BAYES FORMULA

- The Bayes theorem gives us the following formula to compute the probability that the record belongs to class Ci:

$$P(C_i|X_1,\ldots,X_p) = \frac{P(X_1,\ldots,X_p|C_i)P(C_i)}{P(X_1,\ldots,X_p|C_1)P(C_1)+\cdots+P(X_1,\ldots,X_p|C_m)P(C_m)}.$$

Where

Ci : classes of interest

X1,X2,...Xp : Variables which co-exist with Classes of interest

Example : Telecom Customers

- A telecom firm has many customers. Each customer either talks for the duration of more than 100 minutes or less than 100 minutes. The firm has launched a plan for the customers who talk more specially to optimize the amount spent by them on bills.
- Call Centre staff had been instructed to call some customers. In that operation, some customers bought the new plan and others didn't.
- In this case each customer is a record, and the response of interest, Y = {Bought ,Not Bought}, has two classes: C1 = Bought and C2 = Not Bought.

Talks for more than 100 min? (TT >= 100)	Gender	Response
y	male	not bought
n	male	not bought
n	female	not bought
n	female	not bought
n	male	not bought
n	male	not bought

y	male	bought
y	female	bought
n	female	bought
y	female	bought

Assuming independence

$$P(Buy|Male, TT \geq 100)$$

$$= \frac{P(Male, TT \geq 100 \mid Buy)\ P(Buy)}{P(Male, TT \geq 100 \mid Buy)\ P(Buy) + P(Male, TT \geq 100 \mid Not\ Buy)\ P(\ Not\ Buy)}$$

$$= \frac{P(Male|Buy)P(TT \geq 100|Buy)\ P(Buy)}{P(Male|Buy)P(TT \geq 100|Buy)P(Buy) + P(Male|\ Not\ Buy)P(TT \geq 100|Not\ Buy)P(Not\ Buy)}$$

$$= \frac{\frac{1}{4} \times \frac{3}{4} \times \frac{4}{10}}{\frac{1}{4} \times \frac{3}{4} \times \frac{4}{10} + \frac{4}{6} \times \frac{1}{6} \times \frac{6}{10}}$$

$$= 0.529$$

(TT >= 100)	Gender	Response
y	male	not bought
n	male	not bought
n	female	not bought
n	female	not bought
n	male	not bought
n	male	not bought
y	male	bought
y	female	bought
n	female	bought
y	female	bought

P(Buy|Female, TT>=100 == n) = 0.31034483
P(Buy|male, TT>=100 == n) = 0.06976744
P(Won't Buy|Female, TT>=100 == n) = 0.68965517
P(Won't Buy|male, TT>=100 == n) = 0.93023256
P(Buy|Female, TT>=100 == y) = 0.87096774