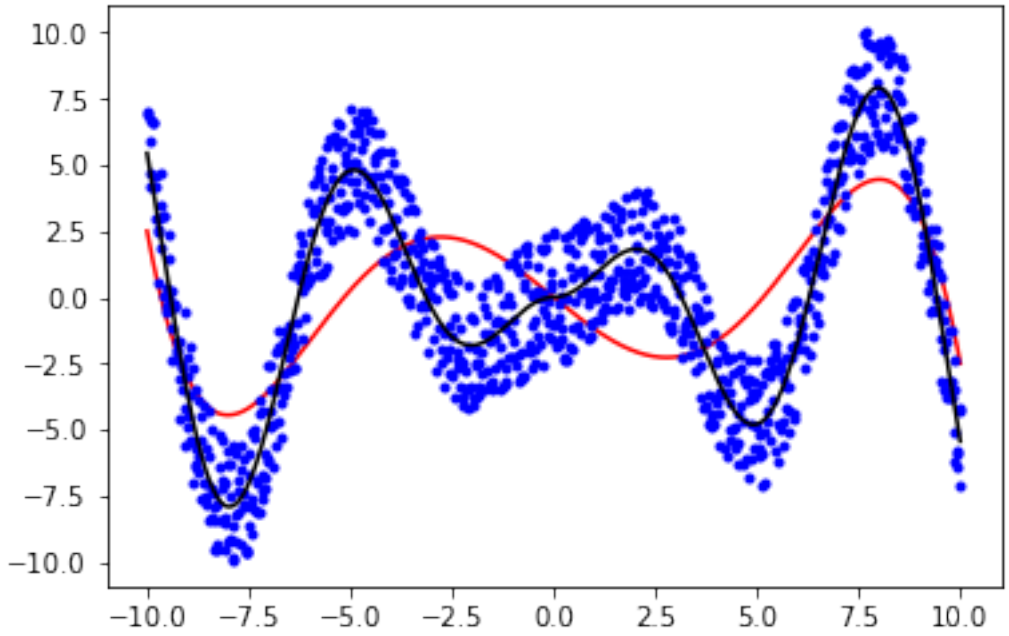
−2.5
0.0
2.5
5.0
7.5
10.0

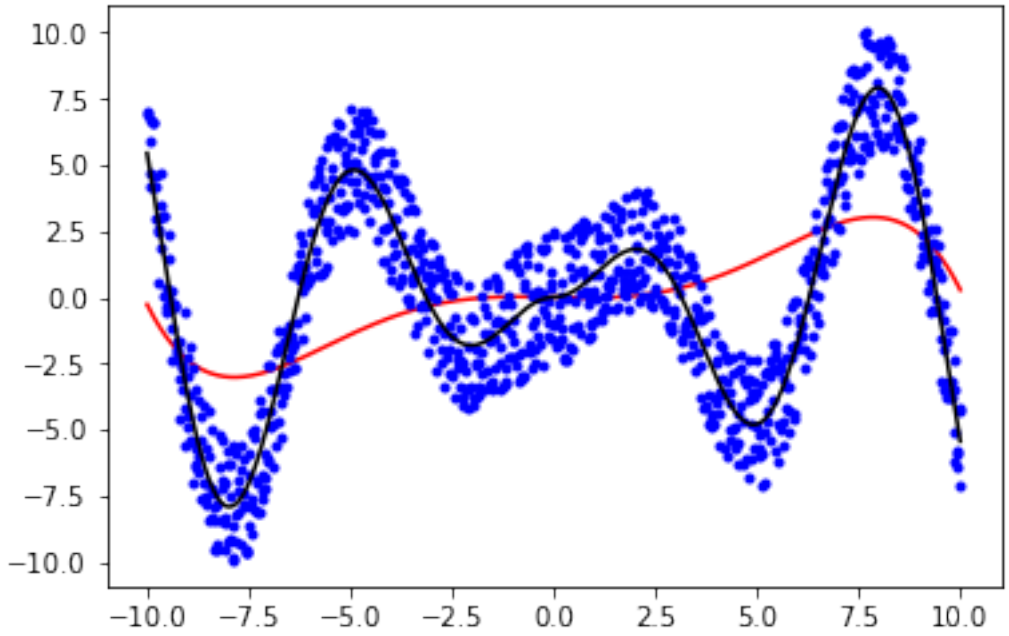
p : 7
lambda 1



p : 7
lambda 2

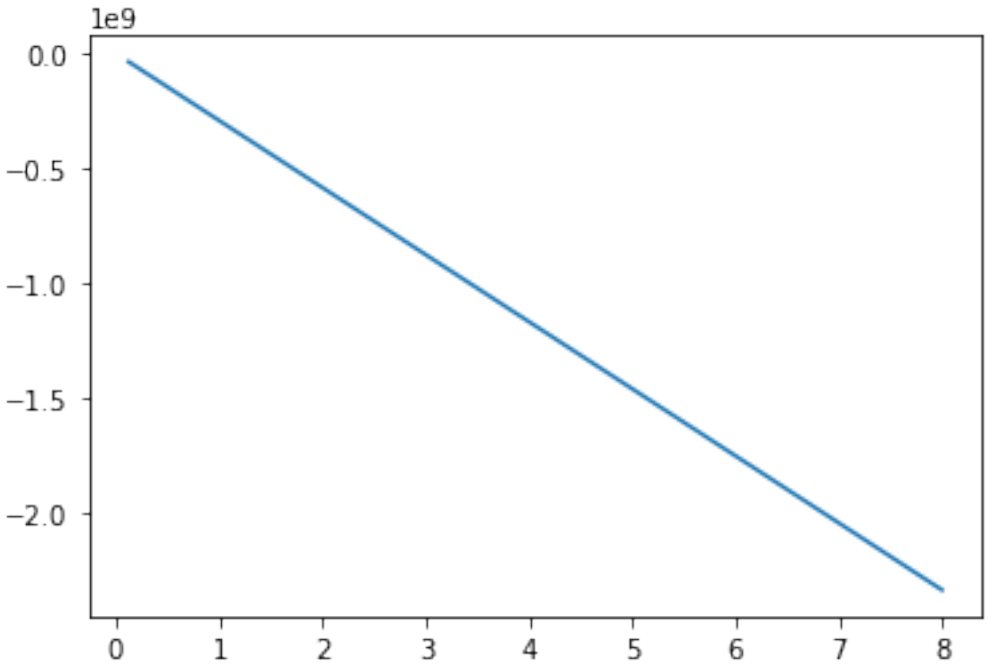


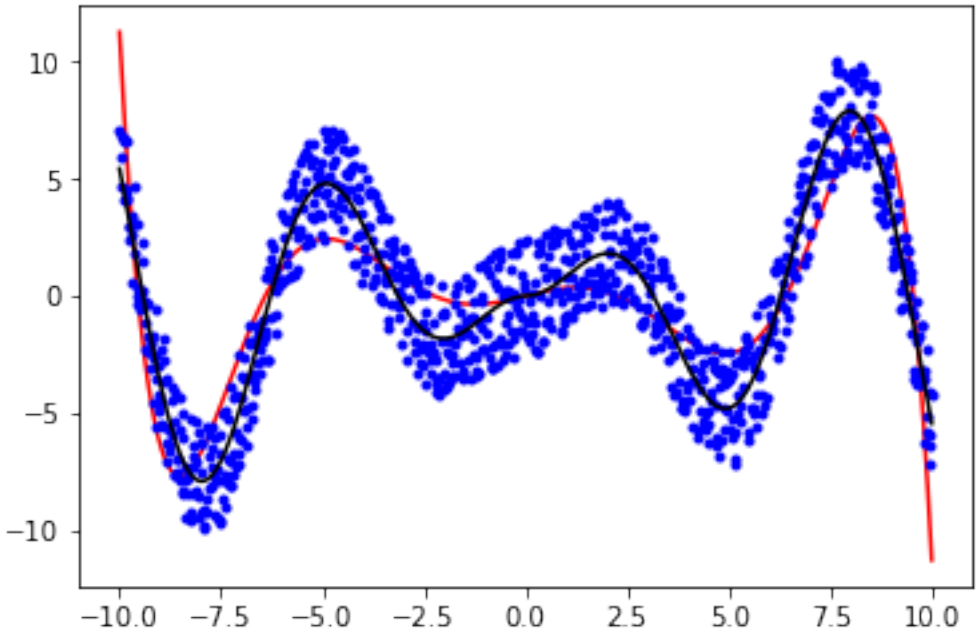
p : 7
lambda 4



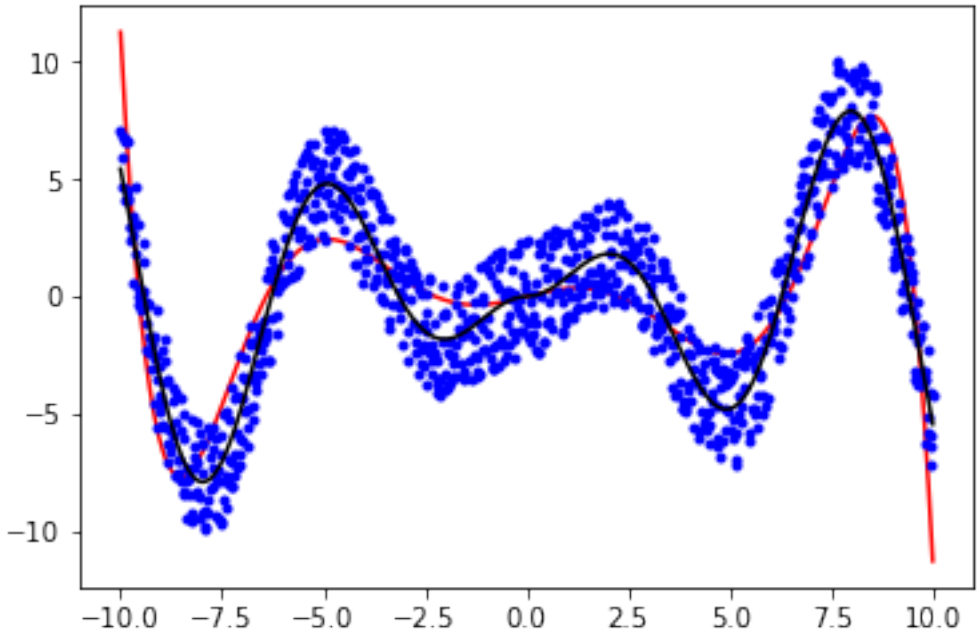
p : 7
lambda 8

<Energy graph When p = 7 >

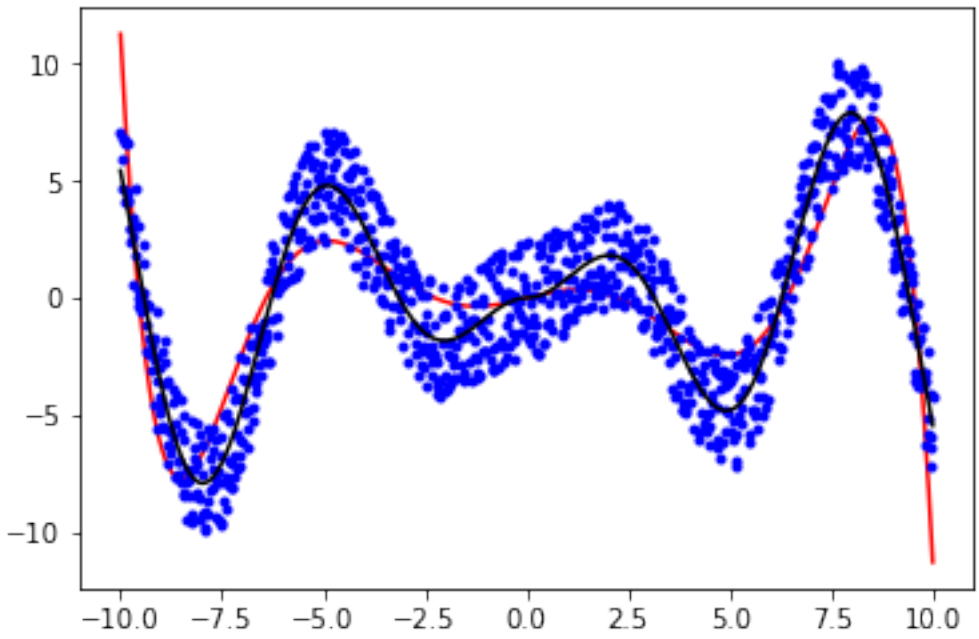




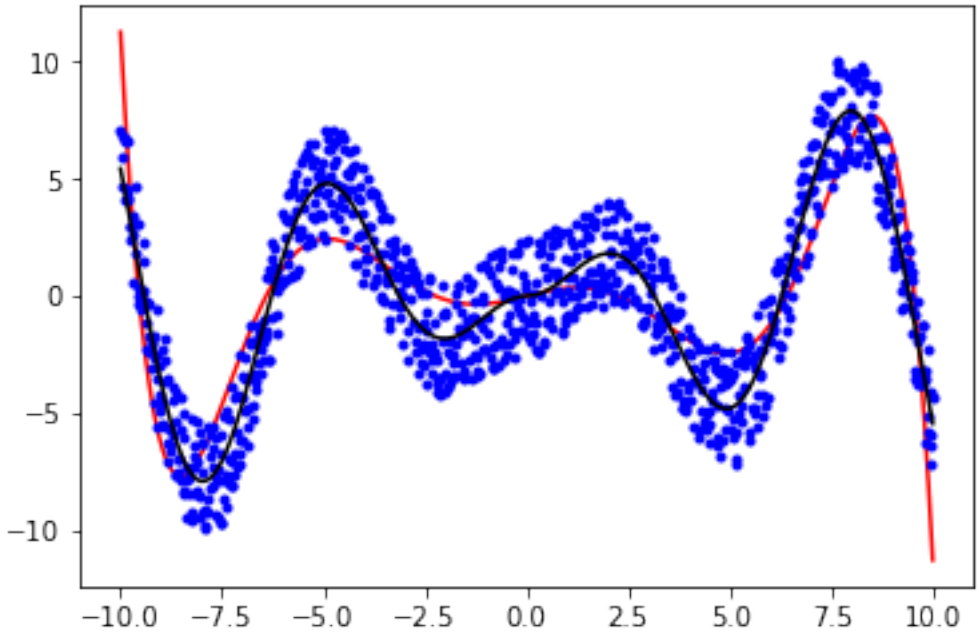

```
p : 8
lambda 0.125
```



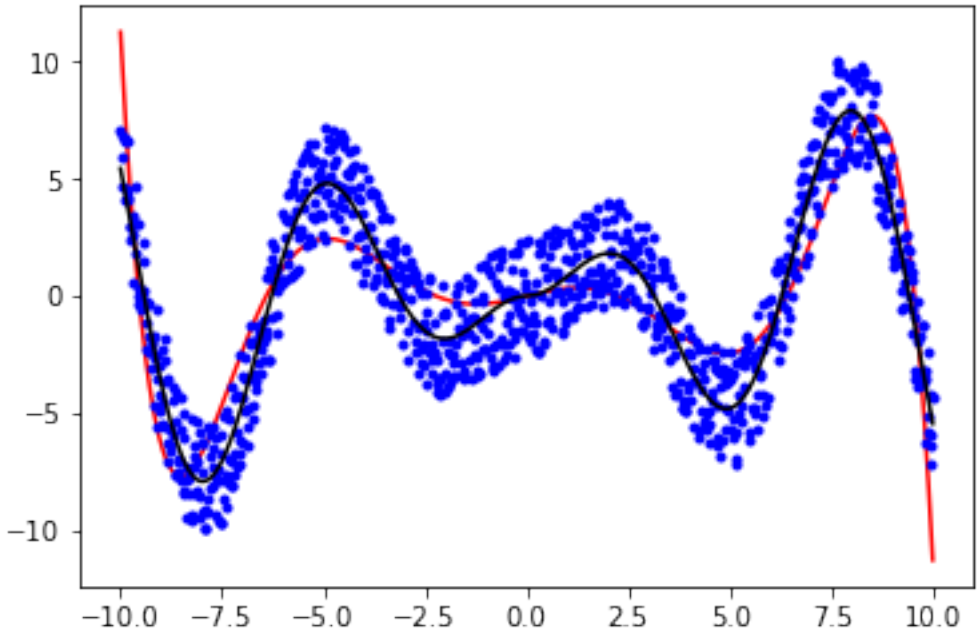

```
p : 8
lambda 0.25
```



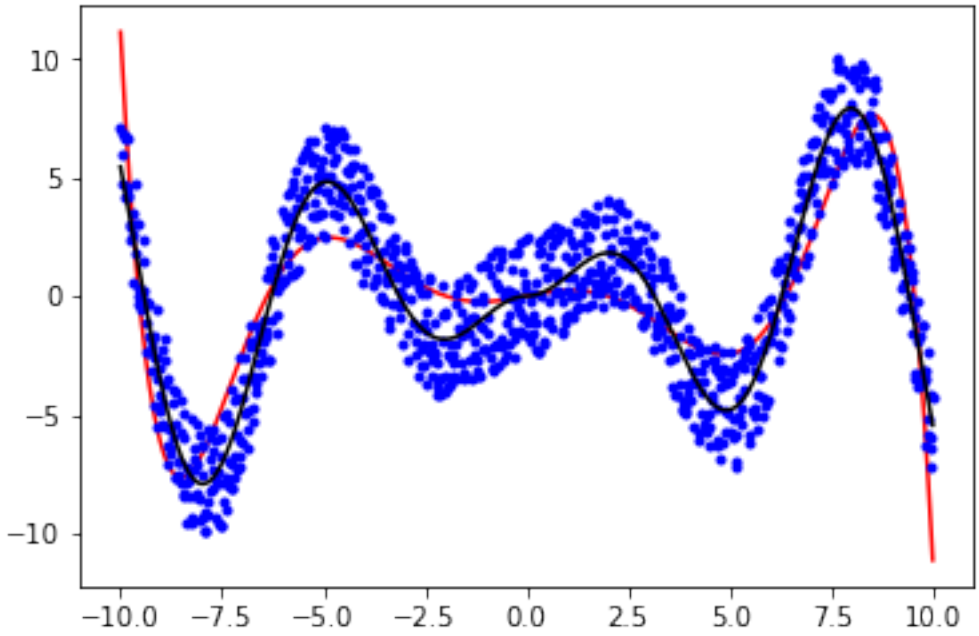
p : 8
lambda 0.5



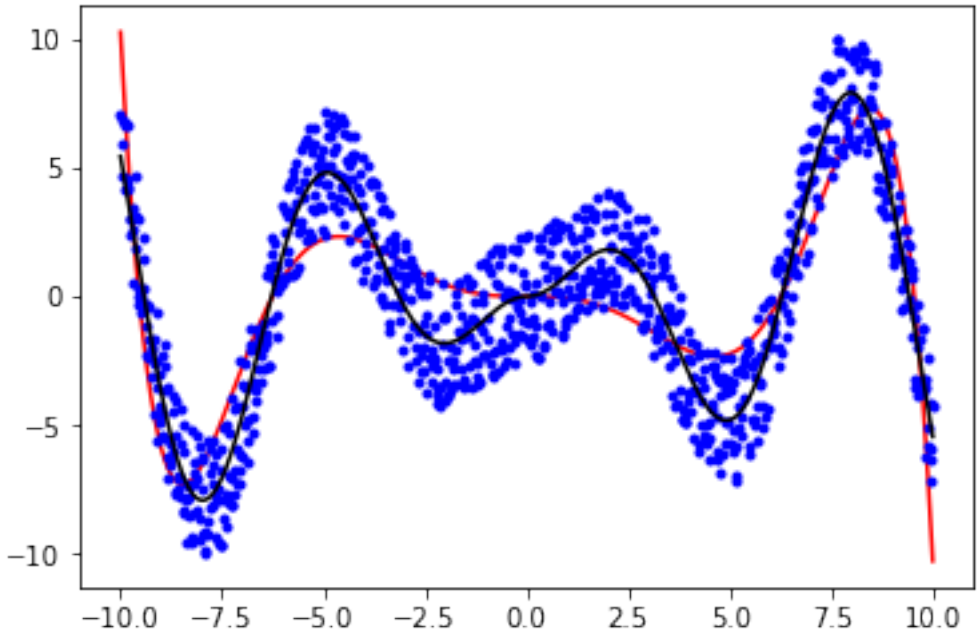
p : 8
lambda 1



```
p : 8
