Events in Probability

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Events in Probability- In Probability, an event can be defined as any outcome or set of outcomes from a random experiment. In other words, an event in probability is the subset of the respective sample space.

> ***Example:***
> ***1.*** *If you roll a die, the event could be "getting a 3" or "getting an even number."*
> ***2.*** *If you toss two coins simultaneously , the event could be getting "getting at least 1 heads" or "getting two tails".*

This concept of events is fundamental to understanding probability theory

In this article, we will learn about the Events in Probability, Types of Events in Probability, definitions, how they are classified, how the algebra of events works, etc.

Sample Space

A Sample Space is the set of all possible outcomes of an experiment or a random phenomenon. Sample Space is denoted by the symbol "S" and represents all the possible outcomes that can occur.

> ***Example:*** *when flipping a coin, the sample space is {heads, tails}, because those are the only two possible outcomes. Similarly, when rolling a six-sided die, the sample space is {1, 2, 3, 4, 5, 6}, because those are the only possible outcomes.*

It is essential to understand the different types of events that can happen while performing random experiments. There are various types of events in probability which are discussed as follows:

- Impossible and Sure Events
- Simple Event and Compound Event
- Dependent and Independent Events
- Mutually Exclusive Events
- Exhaustive Events
- Equally Likely Events

Impossible Event and Sure Event: The event with 0 probability is called the impossible event, as this event never happens. Whereas, the event with probability 1 is called the Sure Event, as this event always happens with 100% certainty.

Examples of Impossible Events:

- *Rolling a 7 on a standard 6-sided die.*
- *Having 30th February in a year.*

Examples of Sure events:

Independent Event and Dependent Event: Independent events are those in which the probability of an event remains the same, regardless of previous outcomes. Whereas, dependent events are those in which the probability of an event changes based on previous outcomes.

Examples of Dependent Events:

Example 1: *Drawing two cards from a deck* ***without replacement****.*
• If you draw one card and do not replace it, the total number of cards in the deck changes. The probability of drawing a specific card on the second draw is affected by the outcome of the first draw, hence they are dependent events.

Example 2: *Picking a marble from a bag,* ***not replacing it****, and then picking another marble.*
• If the first marble is not replaced, the total number of marbles changes, which influences the probability of picking the second marble. Hence, the events are dependent.

Example of Independent Events:

Example 1*: Flipping a coin twice.*
• The outcome of the first flip (heads or tails) does not affect the outcome of the second flip. The probability of each flip remains 1/2, so the events are independent.

Example 2*: Rolling a die and flipping a coin.*
• The result of rolling the die (e.g., getting a 4) has no impact on the result of flipping the coin (heads or tails). Both events are independent.

Learn more about, Dependent and Independent Events

Simple and Compound Event: When an event consists of only one point of the sample space, this event is called a simple event and events with two or more points of the sample space, are called compound events.

Examples of Simple Events:

Rolling a Die:

Sample space: {1, 2, 3, 4, 5, 6}.
*Getting a 4 is a **simple event.***

Example of Compound Event:

Scenario: Rolling a fair six-sided die

Let the sample space S be all possible outcomes when rolling the die:
S = {1, 2, 3, 4, 5, 6}

***Event A**: Rolling an even number (i.e., 2, 4, or 6). So, we can represent it as a set:*
A={2, 4, 6}

***Event B**: Rolling a number greater than 3 (i.e., 4, 5, or 6). So, we can represent it as a set:*
B={4, 5, 6}

Compound Event (Union of A and B): {2,4,5,6}

Mutually Exclusive Events: Mutually exclusive events have no outcomes in common. In other words, if one event happens, the other cannot happen.

***Example:** Let's consider a scenario of flipping a fair coin.*

***Event A**: The coin lands on **heads** .A = {Heads}*
***Event B**: The coin lands on **tails**. B = {Tails}*

*The **intersection** of mutually exclusive events is the empty set: $A \cap B = \emptyset$.*

Exhaustive Events: The collection of those events is exhaustive events that cover all the possible outcomes.

***Example:** Consider a random experiment where a coin is tossed **twice**. The sample space (S) is:*
S = {HH, HT, TH, TT}

Define the following events:

The union of A and B gives: A ∪ B = {HH, HT, TH, TT} = S
*This means the events A and B together cover all possible outcomes in the sample space S. Hence, A and B are **exhaustive events**.*

Equally Likely Events: Equally likely events have the same probability of occurring. In a random experiment, all outcomes are equally likely if none is favored over the others.

