#### **Boosting Algorithm: Gradient Boosting**



Gradient boosting is a technique for regression and classification problems. The prediction model produced in the form of an ensemble of <u>weak prediction models</u>.

The accuracy of a predictive model can be boosted in two ways:

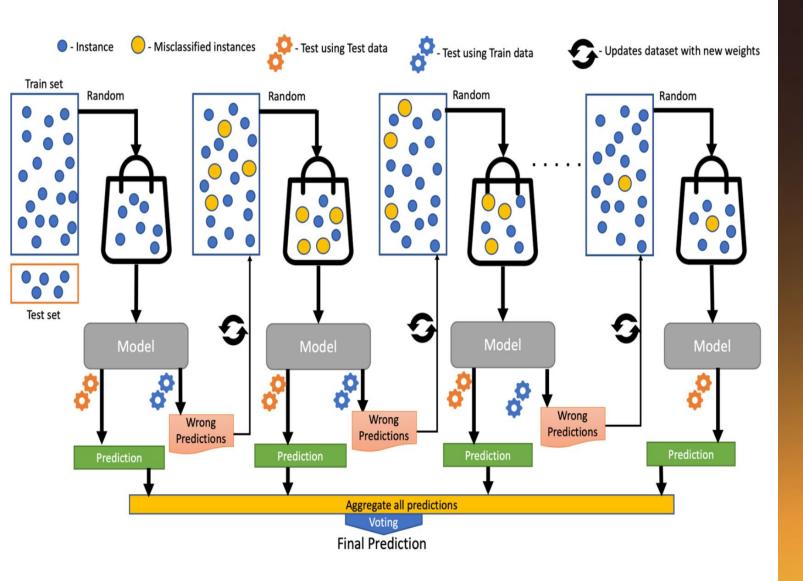
- a. Either by using feature engineering or
- b. By applying boosting algorithms.

There are many boosting algorithms like

- Gradient Boosting
- XGBoost
- AdaBoost

#### Internal working of boosting algorithm

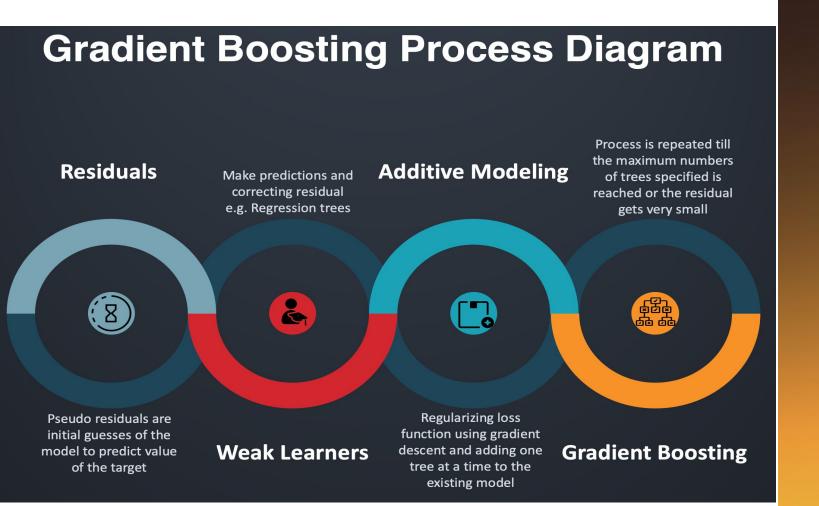




#### **Gradient Boosting**

Gradient boosting Algorithm involves three elements:

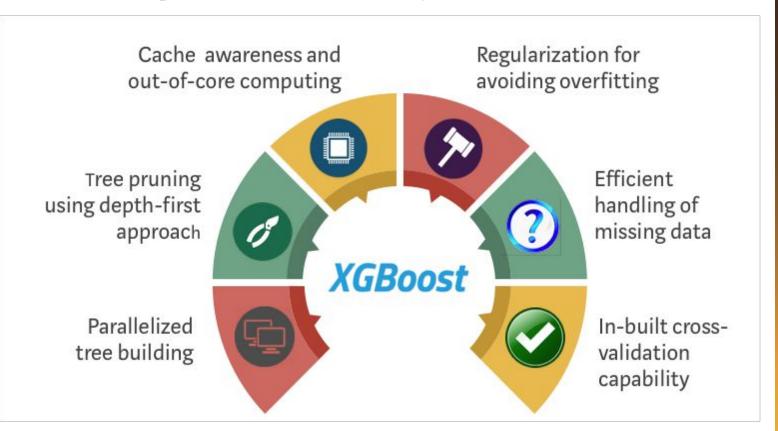
- A loss function to be optimized.
- Weak learner to make predictions.
- An additive model to add weak learners to minimize the loss function.





