Pattern Recognition Computer HW2

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洪聖祥

EXP 1

1. (a) $\hat{u}_{ML} = (-0.0605, -0.0105, -0.0610)$ $\hat{\sigma}_{ML}^2 = (2.9576,\ 4.4889,\ 1.8799)$

   (b) $\hat{u}_{ML} = (-0.0605, -0.0105, -0.0610)$

$$\hat{\Sigma}_{ML} = \begin{matrix} 2.9576 & -0.0620 & -0.0302 \\ -0.0620 & 4.4889 & -0.0468 \\ -0.0302 & -0.0468 & 1.8799 \end{matrix}$$

   (c) The mean is the same for two experiments but covariance matrix is not the same. It is because in (a), we treat 3 features individually whereas in (b) we did not. Therefore, (a) does not have correlation term but (b) does.

   (d) $\hat{u}_{ML} = (0.9568,\ 4.9342, -2.9857)$

$$\hat{\Sigma}_{ML} = \begin{matrix} 0.9399 & 0 & 0 \\ 0 & 3.8063 & 0 \\ 0 & 0 & 5.4873 \end{matrix}$$

   (e) $\hat{u}_{ML} = (0.9568,\ 4.9342, -2.9857)$

$$\hat{\Sigma}_{ML} = \begin{matrix} 0.9399 & -0.0359 & -0.0257 \\ -0.0359 & 3.8063 & 0.7317 \\ -0.0257 & 0.7317 & 5.4873 \end{matrix}$$

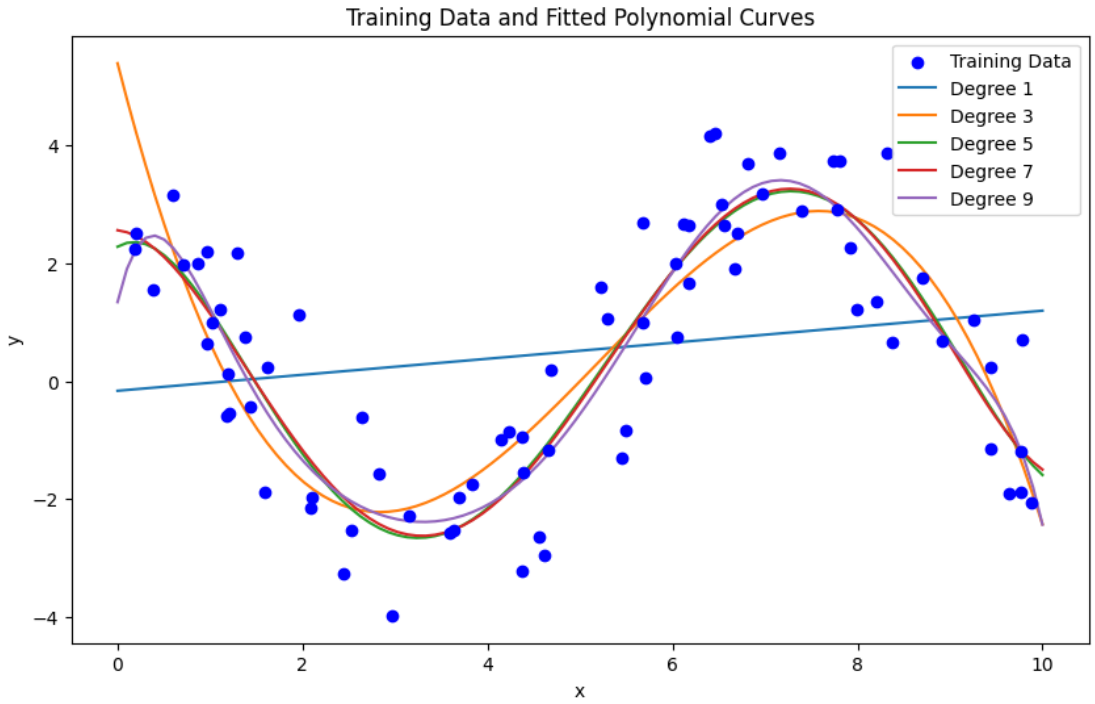
   Same reason as (c), the covariance matrix is not the same because (d) treat each feature individually but (e) does not. Therefore, (e) has correlation term.

2. N = 1000: $\hat{p}_{ML} = 0.712$

   N = 5000: $\hat{p}_{ML} = 0.706$

   From the experiment, when the dataset is large enough, MLE estimates more accurately.

3. (a) Training samples and fitted curves (From 1st to 10th dataset)