lambda 2
```

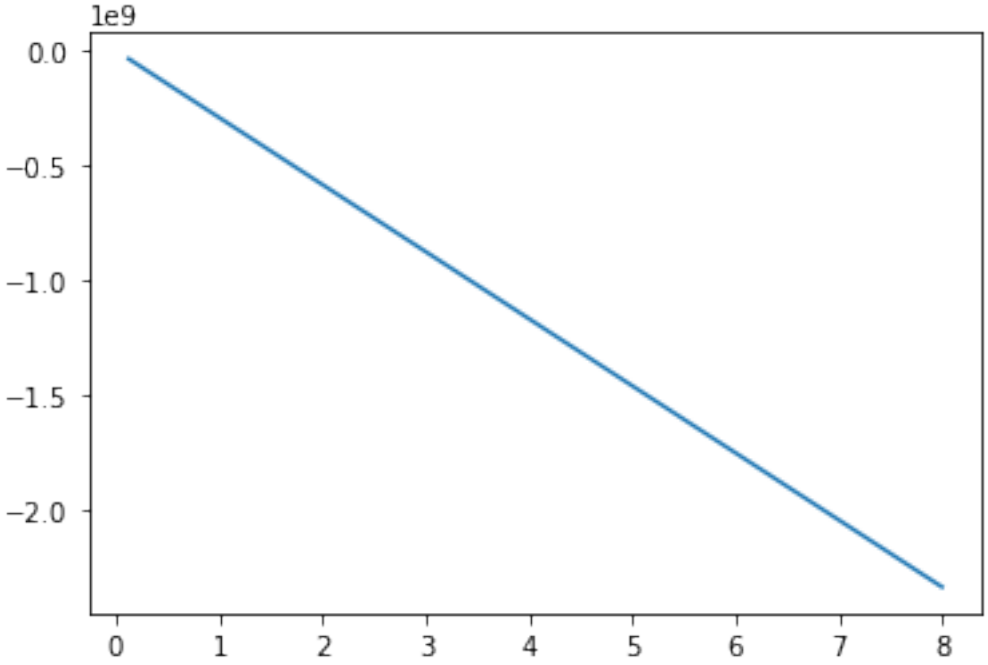


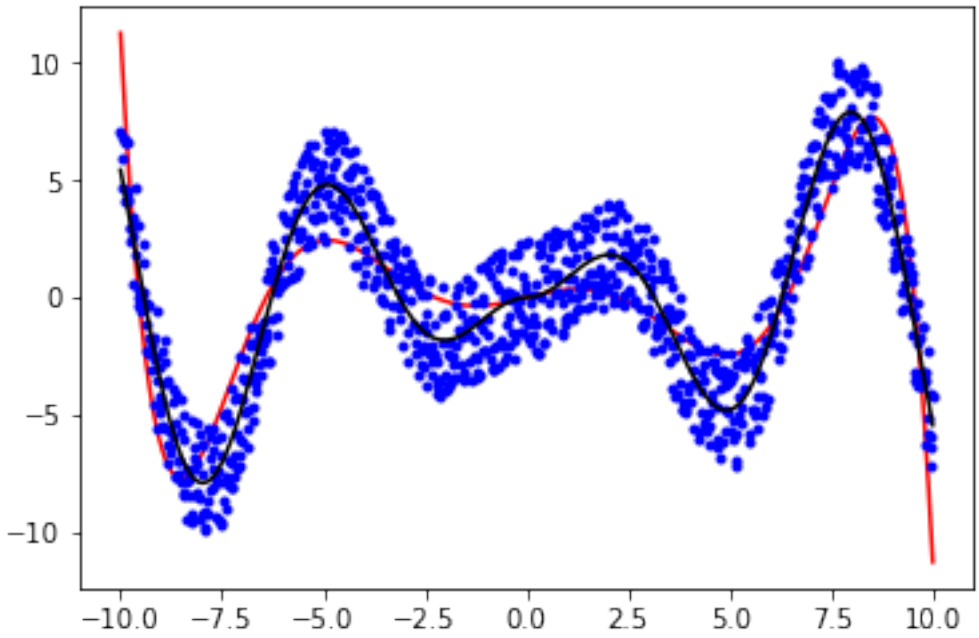

```
p : 8
lambda 4
```



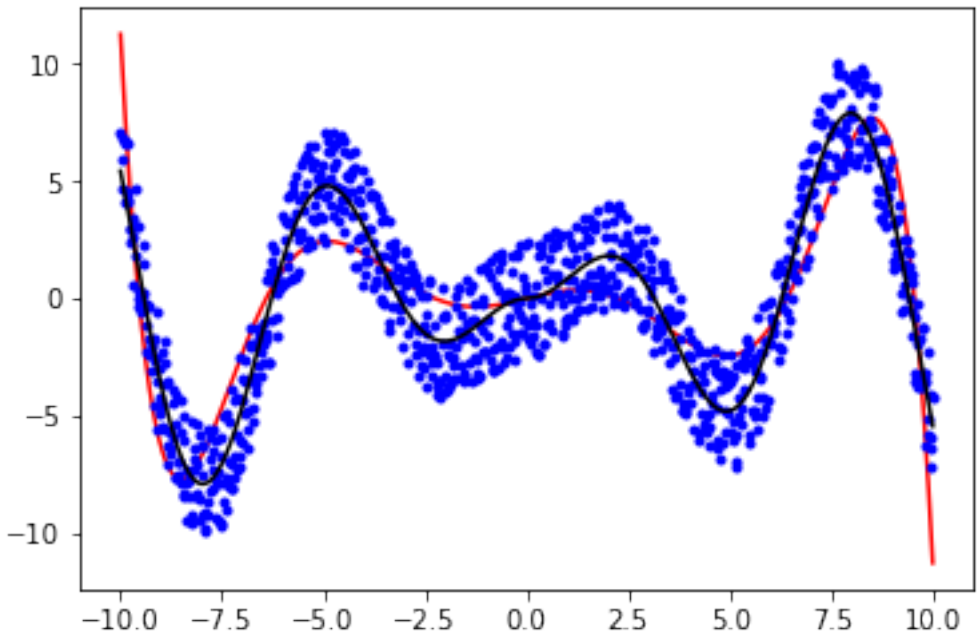
p : 8
lambda 8

<Energy graph When p = 8 >

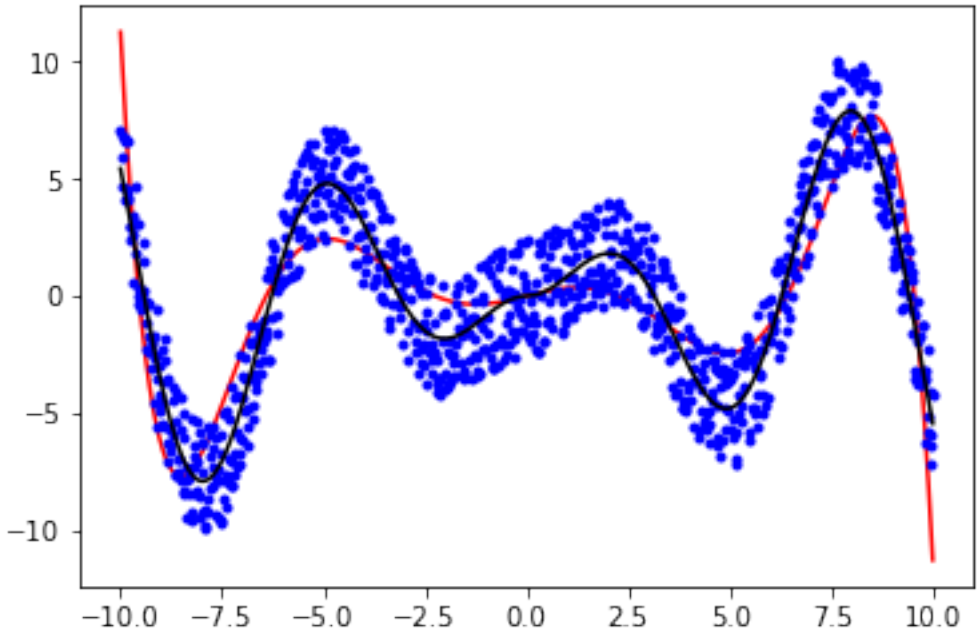




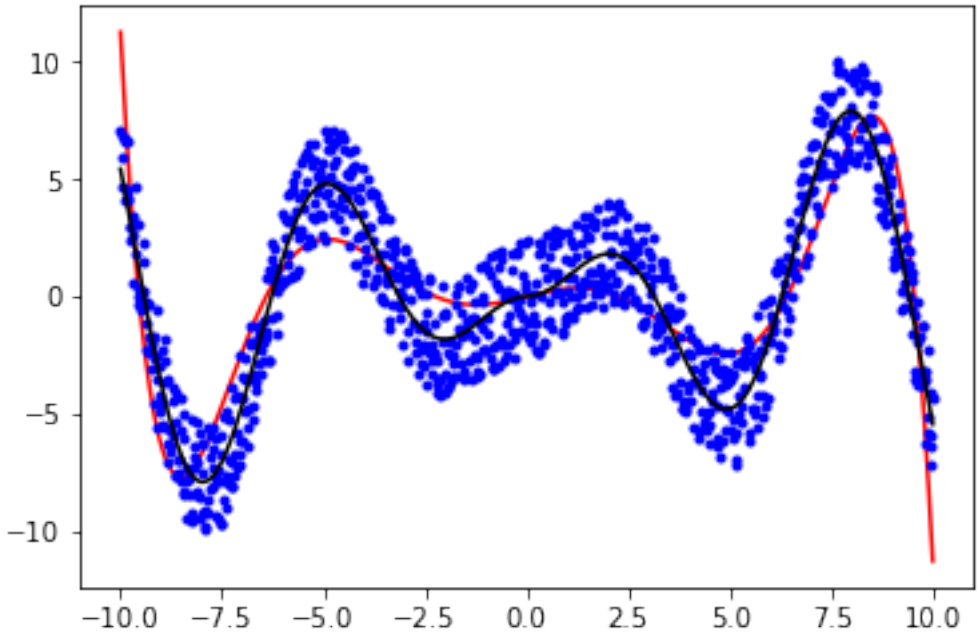

```
p : 9
lambda 0.125
```



p : 9
lambda 0.25



p : 9
lambda 0.5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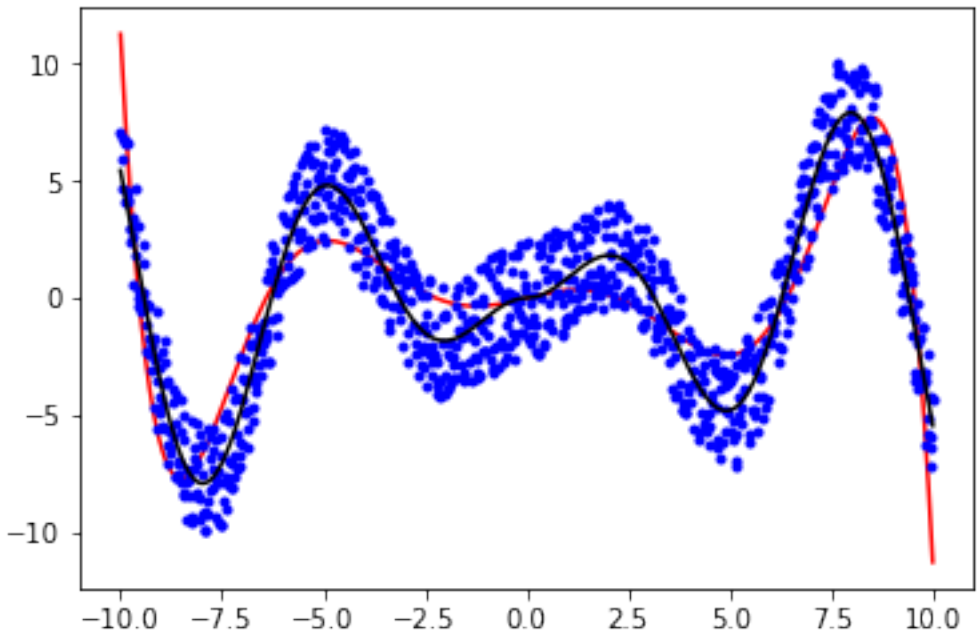
5.0
7.5
10.0

```
p : 9
lambda 1
```


10
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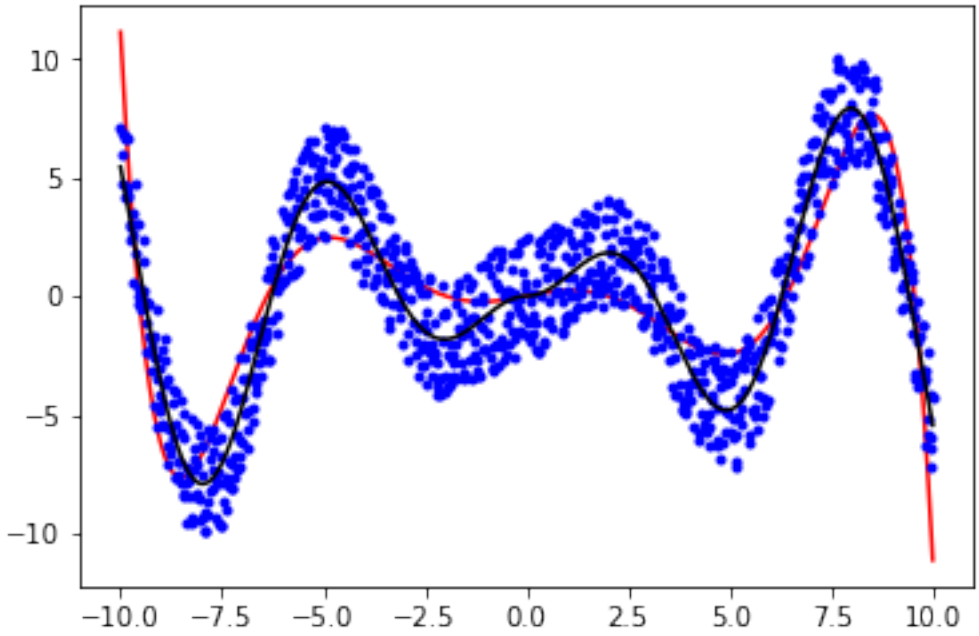
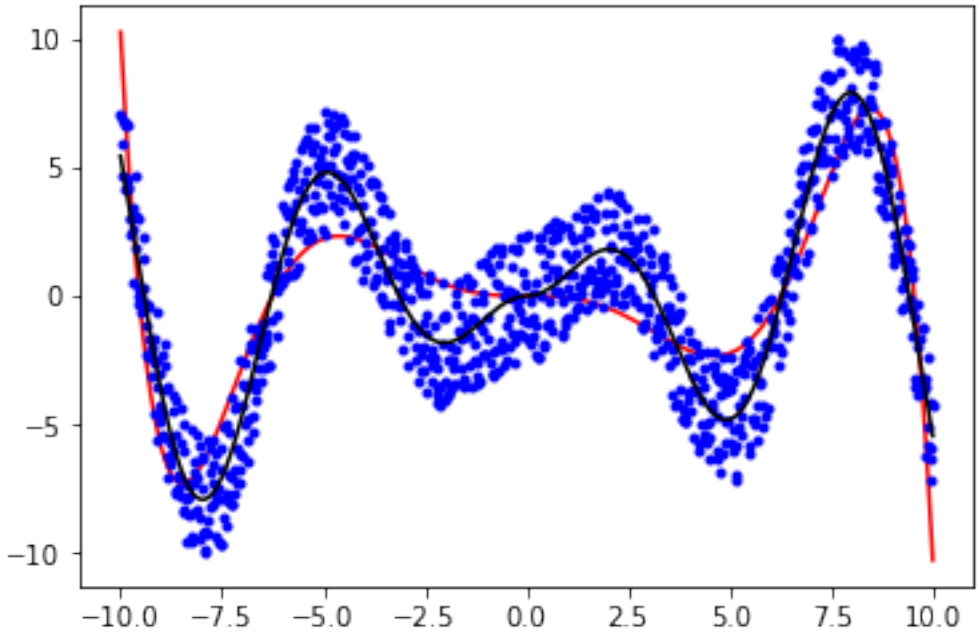
p : 9
lambda 2

