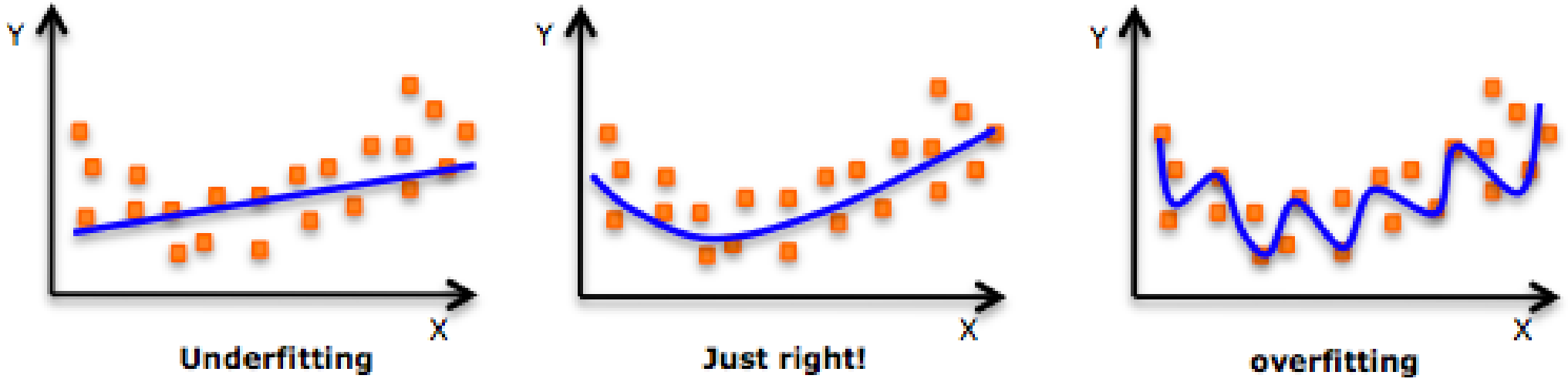
3.04 Bias-Variance Tradeoff

What is Underfitting/Overfitting a Model?

- **Underfitting:** Model doesn't fit training data and is not generalizable to other data sets
- **Overfitting:** Model will be very accurate on training data but is not generalizable to other data sets



