

- Execution description:  
在 colab 案全部執行就可以了

import 的套件：

```
import torch
import numpy as np
import matplotlib.pyplot as plt
import torch.nn as nn
import math

from sklearn.model_selection import KFold
```

- Experimental results:

第一題：

#### Problem 1

+ 程式碼

+ 文字

```
[2] # y = 2x + ε
    torch.manual_seed(35)
    num_points = 15
    x = torch.linspace(-3, 3, 15)
    origin_x = x
    epsilon = torch.randn(15)
    y = 2 * x + epsilon
    # y = y.unsqueeze(1)
    origin_y = y
    print(x)
    print(y)

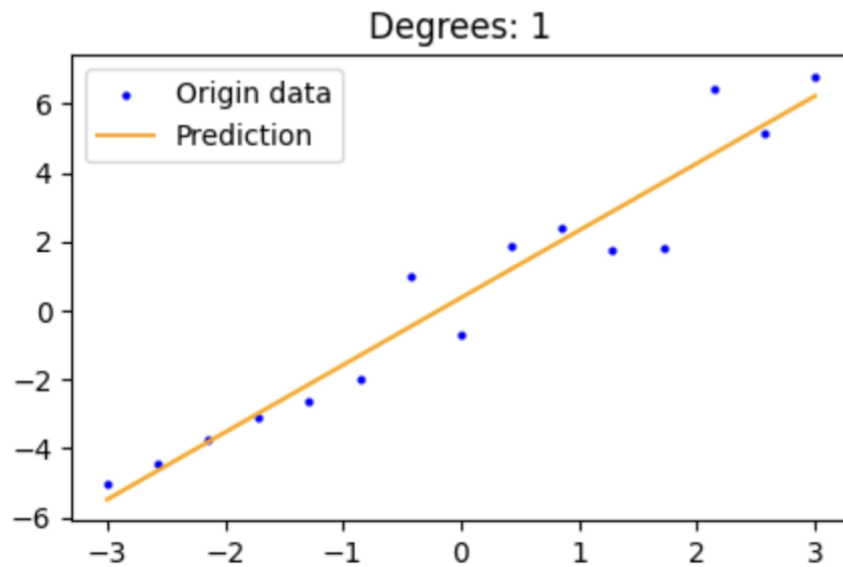
tensor([-3.0000e+00, -2.5714e+00, -2.1429e+00, -1.7143e+00, -1.2857e+00,
        -8.5714e-01, -4.2857e-01, -2.9802e-08,  4.2857e-01,  8.5714e-01,
         1.2857e+00,  1.7143e+00,  2.1429e+00,  2.5714e+00,  3.0000e+00])
tensor([-5.0326, -4.4717, -3.7689, -3.1209, -2.6625, -1.9770,  1.0074, -0.6919,
         1.8821,  2.3990,  1.7763,  1.8114,  6.4094,  5.1596,  6.7926])
```

第二題：

Degrees = 1

Training Error is: 0.9024458527565002 (mean squared error)

5-Fold Cross-Validation Error: 1.6708343029022217 (mean squared error)

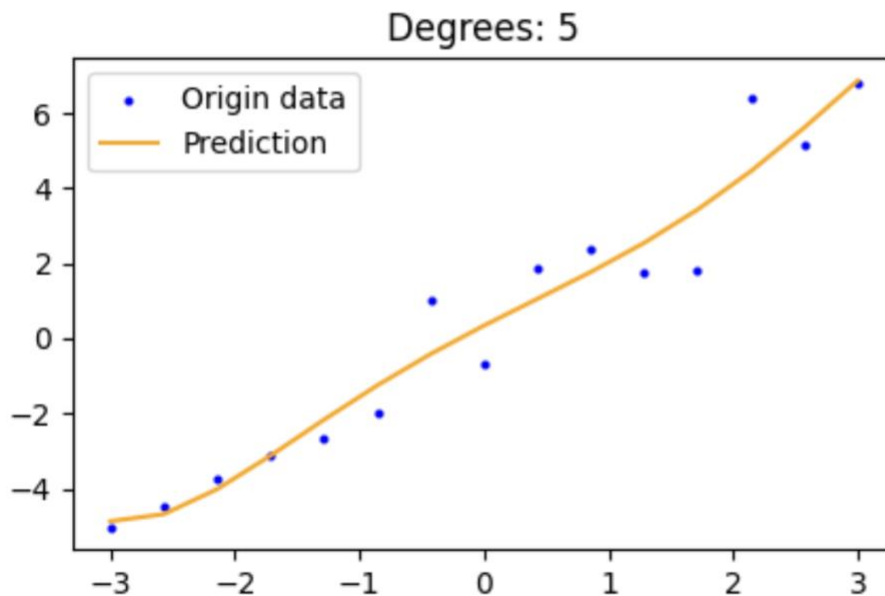


第三題：

Degrees = 5

Training Error is: 0.8215705156326294 (mean squared error)

