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Agenda :-

1. Probability :- All concepts.
2. Applying probability in python.

Probability :- Naive Bayes.

Probability terms :- 1. Experiement or Random Experiement
2. Outcome
3. Sample Space
4. Event.
5. Probability Rules (Intersection, Union, Complement)

1. Experiement :-

Defined as Uncertain Situations which has multiple outcomes.

eg:- 1. Tossing a coin.
2. Rolling a dice
3. Whether it will ram tomorrow?
4. Whether India will win or lose?

2. Outcome :- Result of an experiment

eg :- Toss a coin :- H, T.

2. Roll a dice :- 1, 2, 3, 4, 5, 6

(1)  4 ← outcome

(2)  2 ← outcome for 2nd time.

3. Sample Space :- Collection of all possible results of an experiment

eg:- Tossing a coin :- H, T ⇐ T ⇐ outcome

$S(T_c) = \{H, T\}$

Rolling one dice :-

Sample Space :- $\{1, 2, 3, 4, 5, 6\}$

Q. Write the Sample Space for 2 coins tossed.

$SS :- \{(HH), (TT), (HT), (TH)\}$

Q. Write the Sample Space for a dice rolled.

$SS = \{(1,1), (1,2), (1,3), (1,4), (1,5), (1,6),$

$(2,1), (2,2), (2,3), (2,4), (2,5), (2,6),$

$(3,1), (3,2), (3,3), (3,4), (3,5), (3,6)$

$\vdots$

$(6,1), (6,2), (6,3), (6,4), (6,5), (6,6)\}$

$n(SS) = \underline{\underline{36}}$

4. Event :- Subset of Sample Space.

eg :- (1) A coin is tossed and head turns up. is called an event.

$S = (H, T) \Rightarrow H \leftarrow$ outcome

Subset

(2) India won the match with Aus.

$S = (W, L)$

I W ←

↑ out-come

eg:- 1 Tossing a coin, head turns up

$S = \{H, T\} \Rightarrow n(S) = 2$

Event A:- Head turning up.

$S(A) = \{H\} = n(S(A)) = 1$

eg 2 :- Exp :- Rolling a dice

$S(RD) = \{1, 2, 3, 4, 5, 6\}$

Event :- When a dice rolled, even nos. turn up.

$S(RD) = \{1, 2, 3, 4, 5, 6\}$

$n(S) = 6.$

Event A :- Even nos. turning up.

$S(A) = \{2, 4, 6\} \Rightarrow n(S(A)) = 3$

eg:- Exp :- Toss 2 coins and atleast 1 head turns up.

$S = \{(HH), (HT), (TH), (TT)\} \Rightarrow n(S) = 4$

Event A :- Atleast one head turns up.

$S = \{(HH), (HT), (TH)\} \Rightarrow n(A) = 3$.

Event B :- No tail turns up

$S = \{HH\} \Rightarrow n(B) = \underline{1}$

eg: 2] Exp:- Rolling 2 dice & the sum of two dice is 10.

$S = \{(1,1) \ldots\ldots (6,6)\}$

	1	2	3	4	5	6
1	(1, 1)	(1, 2)	(1, 3)	(1, 4)	(1, 5)	(1, 6)
2	(2, 1)	(2, 2)	(2, 3)	(2, 4)	(2, 5)	(2, 6)
3	(3, 1)	(3, 2)	(3, 3)	(3, 4)	(3, 5)	(3, 6)
4	(4, 1)	(4, 2)	(4, 3)	(4, 4)	(4, 5)	(4, 6)
5	(5, 1)	(5, 2)	(5, 3)	(5, 4)	(5, 5)	(5, 6)
6	(6, 1)	(6, 2)	(6, 3)	(6, 4)	(6, 5)	(6, 6)

$n(S) = \underline{36}$

A :- the sum of two dice turns up as 10

$S(A) = \{(5,5), (6,4), (4,6)\} \Rightarrow \underline{n(A)} = 3$

eg:-3 Exp :- Rolling one dice & Tossing one coin at the same time.

$S = \{(H,1), (H,2), (H,3), (H,4), (H,5), (H,6), (T,1), (T,2), (T,3), (T,4), (T,5), (T,6)\}$

$n(S) = 12$

Event A :- Only Head turns up

$S(A) = \{(H,1), (H,2), (H,3), (H,4), (H,5), (H,6)\}$

$n(S(A)) = 6$

$P(A) = 6/12 = 1/2$

Event B :- Get only even nos. on the dice

$S(B) = \{(H,2), (H,4), (H,6), (T,2), (T,4), (T,6)\} \Rightarrow n(S(B)) = 6$

$P(B) = 6/12$

5. Probability :- of an event A

$$\text{Prob.} = \frac{n(S(A))}{n(S)}$$

A :- is an event.

eg :- Exp :- Tossing a coin $S(H, T) \Rightarrow n(S) = 2$

Event A :- When you toss a coin head turns up

$S = (H) \Rightarrow n(S(A)) = 1$

$$P(A) = \frac{1}{2}$$

Probability Rules :-

1: Complement :-

eg:- Roll 1 dice $S = \{1, 2, 3, 4, 5, 6\} \Rightarrow n(S) = 6$

Event A:- Getting all nos. divisible by 3.

