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Naïve Bayes Algorithm

NAIVE BAYES CLASSIFIER WORKS ON THE PRINCIPLES OF CONDITIONAL PROBABILITY AS GIVEN BY THE BAYES' THEOREM

BEFORE WE MOVE AHEAD, LET US GO THROUGH SOME OF THE SIMPLE CONCEPTS IN PROBABILITY THAT WE WILL BE USING

LET US CONSIDER THE
FOLLOWING EXAMPLE OF
TOSSING TWO COINS

Here, the sample space is:

{HH, HT, TH, TT}

1. P(Getting two heads) = 1/4
2. P(At least one tail) = 3/4
3. P(Second coin being head given first coin is tail) = 1/2
4. P(Getting two heads given first coin is a head) = 1/2

Bayes' Theorem gives the conditional probability of an event A given another event B has occurred

Bayes Theorem

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

where:

$P(A|B)$ = Conditional Probability of A given B

$P(B|A)$ = Conditional Probability of B given A

$P(A)$ = Probability of event A

$P(B)$ = Probability of event A

LET US APPLY BAYES THEOREM
TO OUR EXAMPLE

Here, the sample space is:

{HH, HT, TH, TT}

THESE TWO USE SIMPLE PROBABILITIES CALCULATED DIRECTLY FROM THE SAMPLE SPACE

1. P(Getting two heads) = 1/4
2. P(Atleast one tail) = 3/4
3. P(Second coin being head given first coin is tail) = 1/2
4. P(Getting two heads given first coin is a head) = 1/2

LET US APPLY BAYES THEOREM
TO OUR EXAMPLE

Here, the sample space is:

{HH, HT, TH, TT}

THIS USES CONDITIONAL PROBABILITY. LET US UNDERSTAND THIS IN DETAIL

1. P(Getting two heads) = 1/4
2. P(Atleast one tail) = 3/4
3. P(Second coin being head given first coin is tail) = 1/2
4. P(Getting two heads given first coin is a head) = 1/2

IN THIS SAMPLE SPACE, LET A BE THE EVENT THAT SECOND COIN IS HEAD AND B BE THE EVENT THAT FIRST COIN IS TAIL

In the sample space:

{HH, HT, TH, TT}

P(Second coin being head given first coin is tail)

= P(A|B)

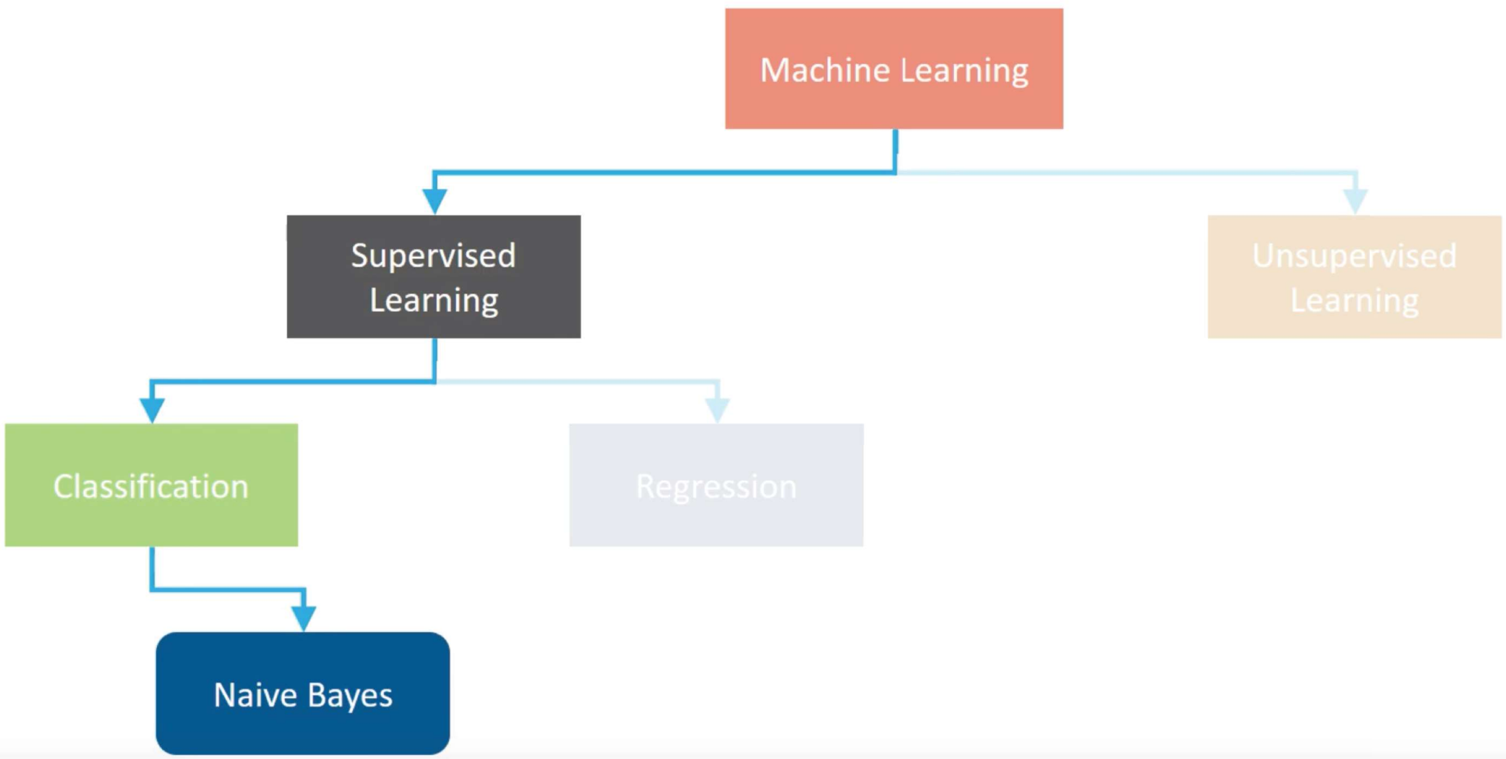
= [P(B|A) * P(A)] / P(B)

