Variance and Bias

Bias - Also called "error due to squared bias," bias is the amount that a model's prediction differs from the target value, compared to the training data. Bias error results from simplifying the assumptions used in a model so the target functions are easier to approximate. Bias can be introduced by model selection.

Variance - Variance indicates how much the estimate of the target function will alter if different training data were used. In other words, variance describes how much a random variable differs from its expected value. Variance is based on a single training set. Variance measures the inconsistency of different predictions using different training sets — it's not a measure of overall accuracy.

For more details check here.

High bias is equivalent to aiming in the wrong place. High variance is equivalent to having an unsteady aim.

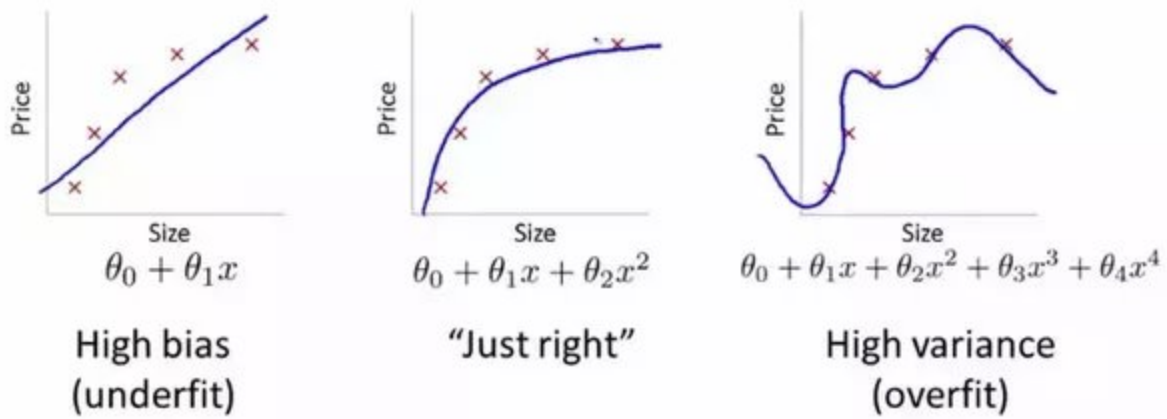This can lead to the following scenarios:

- Low bias, low variance: Aiming at the target and hitting it with good precision.

- Low bias, high variance: Aiming at the target, but not hitting it consistently.

- High bias, low variance: Aiming off the target, but being consistent.

- High bias, high variance: Aiming off the target and being inconsistent.

