

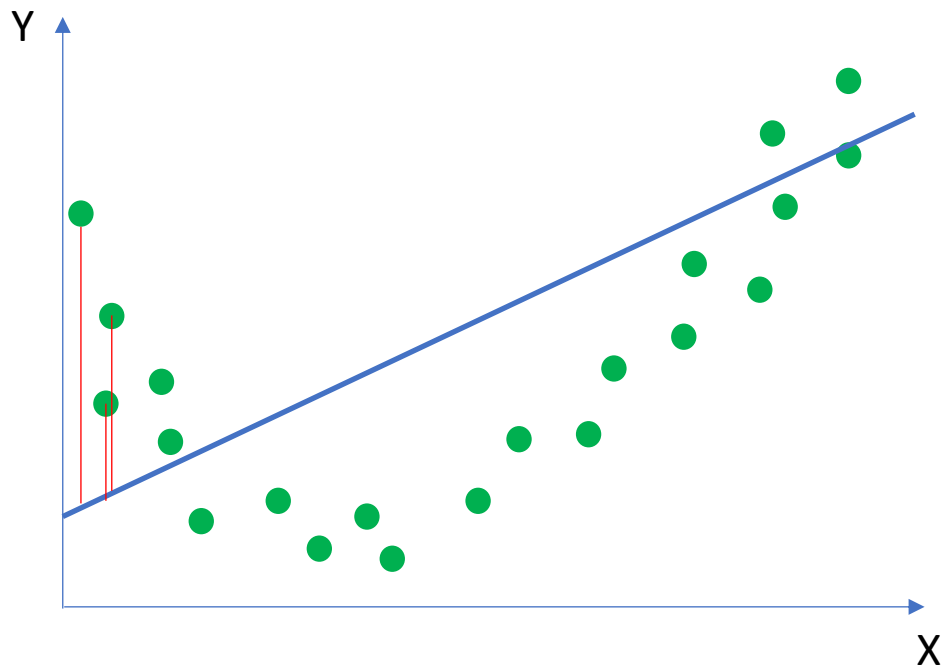
Underfitting and Overfitting 101

Underfitting and Overfitting

Regression Example

