How NAIVE BAYES WORKS? (INTUTION)

Outlook	Temp	Humidity	Windy	Playtennis
sunny	Hot	High	False	No
sunny	Hot	High	True	No
overcast	Hot	High	False	Yes
rainy	Mild	High	False	yes
rainy	Cool	Normal	False	Yes
overcast	cool	Normal	True	Yes
sunny	Mild	High	False	No
sunny	Cool	Normal	False	Yes
Rainy	Mild	Normal	False	Yes
Sunny	Mild	Normal	True	Yes
Overcast	Mild	High	True	Yes
Overcast	Hot	Normal	False	Yes
Rainy	Mild	High	True	No
Rainy	Cool	Normal	True	NO

for a given data, you have to build mechanism that will predict the label of new data

Ex { Sunny, cool, Normal, true }

- You have to predict whether he will play tennis or not
- Our model will generate two probabilites

Yes — 0.82
No — 0.18

- Since Yes prob more, we will assign it Yes.

M	T	W	T	F	S	S

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YOUVA

We know Bayes thiorm

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

- We will find prob of Yes and No using Bayes theorm.
- Our query was ⇒ { Sunny, Cool, Normal, True } let's call it collectively ⇒ W, and these all events are already occured
- Hence, it is problem of conditional prob (Bayes theorm).
- We have to find ⇒ ~~(i) P (Yes~~

(i) P(Yes | W)
- It means finding prob of yes, given weather conditions

(ii) P(No | W)
- find prob of No, given weather conditions

$$\Rightarrow P(Yes|W) = \frac{P(W|Yes) \times P(Yes)}{P(W)}$$

$$\Rightarrow P(No|W) = \frac{P(W|No) \times P(No)}{P(W)}$$

whose probability will be more, will be ~~the~~ considered

- You can remove P(W) as both are getting divided by same factor

1) • $P(Yes \mid W) = P(W \mid Yes)\, P(Yes)$

→ $P(Yes) = \frac{9}{14}$

→ $P(W \mid Yes)$ is difficult

→ W is set of info about weather, putting back W

→ $P(W \mid Yes)$, putting W value

→ $P(Sunny \cap Cool \cap Normal \cap True \mid Yes)$ — ①

→ The above equation tells, in rows in which there is Yes, find the combination where Outlook is sunny, temp is cool, Humidity is normal and wind is true

→ Similarly for $P(No \mid W)$

2) $P(No \mid W) = P(W \mid No) \times P(No)$

→ $P(No) = \frac{5}{14}$

→ $P(W \mid No)$

→ $P(Sunny \cap Cool \cap Normal \cap True \mid No)$

- The above eqⁿ means, In row which there is No, find the combination where Outlook → sunny, Temp → cool, Humidity → Normal and wind → True.

- $P(\text{Sunny} \cap \text{Cool} \cap \text{Normal} \cap \text{True} \mid \text{No}) = 0$

$\therefore P(\text{No} \mid W) = P(W \mid \text{No}) \times P(\text{No})$

$= P(\text{No} \mid W) = 0 \times \frac{5}{14}$

$= \boxed{P(\text{No} \mid W) = 0}$

- $P(\text{Sunny} \cap \text{Cool} \cap \text{Normal} \cap \text{True} \mid \text{Yes}) = 0$

$= P(\text{Yes} \mid W) = P(W \mid \text{Yes}) \times P(\text{Yes})$

$= 0 \times \frac{9}{14}$

$\boxed{P(\text{Yes} \mid W) = 0}$

- This is the problem with Bayes theorm it's not necessary that the combination given for prediction is always present in data and if not present, Naive Bayes can't predict. That's why it is called Naive.

- Because it takes Naive Assumption that it breaks the combined probability into individual (Proof of how breakdown is in formulation)

- Ex :-

$\Rightarrow P(\text{Sunny} \cap \text{Cool} \cap \text{Normal} \cap \text{True} \mid \text{Yes})$

$\Downarrow$

Breakdown into individual

$\Rightarrow P(\text{Sunny} \mid \text{Yes}) \times P(\text{Cool} \mid \text{Yes}) \times P(\text{Normal} \mid \text{Yes}) \times P(\text{True} \mid \text{Yes})$

Benefit? $\Rightarrow$ You can easily find these terms in data

$\Rightarrow P(\text{Sunny} \mid \text{Yes}) = \frac{2}{9}$

$\times$

$\Rightarrow P(\text{Cool} \mid \text{Yes}) = \frac{3}{9}$

$\times$

$\Rightarrow P(\text{Normal} \mid \text{Yes}) = \frac{6}{9}$

$\times$

$\Rightarrow P(\text{True} \mid \text{Yes}) = \frac{3}{9}$

$$P(\text{Yes}/W) = \left(\frac{2}{9} \times \frac{3}{9} \times \frac{6}{9} \times \frac{3}{9}\right) \times P(\text{Yes})$$

$$\boxed{P(\text{Yes}/W) = \left(\frac{2}{9} \times \frac{3}{9} \times \frac{6}{9} \times \frac{3}{9}\right) \times \frac{9}{14}}$$

$$\boxed{P(\text{No} \mid W) = \left(\frac{2}{9} \times \frac{3}{9} \times \frac{6}{9} \times \frac{3}{9}\right) \times \frac{5}{14}}$$

Similarly, it will breakdown term of

$P(\text{No} \mid W) = \underline{P(\text{Sunny} \cap \text{cool} \cap \text{Normal} \cap \text{True} \mid \text{No})} \times P(\text{No})$

$\Downarrow$

$P(\text{Sunny} \mid \text{No}) \times P(\text{Cool} \mid \text{No}) \times P(\text{Normal} \mid \text{No}) \times P(\text{True} \mid \text{No})$