Naive Bayes Analysis :-

Naive-Bayes technique is a supervised learning technique that uses probability-theory-based analysis.

It is a machine learning technique that computes the probabilities of an instance belonging to each one of many target classes, given the prior probabilities of classification using individual factors.

Naive Bayes technique is used often in classifying text documents into one of multiple predefined categories.

Advantages :-

↳ NB algorithm is easy to understand & works fast.

↳ It also performs well in multiclass prediction, such as when the target class has multiple options beyond binary yes/No. classification.

↳ NB can also perform well even in case of categorical input variables as compared to numerical variables.

What is Naive Bayes Classifier ? (Bayesian classifiers)

↳ Bayesian classifiers are statistical classifiers

→ They can predict class membership probabilities such as the probability that a given tuple belongs to a particular class.

→ Bayesian classifier is based on Baye's theorem

→ Naive Baye's classifier assumes that the effect of an attribute value on a given class is independent of the values of other attributes.

This independence is called class-conditional independence.

Baye's Theorem is

↳ let 'X' be a data tuple, 'X' is considered as 'evidence' & is described by "n" attributes.

↳ let 'H' be some hypothesis, such that the data tuple belongs to a specified class 'C'.

↳ For classification problems, we want to determine $P(H|X)$, the probability that the hypothesis 'H' holds true given the 'evidence' or observed data tuple 'X'.

we are looking for the probability that tuple 'X' belongs to class 'C', given that, the attribute description of 'X' is known.

→ $P(H|X)$ is the posterior probability or a posteriori probability of 'H' conditioned on X.

Suppose that, a data tuple 'X' is confined to customers described by the attribute age & income respectively, & 'X' is a 35 years old customer with an income of 45000. Suppose H is the Hypothesis that our customer 'X' will buy a computer, given customer's income & age.:

→ $P(H)$ is the prior probability of 'H'. that is the probability that any given customer will buy a computer or not regardless of age, income or any other information.

→ Posterior probability $P(H|X)$ is based on more information than prior probability $P(H)$ which is independent of X

→ Similarly $P(X|H)$ is the posterior probability of X conditioned on H.

→ $P(X)$ is the prior probability of X.

Baye's Theorem is :-

$$\boxed{P(H|X) = \frac{P(X|H) \cdot P(H)}{P(X)}}$$

Sno.	age	income	Student	credit-rating	Class : Buy Computer
1	Youth	High	No	fair	No
2	Youth	High	No	Excellent	no
3	Middle-age	High	No	fair	yes
4	Senior	medium	No	fair	yes
5	Senior	Low	yes	fair	yes
6	Senior	Low	yes	Excellent	no
7	Middle-age	Low	yes	Excellent	yes
8	Youth	Medium	No	fair	no
9	Youth	Low	yes	fair	yes
10	Senior	Medium	yes	fair	yes
11	youth	Medium	yes	Excellent	yes
12	Middle-age	Medium	No	Excellent	yes
13	Middle-age	High	yes	fair	yes
14	Senior	Medium	No	Excellent	no

'Class'

age	buy computer Yes	No
youth	2	3
middle	4	0
Senior	3	2
	9	5

Student	Yes	No
Yes	6	1
No	3	4
	9	5

Credit-rating	Yes	No
fair	6	2
Excellent	3	3
	9	5

income	Yes	No
low	3	1
Medium	4	2
High	2	2
	9	5

Predicting class label using Bayesian Classifier

$X =$ (age = youth, income = medium, student = yes, credit-rating = fair).

We need to maximize $P(X|c_i) \cdot P(c_i)$

$P(\text{buy-comp} = \text{yes}) = 9/14 = 0.643$

$P(\text{buy-comp} = \text{no}) = 5/14 = 0.357$

$P(\text{age} = \text{youth} \mid \text{buy computer} = \text{yes}) = 2/9 = 0.222$

$P(\text{age} = \text{youth} \mid \text{buy computer} = \text{No}) = 3/5 = 0.6$

$P(\text{income} = \text{medium} \mid \text{buy-computer} = \text{yes}) = 4/3 = 0.444$

$P(\text{income} = \text{medium} \mid \text{buy-computer} = \text{no}) = 2/5 = 0.4$

$P(\text{student} = \text{yes} \mid \text{buy-computer} = \text{yes}) = 6/9 = 0.667$

$P(\text{student} = \text{yes} \mid \text{buy-computer} = \text{No}) = 1/5 = 0.2$

$P(\text{credit-rating} = \text{fair} \mid \text{buy-computer} = \text{yes}) = 6/9 = 0.667$

$P(\text{credit-rating} = \text{fair} \mid \text{buy-computer} = \text{No}) = 2/5 = 0.400$

$P(X \mid \text{buy-computer} = \text{yes}) = P(\text{Age} = \text{youth} \mid \text{yes}) * P(\text{income} = \text{medium} \mid \text{yes}) * P(\text{Student} = \text{yes} \mid \text{yes}) * P(\text{Credit-rating} = \text{fair} \mid \text{yes})$

$= 0.222 * 0.444 * 0.667 * 0.667 = 0.044$

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$P(X \mid buy\_computer = No) = 0.6 * 0.4 * 0.2 * 0.4$
$= 0.019$

To find the class C_i, we need to maximize
$P(C_i \mid X) = P(X \mid C_i) * P(C_i)$

we compute $P(X \mid buy\_computer = yes)$

$= P(X \mid buy\_computer = yes) * P(buy\ computer = yes)$
$= 0.044 * 0.643$
$= 0.028$

$P(X \mid buy\_computer = No)$

$= P(X \mid buy\_computer = No) * P(by\ computer = No)$
$= 0.019 * 0.357$
$= 0.007$

Now since $0.028 > 0.007$

$\therefore$ Given this information, he will buy the comp