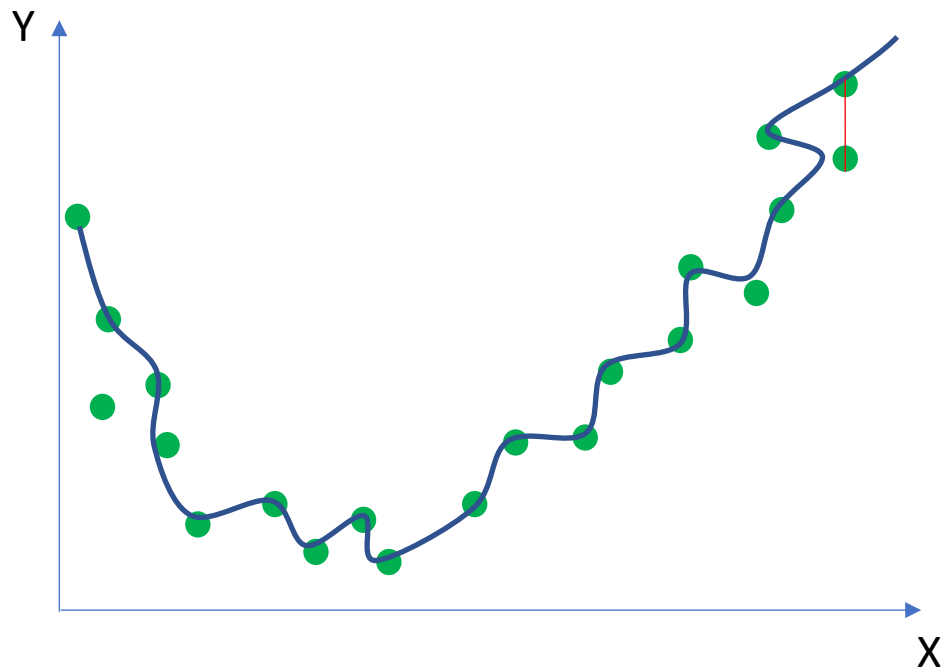
Underfitting

- High bias



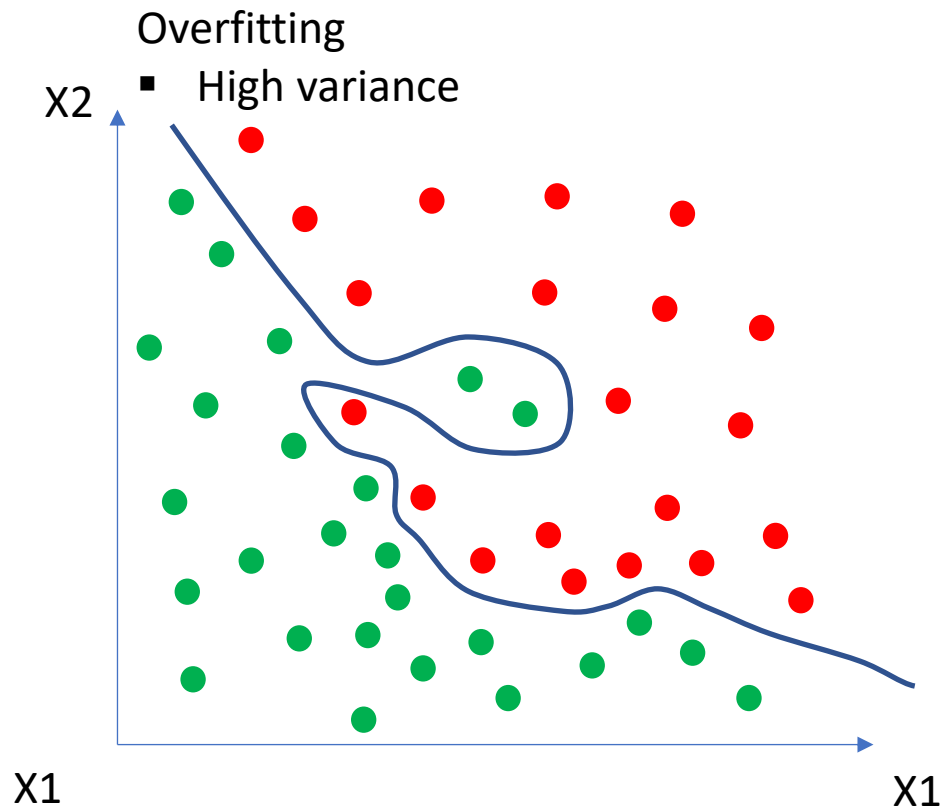
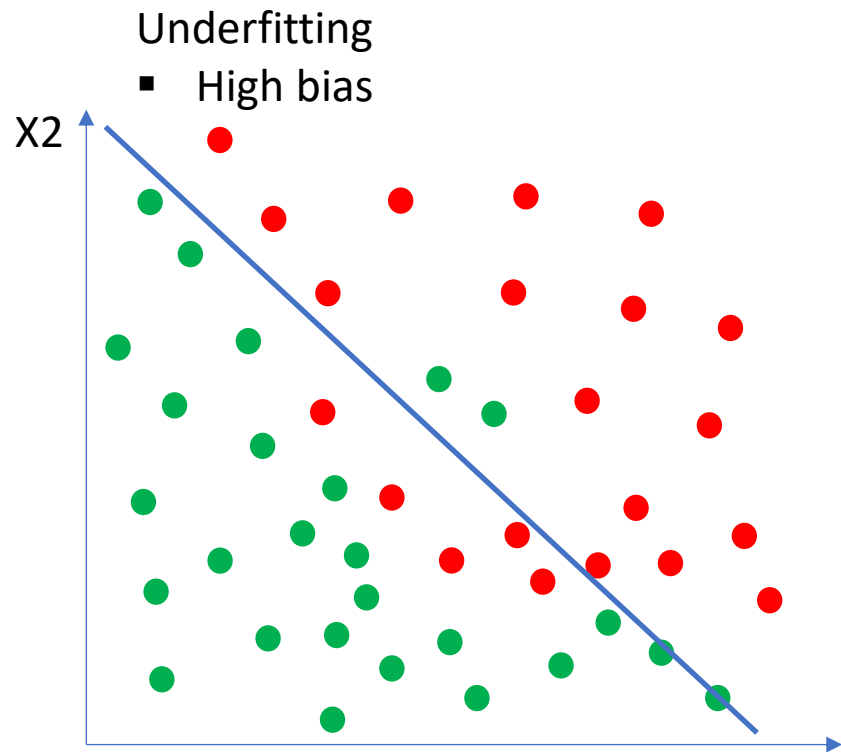
Overfitting