> ***Example:** In the case of rolling a fair six-sided die, there are six equally likely outcomes: 1, 2, 3, 4, 5, and 6. Since all outcomes are equally likely, the probability of rolling any specific number is 1/6.*

Learn more about- Types of Events in Probability

Algebra of Events

Since events are nothing but subsets of sample space, two or more events can be combined using four different operations, union, intersection, difference, and compliment.. Let's consider three events A, B, and C defined over the sample space S.

Union of Events in Probability

Let's say we have two events A and B then the union of A and B represents the event that occurs if either A or B **(or both)** occurs. Union of Events A and B is denoted by **A ∪ B,** and it contains all the outcomes that are in either A, B, or both

Let's consider an example for an Intersection of Events, let two events be E_1 = {2, 3, 4, 5} and E_2 = {3, 4, 7, 8}.

The **union** of E_1 and E_2 is denoted by $E_1 \cup E_2$, and it includes all the elements from both sets without duplication.

Thus, $E_1 \cup E_2$ = {2, 3, 4, 5, 7, 8}

Let's say we have two events A and B then the intersection of A and B represents the event that occurs if both A and B occur simultaneously . The intersection of Events A and B is denoted by **A ∩ B**

Let's consider an example for an Intersection of Events, let two events be E_1 = {2, 3, 4, 5} and E_2 = {3, 4, 7, 8}. Also, assume that the intersection of both events is represented by E i.e., E = $E_1 \cap E_2$. that

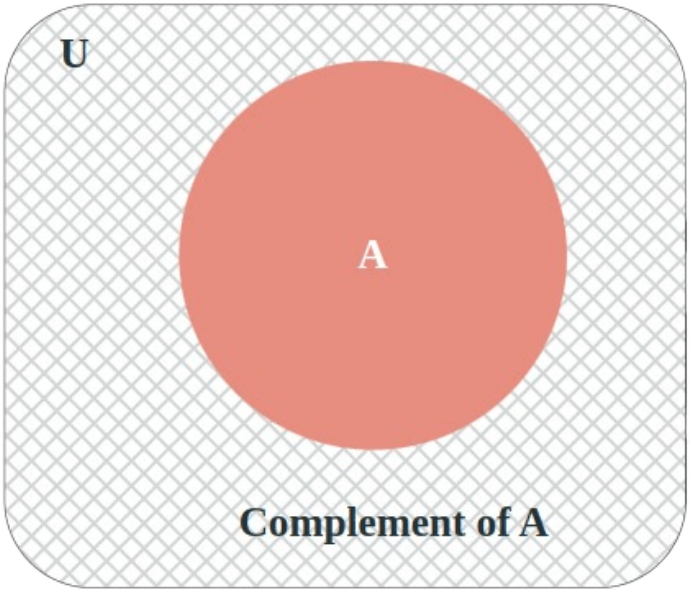
Thus, E = $E_1 \cap E_2$ = {3, 4}

Complimentary Event

For every event A, there exists another event A', which is called a complimentary event. It consists of all those elements which do not belong to event A. **Example:** In the rolling die experiment. Let's say event A is defined as getting even number. So, A = {2,4,6}
The complementary A' of event A will be consists of all the elements in the sample space which are not in event A. Thus, A' = { 1,3,5}

Difference of Events in Probability

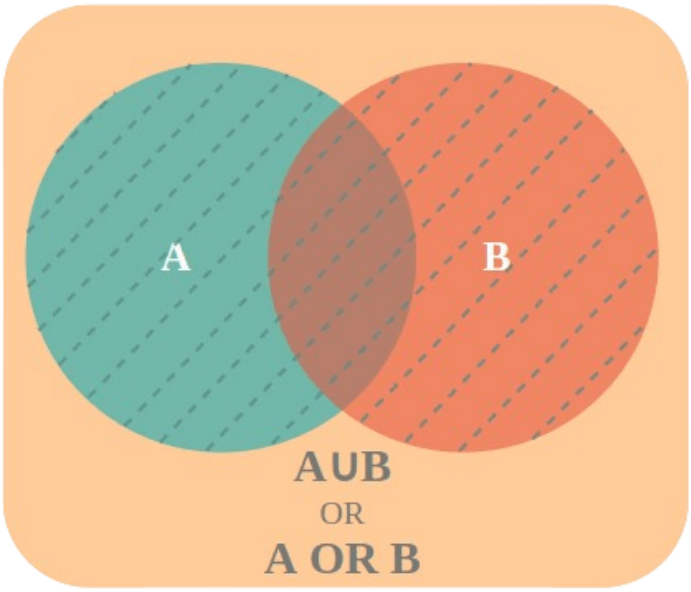
For any two events A and B the difference of A and B represents the event that consists of all the outcomes which are in A but not in B. Difference of events A and B is denoted as **A - B**.