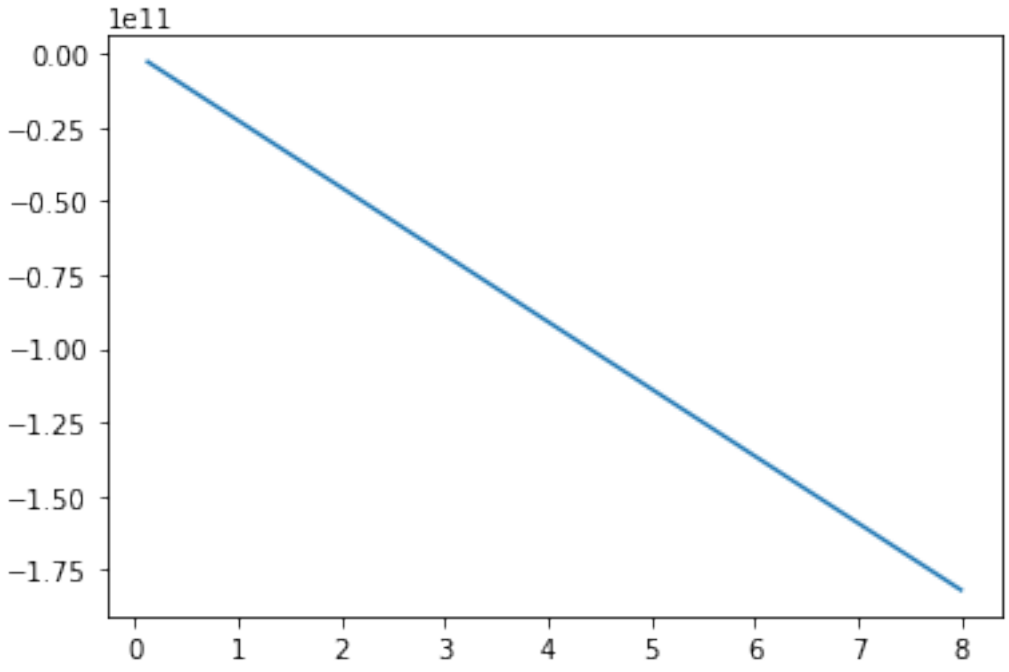


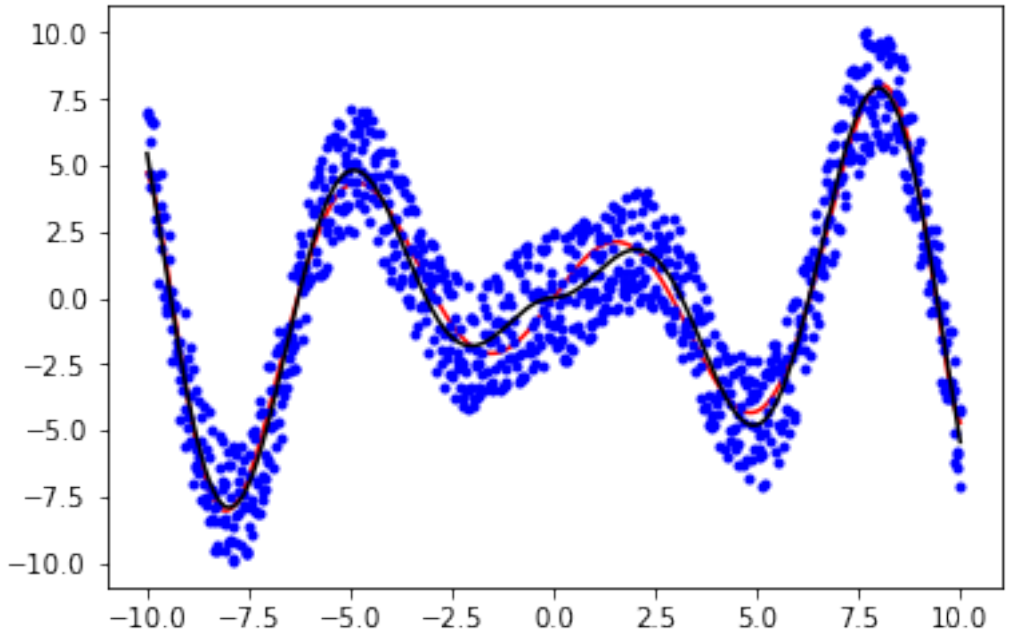
p : 9
lambda 4



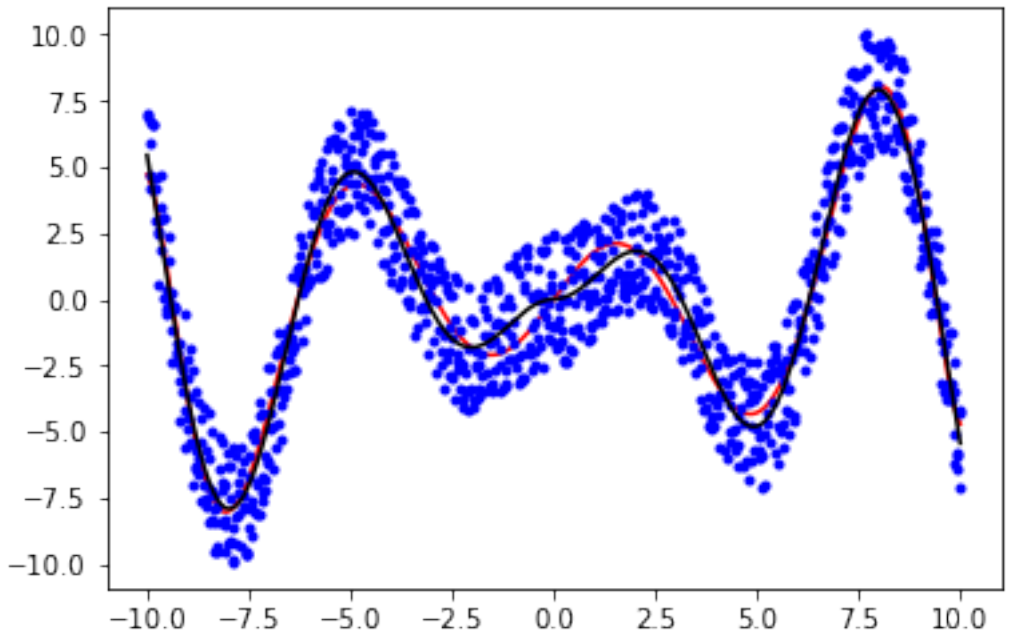
```
p : 9
lambda 8

<Energy graph When p = 9 >
```

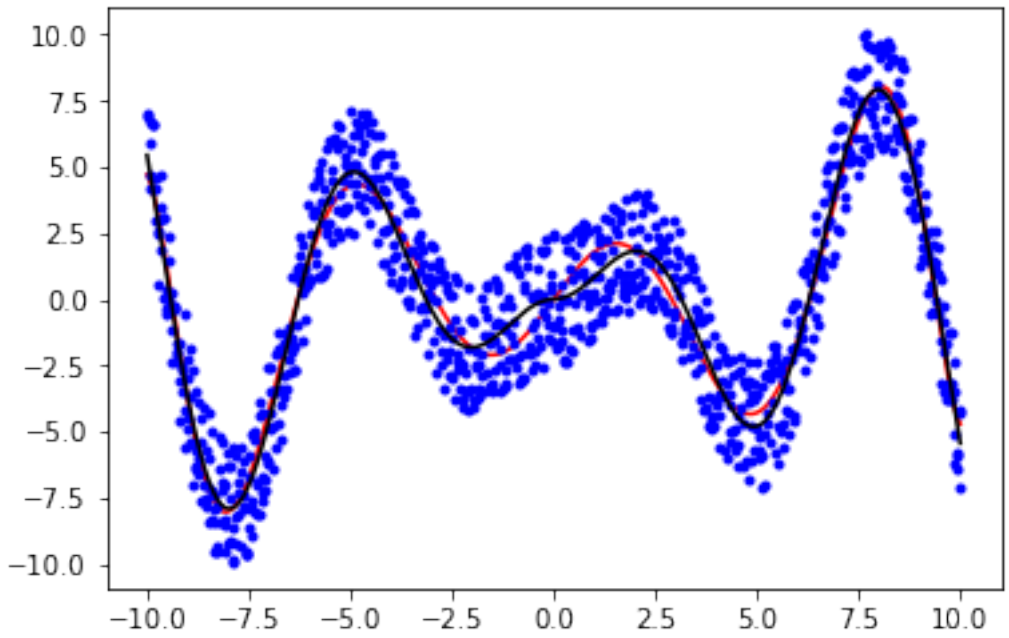




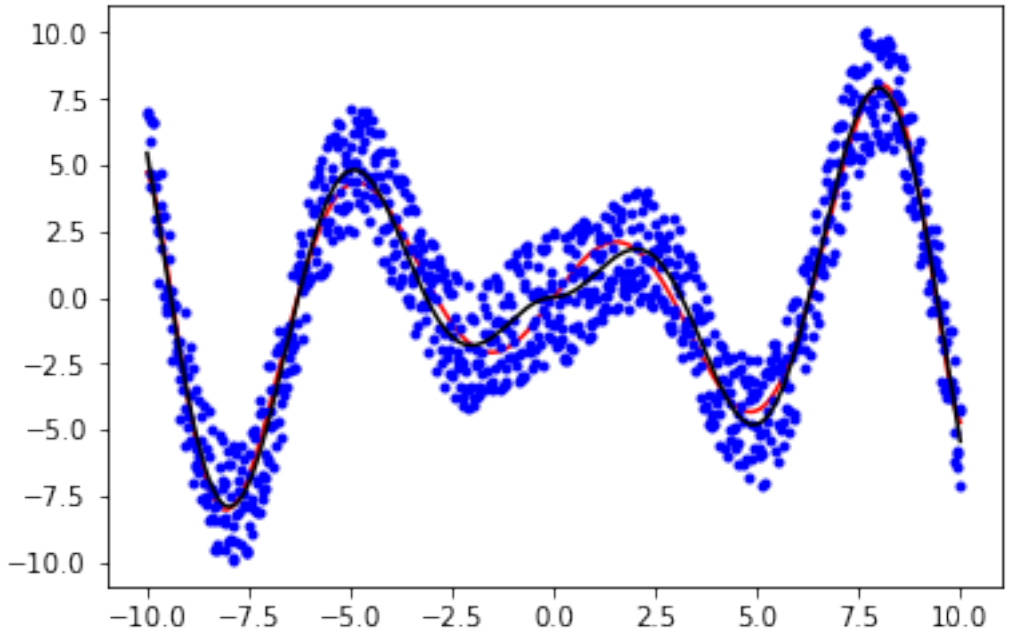

```
p : 10
lambda 0.125
```



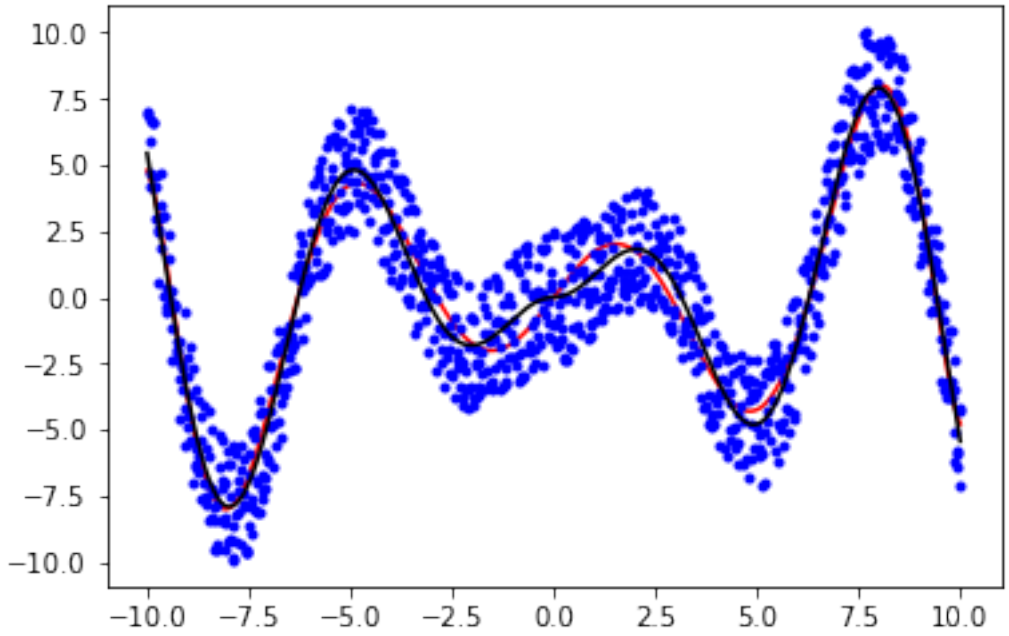
p : 10
lambda 0.25



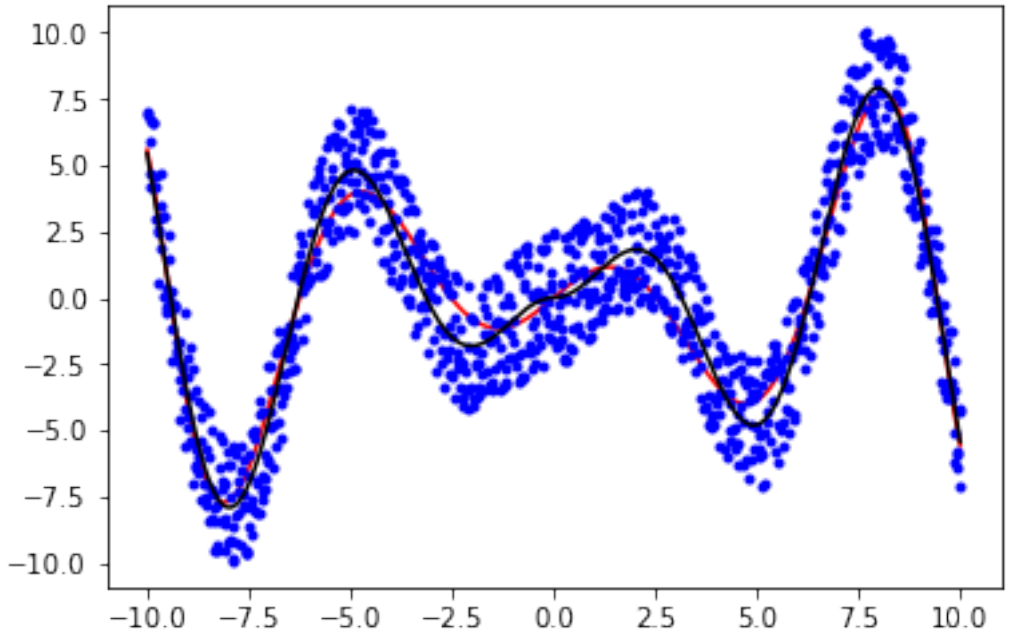
p : 10
lambda 0.5



```
p : 10
lambda 1
```




```
p : 10
lambda 2
```


10.0
7.5
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−7.5
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−10.0
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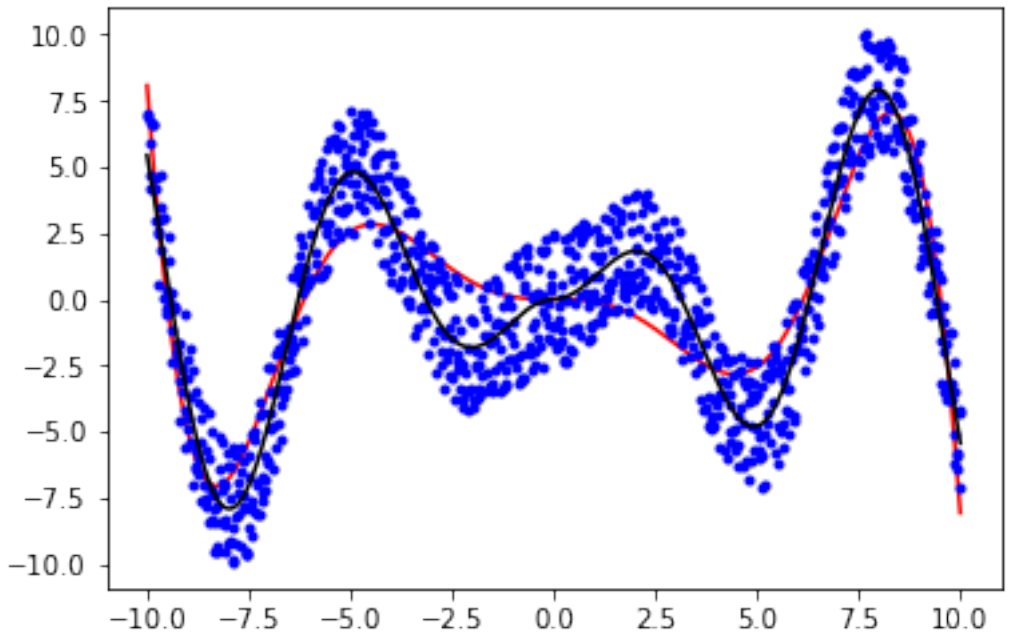
0.0
2.5
5.0
7.5
10.0

```
p : 10
lambda 4
```


