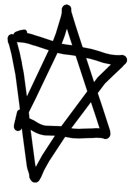
Why is probability important

08 October 2025 18:51

Probability - Every ML model

Pre-modelling
Modelling
Post-modelling



Fundamentals

Sachin's ODI career

Probability => Pandas

Experiment

07 October 2025 21:05

Experiment => Any action or process

{Tossing a coin
Rolling a die}

{Sachin playing the Match} => Experiment

Attempting an exam

Shooting a basketball

Outcome

07 October 2025 21:11

Outcome

1 possible result from the experiment

{Toss a coin => H} Outcome

(Roll a die => 2) outcome

{Man of the Match

No. of Fours and sixes

112 runs in a Match => outcome

{Scoring 0 in a Match}

Sample space

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All possible outcomes

Roll a die

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

Toss a coin

$S = \{H, T\}$

Event and Event vs Outcome

07 October 2025 21:17

An **outcome** = one possible *complete* result of the experiment.
An **event** = any *condition or subset* of outcomes from the sample space.

Outcome vs Event

1 possible result ⇒ Sachin scoring 53 in a Match

{Event ⇒ A group of outcomes}
(Sachin scoring 50 or more)

Event ⇒ When we roll a die
getting an even no.
getting an odd no.
getting multiple of 3.

Event A, Event B,
⇓
Probability

probability

07 October 2025 22:12

$$P(E) = \frac{N(E)}{N(S)} \Rightarrow \frac{\text{No of times a specified event occurs}}{\text{length of the sample space}}$$

Rolling a die

What is prob of $\boxed{\underbrace{\text{even no.}}_{}}$ $\rightarrow$ event

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

$$\frac{3}{6} = 1/2$$

Mutually Exclusive Events

07 October 2025 21:27

Interview Question!

Events that can never happen together

{Sachin Scoring a duck and a century in the same ODI Match} → 0

{Probability of mutually exclusive events happening together is always 0}

{Getting H and T in same toss}

Exhaustive events

08 October 2025 18:39

Let there be two events

A => Sachin scores 100 or more

B => Sachin scores less than 100

C => Sachin did not bat

A, B, C make up entire sample space

Rolling a die example

A => All even no.

B => All odd no.

=> Mutually exhaustive

Mutually exc => No common outcomes

Exhaustive => Common possible, but should cover all outcomes

i) Entire sample ⇒ Ex ✓ ME ✗

ii) Nothing in common ⇒ Ex ✗ ME ✓

[India plays 10 Matches in a tournament $\Rightarrow$ A, B, C, D, F, G, H, K, L, M]

Sachin Scores >= 50 $\Rightarrow$ {A, C, F, G, K} $\Rightarrow \frac{1}{2} = \frac{5}{10}$

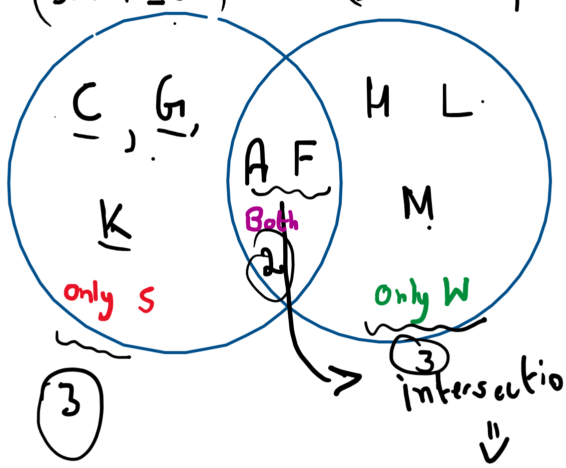
India wins $\Rightarrow$ {A, F, H, L, M} P $\Rightarrow \frac{5}{10} = \frac{1}{2}$

$\Rightarrow$ Data Scince assessments for Consulting
↳ Mckenzie 8 Ch

{Venn Diagram}

Event S (Sachin ≥ 50)

Event W (India Wins)



8

Also called joint events

intersection $S \cap W$

$\Downarrow$

{Both events happening together}

[Union $\Rightarrow$ Either one or all]

[Either sachin ≥ 50 (3), or India Wins (3) or Both (2) happen] $\Rightarrow$ Union

$3 + 3 + 2 = 8$

$$P(S \cup W) = P(\text{only } S) + P(\text{only } W) + P(S \cap W)$$

$P(S)$ and $P(\text{only } S)$ Same or not?

$\Downarrow$ $\frac{5}{10}$ $\Downarrow$ $\frac{3}{10}$

$P(S) = P(\text{only } S) + P(S \cap W)$ ✓

$P(\text{only } S) = P(S) - P(S \cap W)$

$P(\text{only } W) = P(W) - P(S \cap W)$

$P(\underline{S} \cup \underline{W}) = P(\text{only } S) + P(\text{only } W) + P(S \cap W)$

$P(S \cup W) = P(S) - P(S \cap W) + P(W) - P(S \cap W) + P(S \cap W)$

✡ $P(S \cup W) = P(S) + P(W) - P(S \cap W)$ ✡

↓ ✡

1 1 2

$$\frac{}{2} + \frac{}{2} - \frac{}{10}$$

$$\left\{ \frac{2}{2} - \frac{2}{10} = 1 - \frac{2}{10} = \frac{8}{10} = \frac{4}{5} \right\}$$

$$0.8$$

Complement

07 October 2025 22:19

Event A :
Sachin Scores 0

Event A'
:
Sachin does not score 0

I roll a die

Event A => Getting even number

A' => Not getting even number => odd numbers

$$P(A') = 1 - P(A)$$

$$P(odd) = 1 - P(even)$$ => Rolling a die

(Potential interview question)

(Potential interview Question)

{ A and A' are <u>exhaustive</u> and <u>exclusive</u> }

Independent Events

07 October 2025 22:25

Two events are independent when one has no impact or effect on the other

Exam results in two different subjectives

Toss one coin and roll one die

Getting H and getting even no.