Training Data and Fitted Polynomial Curves
Training Data
Degree 1
Degree 3
Degree 5
Degree 7
Degree 9
y
x
4
2
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−4
0
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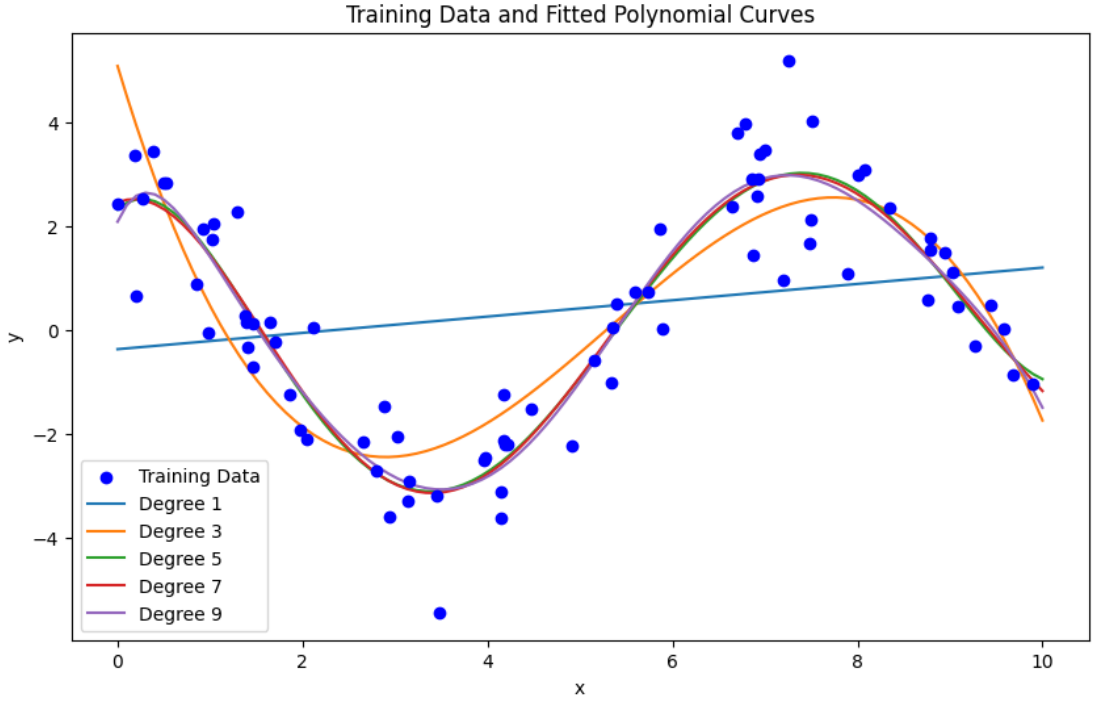
6
8