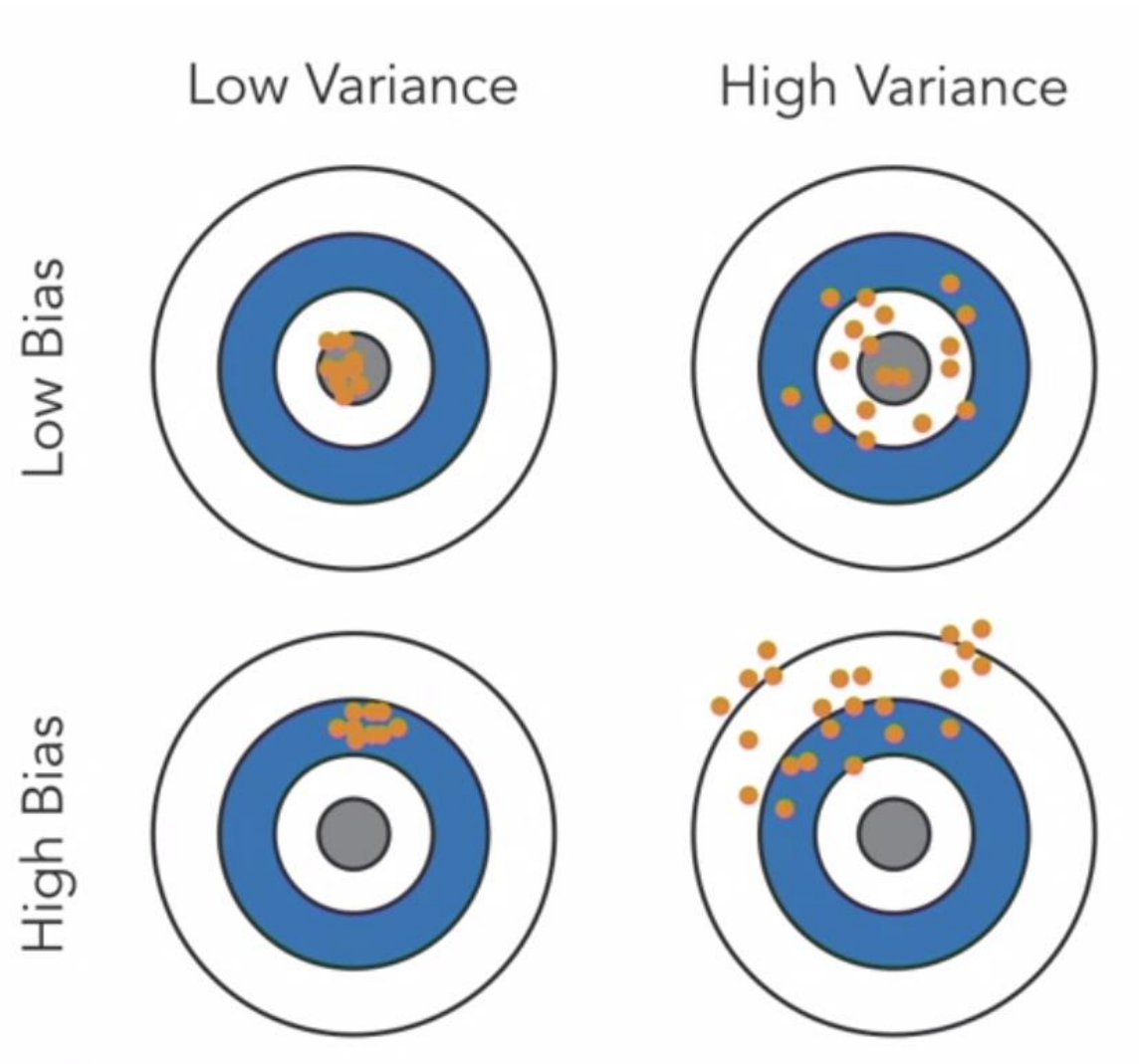
Bias-Variance Tradeoff

- Conflict btw concurrent minimization of these 2 errors that prevent supervised learning algos from generalizing beyond training data

  - Bias is an error from erroneous assumptions in the learning algorithm.
  - High bias can cause an algorithm to miss relevant relationships between features and target outputs (underfitting).

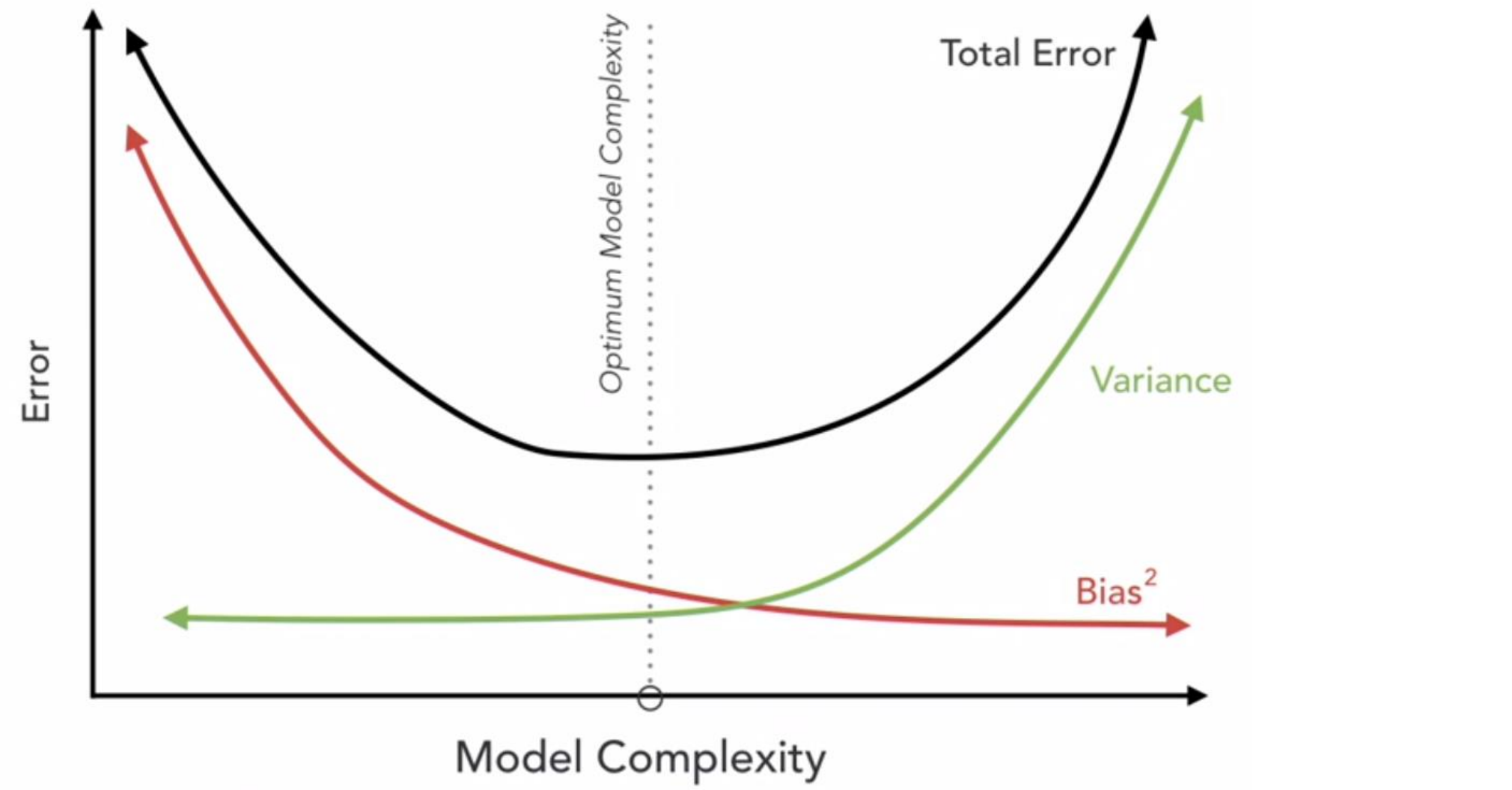
  - Variance is an error from sensitivity to small fluctuations in training data.
  - High variance may result from an algorithm modeling random noise in the training data (overfitting).