For independent events, the **joint probability equals the product of individual probabilities:**

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

- This is the key relationship: **independence is defined via joint probability.**
- Conversely, if $P(A \cap B) = P(A) \cdot P(B)$, the events are independent.

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

when A and B independent of each other

Sachin scoring 100

and

Real Madrid Winning

Proof

$P(\text{century}) = \frac{21}{420} = \frac{1}{20}$

21 centuries

420 matches

3 M 60

3 T 60

3 W 60

3 T 60

3 F 60

3 S 60

3 S 60

3

Probability of

Sachin scoring a century and it being a Monday

$\frac{3}{420} = \frac{1}{140}$

$\frac{3}{420}$

$\left(\frac{}{420}\right)\left(\frac{}{140}\right)$

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

$\Downarrow$

$$\frac{1}{20} \times \frac{1}{7} = \frac{1}{140} \checkmark$$

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

☆ When A and B are independent ☆

[I roll a die. Possible outcomes?]

{1, 2, 3, 4, 5, 6}

Probability of getting a 2 ⇒ $1/6$

$A = \{2\}$

$B = \{2, 4, 6\}$ $3/6$

$A \cap B = \{2\}$ ⇒ $\{1/6\}$

I know beforehand that I will get an even number {2, 4, 6}

{$1/3$} ⇒ Conditional probability

{Given some condition, what is the probability of some event}

$$P(A \mid B) = \frac{P(A \cap B)}{P(B)} = \frac{1/6}{3/6} = \frac{1}{3}$$

A → Prob of getting 2

B → Prob of even number

(10 matches are played in World Cup) ⇒ (A, C, F, G, H, K, L, Q, R, M)

Sachin Scores >= 50 ⇒ {A, C, F, G, K}

1, 2, 3, 4, 5, 6

2, 4, 6

India wins ⇒ {A, F, H, L, M}

$P(S \cap W) = 2/10$

Let us say we know sachin will score >= 50

Find the probability of India winning,
given Sachin >= 50

$$P(W|S) = \frac{P(W \cap S)}{P(S)} = \frac{\frac{2}{10}}{\frac{5}{10}} = \frac{2}{5} \{40\%\}$$

{Given, known, if}

Bayes Theorm

08 October 2025 18:58

$$P(A \mid B) = \left\{ \frac{P(A \cap B)}{P(B)} \right\}$$

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

$$\left\{ P(B \mid A) \times P(A) = P(A \mid B) \times P(B) \right\}$$

$$\left\{ P(B \mid A) = \frac{P(A \mid B) \times P(B)}{P(A)} \right\}$$

Bayes Theorm

or

$$\left(P(A \mid B) = \frac{P(B \mid A) \times P(A)}{P(B)} \right)$$

Across ML ⇒ Naive Bayes ML

Problem solving

07 October 2025 23:22

In a school:

- **10% of students play football.**
- **20% of students play basketball.**
- **Among football players, 60% also play basketball.**

If a student is randomly picked and **plays basketball**, what is the probability that the student **also plays football**?

$$P(F) = \frac{1}{10}$$

$$P(B) = \frac{1}{5}$$

$$\left\{ P(B \mid F) = \frac{3}{5} \right\} \checkmark$$

$$P(F \mid B) = \frac{\frac{3}{5} \times \frac{1}{10}}{\frac{1}{5}} = \frac{\frac{3}{50}}{\frac{1}{5}} \qquad \frac{3}{50} \times \frac{5}{1}$$

$$= 15/50$$

$$P(A \mid B) = \frac{P(B \mid A) \times P(A)}{P(B)}$$

$$P(A \mid B) = \frac{P(A \cap B)}{P(B)} \Rightarrow P(A/B) \times P(B) = P(A \cap B)$$

$$P(B/A) = \frac{P(A \cap B)}{P(A)} \Rightarrow P(B/A) \times P(A) = P(A \cap B)$$

$$P(A/B) \times P(B) = P(B/A) \times P(A)$$

$$\left. P(A|B) = \frac{P(B/A) \times P(A)}{P(B)} \right\} \text{Bayes Theorm}$$

In a school:

- **10% of students play football.**
- **20% of students play basketball.**
- **Among football players 60% also play basketball.**

If a student is randomly picked and **plays basketball**, what is the probability that the student **also plays football**?

$P(F) = 1/10$

$P(B) = 1/5$

$$P(F \mid B) = \frac{\frac{3}{5} \times \frac{1}{10}}{\frac{1}{5}}$$

$P(B \mid F) = 3/5$

$$P(F/B) = \frac{P(F \cap B)}{P(B)} = \frac{3/50}{1/5}$$

$$\checkmark P(B|F) = \frac{P(F \cap B)}{P(F)}$$

$$\frac{3}{5} = \frac{P(F \cap B)}{\frac{1}{10}}$$

$$\frac{3}{5} \times \frac{1}{10} = \frac{3}{50}$$

Colab link

09 October 2025 00:07

https://colab.research.google.com/drive/1Lrj_AB5SUS47H5W76k0OJb-rZthAsiv_?usp=sharing