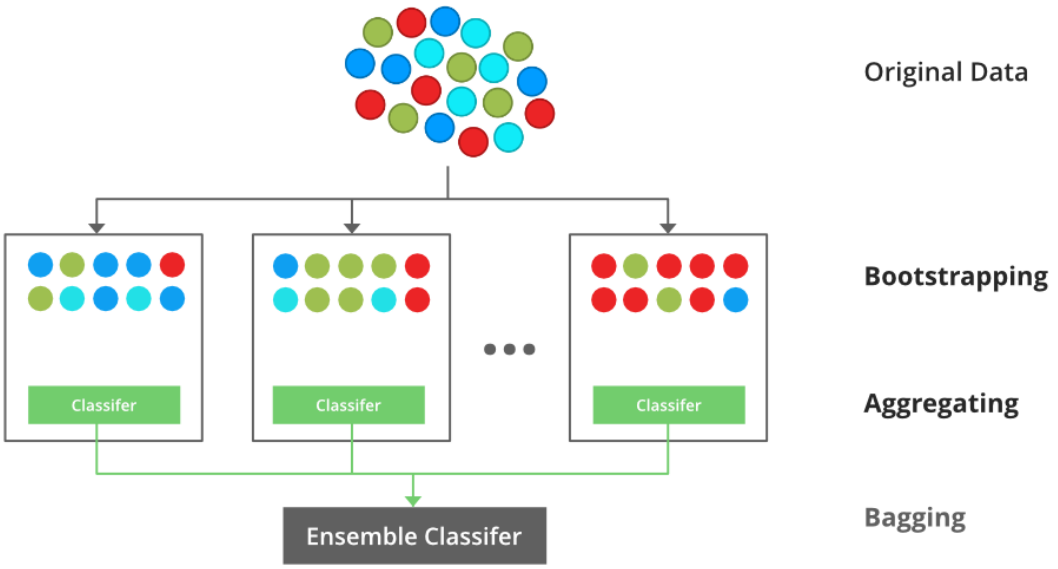
**Ensemble Learning**

- It is a machine learning model that combines the predictions from two or more models
- The predictions are combined using simple statistics such as voting or averaging
- The models that contribute to ensemble are called ensemble members
- They may be of the same type or of different types
- They may or may not be trained on the same training data
- Eg : Bagging, Boosting

**Bagging**

- Bagging, also known as Bootstrap aggregating, is an ensemble learning technique that helps to improve the performance and accuracy of machine learning algorithms.
- It is used to deal with bias-variance trade-offs and reduces the variance of a prediction model.
- Bagging avoids overfitting of data and is used for both regression and classification models, specifically for decision tree algorithms.
- Eg : used in Random forest model




**Bootstrapping**

Bootstrapping is the method of randomly creating samples of data out of a population with replacement to estimate a population parameter.

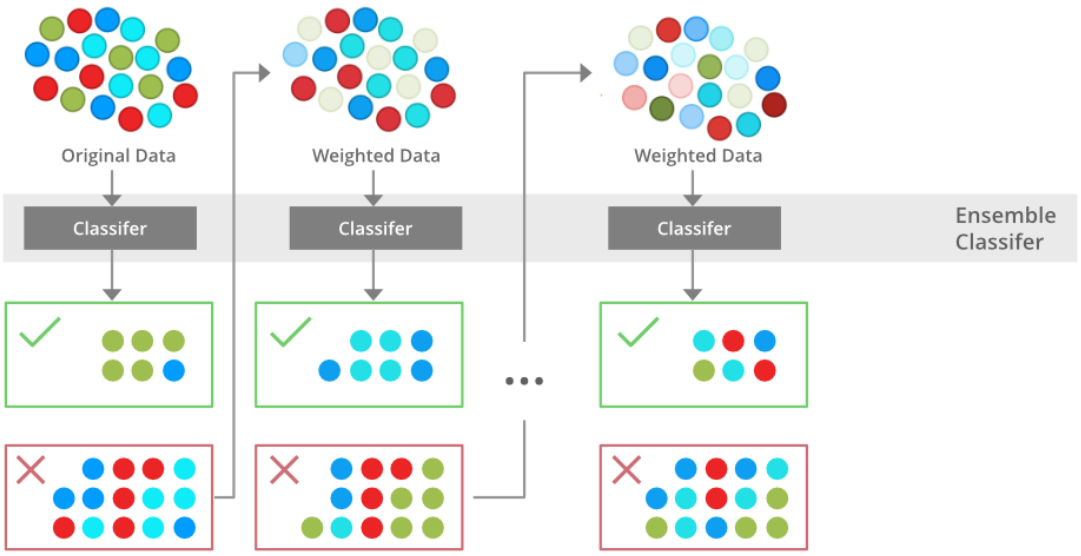
**Steps to perform bagging**

- **Step 1**: Multiple subsets are created from the original data set with equal tuples, selecting observations with replacement.
- **Step 2**: A base model is created on each of these subsets.
- **Step 3**: Each model is learned in parallel with each training set and independent of each other.

- **Step 4**: The final predictions are determined by combining the predictions from all the models.

**Boosting**

- Boosting is an ensemble modeling technique that attempts to build a strong classifier from the number of weak classifiers.
- It is done by building a model by using weak models in series.
- Firstly, a model is built from the training data.
- Then the second model is built which tries to correct the errors present in the first model.
- This procedure is continued and models are added until either the complete training data set is predicted correctly or the maximum number of models are added.
- Eg : Adaboost




**Steps to perform Boosting**

- **Step 1:** The base algorithm reads the data and assigns equal weight to each sample observation.
- **Step 2:** False predictions made by the base learner are identified. In the next iteration, these false predictions are assigned to the next base learner with a higher weightage on these incorrect predictions.
- **Step 3**: Repeat step 2 until the algorithm can correctly classify the output.

Therefore, the main aim of Boosting is to focus more on miss-classified predictions

**Difference between Bagging and Boosting**

| S.NO | Bagging | Boosting |
|---|---|---|
| 1. | The simplest way of combining predictions that belong to the same type. | A way of combining predictions that belong to the different types. |
| 2. | Aim to decrease variance, not bias. | Aim to decrease bias, not variance. |
| 3. | Each model receives equal weight. | Models are weighted according to their performance. |
| 4. | Each model is built independently. | New models are influenced by the performance of previously built models. |
| 5. | Different training data subsets are selected using row sampling with replacement and random sampling methods from the entire training dataset. | Every new subset contains the elements that were misclassified by previous models. |
| 6. | Bagging tries to solve the over-fitting problem. | Boosting tries to reduce bias. |
| 7. | If the classifier is unstable (high variance), then apply bagging. | If the classifier is stable and simple (high bias) the apply boosting. |
| 8. | In this base classifiers are trained parallelly. | In this base classifiers are trained sequentially. |
| 9 | Example: The Random forest model uses Bagging. | Example: The AdaBoost uses Boosting techniques |