10.0
7.5
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2.5
0.0
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−5.0
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2.5
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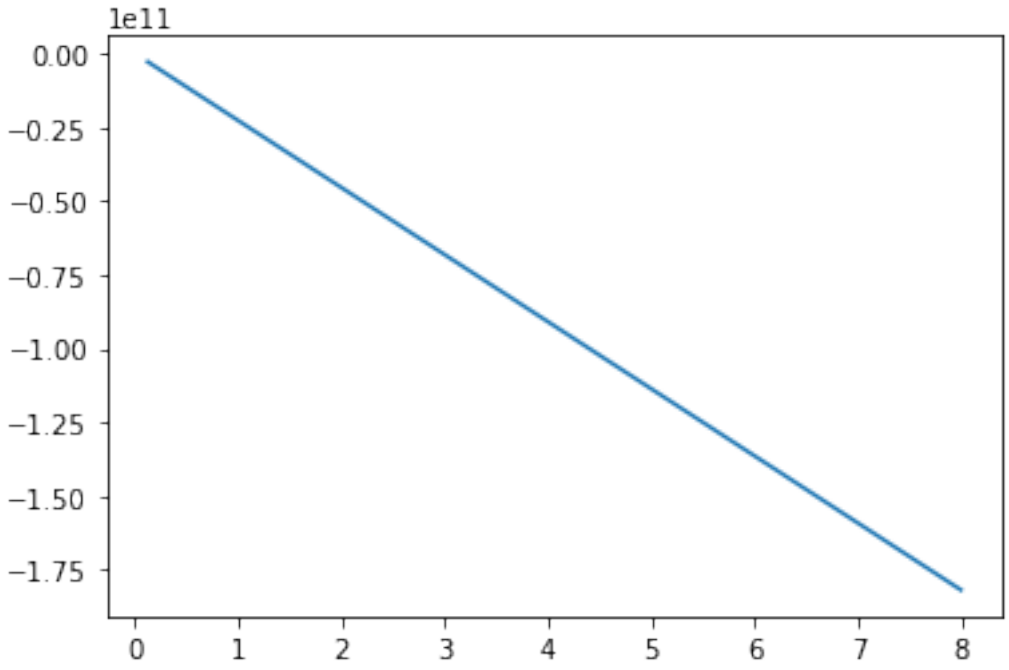
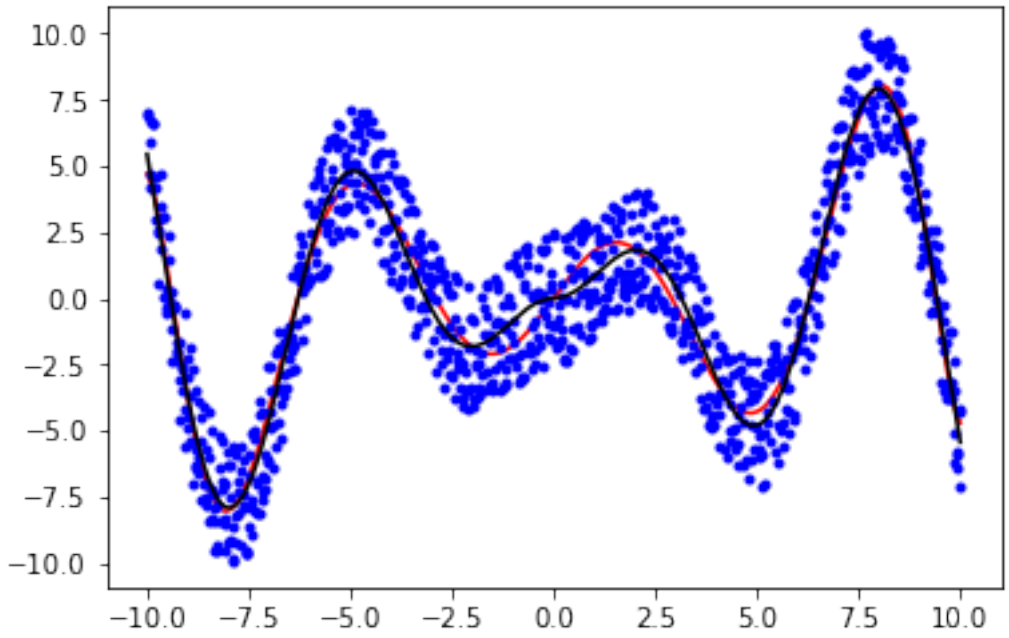
7.5
10.0

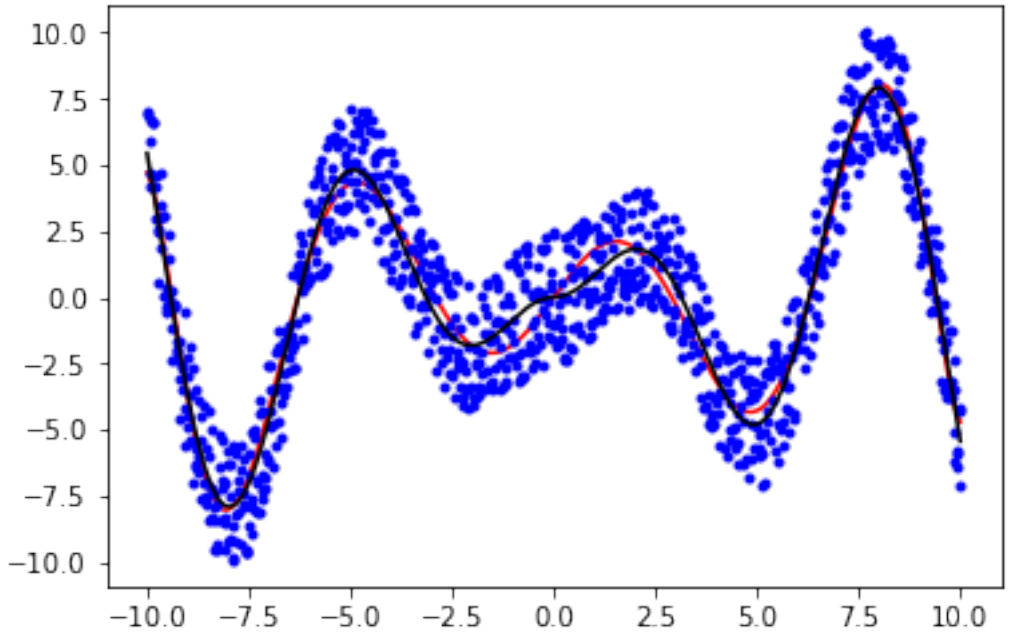
p : 10
lambda 8

<Energy graph When p = 10 >

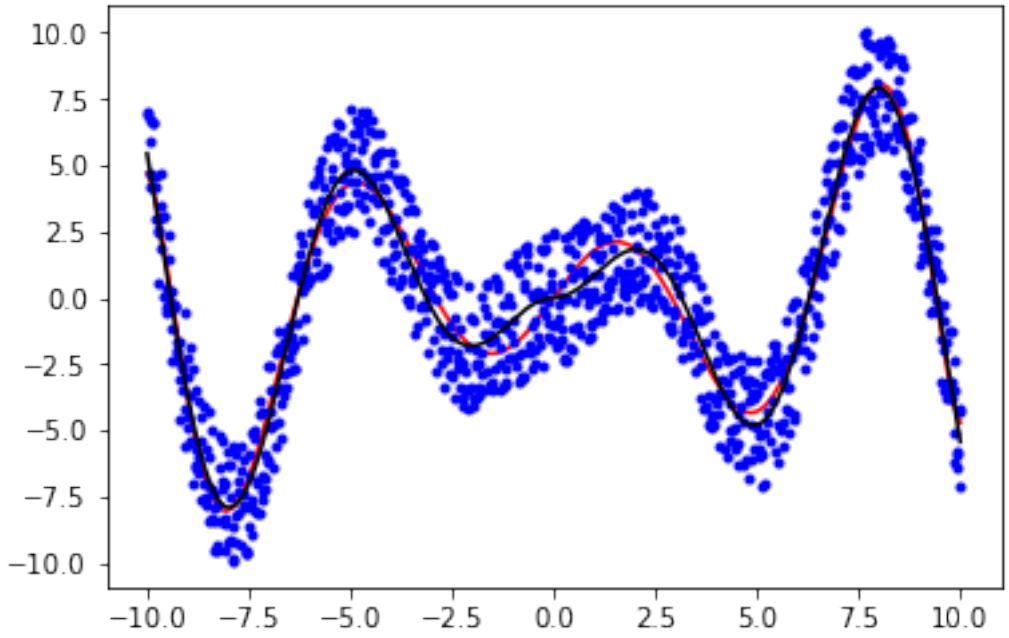




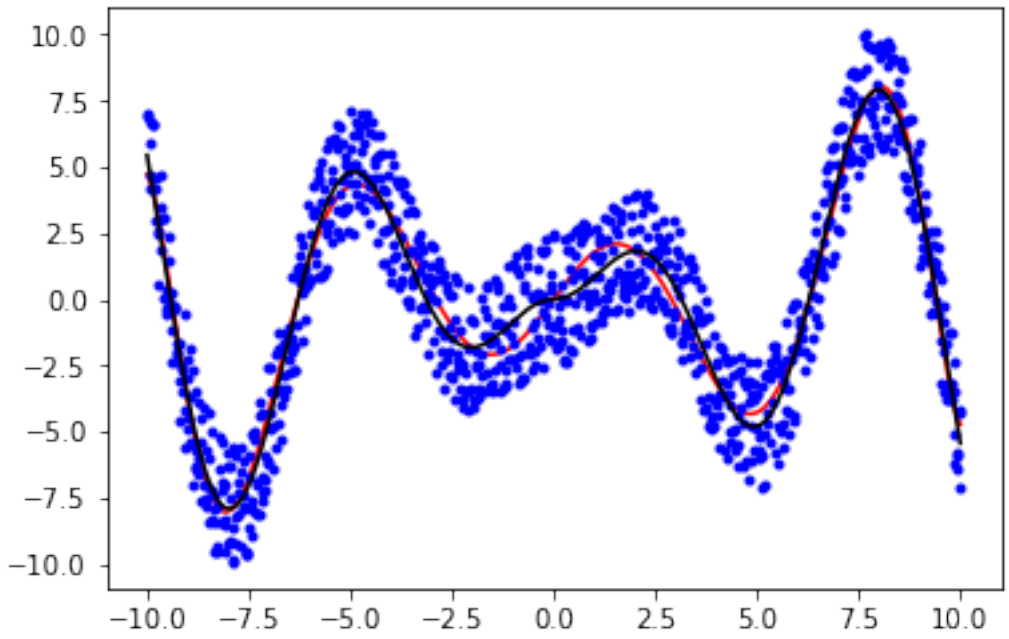
```
p : 11
lambda 0.125
```



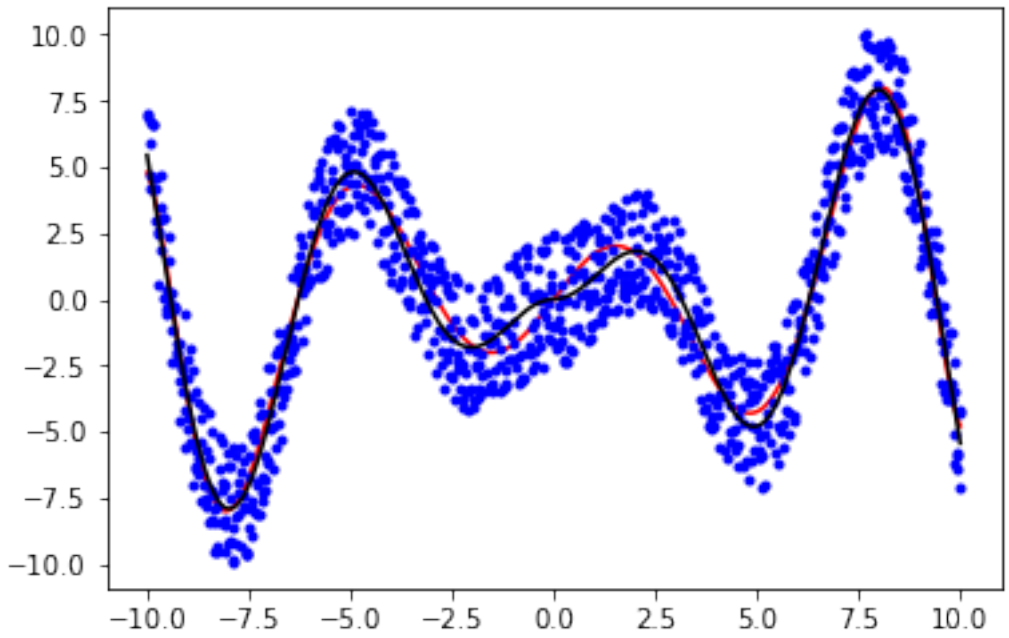

```
p : 11
lambda 0.25
```



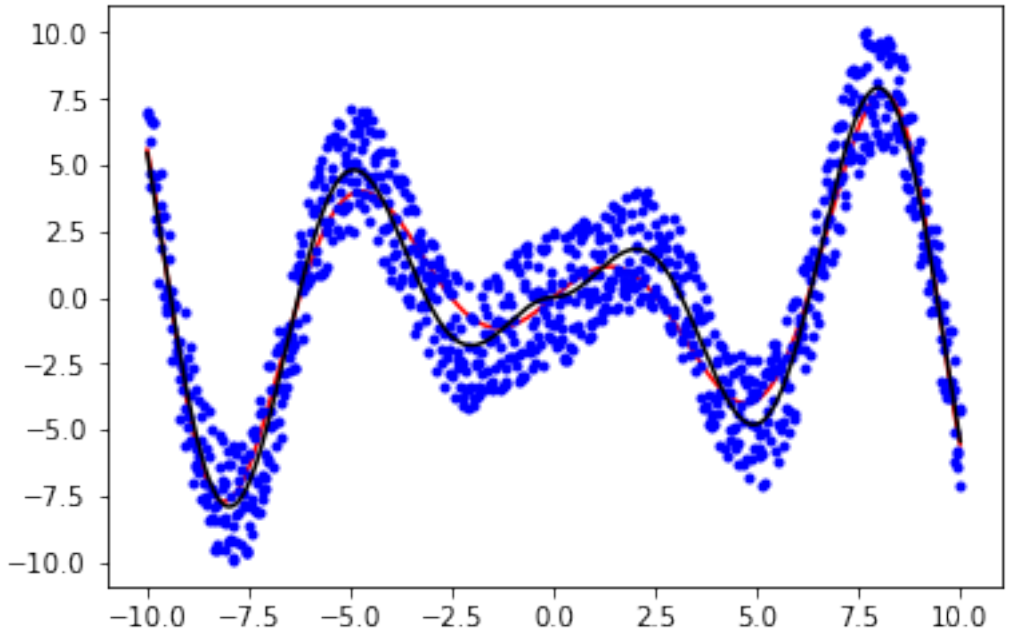

```
p : 11
lambda 0.5
```



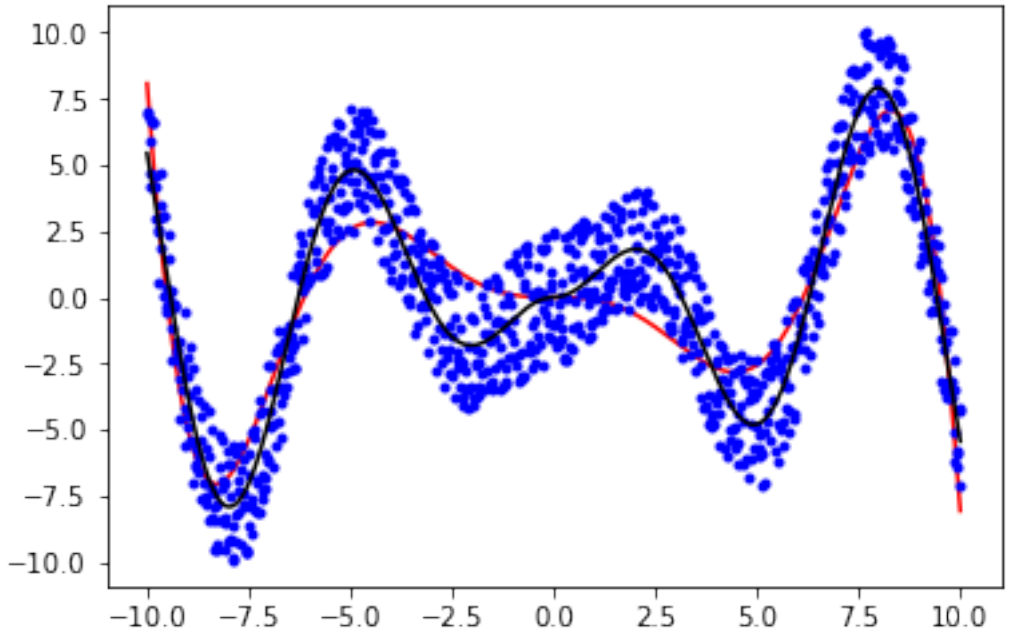
```
p : 11
lambda 1
```




```
p : 11
lambda 2
```