Low Variance | High Variance
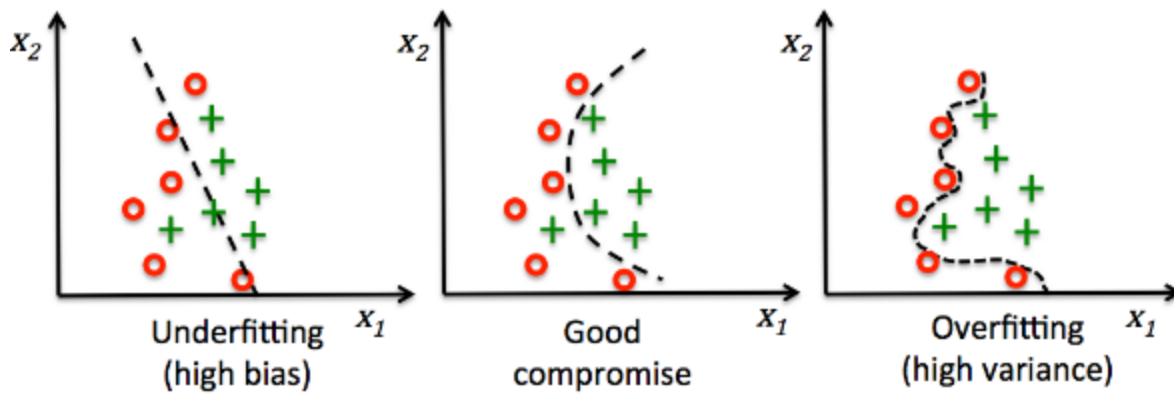
Low Bias | High Bias
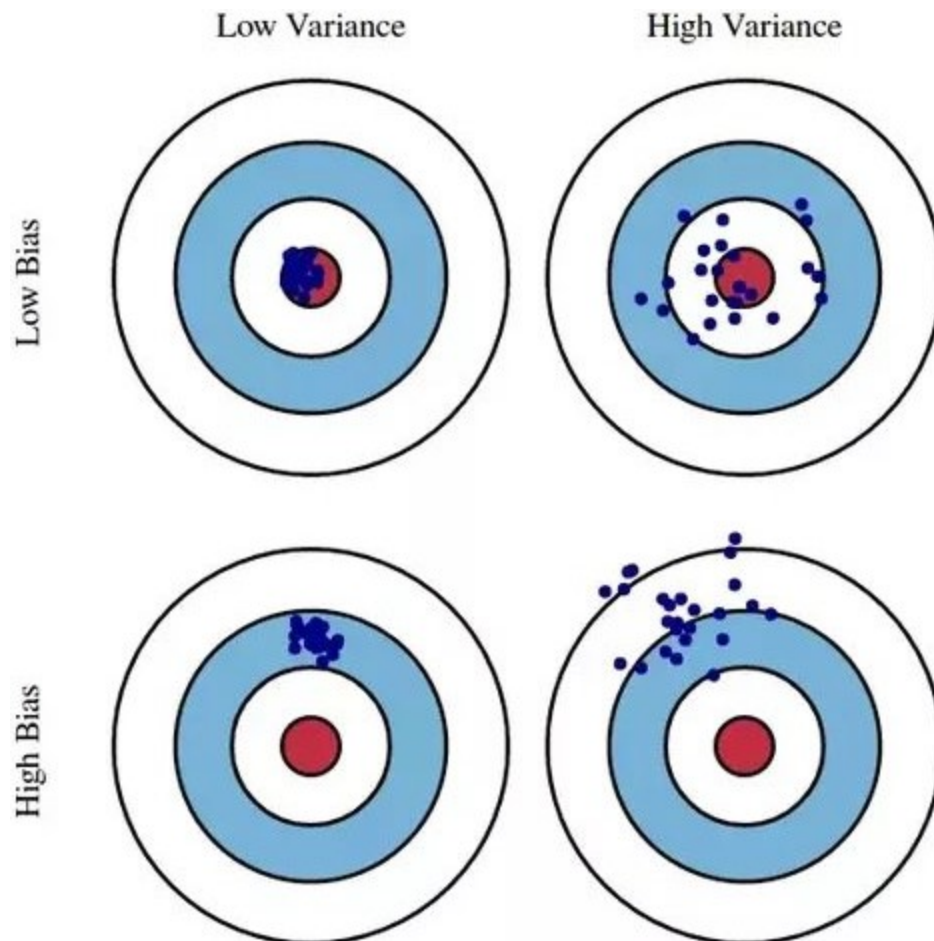
High bias means model is too simple for the data and not able to learn from training data and totally fail to predict on test data. Underfitting leads to high bias. The errors in training data are much higher.

High variance means model is too complex for the data and it is overfitting on noise and error also, fails to generalize so as new data comes in picture it fails to predict. Overfitting leads to high variance. Less errors in training data but large errors in test data.

For linear regression it might look like:

High bias (underfit): $\theta_0 + \theta_1 x$

"Just right": $\theta_0 + \theta_1 x + \theta_2 x^2$

High variance (overfit): $\theta_0 + \theta_1 x + \theta_2 x^2 + \theta_3 x^3 + \theta_4 x^4$

For two variable classification:

Underfitting (high bias) — Good compromise — Overfitting (high variance)

To solve high bias some complex model needs to be used.