10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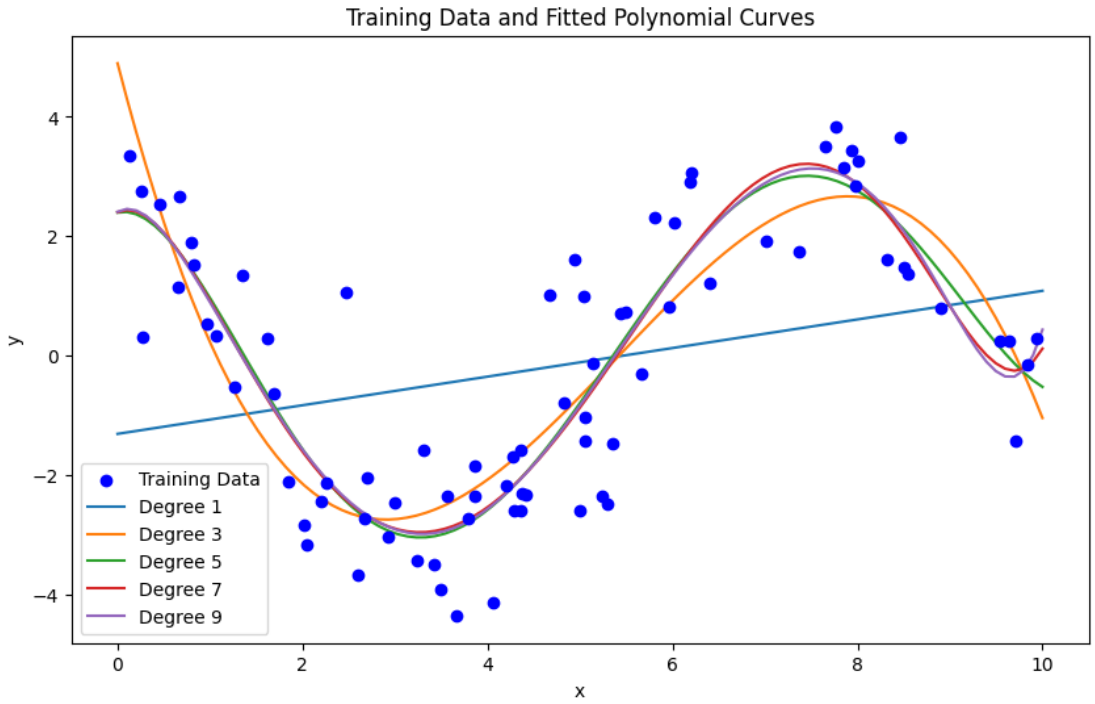
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Degree 3
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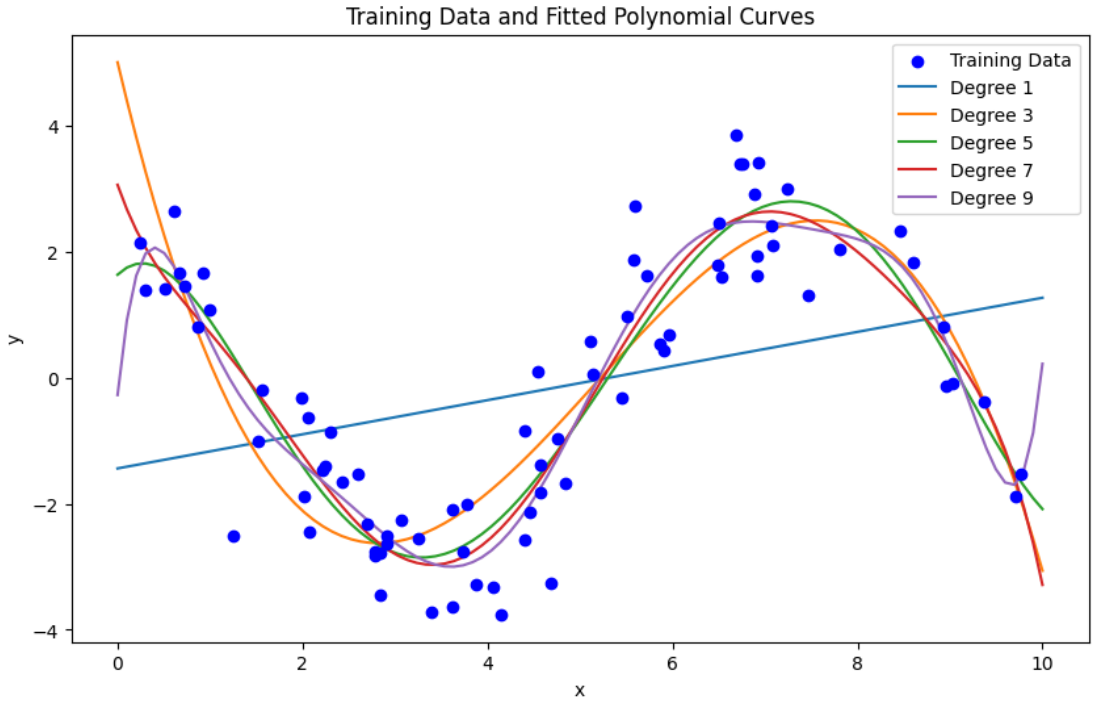
Degree 7
Degree 9
x
