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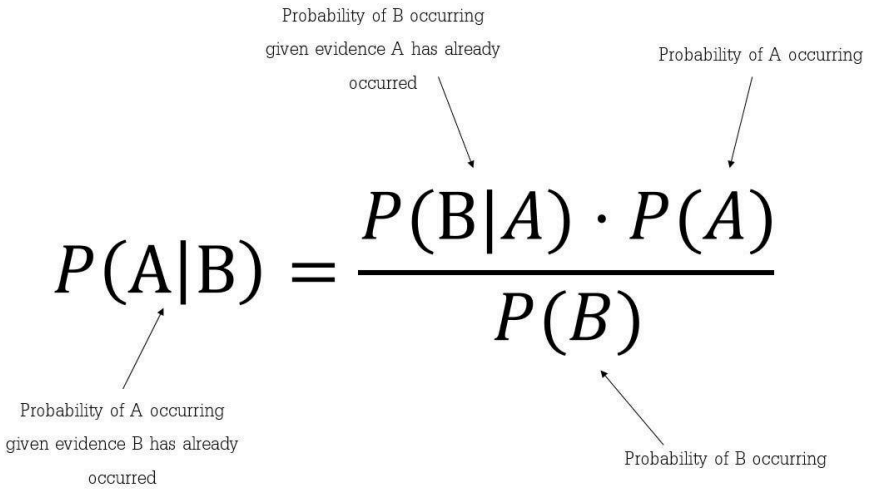
ML Assignment - Naive Bayes Algorithm

Bayes Theorem:

Bayes' theorem describes the probability of occurrence of an event related to any condition. It is also considered for the case of conditional probability. Bayes theorem is also known as the formula for the probability of "causes". The theorem is given as:



Where P(A|B) is the posterior probability and states probability of occurrence of A given B has happened, P(A) is the prior probability, P(B) is the probability of occurrence of event B, P(B|A) is the probability of occurrence of B given A has already happened.

Naive Bayes Classifier:

The Naive Bayes Classifier is based on a simple concept from probability theory called the **Bayes Theorem**. This classification algorithm does really well in predicting the correct class the present features belong to. The 'naive' in the name of this algorithm is used based on the assumption that this algorithm considers while predicting the label of the features. The assumption here is that all the features are independent of each other, though this might not be true in a real-world scenario. Still, the algorithm works fine.

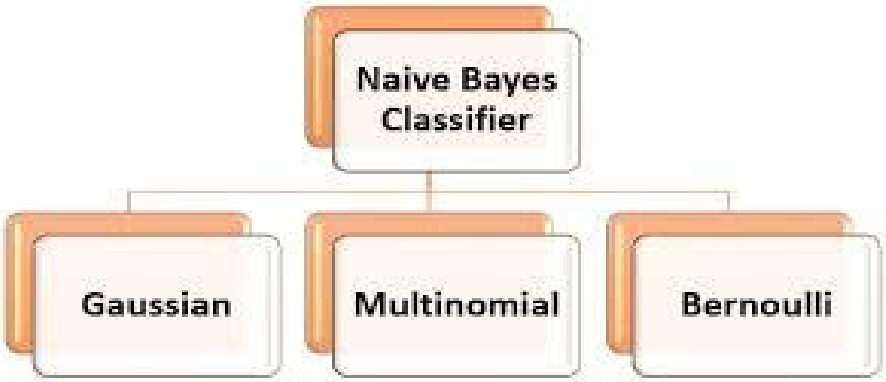
Now discussing about how this algorithm makes prediction or what happens behind the scene of this algorithm, Naive Bayes considers the probability of occurrence of each class and assigns the label value to the class with higher probability.

- **Posterior Probability(P(A|B))**: This is the probability that will help the algorithm determine each class' probability of occurrence. Here **P(A|B)** tells us about the occurrence of class A given the feature B. It is calculated by the help of Bayes theorem given by: **P(A|B) = (P(B|A)*P(A))/(P(B))**

This algorithm then compares different posterior probabilities according to the number of classes present in the data and the class with higher probability is assigned to the feature set present.

Types of Naive Bayes:

There are mainly a total of three types of Naive Bayes algorithms. Different types of naive Bayes are used for different use cases.



1. Bernoulli Naive Bayes

This Naive Bayes Classifier is used when there is a boolean type of dependent or target variable present in the dataset. For example, a dataset has target column categories as Yes and No.

This type of Naive is mainly used in a binary categorical target column where the problem statement is to predict only Yes or No. For Example, sentiment analysis with Positive and Negative Categories.

2. Multinomial Naive Bayes

This type of naive Bayes is used where the data is multinomial distributed. This type of naive Bayes is mainly used when there is a text classification problem.

For Example, if you want to predict whether a text belongs to which tag, education, politics, e-tech, or some other tag, you can use the multinomial Naive Bayes Classifier to classify the same.This naive base outperforms text classification problems and is used the most out of all the other Naive Bayes Classifier.

3. Gaussian Naive Bayes:

Gaussian Naive Bayes is the application of Naive Bayes on a normally distributed data. Gaussian Naive Bayes assumes that the likelihood(P(x$i|y$)) follows the Gaussian Distribution for each xi within y . Therefore,

$$P(x_i|y) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

To classify each new data point x the algorithm finds out the maximum value of the posterior probability of each class and assigns the data point to that class.

Real life example with Gaussian Naive Bayes:

Here we will be applying Gaussian Naive Bayes to the Iris Dataset, this dataset consists of four features namely Sepal Length in cm, Sepal Width in cm, Petal Length in cm, Petal Width in cm and from these features we have to identify which feature set belongs to which specie class.

Implementation of this example is done in google colab.