$S(A) = \{3, 6\} \Rightarrow n(S(A)) = 2.$

$$P(A) = 2/6$$

Event B:- Getting all nos. not divisible by 3.

$S(B) = \{1, 2, 4, 5\} \Rightarrow n(S(B)) = 4$

$$P(B) = 4/6.$$

$$P(A) = \frac{2}{6}$$

$$P(A) = 1 - \frac{2}{6} \Rightarrow \frac{6-2}{6} \Rightarrow \frac{4}{6} \leftarrow P(B)$$

$$P(A) = 1 - P(A^c)$$

eg:- Event C:- Getting all nos. multiple of 2.

$S(C) = \{2, 4, 6\} \Rightarrow n(S(C)) = 3$

$P(C) = 3/6$

$$P(C^c) = 1 - P(C) \Rightarrow 1 - \frac{3}{6} = \frac{3}{6}$$

$$\boxed{P(C') = 1 - P(C)} \Rightarrow 1 - \frac{3}{6} = \frac{3}{6}$$

Event C^c :- Getting all nos. non multiple of 2.

$$S(C') = \{1, 3, 5\} \Rightarrow n(S(C')) = 3$$

$$\boxed{P(C') = 3/6}$$

II Rule :- Roll a dice :-

$S = \{1, 2, 3, 4, 5, 6\} \Rightarrow n(S) = 6$

A :- Get all nos. > 2 & < 6.

$S(A) = (3, 4, 5) \Rightarrow n(S(A)) = 3$

B :- $S(B) = \{1, 5, 6\} \Rightarrow n(S(B)) = 3.$

$S(A \cap B) = \{5\}.$

$P(A \cap B) = 1/6$

$\cap$ = Inter Section

$\cap \rightarrow$ Intersection :- Common elements in Both the events

III :- Union :- S :- {1, 2, 3, 4, 5, 6}

(∪)

S(A) = {2, 4, 6}

S(B) = {1, 2, 5}.

S(A ∪ B) = {1, 2, 4, 5, 6}

P(A ∪ B) = 5/6

eg:- Roll one dice & toss one coin simultaneously

$S = 12$

A:- Getting all odds when it is tail.

$S(A) = 3$

$P(A) = 3/12$

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*Law of Probability :-

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

eg:- Dice :- $S = \{1, 2, 3, 4, 5, 6\}$

$S(A) = \{2, 4, 6\} \Rightarrow P(A) = 3/6$

$S(B) = \{1, 2\} \quad P(B) = 2/6$

$S(A \cap B) = \{2\} \quad P(A \cap B) = 1/6$

$$P(A \cup B) = \frac{3}{6} + \frac{2}{6} - \frac{1}{6} = \frac{3+2-1}{6} = \frac{4}{6}.$$

$P(A \cap B)$, $P(B)$, $P(A \cup B) \Rightarrow P(A)$

Q. What is the range of probability?

R:- $[0, 1] \Rightarrow$ 0 & 1 both are inclusive

eg:- Event A:- Sun rising in west.

$P(A) = 0$

Event B:- Sun rising in east

$P(B) = 1$

Note:- Probability value will never be greater than 1 or less than 0.

eg:- $S = \{1, 2, 3, 4, 5, 6\}$

$S(A) = (2, 4, 6)$

$S(B) = \{1, 3, 5\}$

$S(C) = \{\}$ $\Rightarrow$ $P(C) \Rightarrow 0/6$

$\Downarrow 0$

↑ empty set or a null set

For 2 Events, Event A & Event C.

$S = \{1, 2, 3, 4, 5, 6\}$

$S(A) = \{2, 4, 6\}$

$S(C) = \{1, 3, 5\}$

$S(A \cap C) = \{\}$ ← Event A & Event C are mutually exclusive events or disjoint events

eg:- Tossing a coin.

$S(A) = \{\}$ ← mutually exclusive? ∈ No

Recap :- 1. Experiment.
2. Outcome.
3. Sample Space
4. Event.
5. Probability (Event)

Rules :- 6. Complement =) $P(A) = 1 - P(A^c)$
7. Intersection
8. Union.
9. Range =) $[0, 1]$
10. $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

Law of Prob

11. Empty Set.
12. Mutually Exclusive Event (Disjoint Events)