y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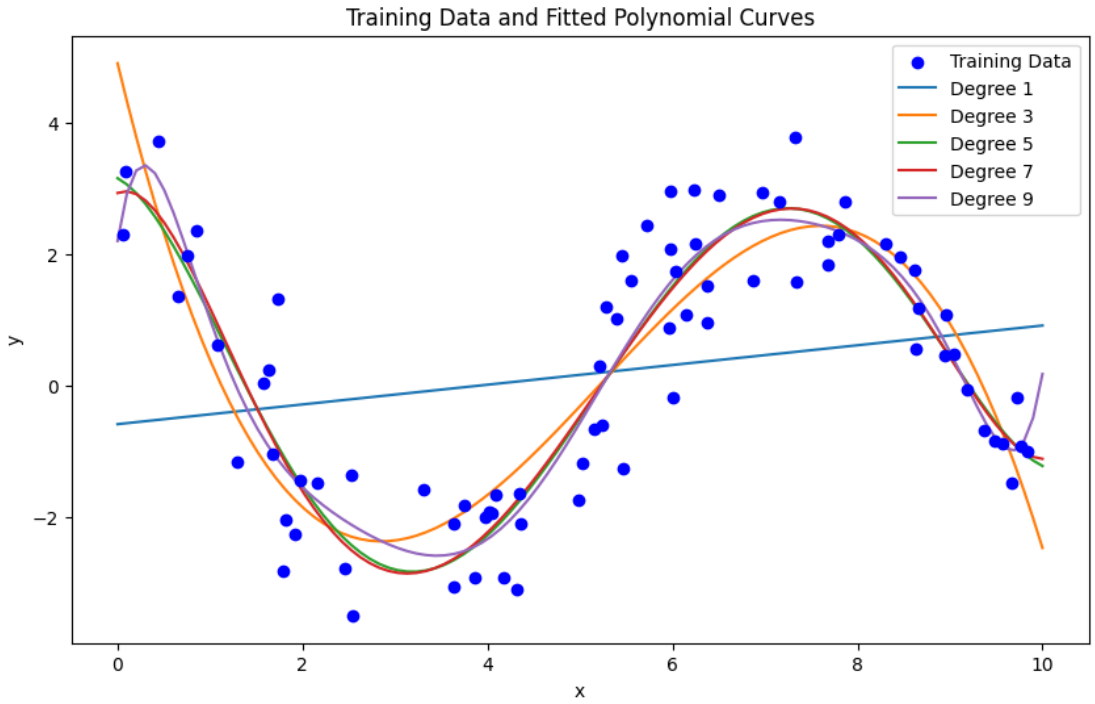
x
y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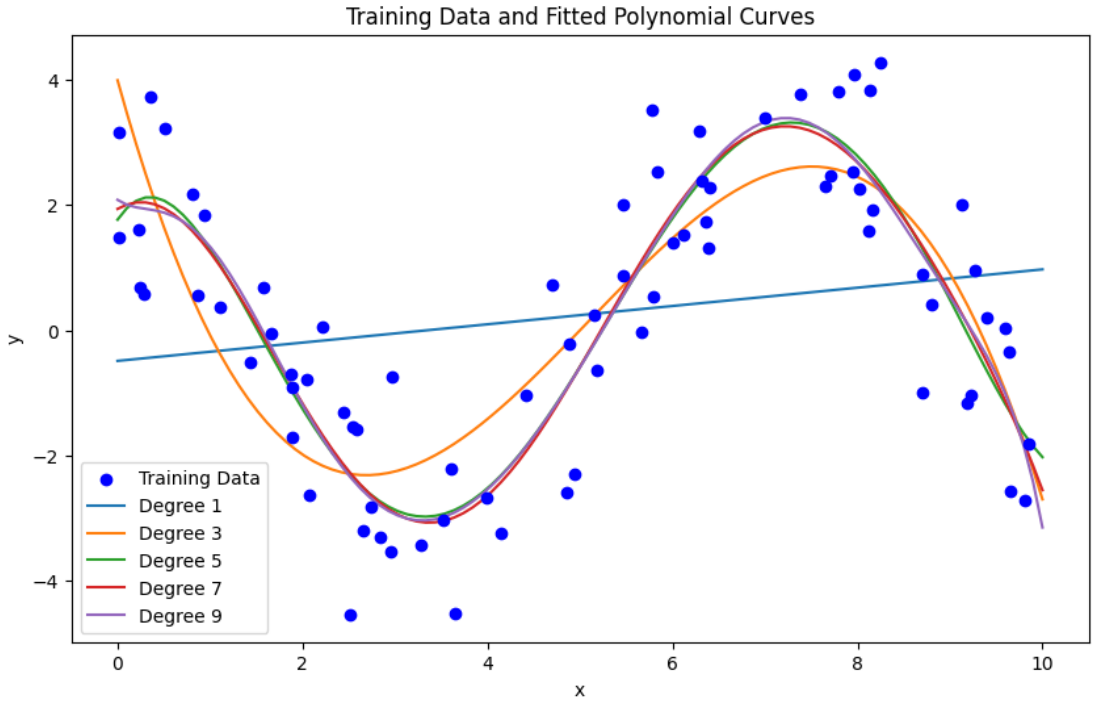
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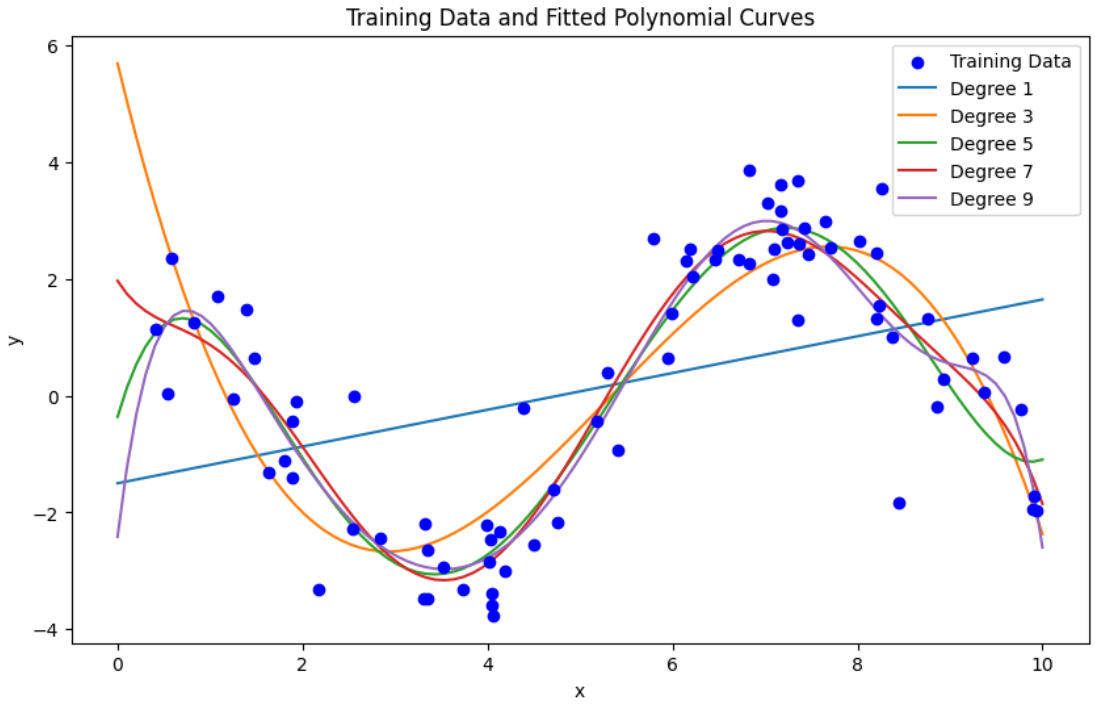
