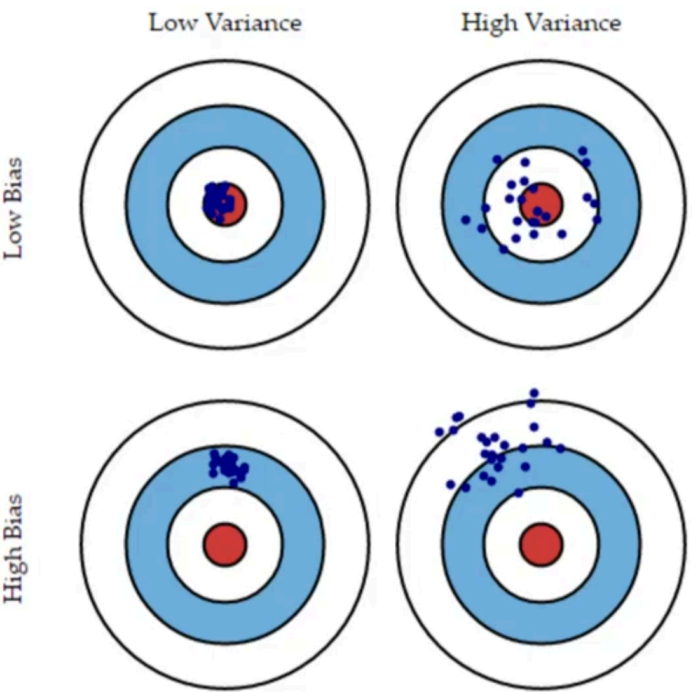
Bias Variance Trade Off is a fundamental topic of understanding your model's performance!

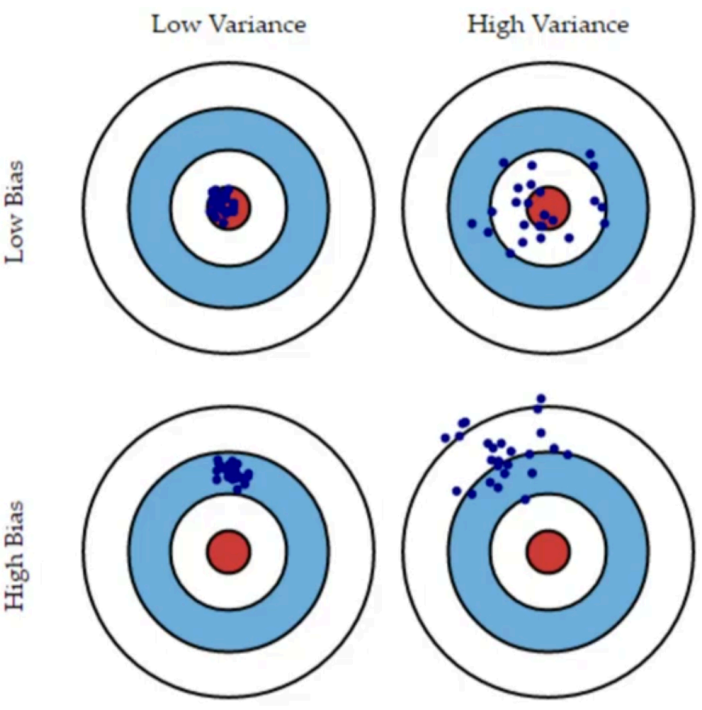
Review Chapter 2 of **Introduction to Statistical Learning** for a more in depth look!

- The bias-variance trade-off is the point where we are adding just noise by adding model complexity (flexibility).
- The training error goes down as it has to, but the test error is starting to go up.
- The model after the bias trade-off begins to overfit.