#### **Extreme Gradient Boosting (XGBoost)**

- XGBoost Algorithm is an implementation of gradient boosted decision trees, <u>designed for speed and performance</u>.
- Basically, it is a type of software library. It can be used for supervised learning tasks such as Regression, Classification, and Ranking.
- It is built on the principles of gradient boosting framework and designed to "push the extreme of the computation limits of machines to provide a scalable, portable and accurate library."

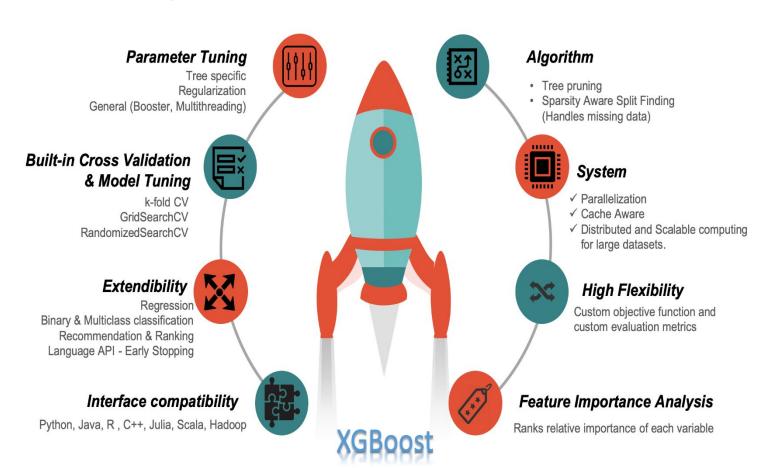




#### System Feature- XGBoost

For use of a range of computing environments this library provides:

- <u>Parallelization of tree</u> construction using all of your CPU cores during training.
- <u>Distributed Computing for training very large models</u> using a cluster of machines & Out-of-Core Computing for very large datasets that don't fit into memory.





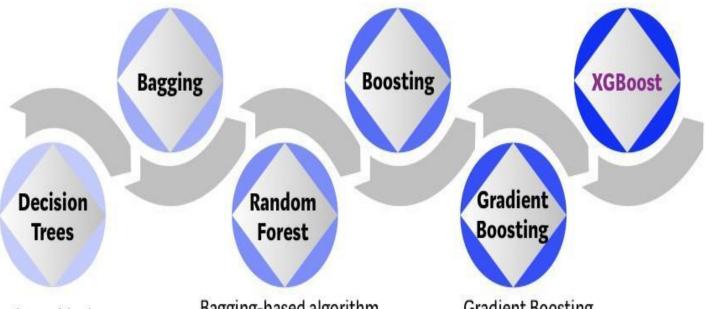
### Comparison-XGBoosting



Bootstrap aggregating or Bagging is a ensemble meta-algorithm combining predictions from multipledecision trees through a majority voting mechanism

Models are built sequentially by minimizing the errors from previous models while increasing (or boosting) influence of high-performing models

Optimized Gradient Boosting algorithm through parallel processing, tree-pruning, handling missing values and regularization to avoid overfitting/bias



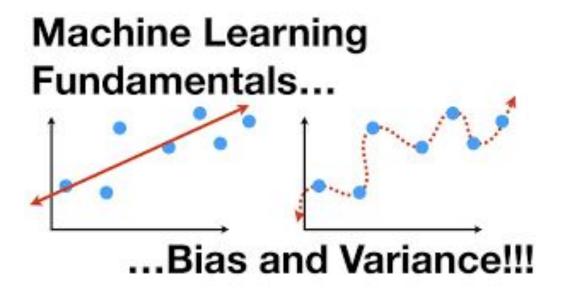
A graphical representation of possible solutions to a decision based on certain conditions Bagging-based algorithm where only a subset of features are selected at random to build a forest or collection of decision trees

Gradient Boosting employs gradient descent algorithm to minimize errors in sequential models

#### What is Bias?



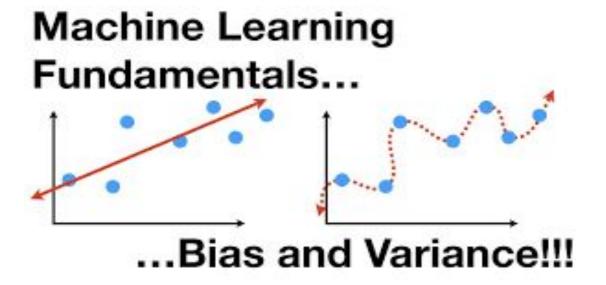
- Bias is how far are the predicted values from the actual values. If the average <u>predicted values are far off</u> from the actual values then the bias is high.
- High bias causes algorithm to <u>miss relevant relationship</u>
  between input and output variable. When a model has a high
  bias then it implies that the model is too simple and does not
  capture the complexity of data thus underfitting the data.



