

NAIVE BAYES ALGORITHM

NAIVE BAYES

- Supervised machine learning algorithm
- Based on Bayes' Theorem
- It assumes that the features are independent of each other – which is a naive assumption

Formula for Bayes' Theorem:

$$P(A|B) = [P(B|A) \cdot P(A)] / P(B)$$

$P(A|B)$ - probability of event A happening given that B is true (posterior)

$P(B|A)$ - Probability of B given A (likelihood)

$P(A)$ - Probability of A (prior)

$P(B)$ - Probability of B (Evidence)

EXAMPLE



We want to predict - “If sunny, should we play?”

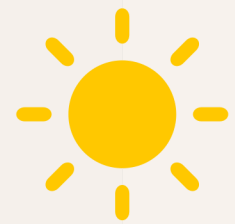


Step-1: Calculate prior probabilities

Total Record = 5

$P(\text{play} = \text{Yes}) = 3/5 = 0.6$

$P(\text{play} = \text{No}) = 2/5 = 0.4$



Step-2: Likelihoods

$P(W = \text{Sunny} | P = \text{Yes}) = \text{How many sunny days when play} = \text{Yes.} \rightarrow 1/3 = 0.33$



$P(W = \text{Sunny} | P = \text{No}) = \text{How many sunny days when play} = \text{No?}$

$\rightarrow 2/2 = 1.0$

EXAMPLE



Bayes' Theorem:

$$P(p = \text{Yes} | \text{Sunny}) = P(\text{Sunny} | P = \text{Yes}) \cdot P(\text{play} = Y) / P(\text{Sunny})$$



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



Proportional Formula (Comparison only)



$$P(\text{Class} | \text{Feature}) \propto P(\text{Feature} | \text{Class}) \cdot P(\text{Class})$$



$$P(p = Y | \text{Sunny}) \propto P(\text{sunny} | p = Y) \cdot P(Y) \rightarrow 0.33 \cdot 0.6 = 0.198$$

$$P(p = N | \text{Sunny}) \propto P(\text{sunny} | p = N) \cdot P(N) \rightarrow 1.0 \cdot 0.4 = 0.4$$

$$0.4 > 0.198$$

predict = No

TYPES OF NAIVE BAYES CLASSIFIER

Naive Bayes Type	Class in <code>sklearn</code>	Suitable For	Assumptions / Notes
GaussianNB	<code>GaussianNB()</code>	Continuous numerical features	Assumes features follow a normal (Gaussian) distribution
MultinomialNB	<code>MultinomialNB()</code>	Discrete counts (e.g., word counts)	Good for text classification using Bag of Words / TF-IDF
BernoulliNB	<code>BernoulliNB()</code>	Binary/Boolean features (0 or 1)	Useful for tasks like spam detection with binary features
ComplementNB	<code>ComplementNB()</code>	Imbalanced text classification	Variant of MultinomialNB, works better for imbalanced classes
CategoricalNB (v0.22+)	<code>CategoricalNB()</code>	Categorical/discrete features	Encoded categorical features (e.g., label-encoded)

MCQS

1. Naive Bayes is based on which probability concept?

- a) Bayes' Theorem
- b) Pythagoras Theorem
- c) Central Limit Theorem
- d) Law of Large Numbers

2. What does the "Naive" in Naive Bayes refer to?

- a) It is simple to implement
- b) It assumes that all features are independent
- c) It is a beginner algorithm
- d) It ignores the training data

3. Which type of problems is Naive Bayes commonly used for?

- a) Regression Problems
- b) Time Series Forecasting
- c) Classification Problems
- d) Clustering Problems

THANK YOU