Naive Bayes Practice

B= (outlook=overcast, temp=Mild, humidity=Normal
wind = Strong)

A= Play = No

Data set in slides 16 to 17

~~if~~ we create ~~to~~ table

we find $P(A|B)$

in marginal probability

we see in which

involves one variable (Fail or Pa

Then we see joint probability

in which we see

intersect between two

variables (e.g Two dice roll)

$(A \cap B)$

Then we see conditional

probability of Random

variable given some

evidance

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

$$\boxed{P(A|B)\ P(B)} = P(A \cap B)$$

we see in childhood

$$A \cap B = B \cap A$$

So $P(B/A)\ P(A) = P(B \cap A$

Supervised learning because labeled data
Classification because we have classes and discrete label.

$$P(A \cap B) = P(B \cap A)$$

$$P(A|B)\,P(B) = P(B|A)\,P(A)$$

likelihood, Prior

$$\boxed{P(A|B) = \frac{P(B|A)\,P(A)}{P(B)} \quad \text{--- (1)}}$$

Posterior, $P(B) \rightarrow$ Evidence

So its called Bayes Rule

Solve (Note: No and Yes is class)

$\Rightarrow$ P(Play=No | outlook=overcast, temp=Mild, humidity=Normal, wind=strong) (11)

$\Rightarrow$ P(Play=Yes | " " " " " " " ")

Now For No. class
we put (11) in (1)

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

= P(outlook=overcast, temp=Mild, himidity=Normal, wind=strong | Play=No) . P(Play=No) / P(outlook=overcast, temp=mild, humidity=Normal, wind=Strong)

After Putting in Bayes Rule we go to on Naive Assumption.
Naive said Every feature have independent to each other, So, we compute given probability separate feature with their class.

find

$$P(A|B) = P(\cancel{overcast}\ outlook{=}overcast \mid Play{=}No) * P(temp{=}Mild \mid Play{=}No) * P(humidity{=}Normal \mid Play{=}No) * P(wind{=}Strong \mid Play{=}No) * P(Play\ No)$$

(iv) $P(outlook{=}overcast,\ temp{=}Mild,\ humidity{=}Normal,\ wind{=}strong)$

We, compute tables separate independent feature with the class.
Then we put easily Probabilities in formula and predict class.

Outlook	Play = Yes	Play = No
Sunny	2/9	3/5
Overcast	4/9	0/5
Rain	3/9	2/5

we see in Question we have given outlook = overcast for No class here is 0/5. if we put 0/5 in formula then mulliply with all and Total Ans going to Zero. So we avoid to zero we use laplace Smoothing with the all features whole presence in formula give.

If we use smoothing laplace with only 0/5 term then we break the rule of probability So, we computing laplace for all features given in formula

So go back and compute table of separate features.

temp	play=Yes	play=No
Hot	2/9	2/5
Mild	4/9	2/5
Cool	3/9	1/5

Humidity	Play=Yes	Play=No
High	3/9	4/5
Normal	6/9	1/5

Wind	Play=Yes	Play=No
Weak	6/9	2/5
Strong	3/9	3/5

No, we see Laplace Smoothing for outlook feature for No class

$$= \frac{0 + \lambda}{5 + K\lambda}$$

Here λ is assumption we assume $\lambda = 1$

and K is ~~total~~

~~out~~ different values in feature.

I outlook we have only Three values comes. ~~Sun~~

(Sunny, Overcast, Rain) = ~~B~~ 3

$$= \frac{0+1}{5+3(1)} = \frac{1}{8}$$

Little Note about Laplace

we playwin = label class feature.

$$P(play = No) = \frac{5}{14} \text{ After laplace}$$

$$= \frac{5+1}{14+2(1)} = \frac{6}{16}$$

$$P(play = Yes) = \frac{9}{14} \text{ After laplace}$$

$$= \frac{9+1}{14+2(1)} = \frac{10}{16}$$

without Smoothing	with smoothing
$= \frac{5}{14} + \frac{9}{14}$	$= \frac{6}{16} + \frac{10}{16}$
$= \frac{\cancel{14}}{\cancel{14}} = 1$	$= \frac{\cancel{16}}{\cancel{16}} = 1$

Smoothing and without smoothing
Ans is 1 of label
class. So, we don't break
rule we are good.

go back and find ~~to~~
Smoothing of temp feature
according formula.

$$P(\text{temp=mild} \mid \text{play=No}) = \frac{2+1}{5+3(1)} = \frac{3}{8}$$

$$P(\text{humidity=Normal} \mid \text{play=No}) = \frac{1+1}{5+2(1)}$$

$$= \frac{2}{7}$$

$$P(\text{wind=strong} \mid \text{play=No}) = \frac{3+1}{5+2(1)}$$

$$= \frac{4}{7}$$

go back - (IV)

$P(A|B) = P(\text{Outlook} = \text{overcast} \mid \text{Play} = \text{No}) * P(\text{temp} = \text{Mild} \mid \text{Play} = \text{No}) * P(\text{humidity} = \text{Normal} \mid \text{Play} = \text{No}) * P(\text{wind} = \text{Strong} \mid \text{play} = \text{No}) \, P(\text{Play} = \text{No})$

$\overline{}$

$P(B)$

put values in. (∵ if we compute MLE we solve only this)

$$= \underbrace{\frac{1}{8} * \frac{3}{8} * \frac{2}{7} * \frac{4}{7}} * \left(\frac{6}{16}\right)$$

(if MaP add this)

$\overline{}$

(first we ignore denominator we compute upper term first)

$$= \frac{0.125 * 0.375 * 0.2857 * 0.57 * 0.375}{0.024 + 0.0028}$$

$$= \frac{0.0028}{0.0268} = \underline{\underline{0.1044}}$$

denominator fill after compute the Ans of play=Yes class because denominator is Sum of Ans of all classes.

So play = Yes

$$P(A|B) = \frac{P(\text{outlook}=\text{overcast} \mid \text{play}=\text{Yes}) * P(\text{temp}=\text{Mild} \mid \text{play}=\text{Yes}) * P(\text{Humidity}=\text{Normal} \mid \text{play}=\text{Yes}) * P(\text{wind}=\text{Strong} \mid \text{play}=\text{Yes}) * P(\text{play}=\text{Yes})}{P(B)}$$

(V)

Firstly computing smoothing of features according Yes class

$P(\text{outlook}=\text{overcast} \mid \text{play}=\text{Yes})$

$$= \frac{4+1}{9+3(1)} = \frac{5}{12}$$

$P(\text{temp}=\text{Mild} \mid \text{play}=\text{Yes})$

$$= \frac{4+1}{9+3(1)} = \frac{5}{12}$$

$P(\text{humidity}=\text{Normal} \mid \text{play}=\text{Yes})$

$$= \frac{6+1}{9+2(1)} = \frac{7}{11}$$

$$P(\text{wind}=\text{Strong} \mid \text{play}=\text{Yes}) = \frac{3+1}{9+2(1)} = \frac{4}{11}$$

Put values in — (v) MLE ≠ MAP

$$= \frac{\frac{5}{12} * \frac{5}{12} * \frac{7}{11} * \frac{4}{11} * \frac{10}{16}}{0.024 + 0.0028}$$

$$= \frac{0.41 * 0.41 * 0.63 * 0.363 * 0.625}{0.0268}$$

$$= \frac{0.024}{0.0268} = 0.8955$$

So, over P(A|B) = play = Yes

Because 0.89 probability of Yes and 0.10 for No

Solve Done Naive Bayes with laplace Smoothing