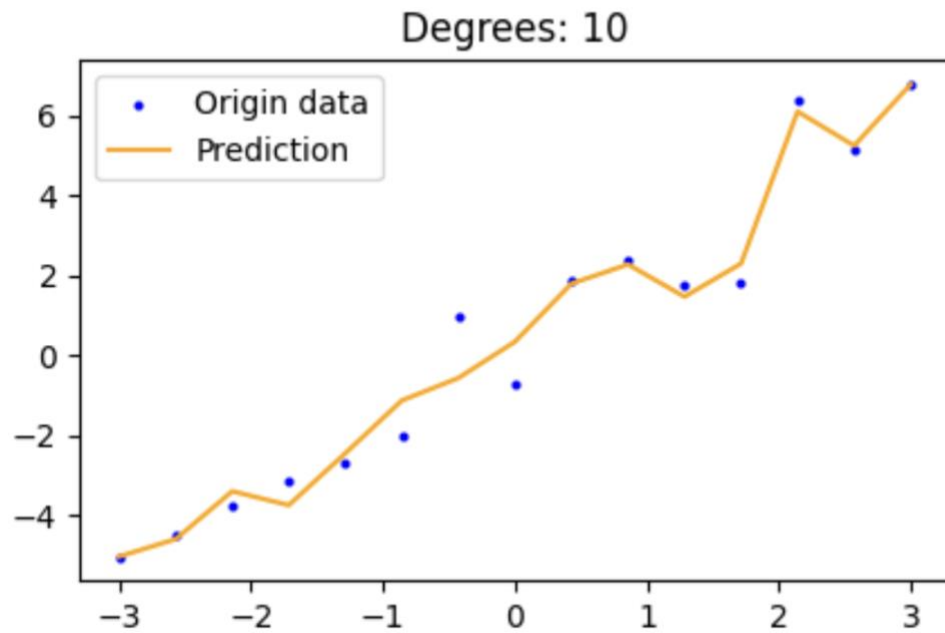
5-Fold Cross-Validation Error: 81.16810607910156 (mean squared error)



Degrees = 10

Training Error is: 0.3539617955684662 (mean squared error)

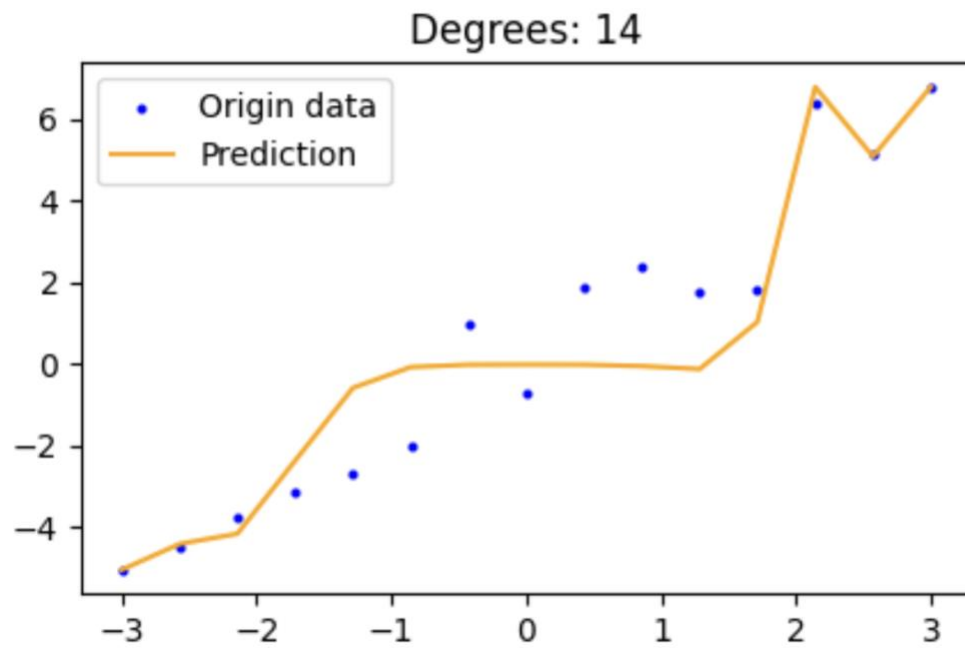
5-Fold Cross-Validation Error: 990975.875 (mean squared error)



Degrees = 14

Training Error is: 1.60736882686615 (mean squared error)

