

Bayes' Theorem:

- Bayes' theorem is also known as **Bayes' Rule** or **Bayes' law**, which is used to determine the probability of a hypothesis with prior knowledge. It depends on the conditional probability.
- The formula for Bayes' theorem is given as:

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

Where,

P(A|B) is Posterior probability: Probability of hypothesis A on the observed event B.

P(B|A) is Likelihood probability: Probability of the evidence given that the probability of a hypothesis is true.

P(A) is Prior Probability: Probability of hypothesis before observing the evidence.

P(B) is Marginal Probability: Probability of Evidence.

Working of Naïve Bayes' Classifier:

Working of Naïve Bayes' Classifier can be understood with the help of the below example:

Suppose we have a dataset of **weather conditions** and corresponding target variable "**Play**". So using this dataset we need to decide that whether we should play or not on a particular day according to the weather conditions. So to solve this problem, we need to follow the below steps:

1. Convert the given dataset into frequency tables.
2. Generate Likelihood table by finding the probabilities of given features.
3. Now, use Bayes theorem to calculate the posterior probability.

Problem: If the weather is sunny, then the Player should play or not?

Solution: To solve this, first consider the below dataset:

Good Luck!

	Outlook	Play
0	Rainy	Yes
1	Sunny	Yes
2	Overcast	Yes
3	Overcast	Yes
4	Sunny	No
5	Rainy	Yes
6	Sunny	Yes
7	Overcast	Yes
8	Rainy	No
9	Sunny	No
10	Sunny	Yes
11	Rainy	No
12	Overcast	Yes
13	Overcast	Yes

Frequency table for the Weather Conditions:

Weather	Yes	No
Overcast	5	0
Rainy	2	2
Sunny	3	2
Total	10	4

Likelihood table weather condition:

Weather	No	Yes	
Overcast	0	5	$5/14 = 0.35$
Rainy	2	2	$4/14 = 0.29$
Sunny	2	3	$5/14 = 0.35$
All	$4/14 = 0.29$	$10/14 = 0.71$	

Applying Bayes' theorem:

$$P(\text{Yes}|\text{Sunny}) = P(\text{Sunny}|\text{Yes}) * P(\text{Yes}) / P(\text{Sunny})$$

$$P(\text{Sunny}|\text{Yes}) = 3/10 = 0.3$$

$$P(\text{Sunny}) = 0.35$$

$$P(\text{Yes}) = 0.71$$

$$\text{So } P(\text{Yes}|\text{Sunny}) = 0.3 * 0.71 / 0.35 = \mathbf{0.60}$$

$$P(\text{No}|\text{Sunny}) = P(\text{Sunny}|\text{No}) * P(\text{No}) / P(\text{Sunny})$$

$$P(\text{Sunny}|\text{NO}) = 2/4 = 0.5$$

$$P(\text{No}) = 0.29$$

$$P(\text{Sunny}) = 0.35$$

$$\text{So } P(\text{No}|\text{Sunny}) = 0.5 * 0.29 / 0.35 = \mathbf{0.41}$$

So as we can see from the above calculation that $P(\text{Yes}|\text{Sunny}) > P(\text{No}|\text{Sunny})$

Hence on a Sunny day, Player can play the game.