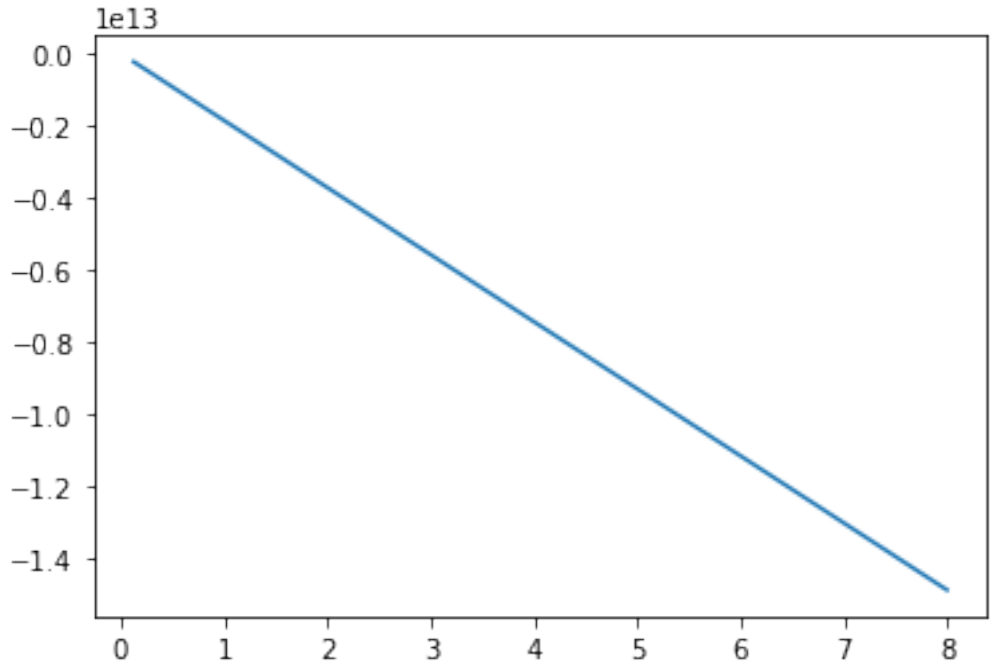


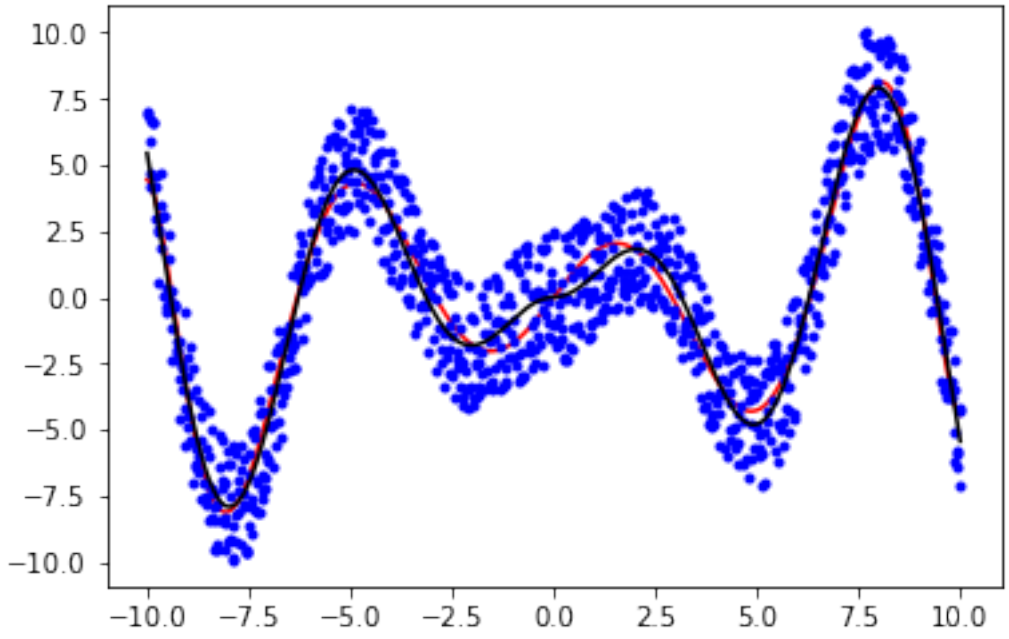
p : 11
lambda 4



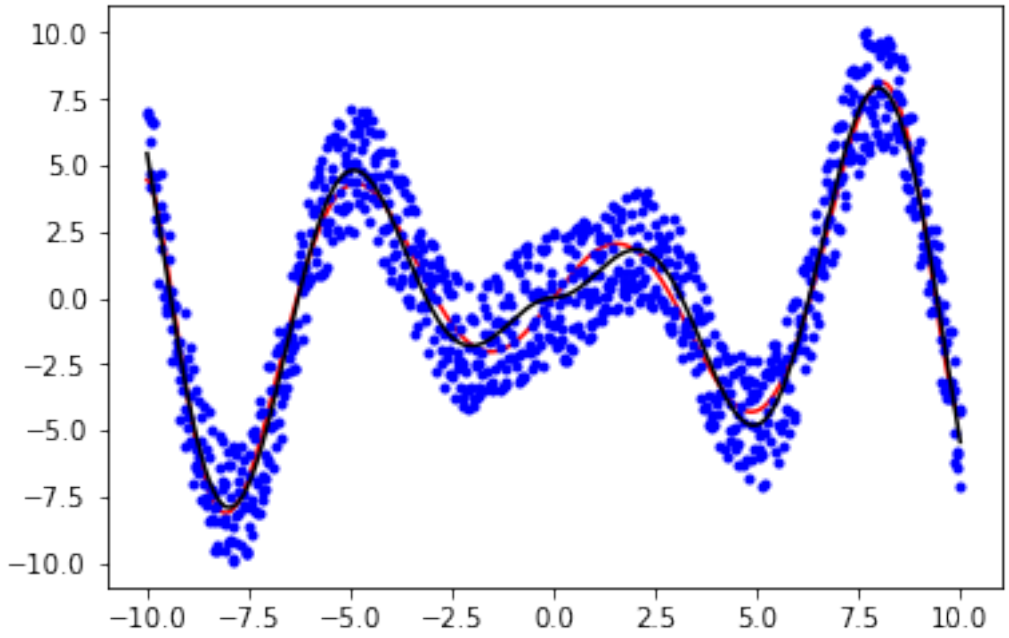
p : 11
lambda 8

<Energy graph When p = 11 >

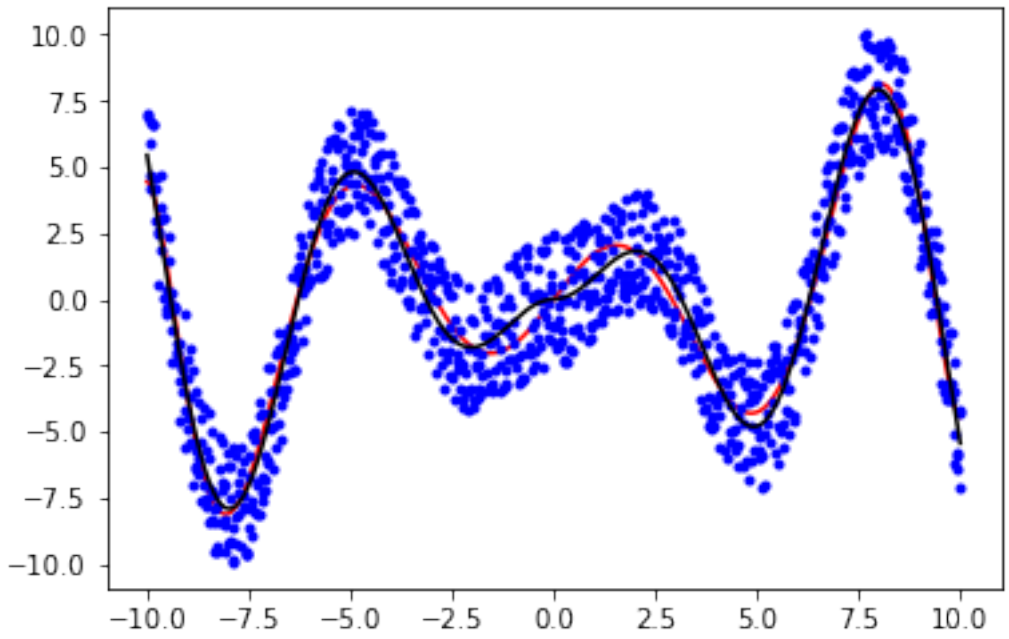




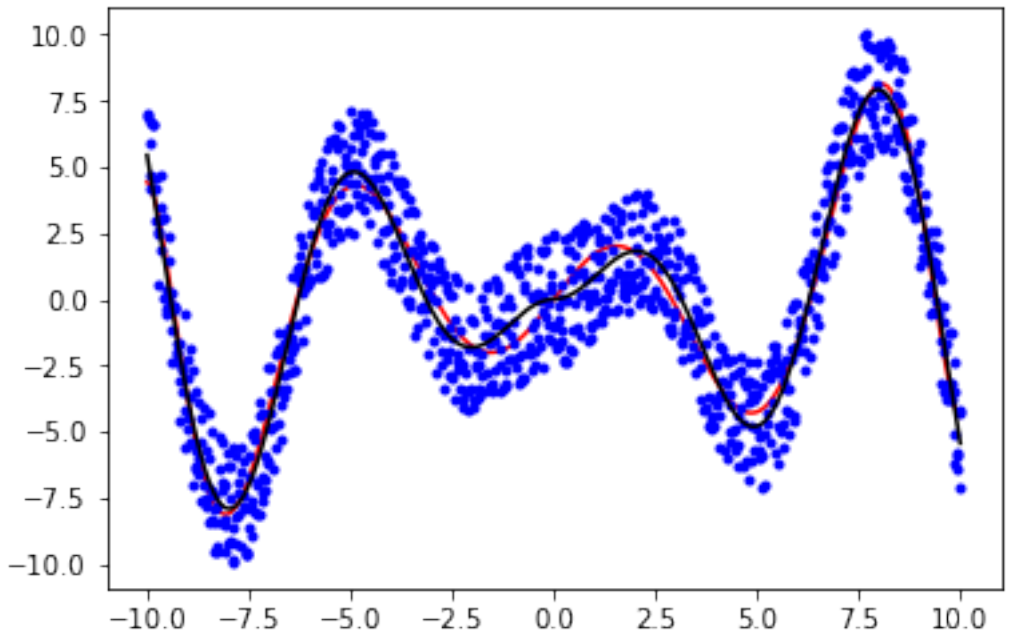

```
p : 12
lambda 0.125
```



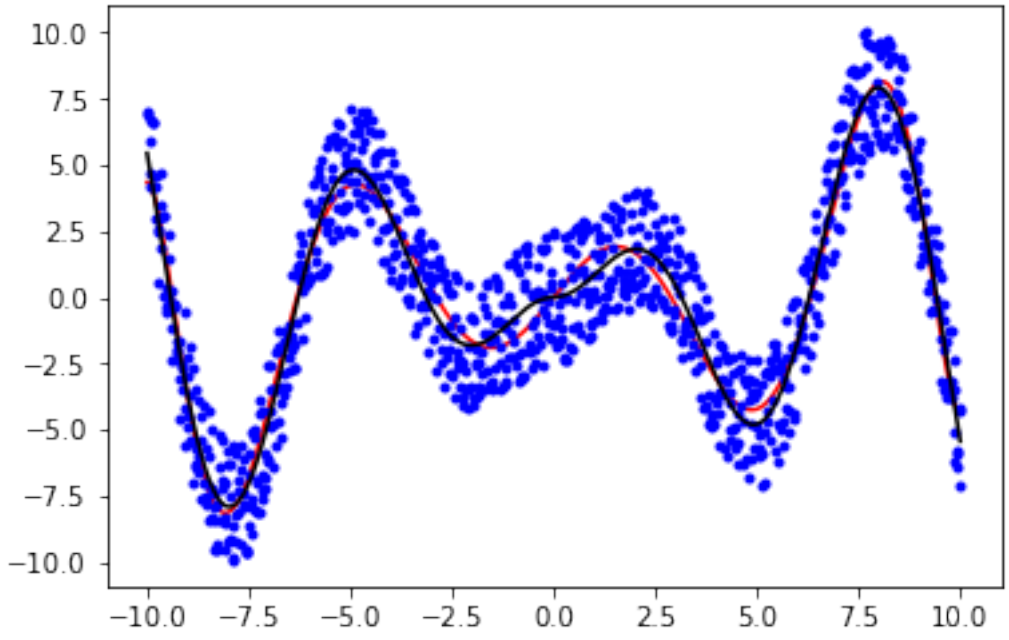

```
p : 12
lambda 0.25
```



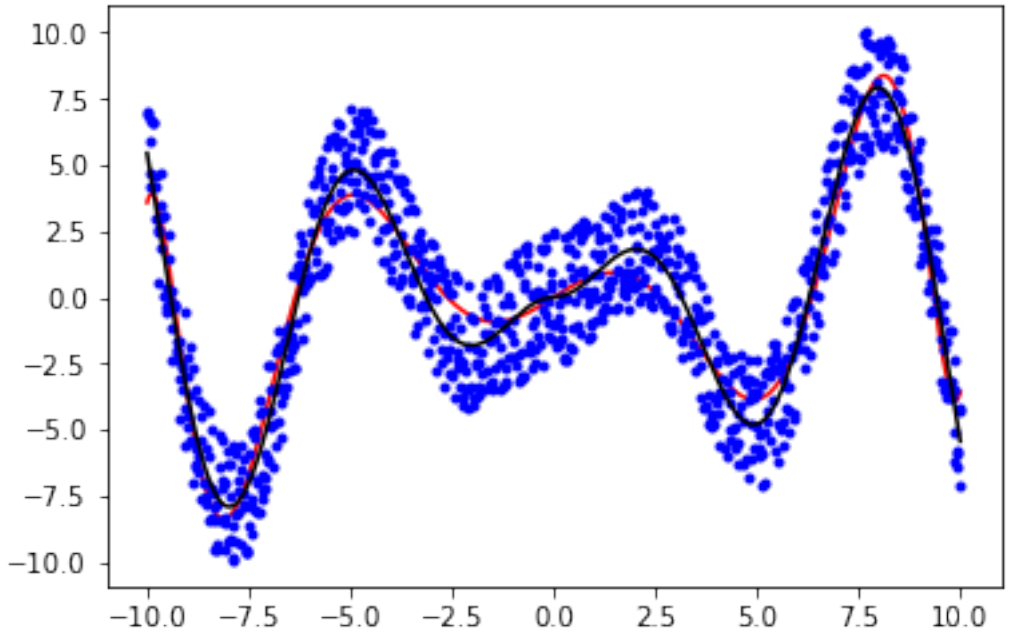
```
p : 12
lambda 0.5
```



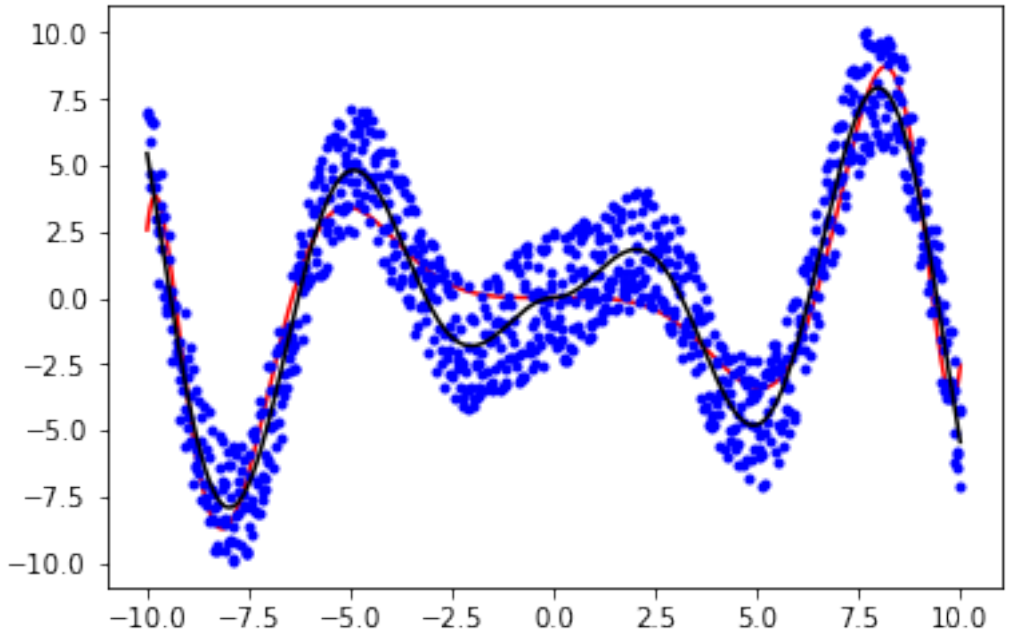

```
p : 12
lambda 1
```



```
p : 12
lambda 2
```