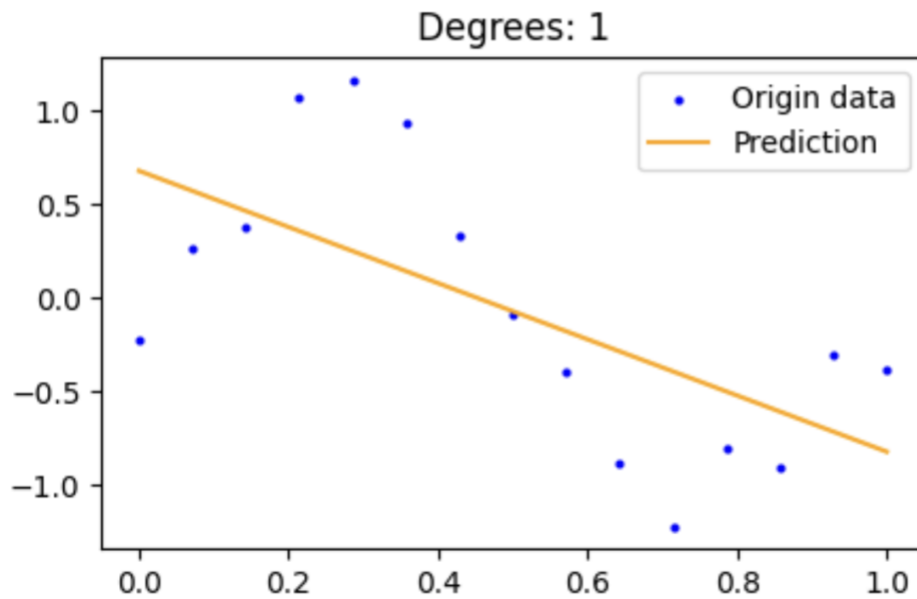
5-Fold Cross-Validation Error: 205014208.0 (mean squared error)



第四題：

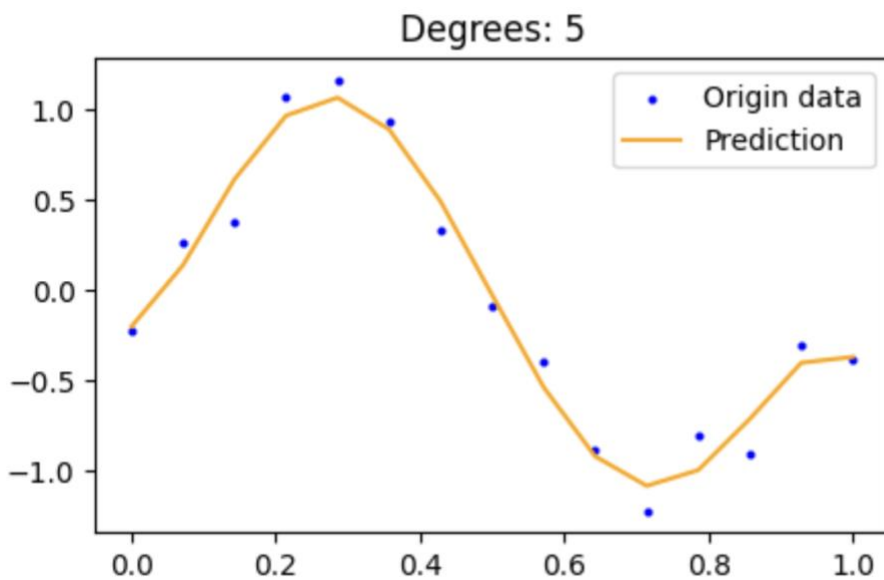
Degree = 1

Training Error is: 0.30867519974708557 (mean squared error)  
5-Fold Cross-Validation Error: 0.762559711933136 (mean squared error)



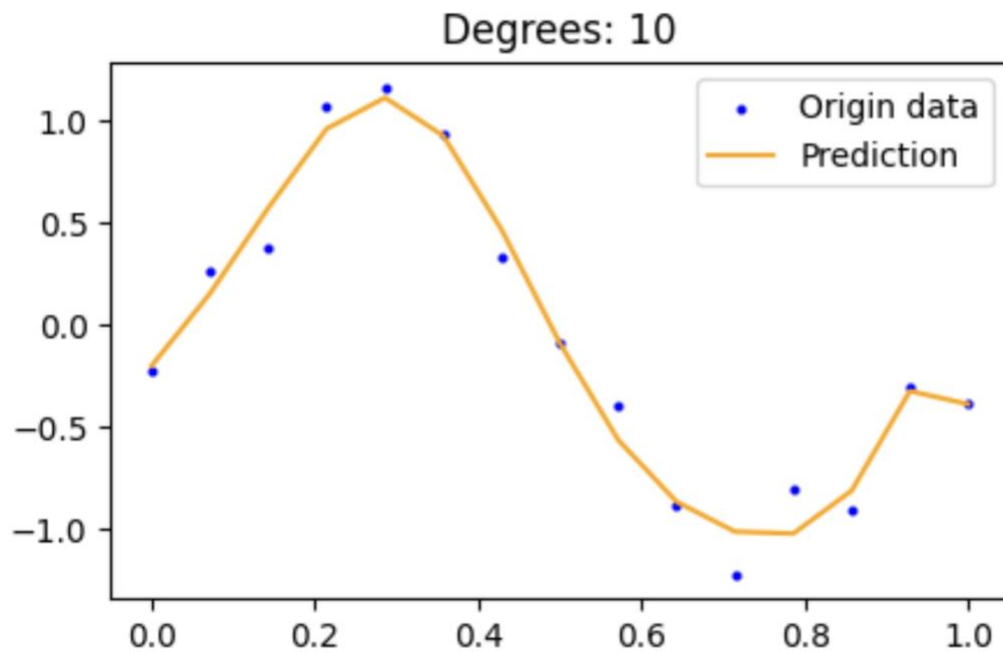
Degree = 5

Training Error is: 0.01661587320268154 (mean squared error)  
5-Fold Cross-Validation Error: 0.6186081171035767 (mean squared error)