- High variance



Underfitting and Overfitting

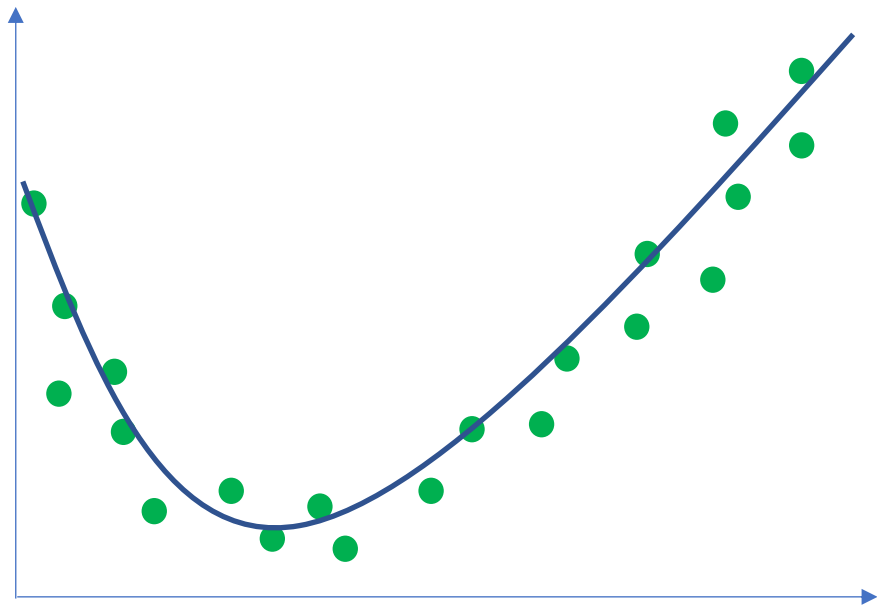
Classification Example



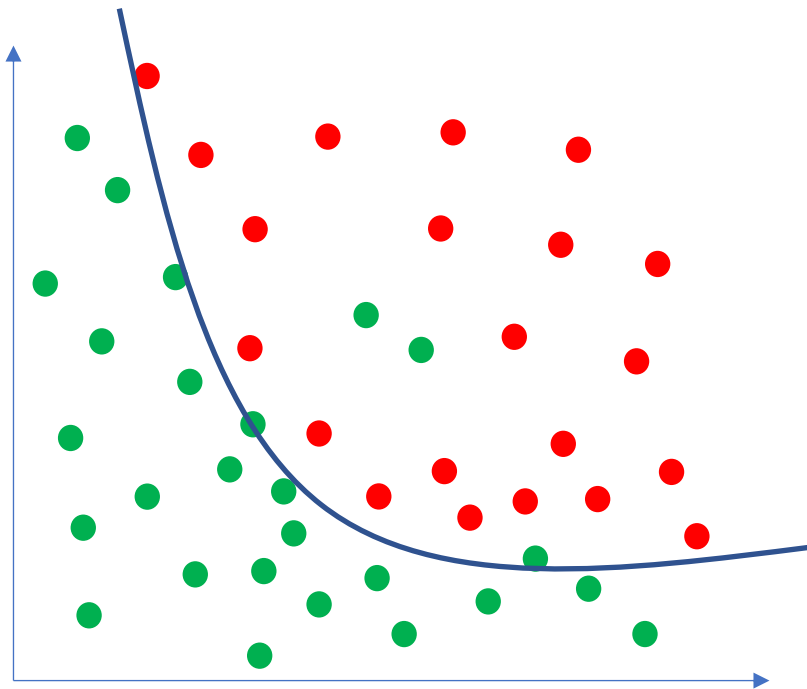
Underfitting and Overfitting

Good Fits

- Regression Example

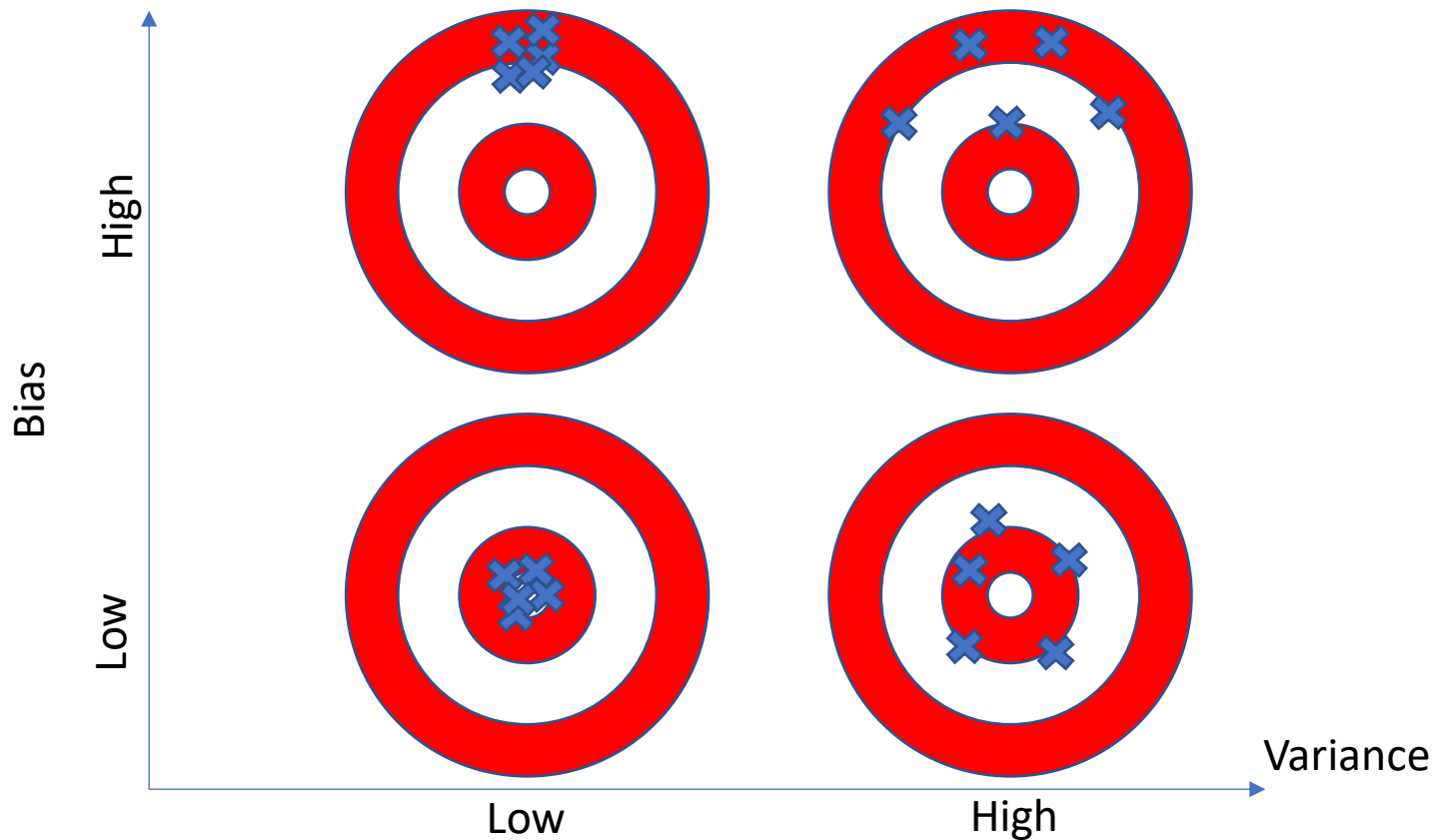