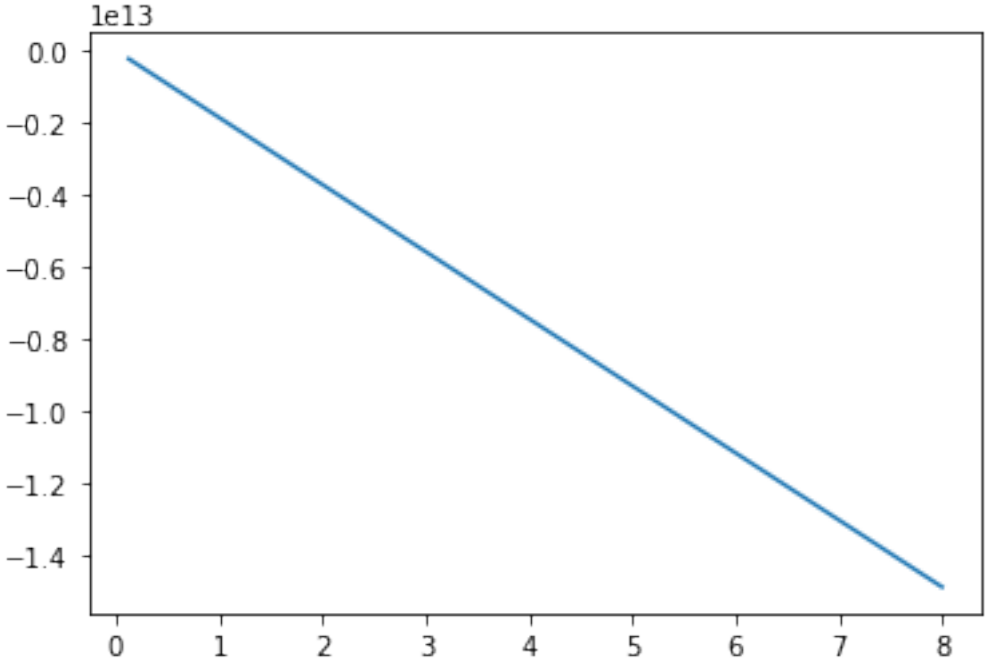


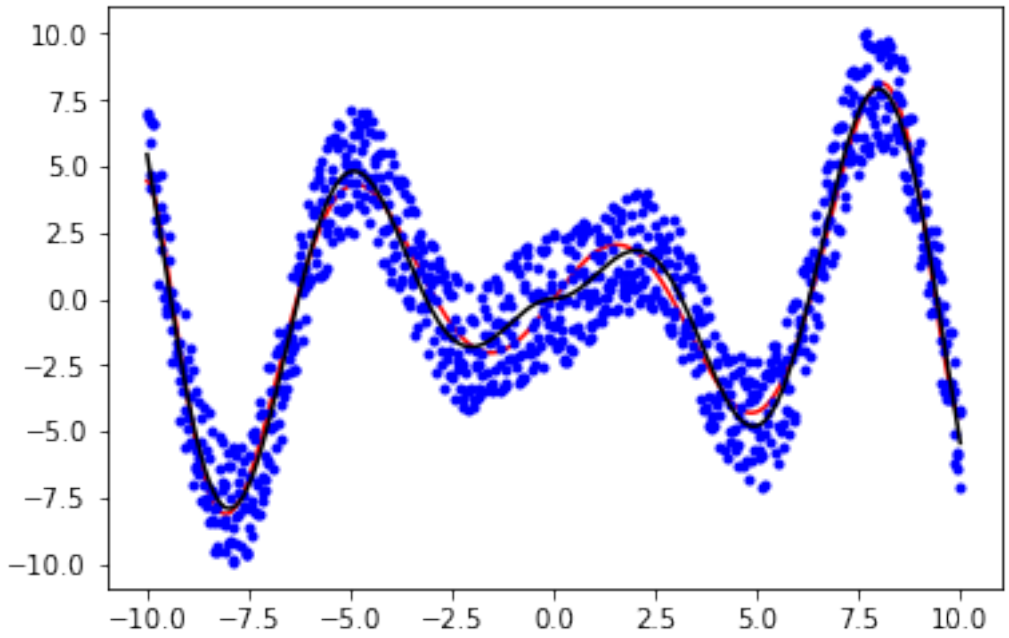

```
p : 12
lambda 4
```



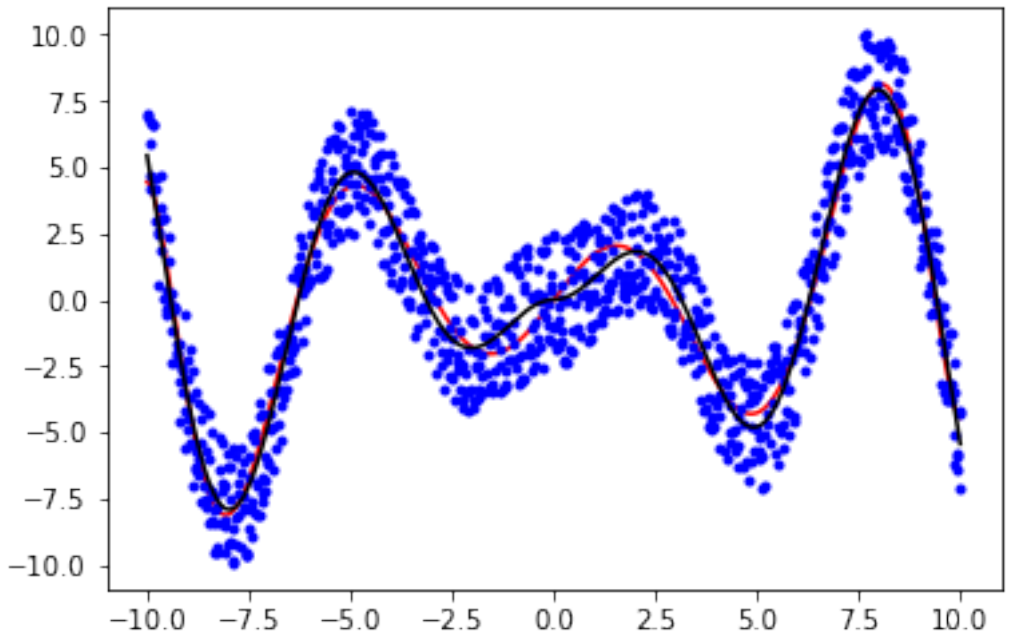
p : 12
lambda 8

<Energy graph When p = 12 >

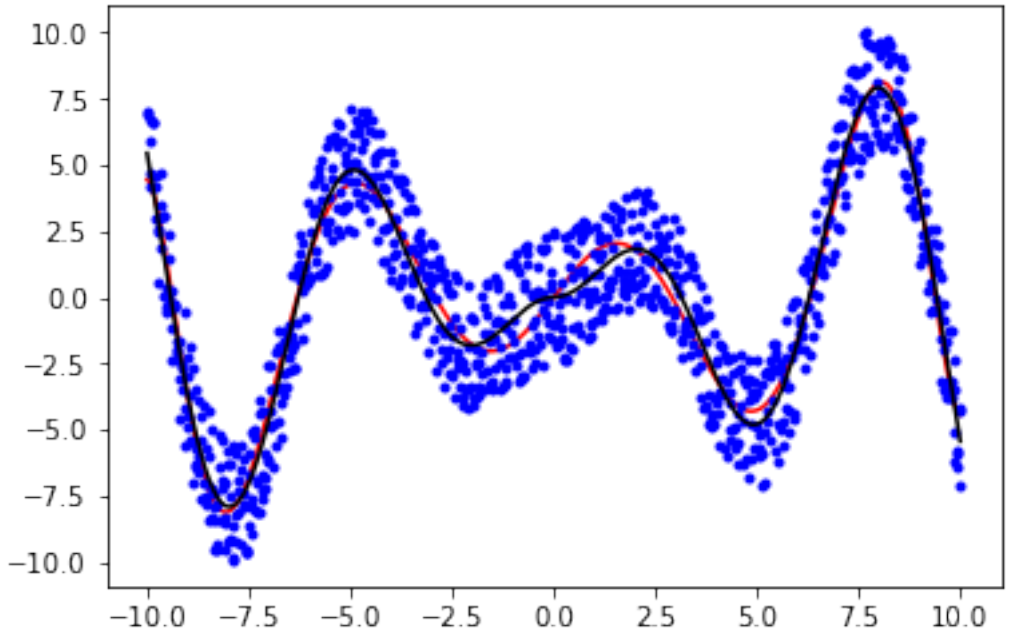




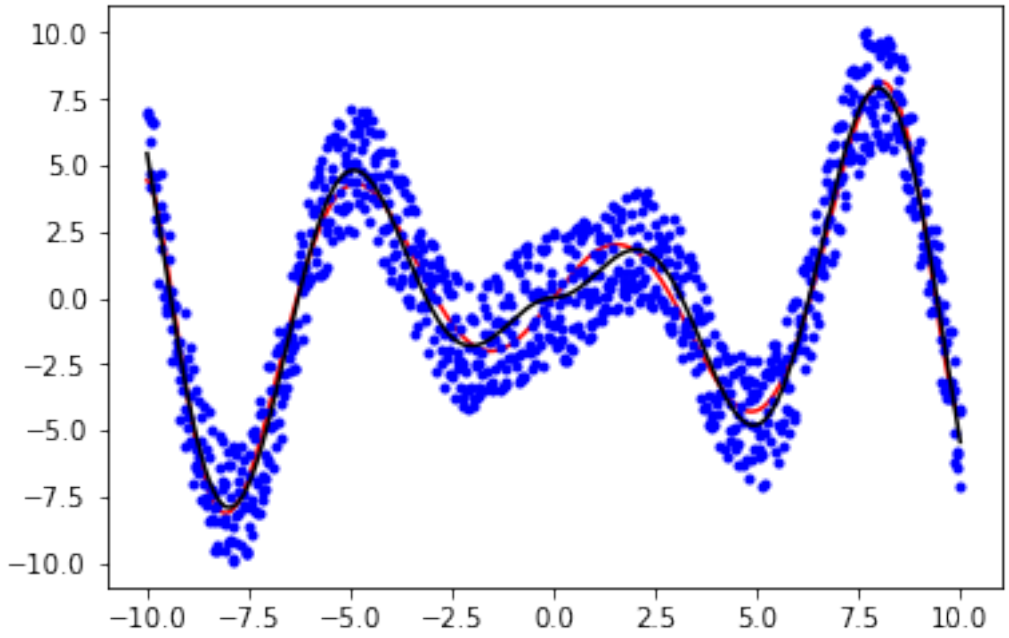

```
p : 13
lambda 0.125
```



```
p : 13
lambda 0.25
```




```
p : 13
lambda 0.5
```


10.0
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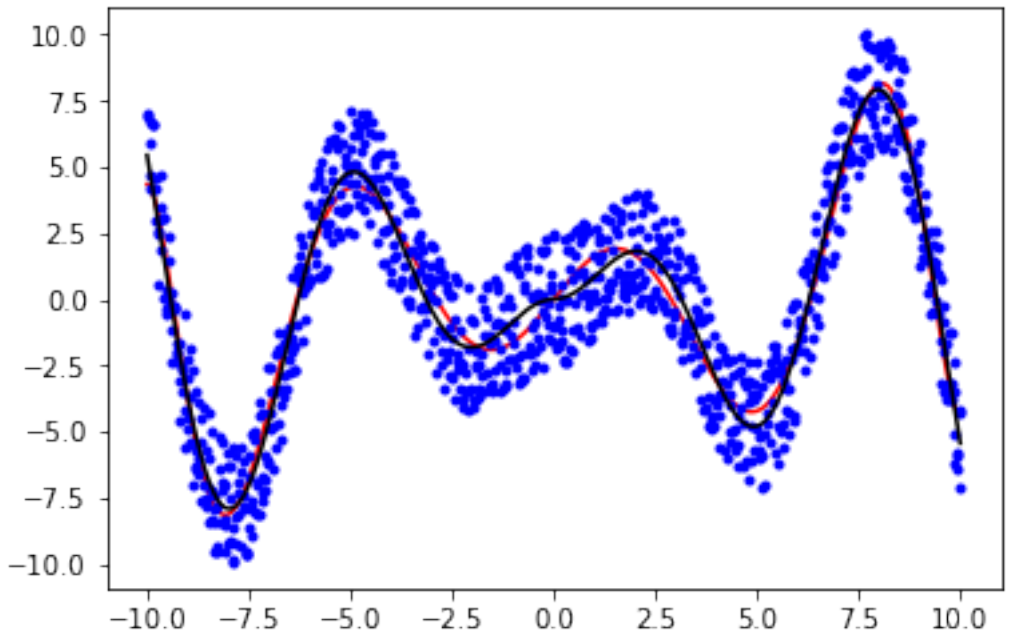
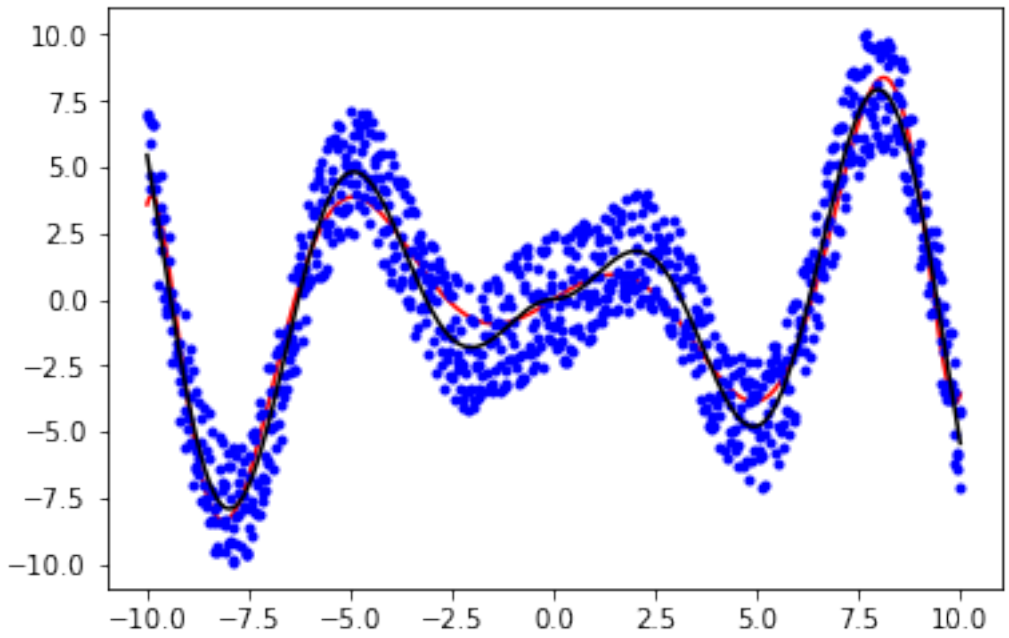
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
−10.0
−7.5
−5.0
−2.5
0.0
2.5
5.0
7.5
10.0

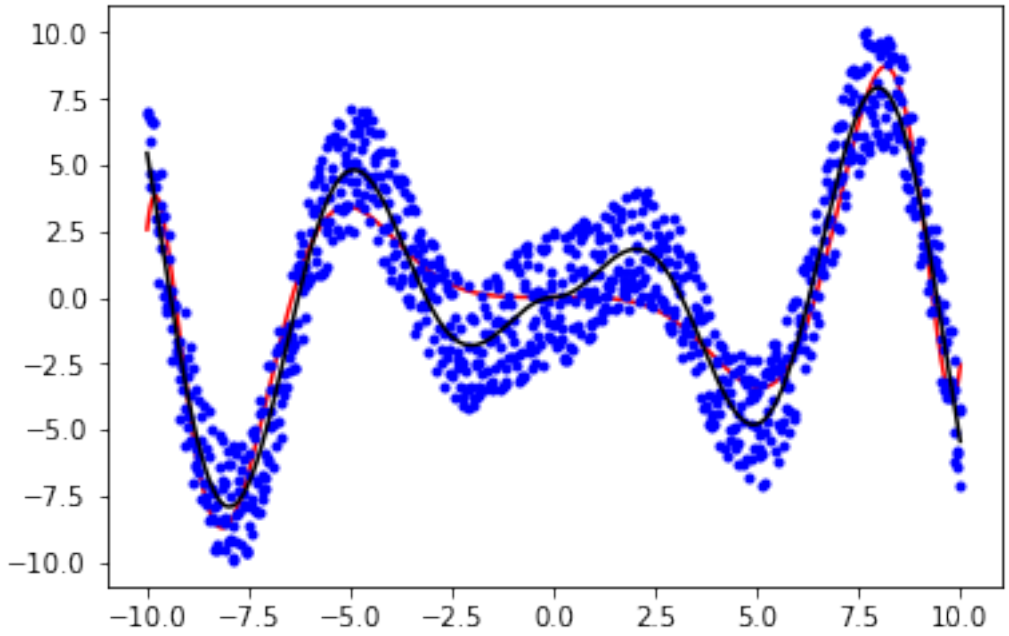
```
p : 13
lambda 1
```


10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
−10.0
−7.5
−5.0
−2.5
0.0
2.5
5.0
7.5
10.0