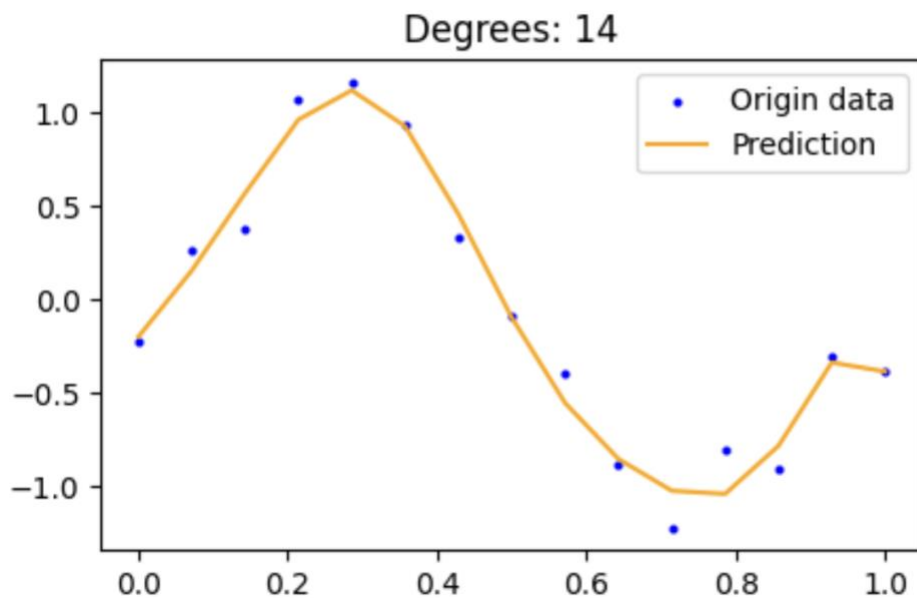
Degree = 10

Training Error is: 0.014223647303879261 (mean squared error)  
5-Fold Cross-Validation Error: 3332.671875 (mean squared error)



Degree = 14

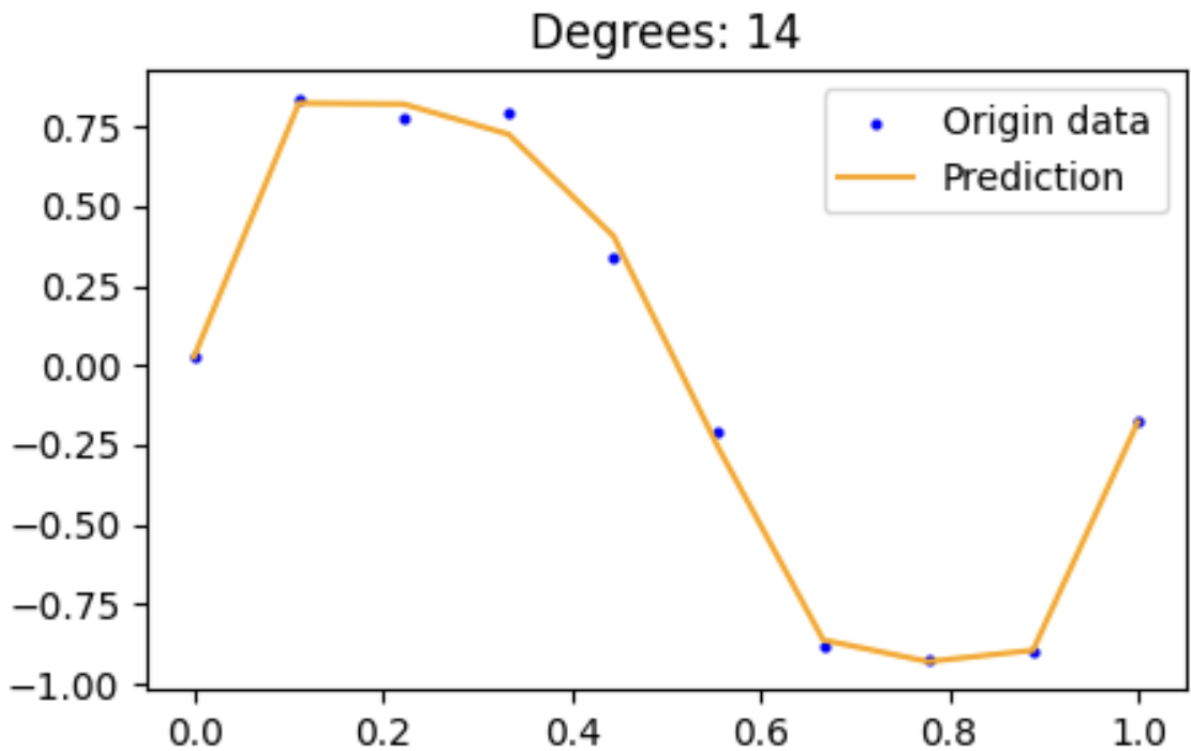
Training Error is: 0.014435188844799995 (mean squared error)  
5-Fold Cross-Validation Error: 56095.4609375 (mean squared error)