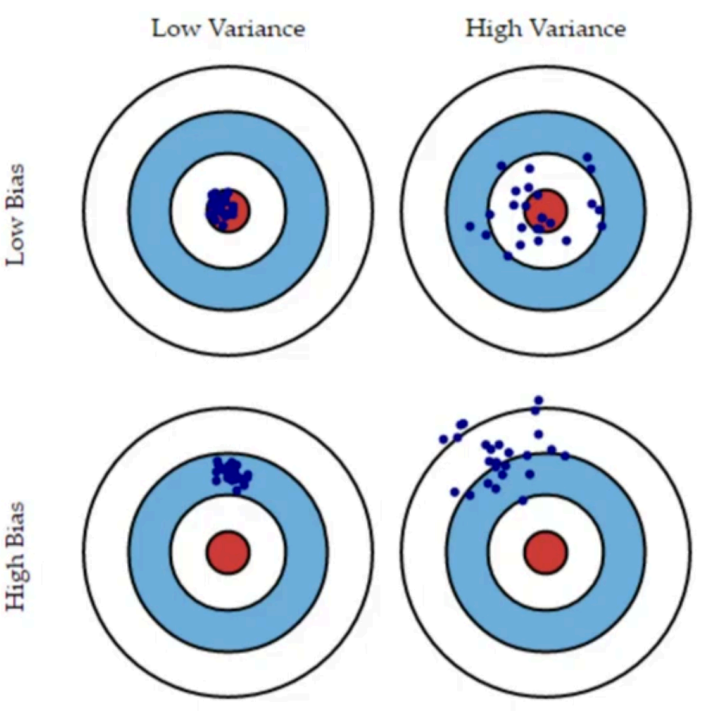
- Imagine that the center of the target is a model that perfectly predicts the correct values.
- As we move away from the bulls-eye, our predictions get worse and worse.



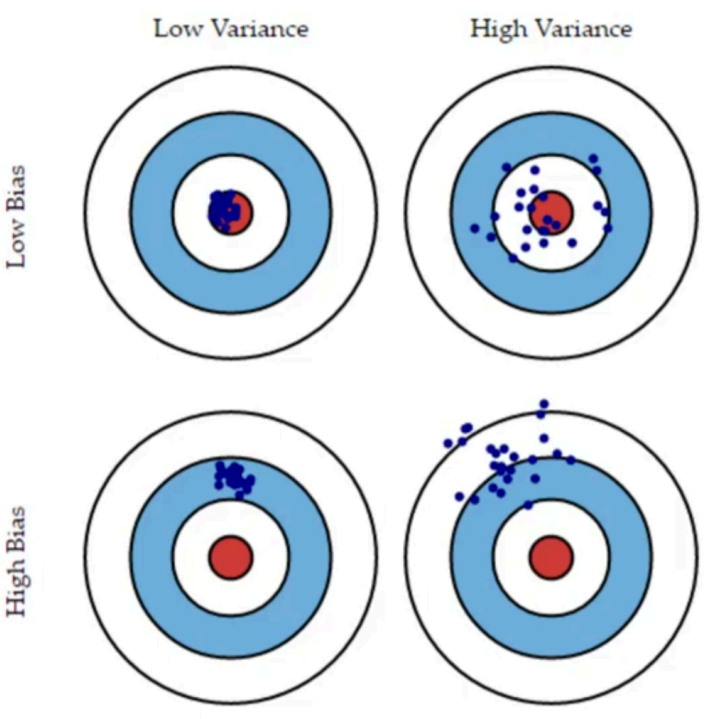
- Imagine we can repeat our entire model building process to get a number of separate hits on the target.
- Each hit represents an individual realization of our model, given the chance variability in the training data we gather.



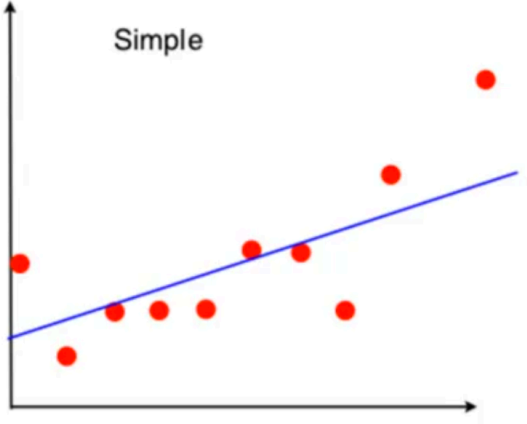
- Sometimes we will get a good distribution of training data so we predict very well and we are close to the bulls-eye, while sometimes our training data might be full of outliers or non-standard values resulting in poorer predictions.

