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Agenda :-

Naive Bayes :- Entirely about probability

↳ Intro to probability

Probabilities :- 1. Experiement or Random Experiement

2. Outcome of an experiement

3. Sample Space

4. Event.

5. Probability Rules

(Intersection, Union, Complement)

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1. Experiement or Random Experiement :-

Defined as [Uncertain] situations which can have [multiple] results.

eg :- ① Tossing a coin

② Rolling a dice

③ Whether it will rain today?

2. Outcome :- The result of an experiment

eg :- ① Toss a Coin :- [H], [T] ← outcome

↓

outcome of exp.

② Rolling a dice :-

outcome

① 4 ← 

② 3 ← 

outcome 3

3. Sample Space :- Collection of all outcomes of the experiment

(1) Toss a coin :- H, T

↓

Sample Space :- {H, T}

(2) Roll a dice :- {1, 2, 3, 4, 5, 6}

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Write the sample space for :- 2 Coins tossed.

$S = \{ HH, HT, TH, TT \}$

Write the Sample Space for :- 2 dice rolled together

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

④ Event :- It is defined as subset of Sample Space

eg:- Toss a coin :- H

Tossing a coin and getting head in the output combined is called as an Event.

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eg:- Toss a coin

$S = \{H, T\}$

Event) Focus is only on tossing a coin & getting head in the output

$S(\text{Event}) = \{H\}$

eg :- 2 : Experiement :- Rolling a dice

Outcomes :- 1, 2, 3, 4, 5, 6.

Sample Space (S) :- {1, 2, 3, 4, 5, 6}

Event :- Roll a dice & get only odd nos.

Outcome(Event) :- {1, 3, 5}

S(Event) :- {1, 3, 5}

eg:- 3. Experiement :- Roll a dice & Toss a coin simultaneously

Possible outcomes :- {1, 2, 3, 4, 5, 6} {H, T}

Sample Space :- {(H,1), (H,2), (H,3), (H,4), (H,5), (H,6),
(T,1), (T,2), (T,3), (T,4), (T,5), (T,6)}

2 × 6 = 12

Event (A) :- Get only Tails :-

S(A) :- {(T,1), (T,2), (T,3), (T,4), (T,5), (T,6)}

Event (B) :- Get only dice where divisible by 2.

S(B) :- {(H,2), (H,4), (H,6),
(T,2), (T,4), (T,6)}

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What is Probability ?

$$\text{Prob} = \frac{\text{no. of elements in Sample Space of that Event}}{\text{no. of elements in the Sample Space.}}$$

∴ Experiement :- E

S :- { .... }

Event :- A

$S(A)$:- { .... }

$$\boxed{P(A) = \frac{S(A)}{S}}$$

eg:- Toss a coin.

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

$A :-$ Getting only Head

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

$$P(A) :- \frac{1}{2}$$

eg:-2:- Roll a dice

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

A :- Get all nos. divisible by 3.

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

$P(A) = \frac{2}{6} = \frac{1}{3}$.

eg:- Roll a dice

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

A :- All odd outcomes.

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

$P(A) :- \frac{3}{6} = \frac{1}{2}$

Probability Rules :-

1. Complement :-

eg :- Rolling a dice

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

A :- Getting all nos. divisible by 3

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

$P(A) = \frac{2}{6} = \frac{1}{3}.$

$$\boxed{P(A^c) = 1 - P(A)}$$

$P(A^c) = \left(1 - \frac{2}{6}\right) = \boxed{\frac{4}{6}}$

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

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

$P(B) = \frac{4}{6} = \boxed{\frac{4}{6} \Rightarrow P(A^c)}$

eg:- Roll a dice

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

A:- Get all nos. div. by 3

$S(A) = \{3, 6\}$

$P(A) = \frac{2}{6} = \frac{1}{3}$

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

$= \left(1 - \frac{2}{6}\right) \Rightarrow \frac{4}{6}$.

B:- Get all nos. not div. by 3

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

$P(B) = \frac{4}{6}$.

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

$S(A) = \{3, 4, 5\}$ $\quad P(A) = 3/6$

$S(B) = \{1, 5, 6\}$ $\quad P(B) = 3/6.$

$\cap$ ↓ intersection

$S(A \cap B) = \{5\}$ $\quad n(S(A \cap B)) = 1$

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

Intersection = common in both

3. Union :- Not common.

$\cup \Rightarrow$ or
$\cap \Rightarrow$ and

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

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

$S(B) :- \{1, 2\}$

$S(A \cup B) :- \{1, 4, 6\} \Rightarrow 3$

$P(A \cup B) :- \frac{3}{6} = 1/2$

* Law of probability :-

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

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

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

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

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

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

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

S(A) :- {2, 4, 6}

S(B) :- {1, 3, 5}

S(C) :- { } ← null set or empty set.

$S(A \cap C) = \{\}$

$P(A \cap C) = 0$

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For 2 Events, eg :- A & C

$$S(A \cap C) = \{\}$$
$$P(A \cap C) = 0$$

← Event A & Event C are mutually exclusive events. or disjoint events

eg :- Tossing a coin

A = { } ← Mutually exclusive ? => No

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Recap :- Experiement

Outcome

Sample Space

Event

Prob (Event)

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

Intersection

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

Mutually Exclusive Event or Disjoint Event