第五題：

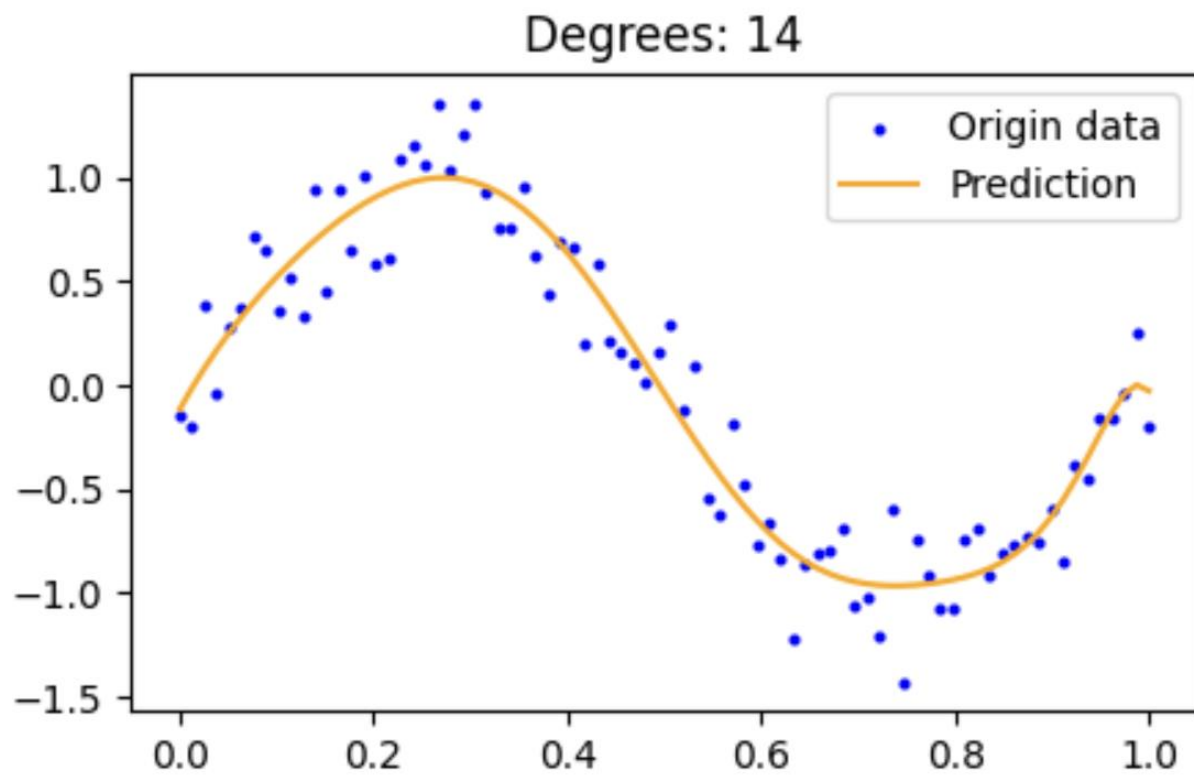
$m = 10$

Training Error is: 0.0014178322162479162 (mean squared error)  
5-Fold Cross-Validation Error: 48931.18359375 (mean squared error)



$m = 80$

Training Error is: 0.03948710486292839 (mean squared error)  
5-Fold Cross-Validation Error: 22.365032196044922 (mean squared error)