- Classification Example



Underfitting and Overfitting

Bias and Variance

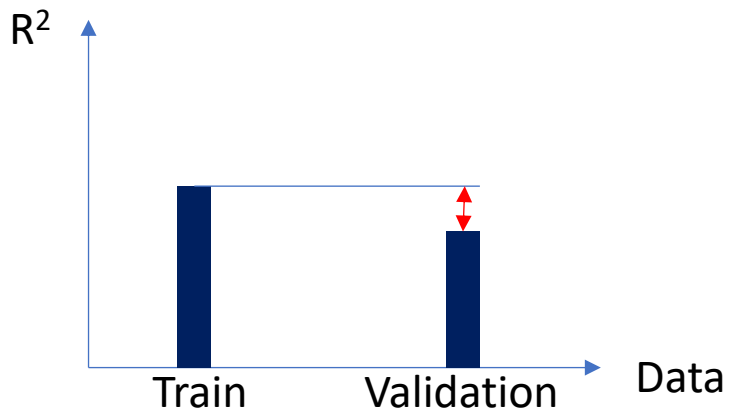


Underfitting and Overfitting

Bias and Variance

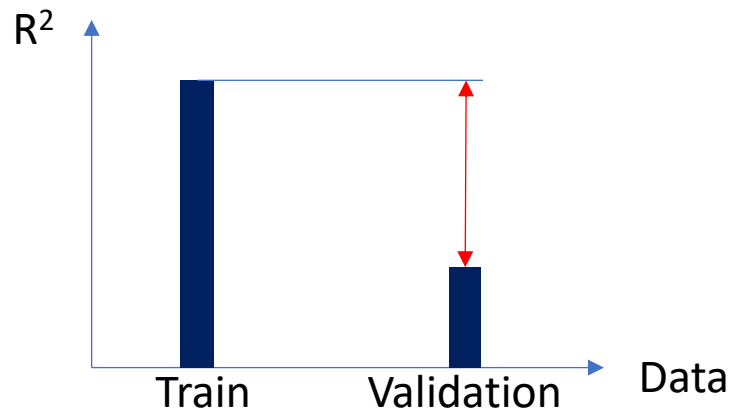
Bias

- Difference prediction / actual values of **training** data
- Example High Bias / Low Variance
 - $R^2=0.5$ for training
 - $R^2=0.48$ for validation



Variance

- Difference prediction of **training** data **vs.** prediction **validation** data
- Example Low Bias / High Variance
 - $R^2=0.97$ for training
 - $R^2=0.3$ for validation