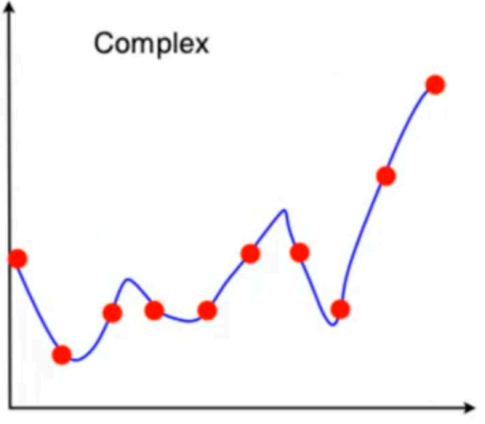


- These different realizations result in a scatter of hits on the target.

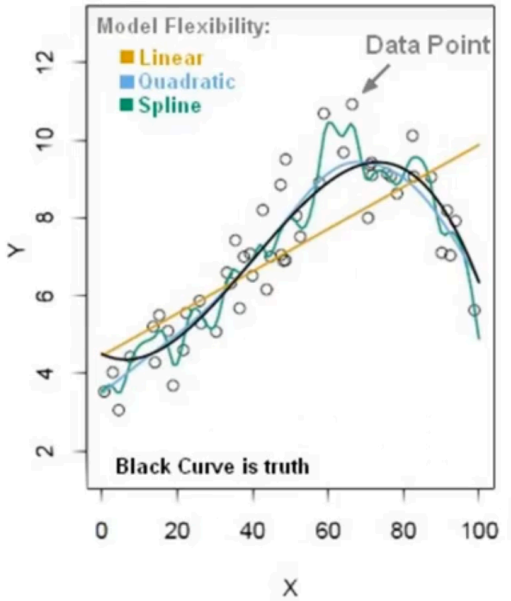


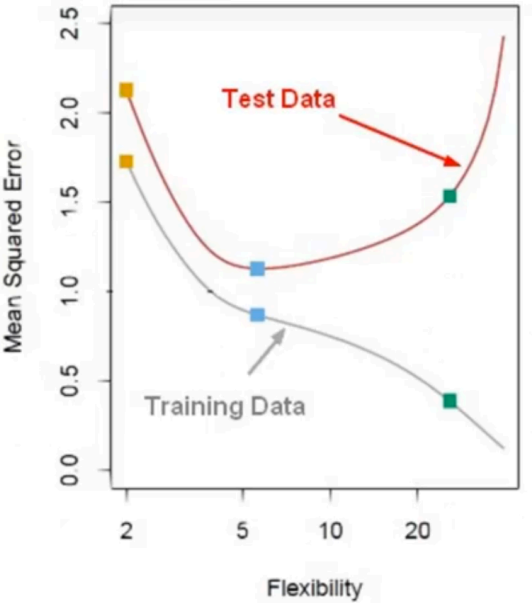
- A common temptation for beginners is to continually add complexity to a model until it fits the training set very well.