p : 13
lambda 2

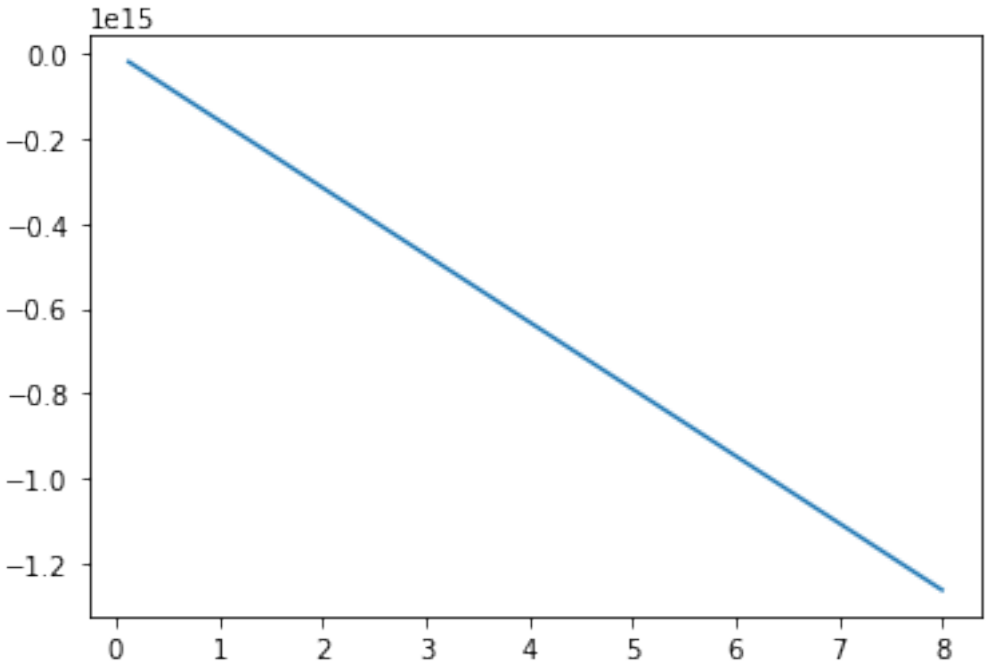


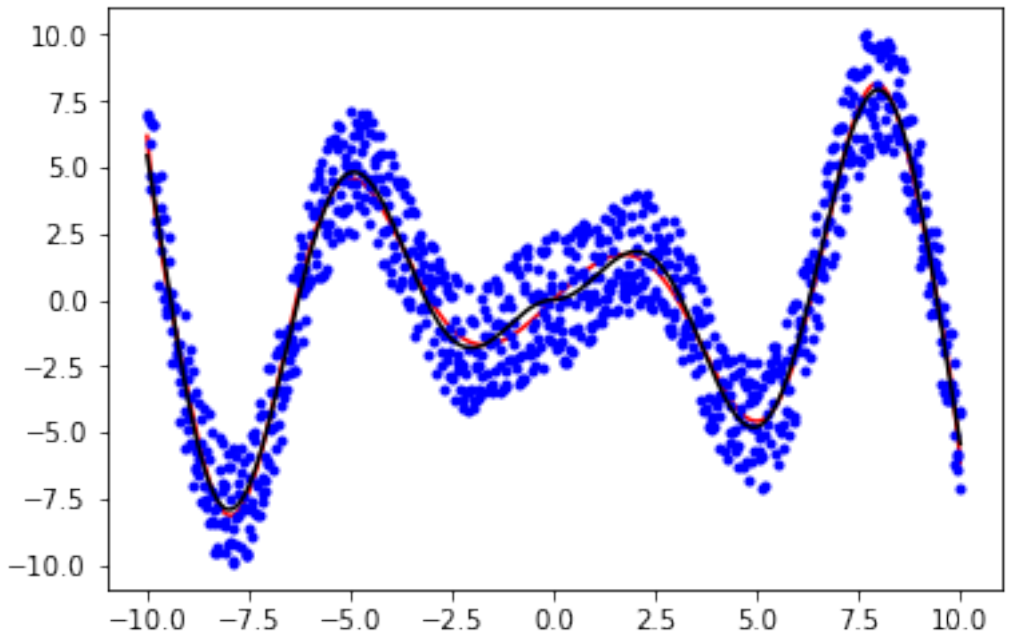
p : 13
lambda 4



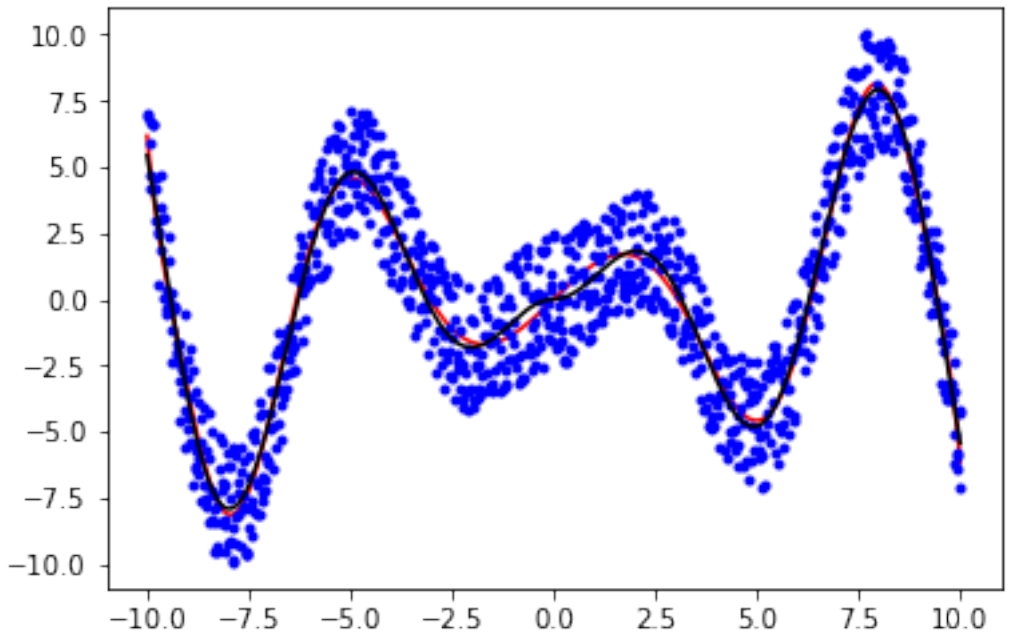
```
p : 13
lambda 8

<Energy graph When p = 13 >
```

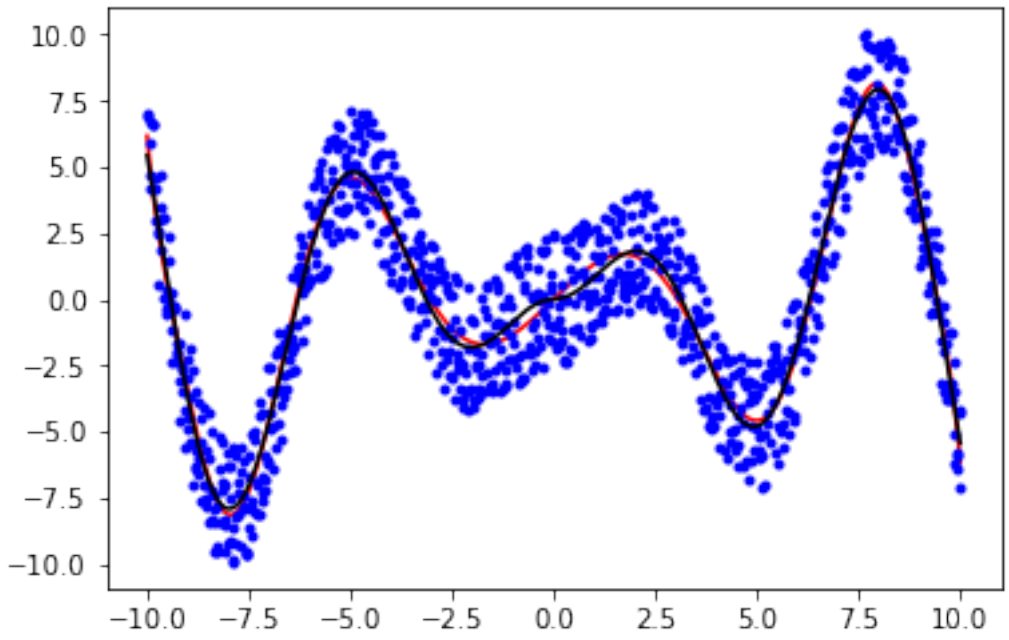




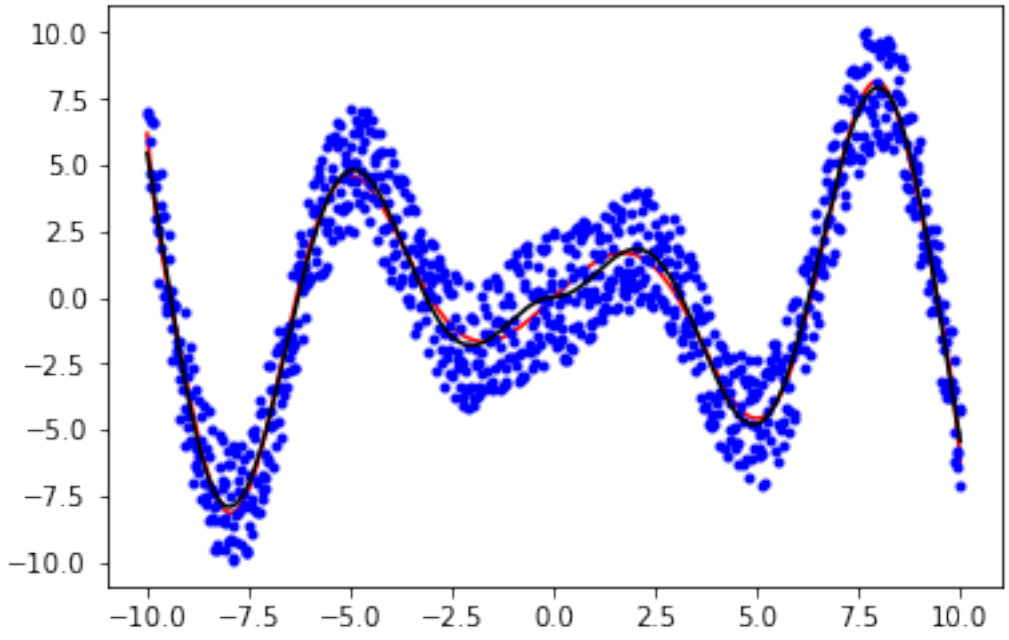

```
p : 14
lambda 0.125
```



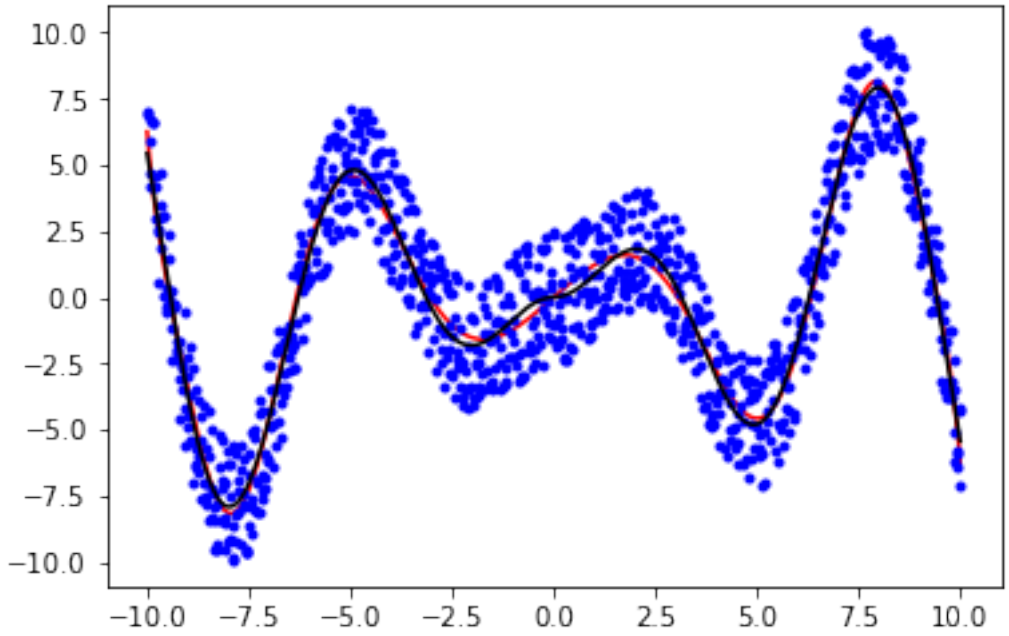
```
p : 14
lambda 0.25
```



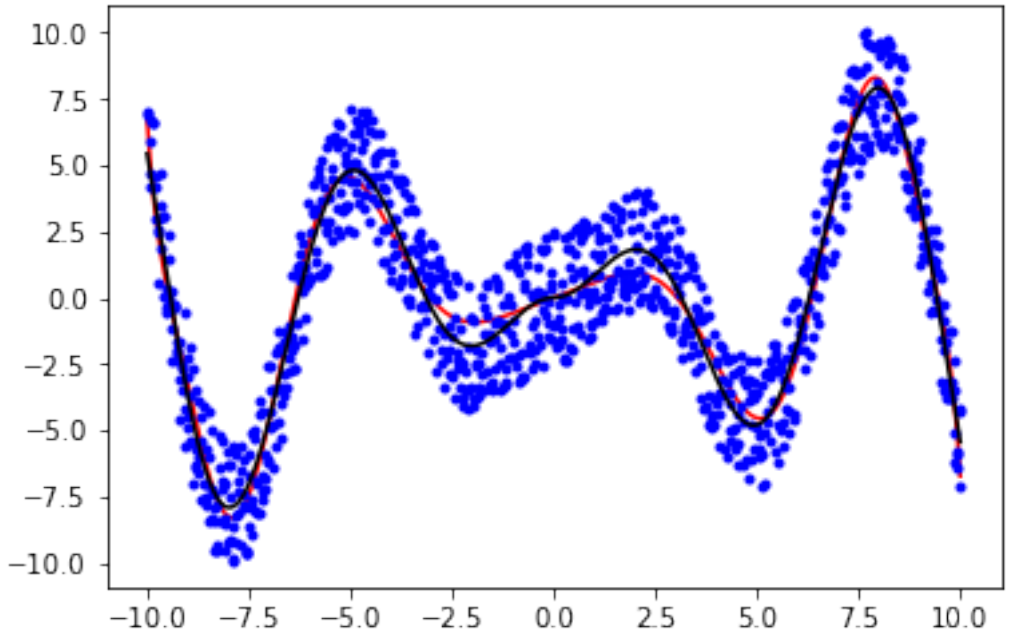

```
p : 14
lambda 0.5
```



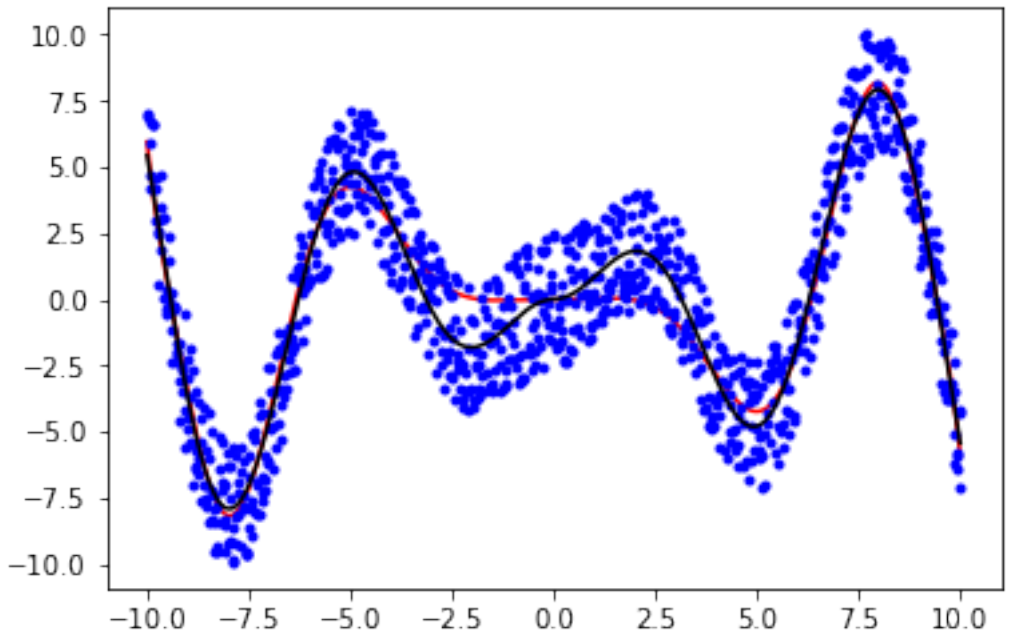
```
p : 14
lambda 1
```




```
p : 14
lambda 2
```

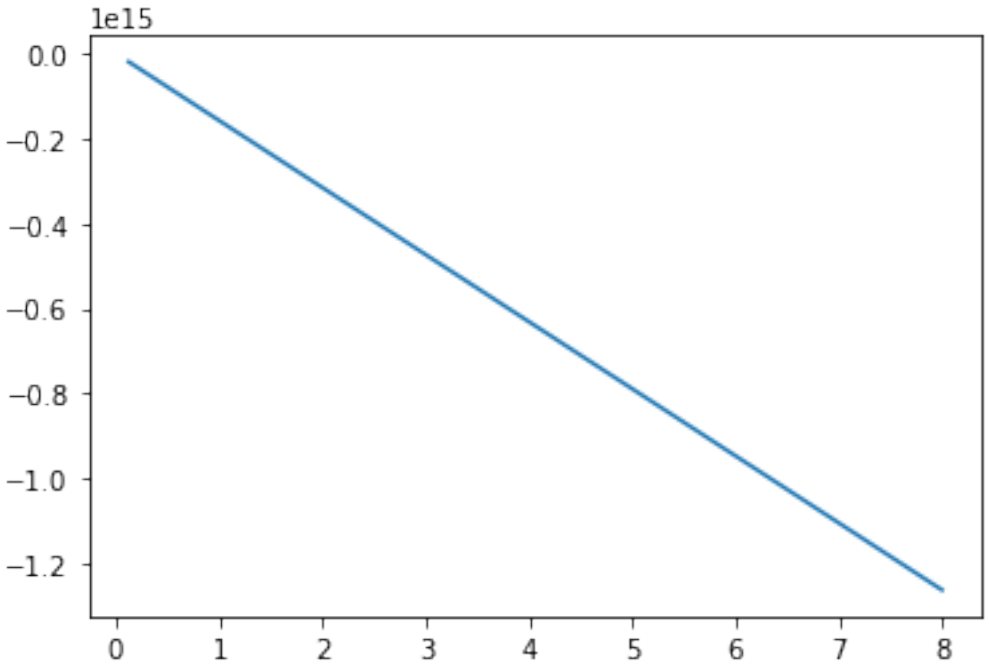

10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
−10.0
−7.5
−5.0
−2.5
0.0
2.5
5.0
7.5
10.0

