Source:https://elitedatascience.com/bias-variance-tradeoff

An Intuitive explanation to Bias Variance Tradeoff

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It has always been hard for me to remember what these term actually represent. Wherever I went I came across only one definition , *High Bias means under fitting and High Variance means over fitting.* Since, it is a very important concept in deciding which algorithm to chose for your problem, and also helps tune your algorithm in a correct way, I decided to provide an intuitive explanation to this concept.

Bias and Variance in real world

In dictionary terms :

Bias : Prejudice in favor of or against one thing, person, or group compared with another, usually in a way considered to be unfair.

Variance: The state or fact of disagreeing or quarreling.

In short, Bias represents how unfair is something towards others, and Variance represents how likely some thing changes with respect to others.

Confusing ? Worry not. This example will clarify all your doubts.

Lets assume you have called two weather examiners, Mr. Bishop and Mr. Varian to **test** if it will rain or not.

Mr. Bishop loves rain a lot. And Mr. Varian is a book worm.

Let us talk about three conditions. It rains only if its little humid and does not if its windy, hot or freezing.

*You ask Mr. Bishop (**Despite of his training, he is too biased towards rain**) :*

Me :Sir, its extremely hot out here, will it rain ?
Mr. Bishop : Yup.

Me :Sir, its little windy, will it rain ?
Mr. Bishop : May be not.

Me :Sir, its freezing will it rain ?
Mr. Bishop : Yes of course.

Me :Sir, its little humid, will it rain ?
Mr. Bishop : Damn sure.

Did you notice, Mr. Bishop is highly _Biased_ towards chances of having rain. During the test, he is unable to predict most of them correctly.

This condition is called under fitting.

Now let us see your conversation with Mr. Varian **(a bookworm who completely remembers the training he had):**

Me :Sir, its extremely hot out here, will it rain ?
Mr. Varian: Nope.

Me :Sir, its little windy, will it rain ?
Mr. Varian: No way.

Me :Sir, its freezing, will it rain ?
Mr. Varian: No way.

Me :Sir, its little humid, will it rain ?
Mr. Varian: Yes it will.

Mr. Varian successfully predicted whether it will rain or not. But being a book worm, Mr. Varian is unknown to the conditions not described in the book during training.

Now, we ask Mr. Varian :

Me :Sir, there is a giant sitting on the cloud who lost his candy. Will it rain ?
Mr. Varian: Not sure, since the answer is "No" to most of the conditions, there is a high possibility that it will not rain .

Now, although the decision of Mr. Varian varies perfectly with the input conditions, he is not able to predict for the new and unseen condition (other general conditions apart from the given specific conditions while training).

This condition is called over fitting. And it offers poor generalizability.

Then what is better, high bias (high generalizability) or high variance (high accuracy on training data) ?

Well, the answer is, *"Best of both worlds"*. We neither need high bias nor high variance. We would want our algorithm to perform better on training set and also offer best result on unseen data (the test set).

In general, having high bias reduces the performance of the algorithm on training set while having high variance reduces performance on unseen data.

This is known as Bias Variance Trade off.

In my next story, we will talk about how to tune an algorithm suffering from high bias or high variance, and how to fit your algorithm just right.

Machine Learning   Bias Variance Tradeoff   Bias   Variance