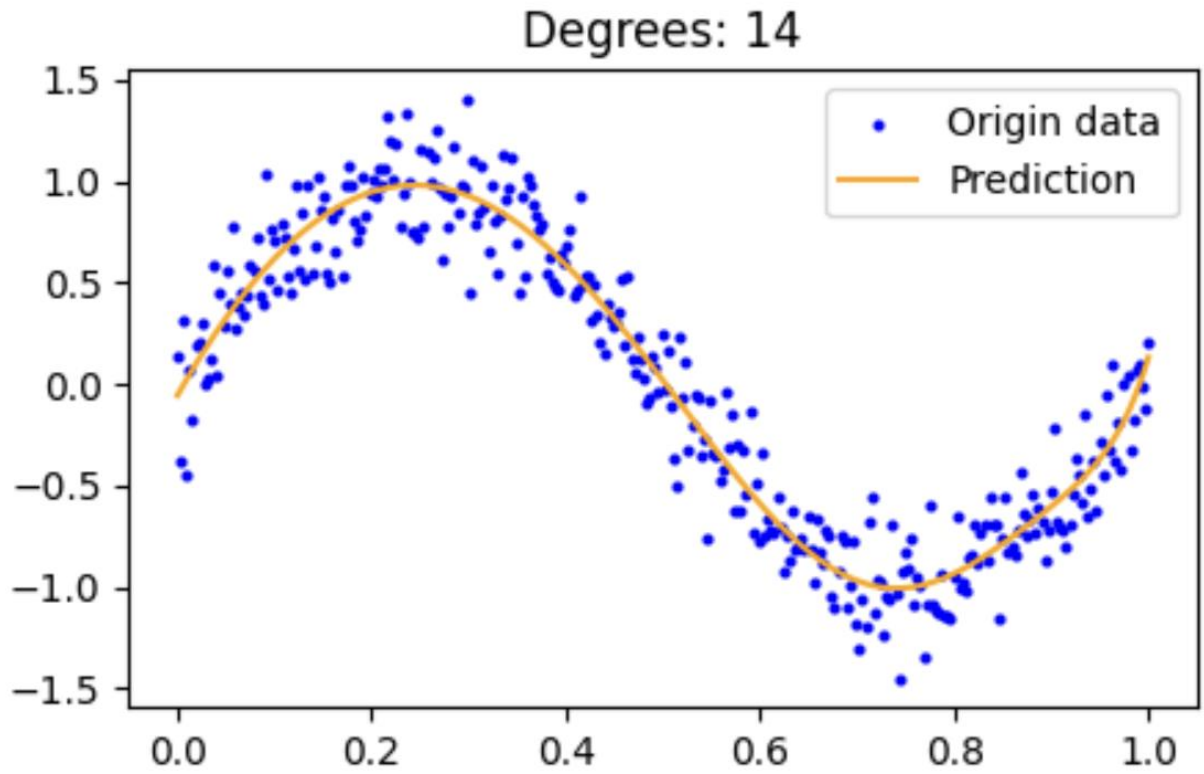


$m = 320$

Training Error is: 0.03321254998445511 (mean squared error)

5-Fold Cross-Validation Error: 0.9071736335754395 (mean squared error)