Event A or B

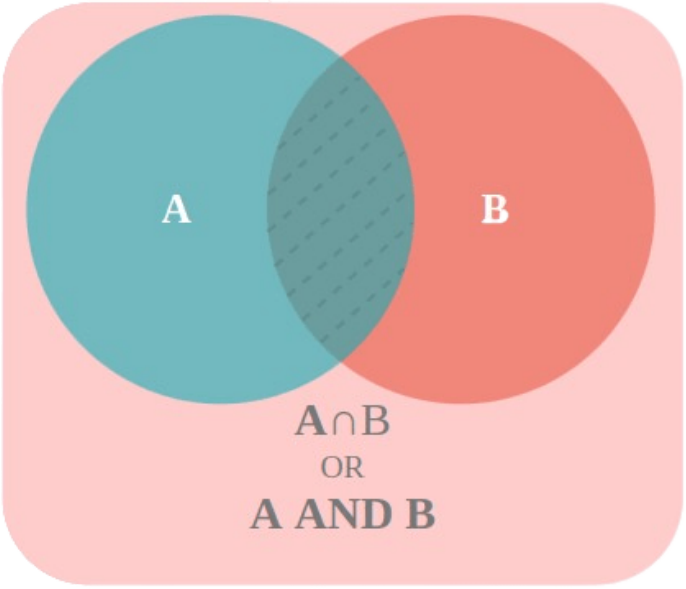
The Union of two sets A and B is denoted as A ∪ B. This contains all the elements that are in either set A, set B, or both. This event A or B is defined as,

$$\textit{Event A or B} = A \cup B$$
$$A \cup B = \{w : w \in A \text{ or } w \in B\}$$



The intersection of two sets A and B is denoted as A ∩ B. This contains all the elements which are in both set A and set B. This event A and B is defined as,

$$\textit{Event A and B} = A \cap B$$
$$A \cap B = \{w: w \in A \text{ and } w \in B\}$$

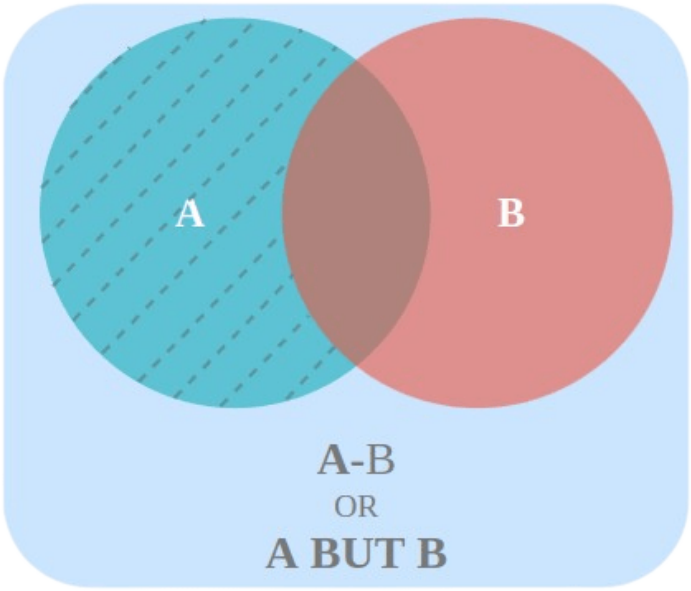


Event A but not B

The set difference A - B consists of all the elements which are in A but not in B. The events A but not B are defined as,

$$\textit{A but not B} = A - B$$
$$A - B = A \cap B'$$

*Where **B'** is the complement of event B.*



How to Find the Probability of an Event

We can easily find the probability of an event by following the steps discussed below,

- ***Step 1:*** *Find the total sample space of the experiment.*
- ***Step 2:*** *Find the number of favourable outcomes of the experiment.*
- ***Step 3:*** *Use the formula to calculate the probability as,*
  Probability = (Favourable Outcome)/(Total Outcome)