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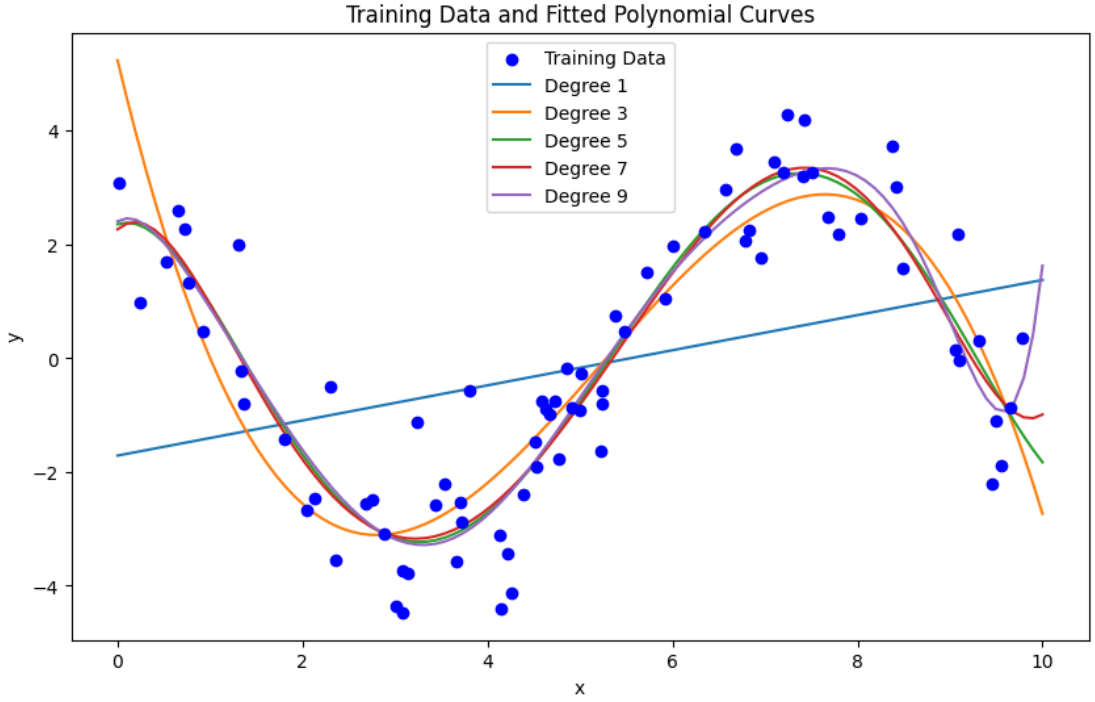
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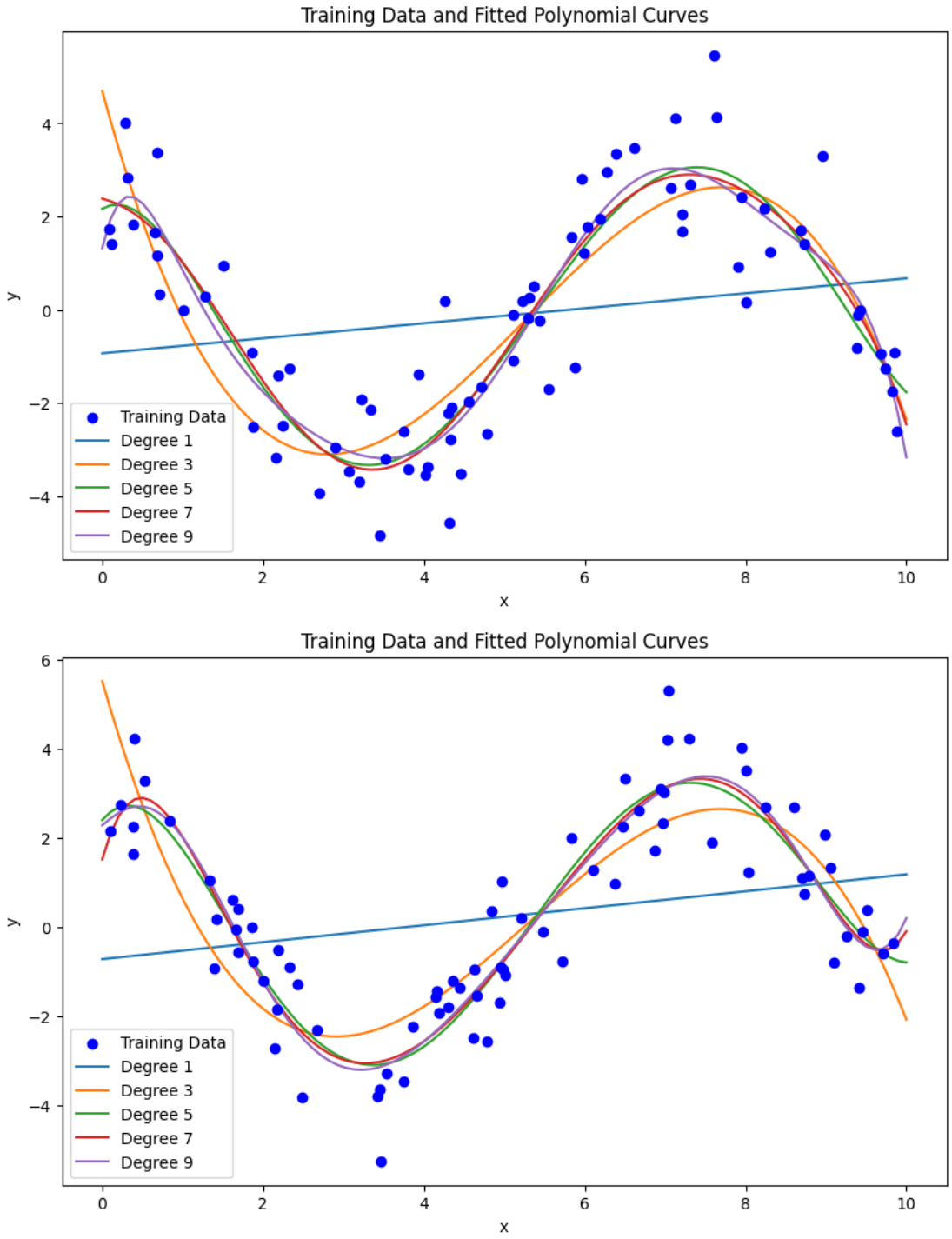
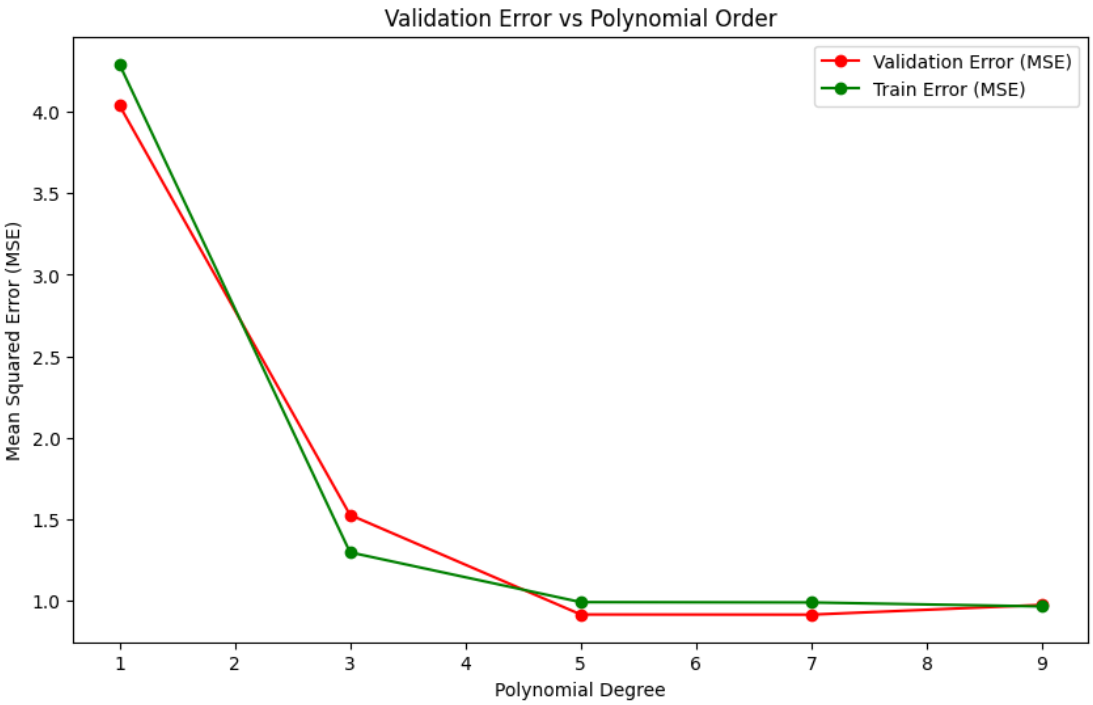
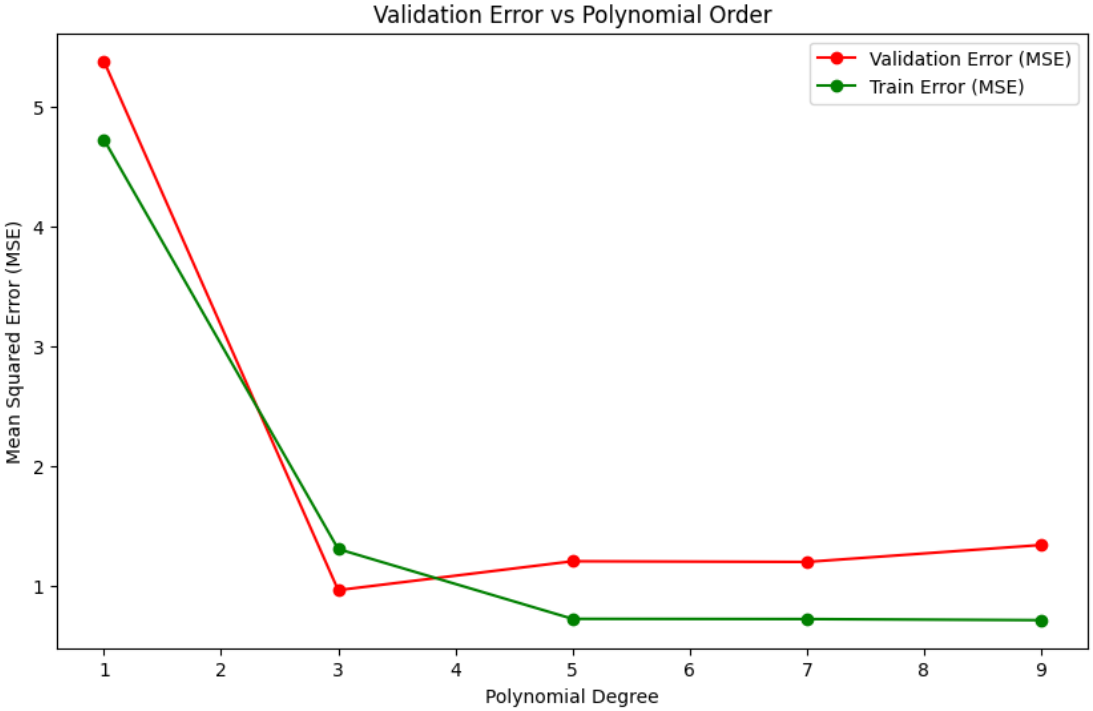