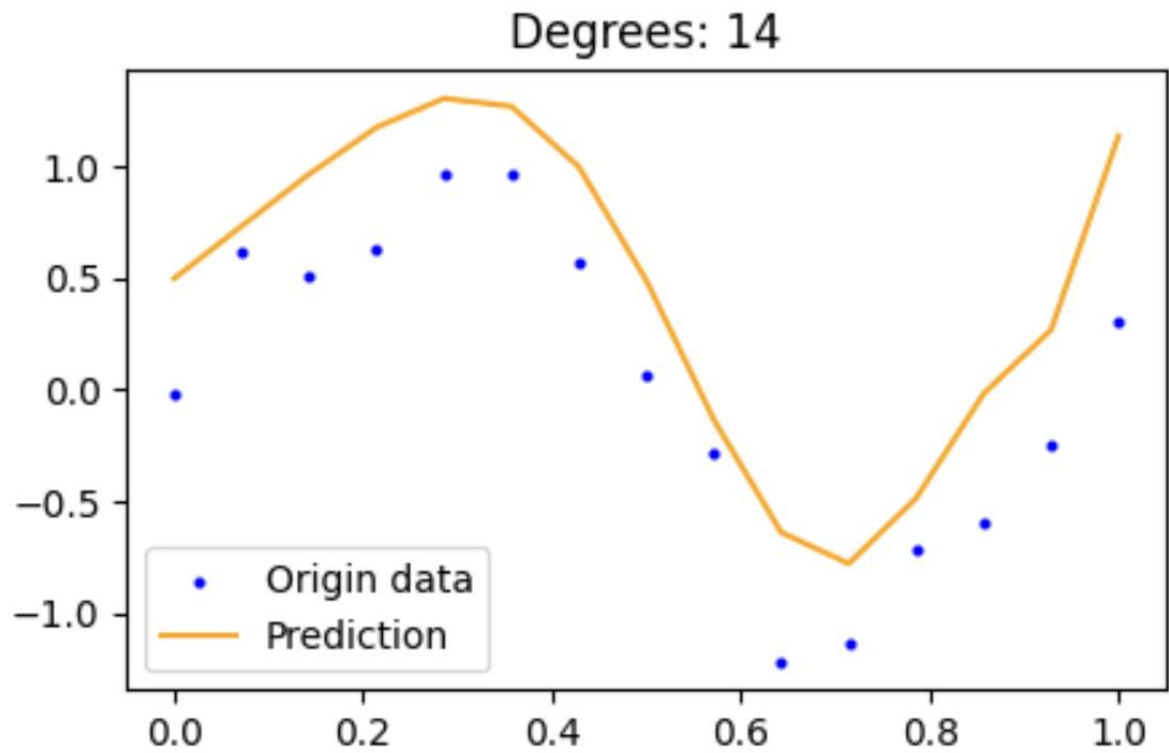




第六題：

$\lambda = 0$

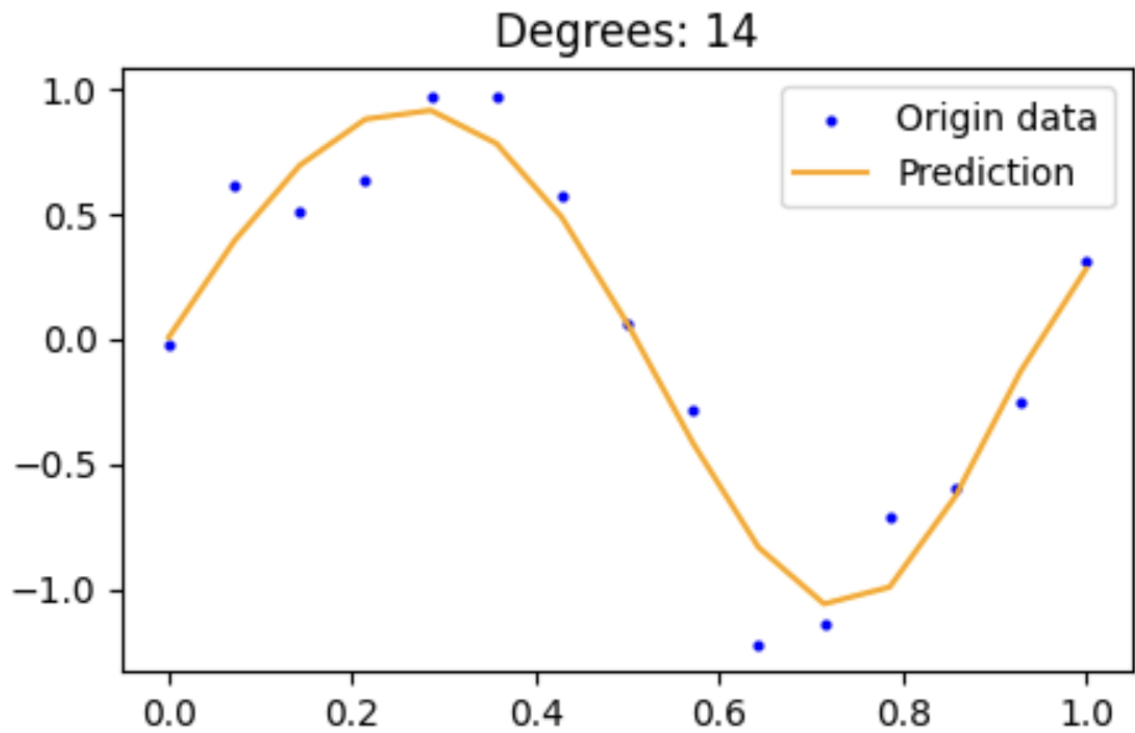
Training Error is: 1.1391408443450928 (mean squared error)  
5-Fold Cross-Validation Error: 16787844.0 (mean squared error)



$\lambda = 0.001/m$

Training Error is: 0.9118373394012451 (mean squared error)

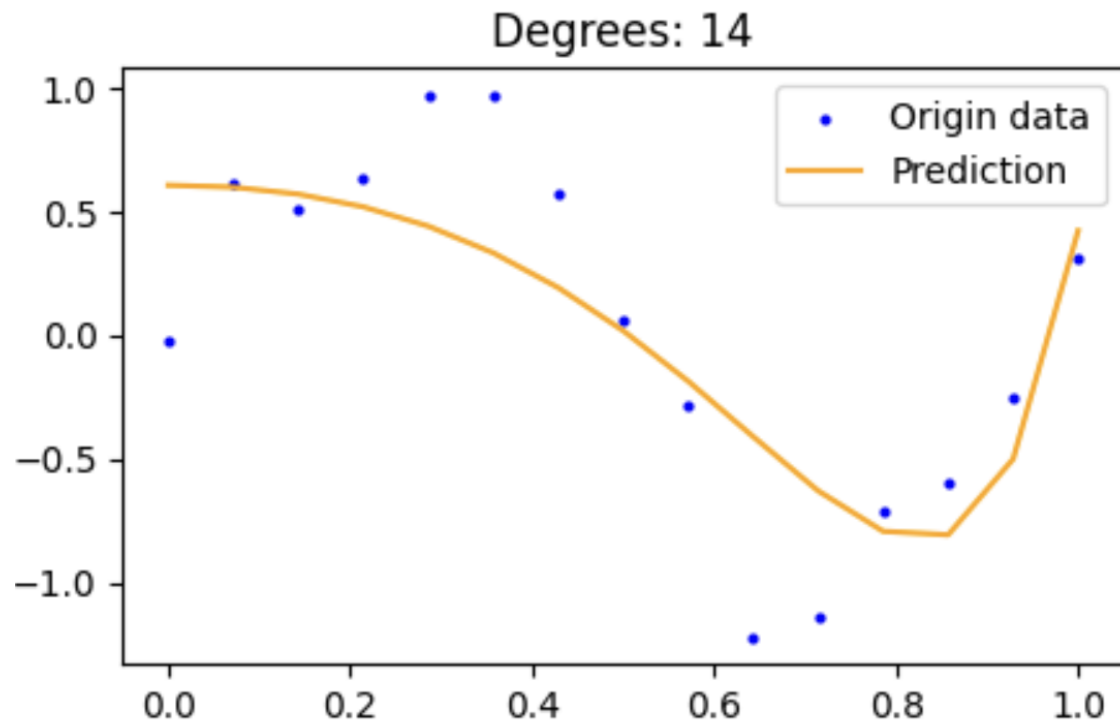
5-Fold Cross-Validation Error: 38.916656494140625 (mean squared error)



