

# Naïve Bayes

Q1) Apply the Naïve Bayes classifier to classify the tuple  $\langle \text{Red, SUV, Domestic} \rangle$  for the given dataset below:

Instance no	Color	Type	Origin	Stolen
1	Red	Sports	Domestic	Yes
2	Red	Sports	Domestic	No
3	Red	Sports	Domestic	Yes
4	Yellow	Sports	Domestic	No
5	Yellow	Sports	Imported	Yes
6	Yellow	SUV	Imported	No
7	Yellow	SUV	Imported	Yes
8	Yellow	SUV	Domestic	No
9	Red	SUV	Imported	No
10	Red	Sports	Imported	Yes

⇒ Step 1: Calculate the prior probabilities  
For (Stolen: Yes / No)

$$P(\text{Stolen} = \text{Yes}) = \frac{\text{No of Yes}}{\text{Total}} = \frac{5}{10} = 0.5$$

$$P(\text{Stolen} = \text{No}) = \frac{\text{No of No}}{\text{Total}} = \frac{5}{10} = 0.5$$

Step 2. Calculate likelihood probabilities

For Yes :  $\frac{\text{no of item in Yes}}{\text{Total Yes}}$

For no :  $\frac{\text{no of item in no}}{\text{Total no}}$



Likelihood Color	probability of color	
	Yes	No
Red	$3/5$	$2/5$
Yellow	$2/5$	$3/5$

Likelihood Type	probability of type	
	Yes	No
Sports	$4/5$	$2/5$
SUV	$1/5$	$3/5$

Likelihood Origin	probability of origin	
	Yes	No
Domestic	$2/5$	$3/5$
Imported	$3/5$	$2/5$

Step 3: Calculate Posterior probabilities

$$\begin{aligned}
 P(\text{Yes} | \text{New Instance}) &= P(\text{Yes}) * P(\text{Color} = \text{Red} | \text{Yes}) \\
 &\quad * P(\text{Type} = \text{SUV} | \text{Yes}) * P(\text{Origin} = \text{Domestic} | \text{Yes}) \\
 &= \frac{5}{10} * \frac{3}{5} * \frac{1}{5} * \frac{2}{5} \\
 &= \frac{3}{125} = 0.024
 \end{aligned}$$

$$\begin{aligned}
 P(\text{No} | \text{New Instance}) &= P(\text{No}) * P(\text{Color} = \text{Red} | \text{No}) * \\
 &\quad P(\text{Type} = \text{SUV} | \text{No}) * P(\text{Origin} = \text{Domestic} | \text{No}) \\
 &= \frac{5}{10} * \frac{2}{5} * \frac{3}{5} * \frac{3}{5} = \frac{9}{125} = 0.072
 \end{aligned}$$

$\therefore P(\text{No} | \text{New Instance}) > P(\text{Yes} | \text{New Instance})$   
 So, the tuple  $\langle \text{Red}, \text{SUV}, \text{domestic} \rangle$  will not be stolen



Q22) A data sample is given below. Find whether patient X has flu or not using Naive Bayes classifier. If  $X = (\text{chills} = Y, \text{runny nose} = N, \text{headache} = \text{Mild}, \text{fever} = Y, \text{flu} = ?)$

chills	Runny nose	headache	fever	Flu
Y	N	Mild	Y	N
Y	Y	No	N	Y
Y	N	Strong	Y	Y
N	Y	Mild	Y	Y
N	N	No	N	N
N	Y	Strong	Y	Y
N	Y	Strong	N	N
Y	Y	Mild	Y	Y

⇒ For (Flu : Yes or No)

$$P(\text{Flu} = \text{Yes}) = \frac{5}{8} = 0.625$$

$$P(\text{Flu} = \text{No}) = \frac{3}{8} = 0.375$$

Likelihood probabilities  
For Chills

Chills	Yes	No
Y	3/5	1/3
N	2/5	2/3

For Runny nose

Runny nose	Yes	No
Y	4/5	1/3
N	1/5	2/3



Fever	Yes	No
Y	4/5	1/3
N	1/5	2/3

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For headache

Headache	Yes	No
Mild	2/5	1/3
Strong	2/5	1/3
No	1/5	1/3

$$\begin{aligned}
 P(\text{Yes} | \text{New Instance}) &= P(\text{Yes}) * P(\text{Chills} = Y | \text{Yes}) * \\
 &P(\text{Runny nose} = N | \text{Yes}) * P(\text{Headache} = \text{Mild} | \text{Yes}) * \\
 &P(\text{Fever} = Y | \text{Yes}) \\
 &= \frac{5}{8} * \frac{3}{5} * \frac{1}{5} * \frac{2}{5} * \frac{4}{5} \\
 &= 0.024
 \end{aligned}$$

$$\begin{aligned}
 P(\text{No} | \text{New Instance}) &= P(\text{No}) * P(\text{Chills} = Y | \text{No}) * \\
 &P(\text{Runny nose} = N | \text{No}) * P(\text{Headache} = \text{Mild} | \text{No}) * \\
 &P(\text{Fever} = Y | \text{No}) \\
 &= \frac{3}{8} * \frac{1}{3} * \frac{2}{3} * \frac{1}{3} * \frac{1}{3} \\
 &= 0.00925
 \end{aligned}$$

$$P(\text{Yes} | \text{New Instance}) > P(\text{No} | \text{New Instance})$$

∴ Patient X has flu