# Introduction to Probability 

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## 1. Definition:

- Probability is a measure of the likelihood that an event will occur.
- It is expressed as a number between 0 and 1 , where 0 indicates impossibility and 1 indicates certainty.

2. Sample Space and Events:

- The sample space, denoted by S, is the set of all possible outcomes of an experiment.
- An event is any subset of the sample space.


## 3. Probability of an Event:

- The probability of an event A , denoted by $\mathrm{P}(\mathrm{A})$, is the sum of the probabilities of all outcomes in A.
- It satisfies the following properties:

1. $0 \leq \mathrm{P}(\mathrm{A}) \leq 1$ for any event A .
2. $P(S)=1$, where $S$ is the sample space.
3. If A and B are disjoint events (i.e., they have no outcomes in common), then $\mathrm{P}(\mathrm{A} \cup$ $B)=P(A)+P(B)$.

## 4. Probability Rules:

- Complement Rule: The probability of the complement of an event A, denoted by A' or $\mathrm{A}^{\wedge} \mathrm{c}$, is $\mathrm{P}\left(\mathrm{A}^{\prime}\right)=1-\mathrm{P}(\mathrm{A})$.
Union Rule: The probability of the union of two events $A$ and $B$, denoted by $A \cup B$, is $P(A \cup B)=P(A)+P(B)-P(A \cap B)$.
$\circ$ Intersection Rule: If $A$ and $B$ are independent events, then $P(A \cap B)=P(A) \times P(B)$.

5. Types of Probability:

- Classical Probability: Based on equally likely outcomes in a sample space.
- Empirical Probability: Based on observed frequencies from data.
- Subjective Probability: Based on personal judgment or opinion.


## 6. Conditional Probability:

- Conditional probability measures the likelihood of an event occurring given that another event has already occurred.
- It is denoted by $\mathrm{P}(\mathrm{A} \mid \mathrm{B})$ and calculated as $\mathrm{P}(\mathrm{A} \mid \mathrm{B})=\mathrm{P}(\mathrm{A} \cap \mathrm{B}) / \mathrm{P}(\mathrm{B})$.


## 7. Independence:

- Two events A and B are independent if the occurrence of one event does not affect the occurrence of the other.
- Mathematically, $\mathrm{P}(\mathrm{A} \cap \mathrm{B})=\mathrm{P}(\mathrm{A}) \times \mathrm{P}(\mathrm{B})$.
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