(b) Error on train validation set vs. polynomial order (From 1st to 10th dataset)


Validation Error vs Polynomial Order
Validation Error (MSE)
Train Error (MSE)
Mean Squared Error (MSE)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
1
2
3
4
5
6
7
8
9
Polynomial Degree


Validation Error vs Polynomial Order
Validation Error (MSE)
Train Error (MSE)
Mean Squared Error (MSE)
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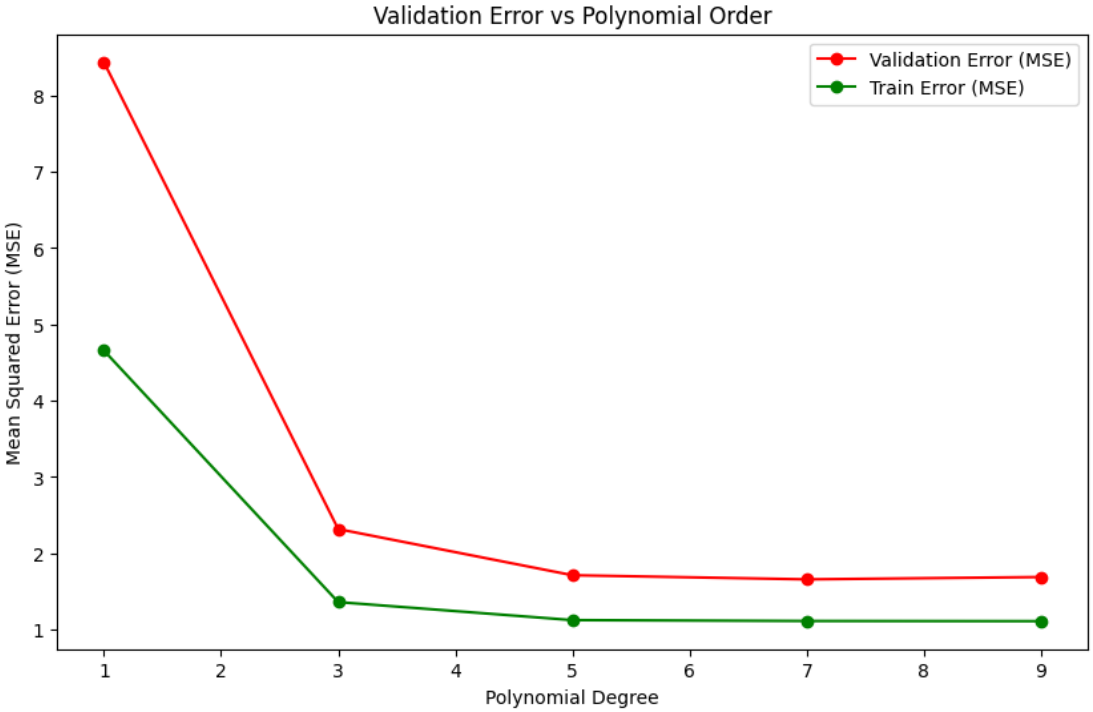
4
3
2
1
1
2
3
4
5
6
7
8
9