= [P(First coin being tail given second coin is head) * P(Second coin being head)] / P(First coin being tail)

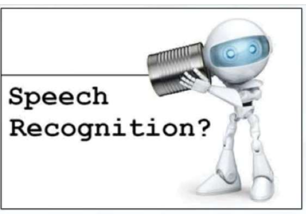
= [(1/2) * (1/2)] / (1/2)

= 1/2 = 0.5

Understanding Naïve Bayes Classifier


Machine Learning
Supervised Learning
Unsupervised Learning
Classification
Regression
Naive Bayes

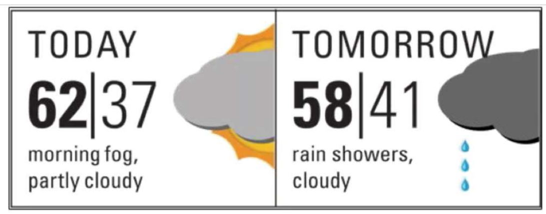
Where is it used?



Speech Recognition

Face Recognition

Anti Virus



Weather Prediction

Let us understand how Bayes' Theorem can be used in Naive Bayes classifier:

$$\underbrace{P(c|x)}_{\text{Posterior Probability}} = \frac{\overbrace{P(x|c)}^{\text{Likelihood}}\;\overbrace{P(c)}^{\text{Class Prior Probability}}}{\underbrace{P(x)}_{\text{Predictor Prior Probability}}}$$

Let us learn with an Example - 1

To predict whether a person will purchase a product on a specific combination of **Day**, **Discount** and **Free Delivery** using **Naive Bayes Classifier**

We have a small sample dataset of 30 rows for our demo

	A	B	C	D
1	Day	Discount	Free Delivery	Purchase
2	Weekday	Yes	Yes	Yes
3	Weekday	Yes	Yes	Yes
4	Weekday	No	No	No
5	Holiday	Yes	Yes	Yes
6	Weekend	Yes	Yes	Yes
7	Holiday	No	No	No
8	Weekend	Yes	No	Yes
9	Weekday	Yes	Yes	Yes
10	Weekend	Yes	Yes	Yes
11	Holiday	Yes	Yes	Yes
12	Holiday	No	Yes	Yes
13	Holiday	No	No	No
14	Weekend	Yes	Yes	Yes
15	Holiday	Yes	Yes	Yes

Naive_Bayes_Dataset

Converting it to frequency table on each category

Based on this dataset containing three input types of *Day*, *Discount* and *Free Delivery*, we will populate frequency tables for each attribute

Frequency Table		Buy: Yes	Buy: No
Discount	Yes	19	1
	No	5	5

Frequency Table		Buy: Yes	Buy: No
Free Delivery	Yes	21	2
	No	3	4

Frequency Table		Buy: Yes	Buy: No
Day	Weekday	9	2
	Weekend	7	1
	Holiday	8	3

Based on this dataset containing three input types of *Day*, *Discount* and *Free Delivery*, we will populate frequency tables for each attribute

Frequency Table		Buy: Yes	Buy: No
Discount	Yes	19	1
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Frequency Table		Buy: Yes	Buy: No
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	No	3	4

Frequency Table		Buy: Yes	Buy: No
Day	Weekday	9	2
	Weekend	7	1
	Holiday	8	3

A

B

Creating a Likelihood table

Now let us calculate the Likelihood table for one of the variable, *Day* which includes ***Weekday***, ***Weekend*** and ***Holiday***

Frequency Table		Buy		
		Yes	No	
Day	Weekday	9	2	11
	Weekend	7	1	8
	Holiday	8	3	11
		24	6	30

Likelihood Table		Buy		
		Yes	No	
Day	Weekday	9/24	2/6	11/30
	Weekend	7/24	1/6	8/30
	Holiday	8/24	3/6	11/30
		24/30	6/30	

P(B) = **P(Weekday)**
= 11/30 = 0.37

P(A) = **P(No Buy)**
= 6/30 = 0.2

P(B|A)
= **P(Weekday | No Buy)**
= 2/6 = 0.33