$$\lambda = 1/m$$

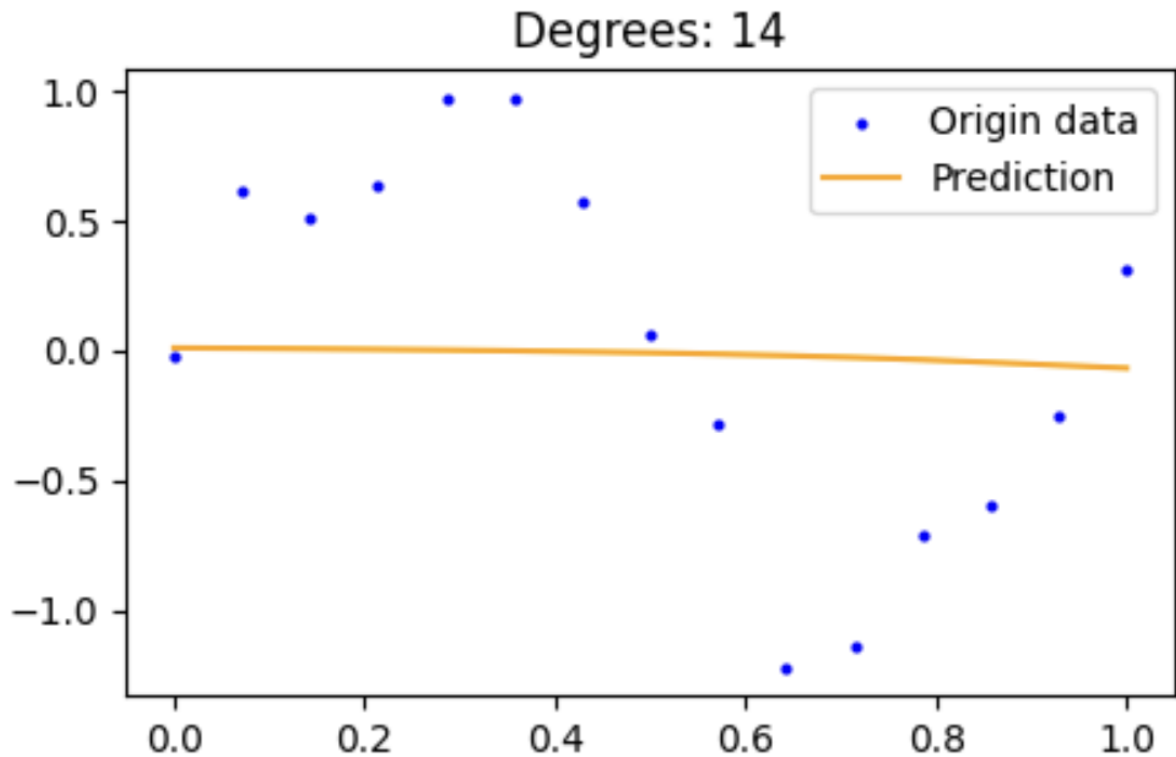
Training Error is: 0.7397658824920654 (mean squared error)

5-Fold Cross-Validation Error: 0.9209146499633789 (mean squared error)



$\lambda = 1000/m$

Training Error is: 0.47869107127189636 (mean squared error)  
5-Fold Cross-Validation Error: 0.5066391229629517 (mean squared error)



- Conclusion:

1. 通常 degree 越大，training error 會逐漸變小，但是 five-fold cross-validation errors 會上升很多，可能有 overfitting。
2. 當 data 越多，five-fold cross-validation errors 會下降很多。
3. 有 regulariztion 時，five-fold cross-validation errors 會下降很多，且預測的線會越來越平滑。

- Discussion:

需要將上課公式轉化為程式碼，而且時常遇到要處理維度的問題。