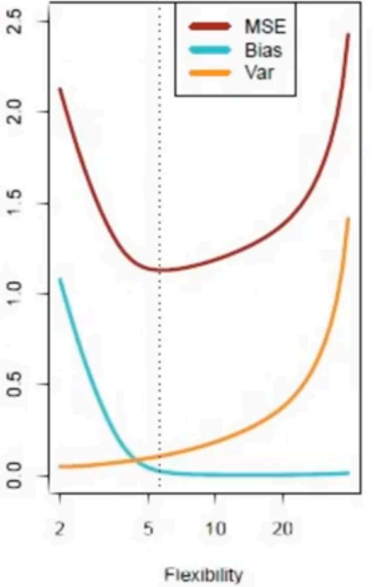


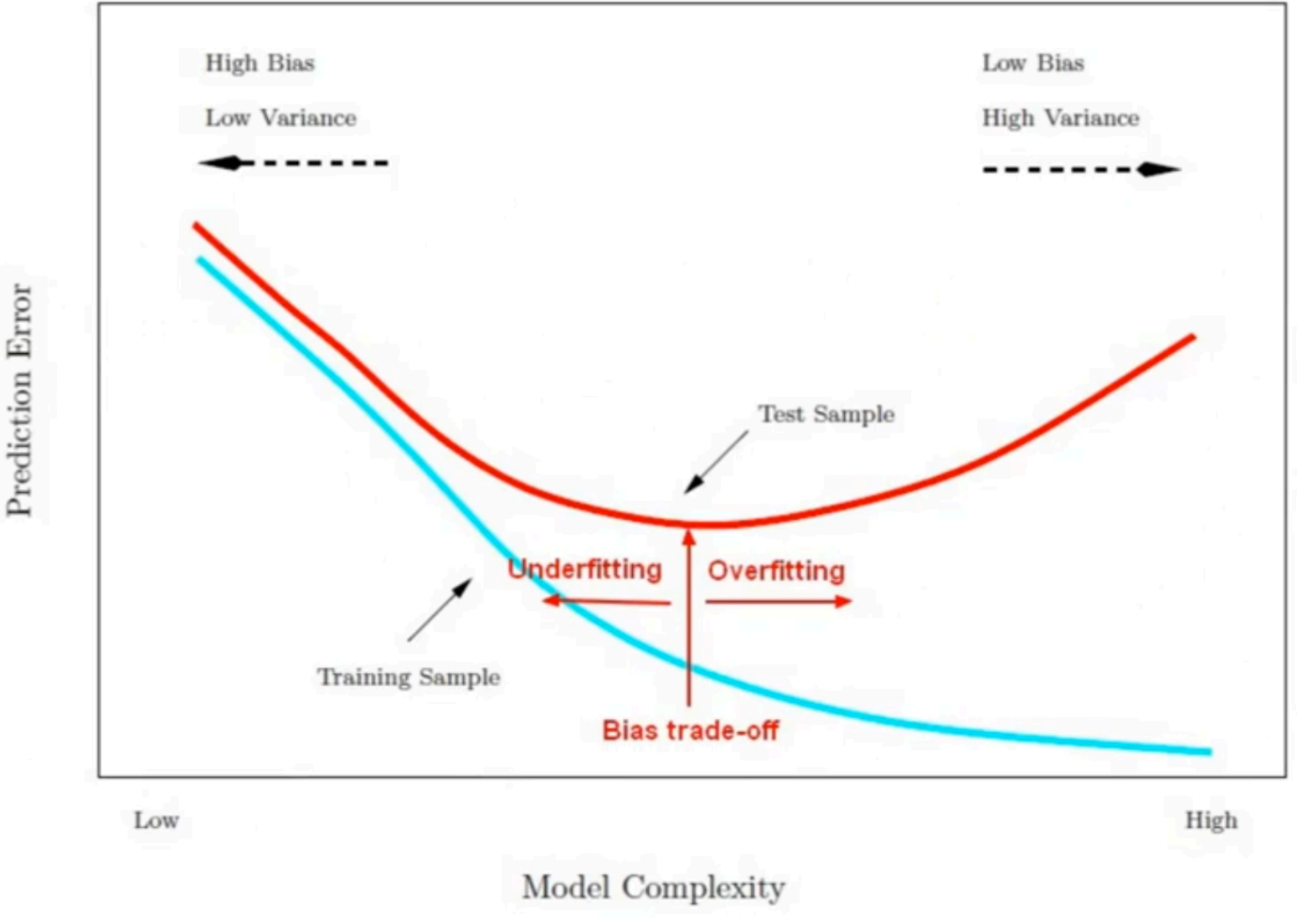


- Doing this can cause a model to overfit to your training data and cause large errors on new data, such as the test set.
- Let's take a look at an example model on how we can see overfitting occur from a error standpoint using test data!
- We'll use a black curve with some "noise" points off of it to represent the True shape the data follows.


Model Flexibility:
Linear
Quadratic
Spline
Data Point
Black Curve is truth
Y
X
0
20
40
60
80
100
2
4
6
8
10
12


Test Data
Training Data
Mean Squared Error
Flexibility
2
5
10
20
0.0
0.5
1.0
1.5
2.0
2.5


MSE
Bias
Var
Flexibility
2
5
10
20
0.0
0.5
1.0
1.5
2.0
2.5


High Bias
Low Variance
Low Bias
High Variance
Prediction Error
Test Sample
Underfitting
Overfitting
Training Sample
Bias trade-off
Low
High
Model Complexity