#### What is Variance?

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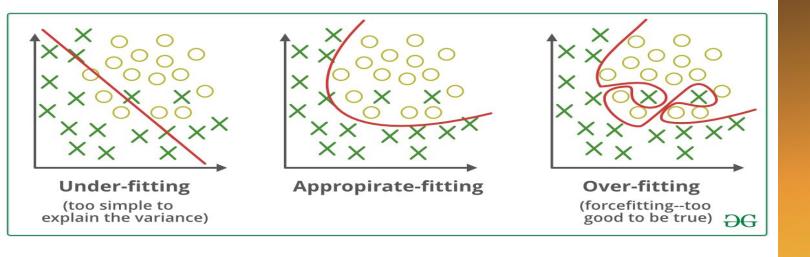
- Variance occurs when the model performs good on the trained dataset but does not do well on a dataset that it is not trained on, like a test dataset or validation dataset. <u>Variance tells us how scattered are the predicted</u> <u>value from the actual value</u>.
- High variance causes overfitting that implies that the algorithm models random noise present in the training data.



# What is Underfitting?



- A statistical model or a algorithm is said to have underfitting when it cannot capture the underlying trend of the data.
- Underfitting destroys the accuracy of our machine learning model.
- Its occurrence simply means that our model or the algorithm does not fit the data well enough.
- It usually happens when we have less data to build an accurate model and also when we try to build a linear model with a non-linear data.

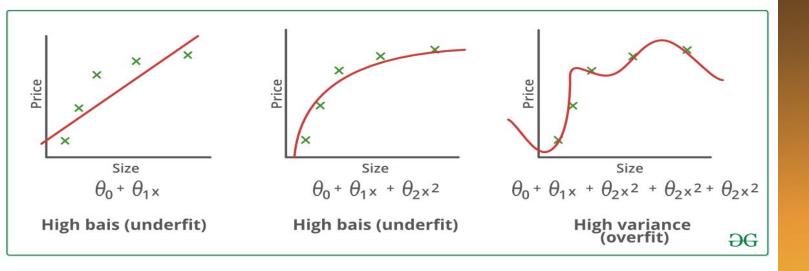


# **Underfitting**



 Underfitting can be avoided by using more data and also reducing the features by feature selection.

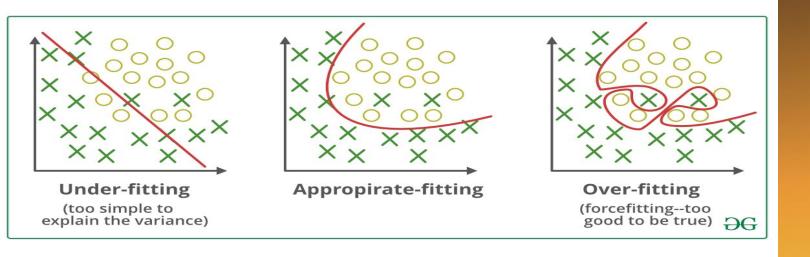
Underfitting – High bias and low variance



# What is Overfitting?



- Overfitting refers to a model that models the training data too well.
- Overfitting happens when a model 'learns' the detail and noise in the training data to the extent that it <u>try to 'cheat'</u> <u>predictions on new data</u>.
- This means that the noise or random fluctuations in the training data is picked up and learned as concepts by the model.

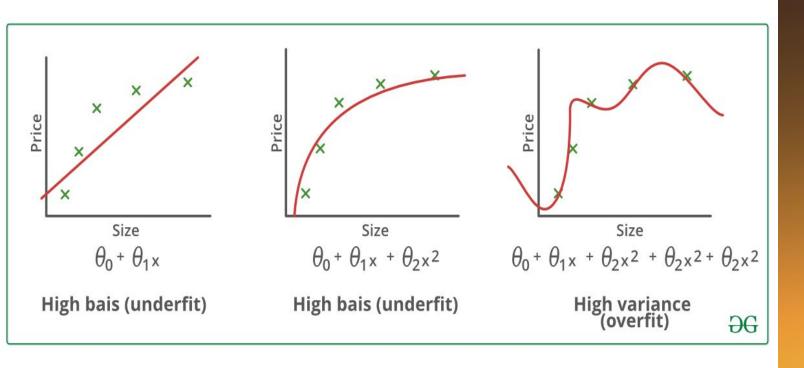


## **Overfitting**



 When a model gets trained with so much of data, it starts learning from the noise and inaccurate data entries in our data set.