Underfitting and Overfitting

Bias and Variance

Adding more parameters to a model
increases model complexity

Model complexity ↑

Bias ↓

Variance ↑

Using a more complex model

Model complexity ↑

Bias ↓

Variance ↑

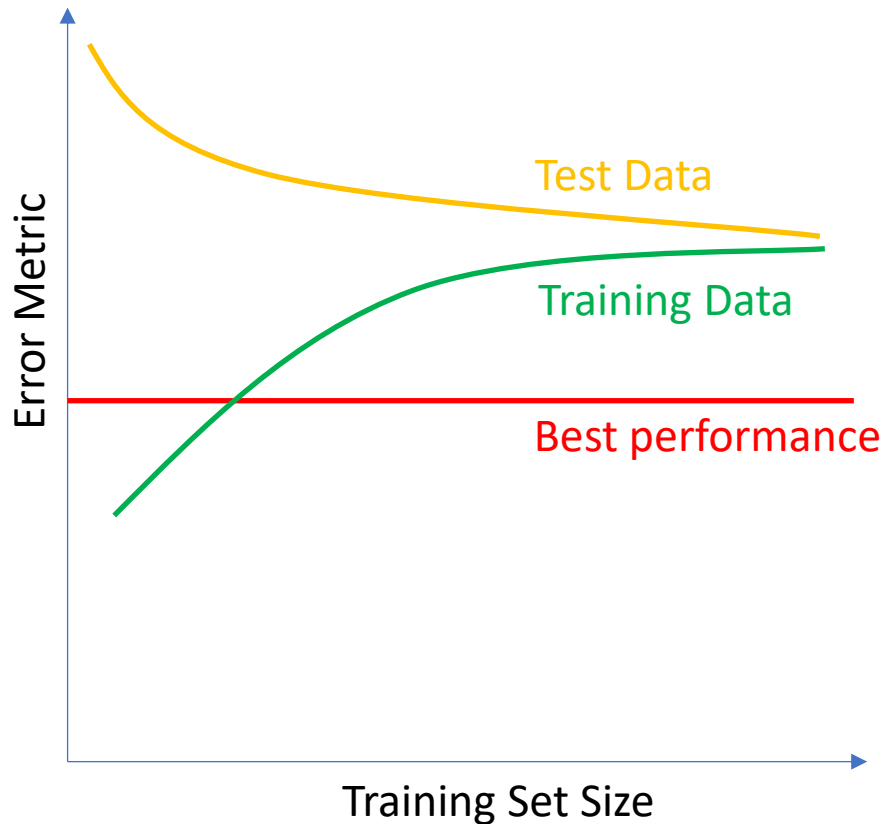
Underfitting and Overfitting

Bias

High Bias

- Learns fast
- Easy to understand (fewer parameters)
- Poor performance on complex problems

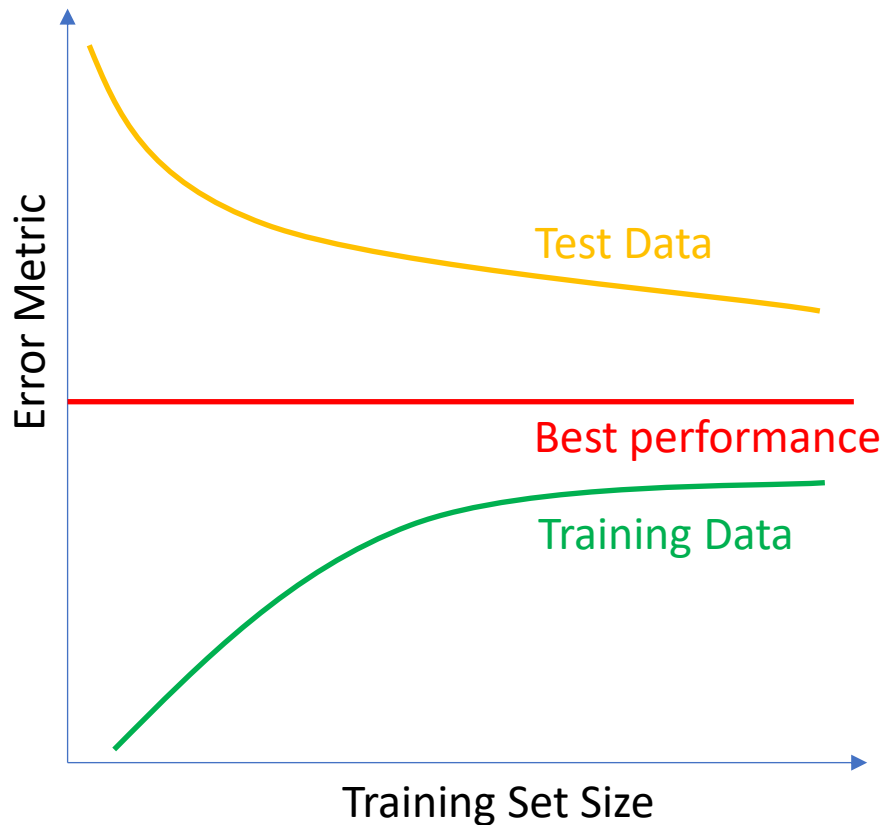
→ Underfitting



Underfitting and Overfitting

Variance

- High Variance → Large change of predictions if different training data is used
 - Low variance algorithms: Linear Regression, LDA, Logistic Regression
 - High variance algorithms: Decision Trees, kNN, SVM
 - High Variance → more parameters
 - Good training performance, poor validation performance → poor generalization
- Overfitting



Underfitting and Overfitting

Bias Variance Tradeoff

- Goal:
 - low bias / low variance
 - Good prediction performance
- Bias and variance have opposite directions
- Linear ML algorithms typically high bias, low variance
- Non-linear ML algorithms typically low bias, high variance
- Non-linear ML algorithms often have hyperparameters for tuning