Polynomial Degree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Train Error (MSE)
Mean Squared Error (MSE)
Polynomial Degree
1
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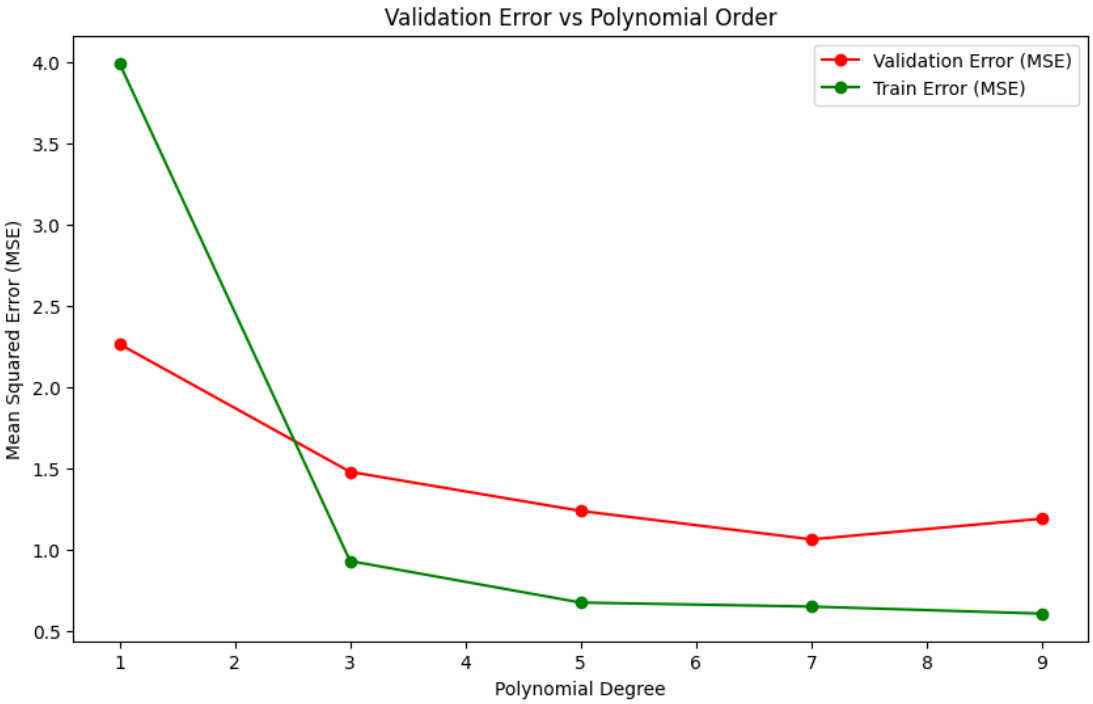
Validation Error vs Polynomial Order
Validation Error (MSE)
Train Error (MSE)
Mean Squared Error (MSE)
Polynomial Degree
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
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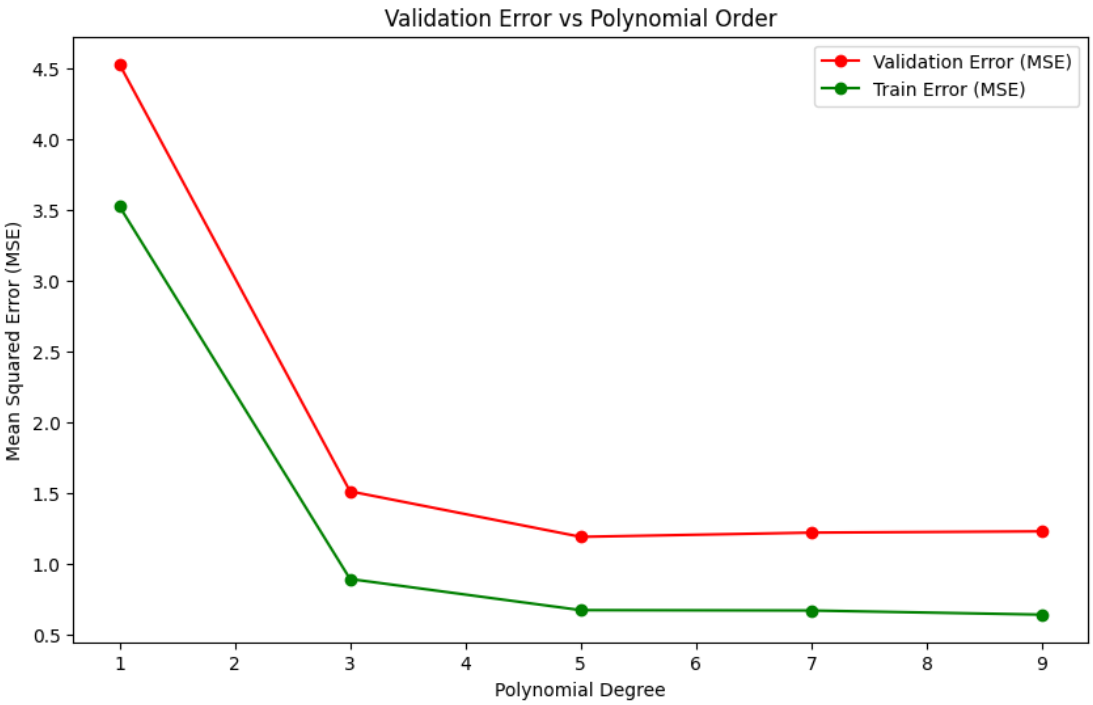