Bias-Variance Tradeoff

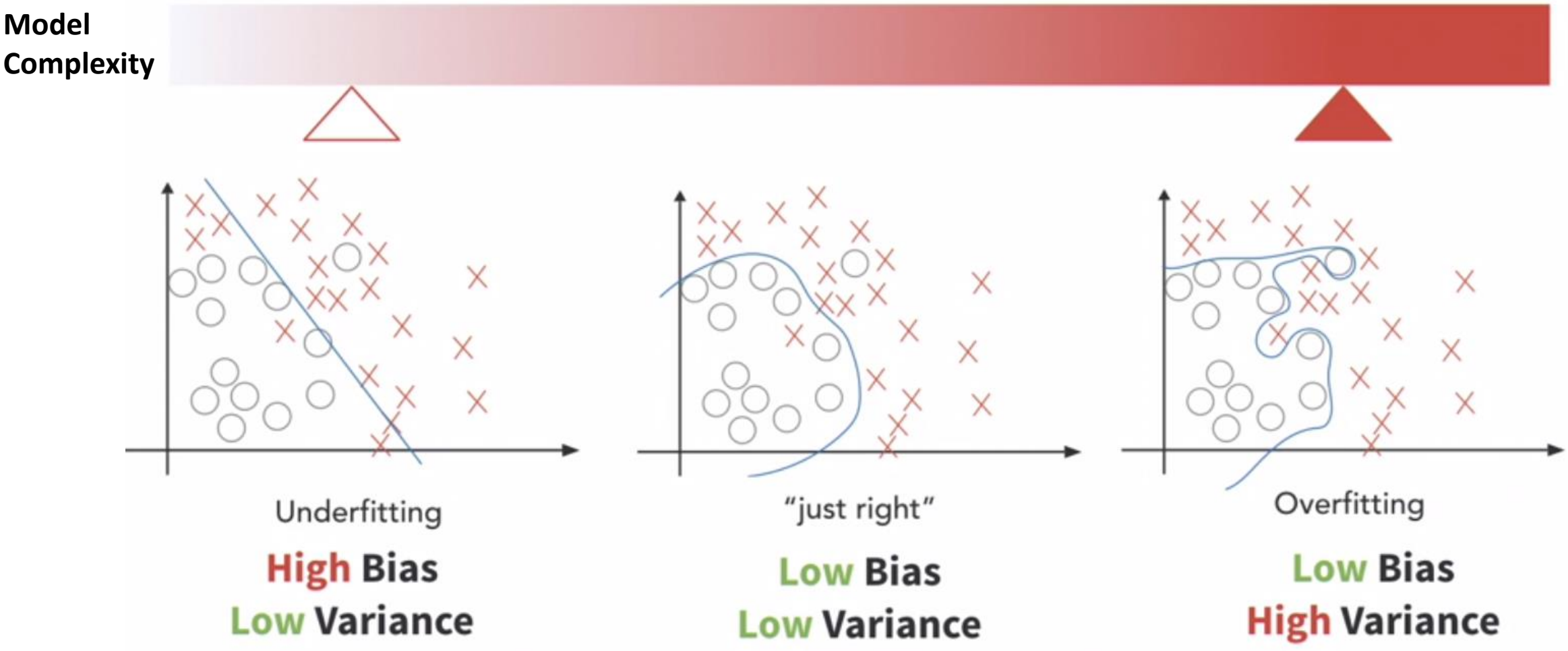


Bias-Variance Tradeoff

Total Error = ($Bias^2$ + Variance) + Irreducible Error



Bias-Variance Tradeoff
Find the optimal tradeoff



Conclusion – Bias Variance Trade-off

- When it comes to Bias and Variance, reducing one over the other is not the preferred method.

- **Bias** is an error between the actual values and the model's predicted values.

- **Variance** is also an error but from the model's sensitivity to the training data.

Conclusion – Bias Variance Trade-off

- If we were to aim to reduce only one of the two then the other will increase.

- A prioritization of Bias over Variance will lead to a model that overfits the data. Prioritizing Variance will have a model underfit the data. Neither of these outcomes are favoured.

- However, there is a point where we can reduce both Bias and Variance without affecting the other and that point is what we are searching for.

Conclusion – Bias Variance Trade-off

- In order to achieve the best machine learning model, we have to balance out the reduction of both.

- This will give us a model that is not too simple (underfitting of the data) and not too complex (overfitting of the data).

- A balance in the reduction of the two errors will lead us to the optimum model complexity. This is the overall concept of the Bias-Variance Tradeoff.