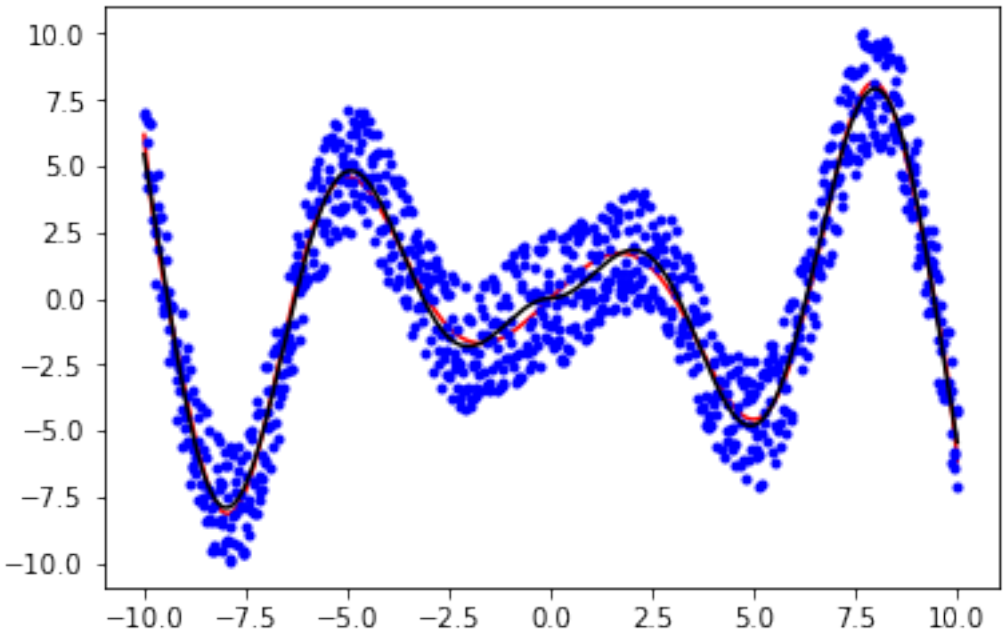
```
p : 14
lambda 4
```


10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
−10.0
−7.5
−5.0
−2.5
0.0
2.5
5.0
7.5
10.0

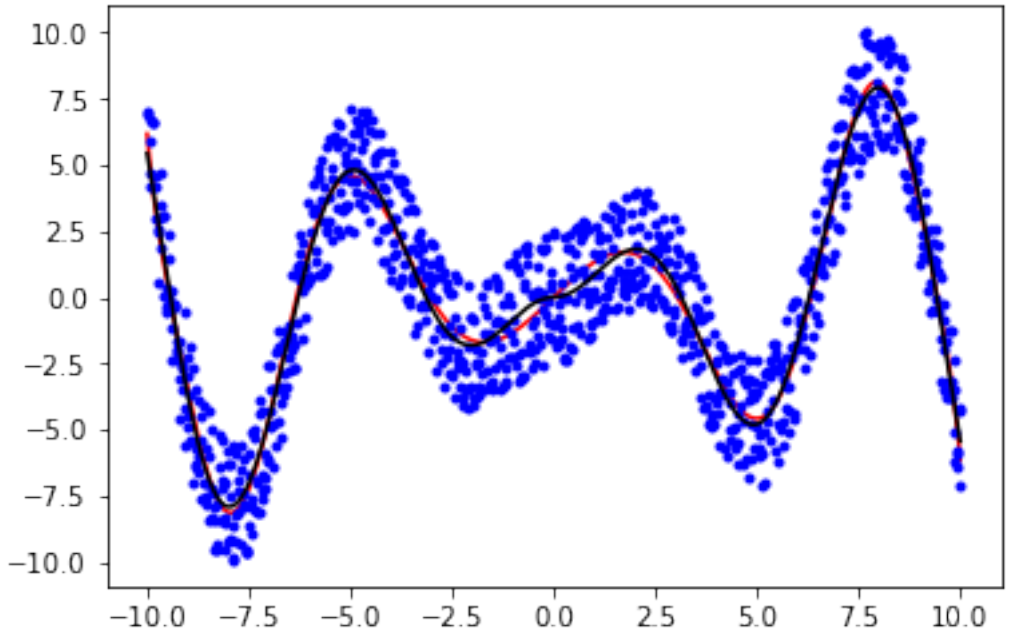
```
p : 14
lambda 8

<Energy graph When p = 14 >
```

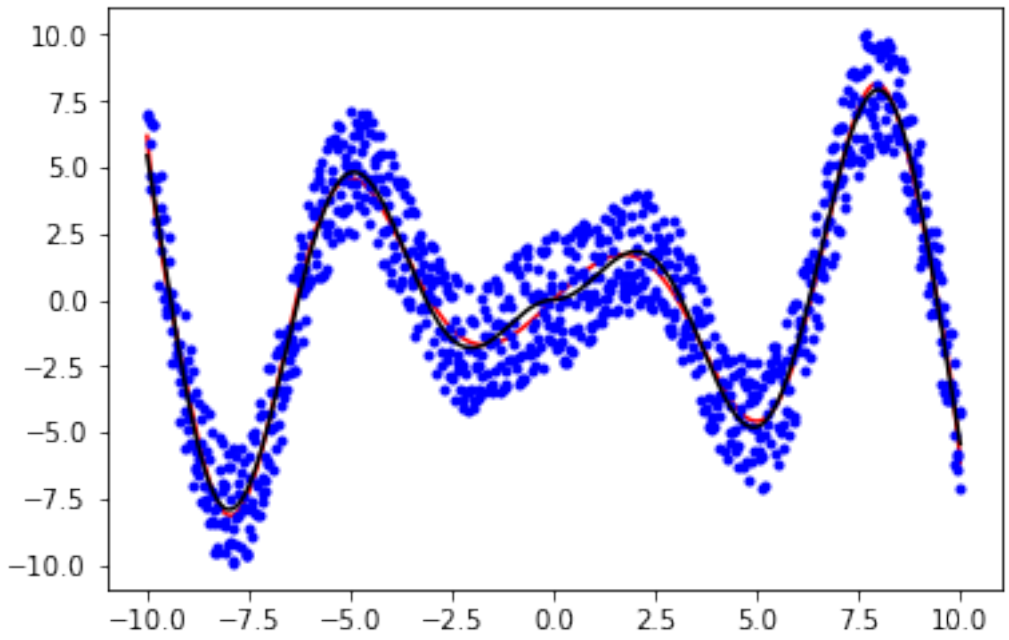




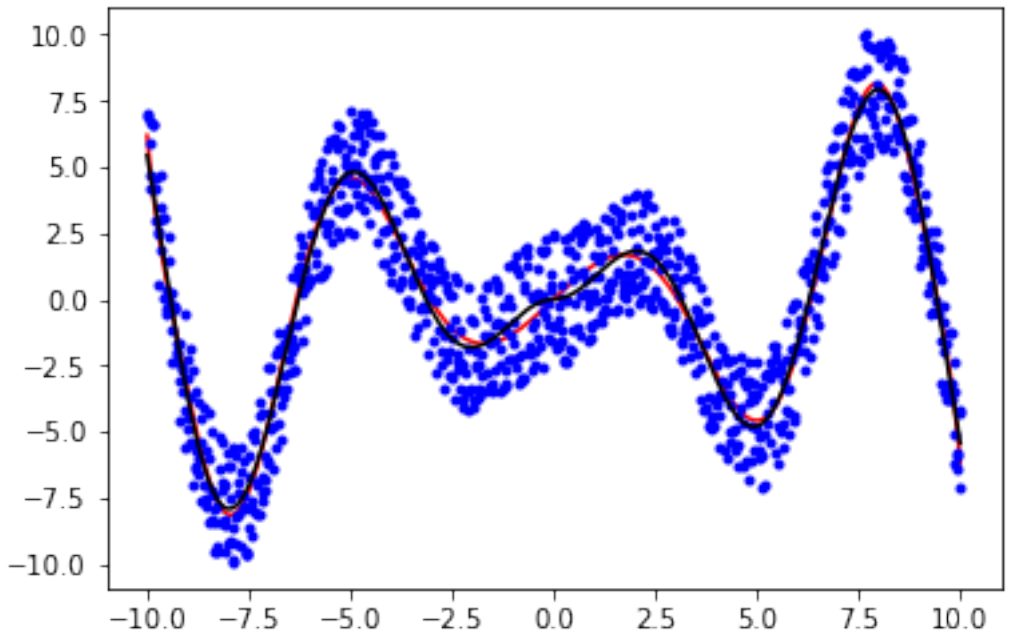
```
p : 15
lambda 0.125
```



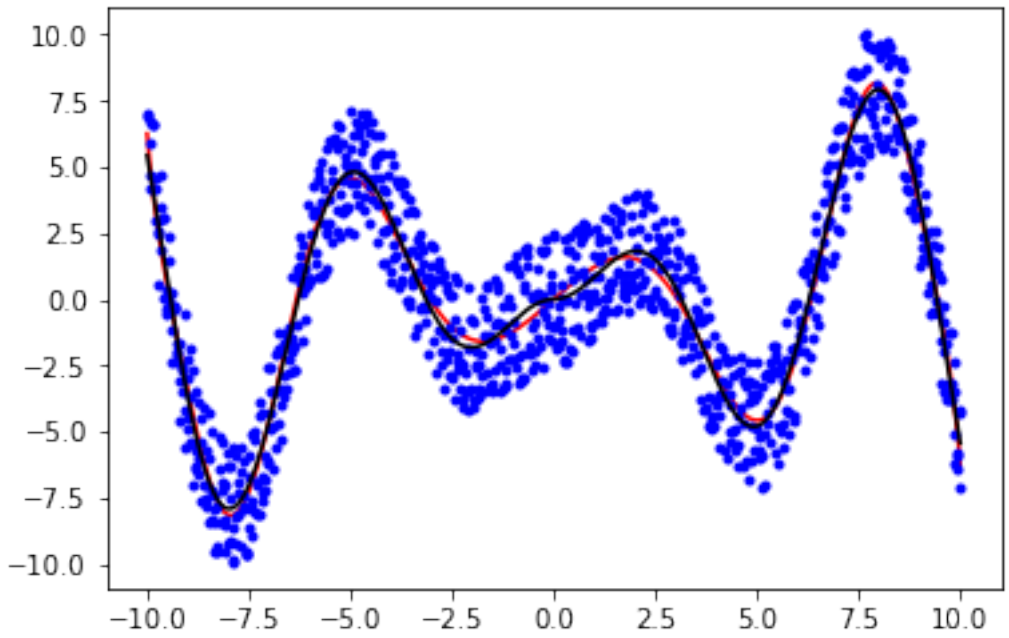

```
p : 15
lambda 0.25
```



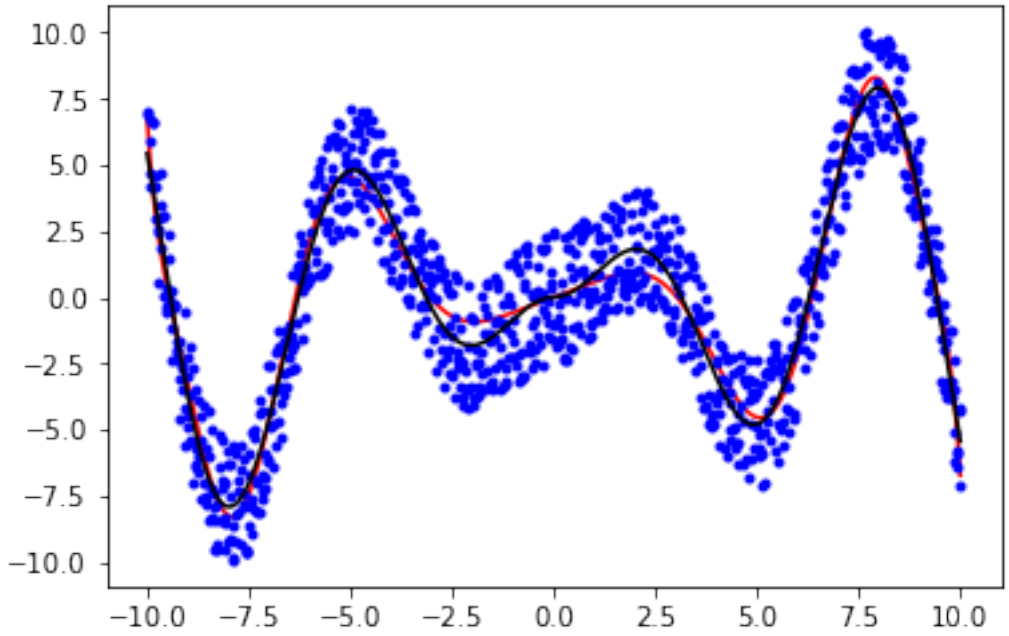

```
p : 15
lambda 0.5
```



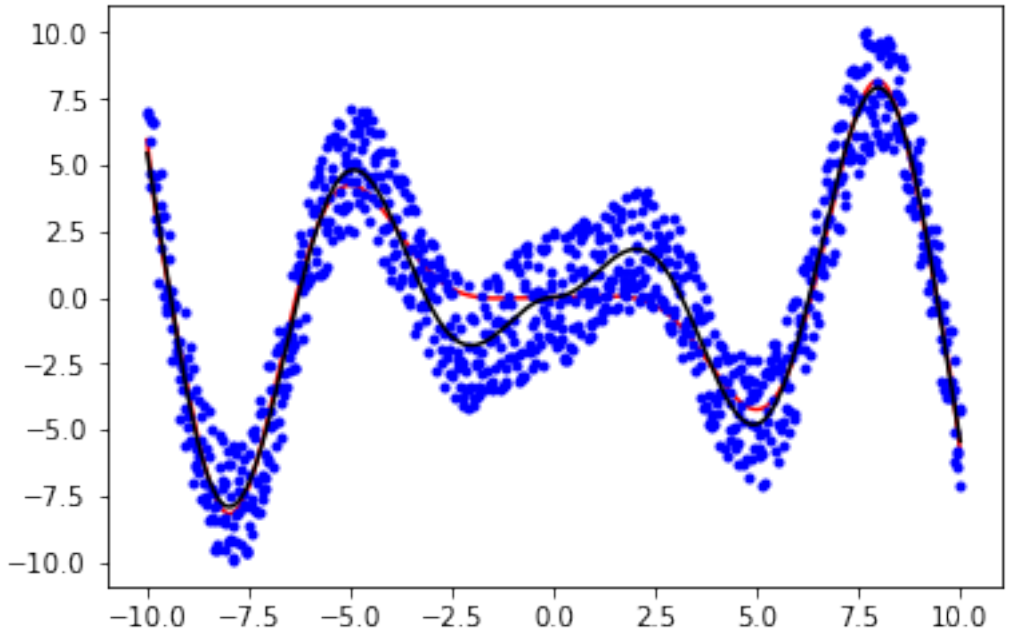
```
p : 15
lambda 1
```




```
p : 15
lambda 2
```

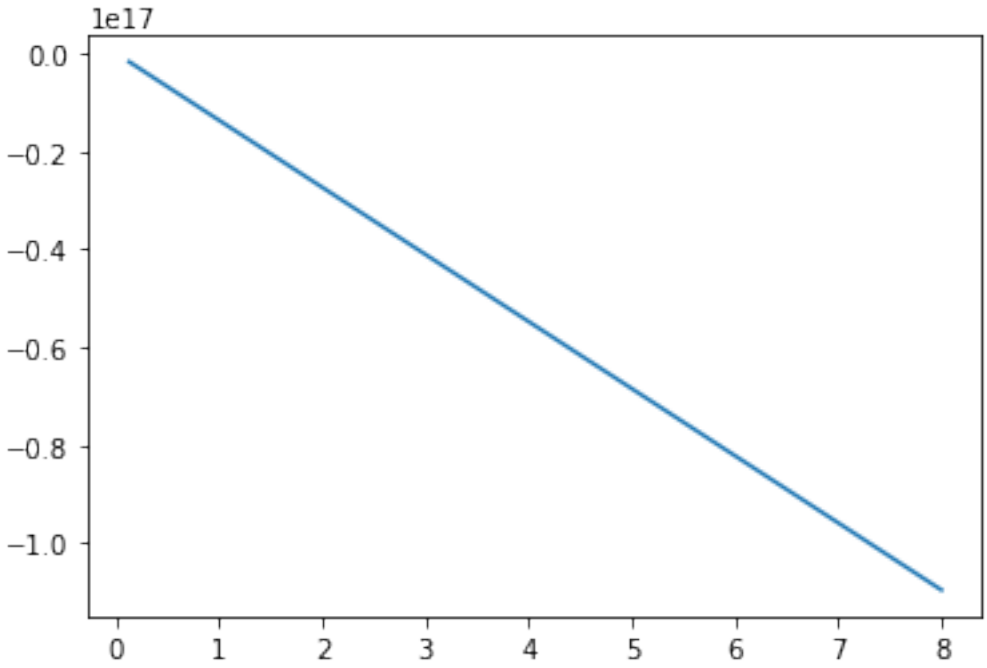


p : 15
lambda 4



p : 15
lambda 8

<Energy graph When p = 15 >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−0.2
−0.4
−0.6
−0.8
−1.0
0
1
2
3
4
5
6
7
8