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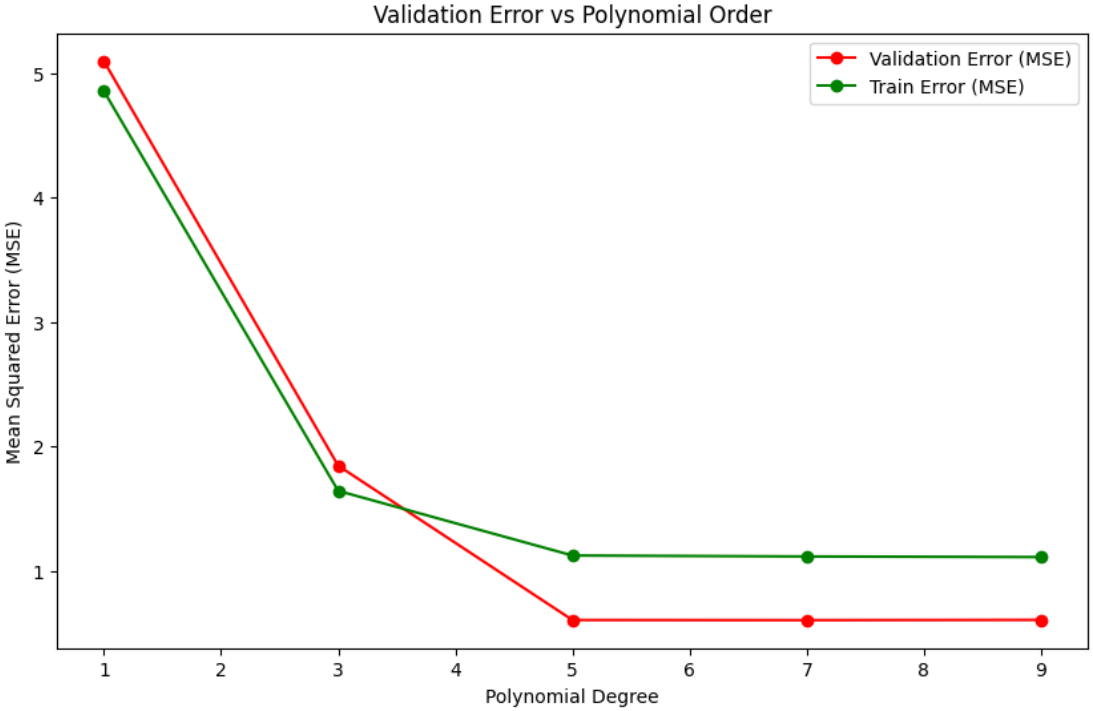
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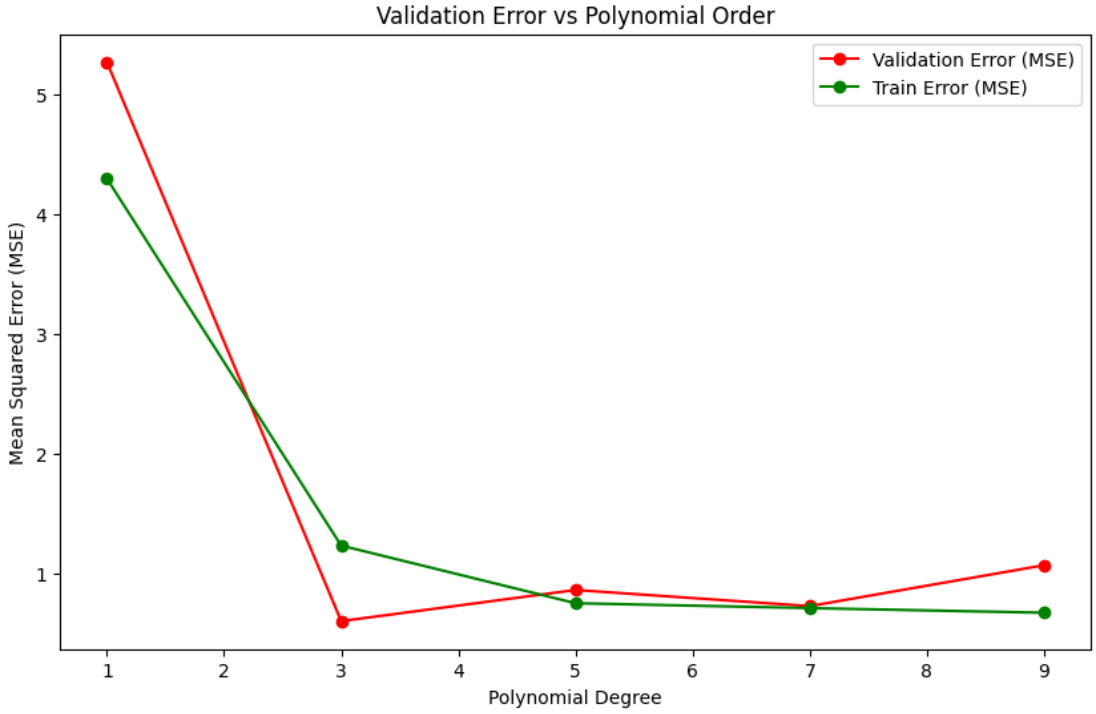
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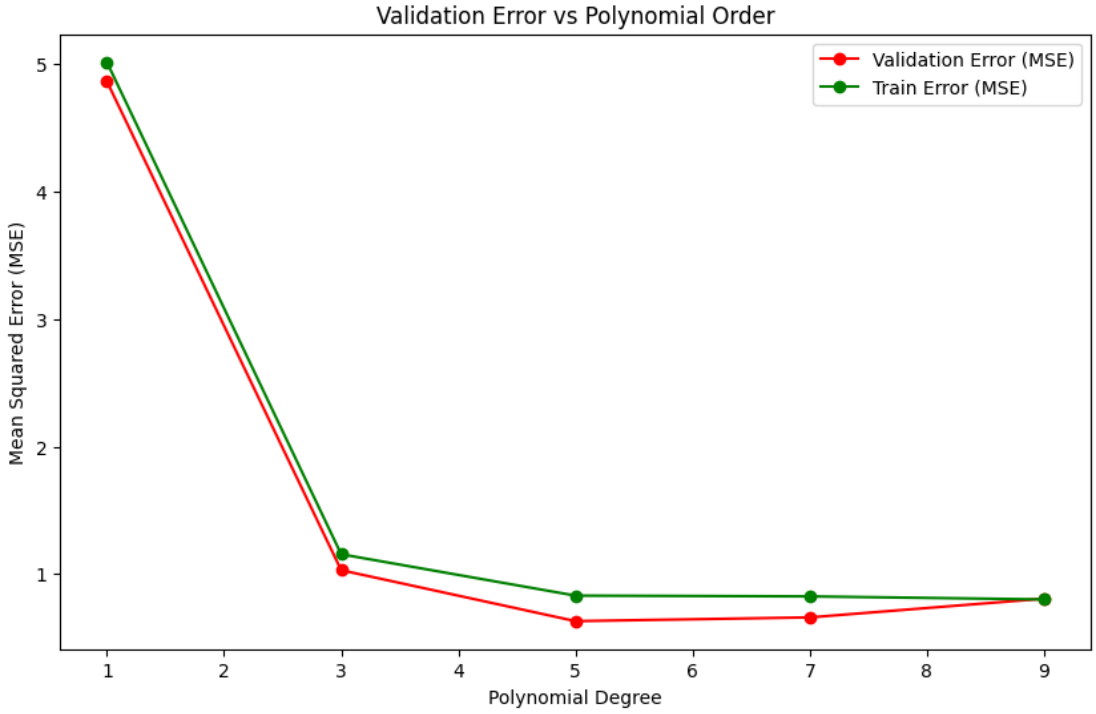
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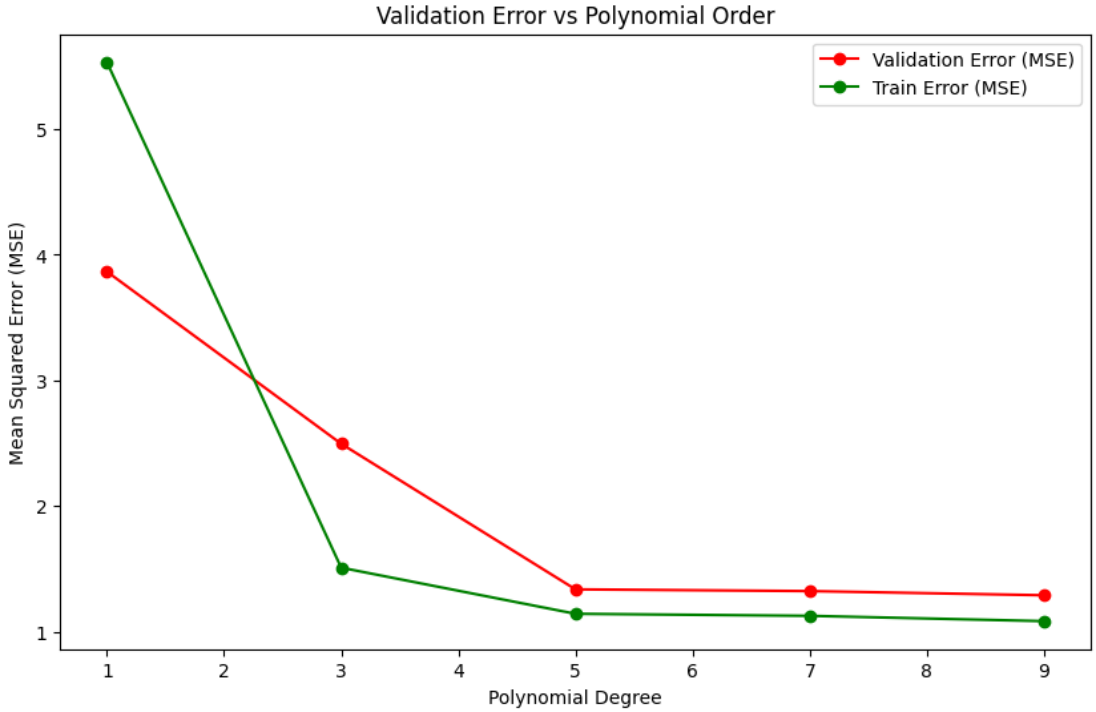
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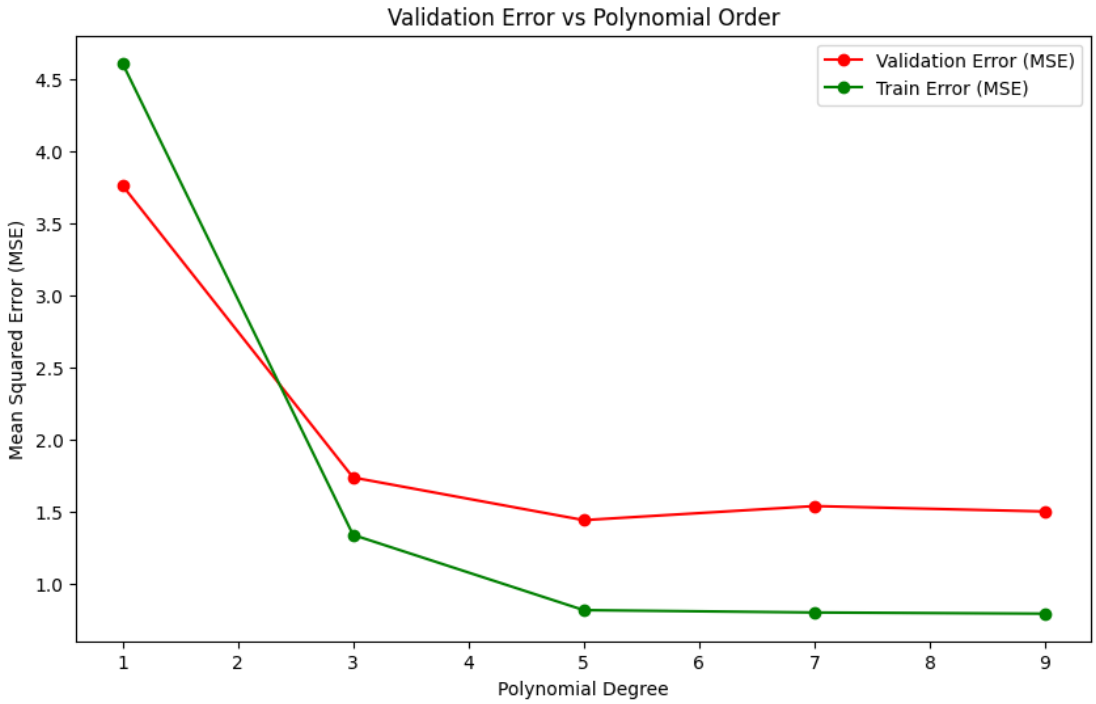
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