#### **Overfitting – High variance and low bias**



## How to reduce Overfitting?



Techniques to reduce overfitting:

- 1. Increase training data.
- 2. Reduce model complexity.
- 3. Early stopping during the training phase (have an eye over the loss over the training period as soon as loss begins to increase stop training).
- 4. Use dropout for neural networks to tackle overfitting.

## How to reduce Underfitting?



#### Techniques to reduce underfitting

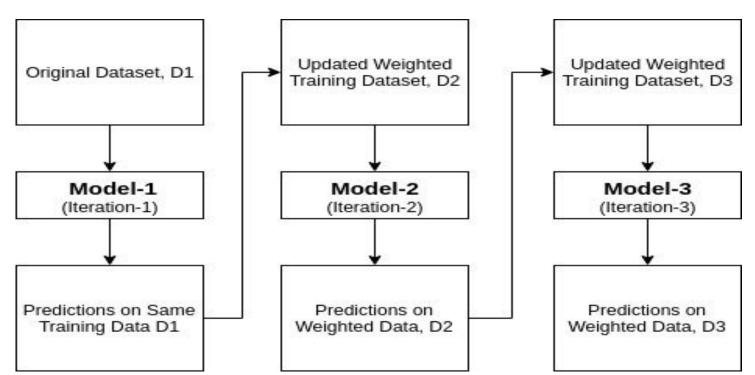
- 1. Increase model complexity
- 2. Increase number of features, performing feature engineering
- 3. Remove noise from the data.
- 4. Increase the number of epochs or increase the duration of training to get better results.



#### **AdaBoost**



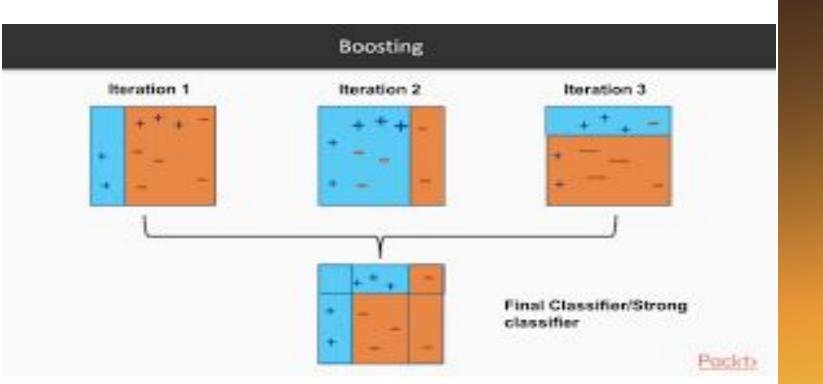
- AdaBoost is short for Adaptive Boosting.
- It combines multiple classifiers to increase the accuracy of classifiers.
- AdaBoost is an iterative ensemble method.
- AdaBoost classifier builds a strong classifier by combining multiple poorly performing classifiers so that you will get high accuracy strong classifier.



## AdaBoosting

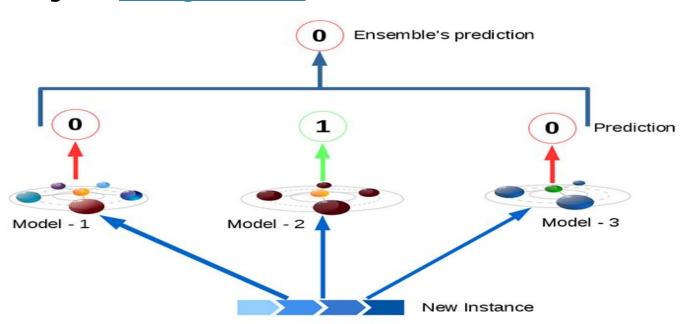
INTERNSHIPSTUDIO

- → The weak learners in AdaBoost are decision trees with a single split, called decision stumps.
- → AdaBoost works by putting more weight on difficult to classify instances and less on those already handled well.
- → AdaBoost algorithms can be used for both classification and regression problem.



## **Voting**

- Voting is one of the simplest ways of combining the predictions from multiple machine learning algorithms.
- It works by first creating two or more standalone models from your training dataset. A Voting Classifier can then be used to wrap your models and average the predictions of the sub-models when asked to make predictions for new data.
- You can create a voting ensemble model for classification using the <u>VotingClassifier</u> class.









- Q.1 What is Gradient Boosting?
- Q.2 What is XGBoosting?
- Q.3 What is Overfitting?
- Q.4 What is Underfitting?
- Q.5 How to reduce Overfitting?



### **Thank You**