Read More,

- *Probability Distribution*
- *Chance and Probability*
- *Union of Sets*

Sample Problems on Events in Probability

Here we have provided you with a few solved sample problems on events in probability:

1. **E_1 or E_2**
2. **E_1 and E_2**

Solution:

The sample space for the die will be,
S= {1, 2, 3, 4, 5, 6}

- *E_1 (only even numbers) = {2, 4, 6}*
- *E_2 (number more than 3) = {4, 5, 6}*

1. *E_1 or E_2 = {2, 4, 5, 6}*
2. *E_1 and E_2 = {4, 6}*

Problem 2: A die is thrown and the set for the sample space obtained is, S = {1, 2, 3, 4, 5, 6} E_1 is defined as the event of obtaining a number less than 5 and E_2 is defined as the event of obtaining a number more than 2.
Find the set for the following,

1. **E_1 but not E_2**
2. **E_2 but not E_1**

Solution:

Sample space will be,
S= {1, 2, 3, 4, 5, 6}

- *E_1 (a number less than 5)= {1, 2, 3, 4}*
- *E_2 (a number more than 2)= {3, 4, 5, 6}*

1. *E_1 but not E_2 = {1, 2}*
2. *E_2 but not E_1 = {5, 6}*

Solution:

Tossing Three Coins the sample space is,
S = {(H, H, H), (H, H, T), (H, T, H), (T, H, H), (T, T, H), (T, H, T), (H, T, T), (T, T, T)}

Hence, the Sample Space Comprises 6 Possible Outcomes
Event (E) for the occurrence of exactly two heads,

E = {(H, H, T), (H, T, H), (T, H, H)}

Problem 4: Name the types of events obtained from the given below experiments,

1. **A coin is tossed for the 5th time and in the event of getting a tail when the first four times, the result was ahead.**
2. **S (sample space)= {1, 2, 3, 4, 5} and E= {4}**
3. **S= {1, 2, 3, 4, 5} and E= {2, 4}**
4. **S= {1, 2, 3, 4, 5}, E_1= {1, 2} and E_2= {3, 4}**

Solution:

1. *No matter how many times the coin is tossed, every time the probability of getting a tail will be 0.5 irrespective of the previous outcomes, therefore the event will be an independent event.*

2. *E= {4} is a Simple event.*

3. *E= {2, 4} is a compound event.*

4. *E_1 and E_2 are Mutually exclusive events.*

Problem 5: The sample Space of an experiment is given as,

S = {10, 11, 12, 13, 14, 15, 16, 17} and the event, E is defined as all the even numbers. What will be the complementary event for E?

Solution:

S = {10, 11, 12, 13, 14, 15, 16, 17}

Problem 6: Consider the experiment of tossing a fair coin 3 times, Event A is defined as getting all tails. What kind of event is this?

Solution:

Sample space for the coin toss will be,

$$S = \{HHH, HHT, HTH, HTT, THH, THT, TTH, TTT\}$$

For the event A,
A = {TTT}

This event is only mapped to one element of sample space. Thus, it is a simple event.

Problem 7: Let's say a coin is tossed once, state whether the following statement is True or False.

"If we define an event X which means getting both heads and tails. This event will be a simple event."

Solution:

When a coin it tossed, there can be only two outcomes, Heads or Tails.
S = {H, T}

Getting both Heads and Tails is not possible, thus event X is an empty set.
Thus, it is an impossible and sure event. So, this statement is False.

Problem 8: A die is rolled, and three events A, B, and C are defined below:

- **A: Getting a number greater than 3**
- **B: Getting a number that is multiple of 3.**
- **C: Getting an odd number**

Find A ∩ B, A ∩ B ∩ C, and A ∪ B.

Sample space for die roll will be,
S = {1, 2, 3, 4, 5, 6}

For the event A,
A = {4, 5, 6}

For the event B,

B = {3, 6}

For the event C,
C = {1, 3, 5}

A ∩ B = {4, 5, 6} ∩ {3, 6}
A ∩ B = {6}

A ∩ B ∩ C = {4, 5, 6} ∩ {3, 6} ∩ {1, 3, 5}
A ∩ B ∩ C = ∅ (Empty Set)

A ∪ B = {4, 5, 6} ∪ {3, 6}
A ∪ B = {3, 4, 5, 6}

Problem 9: A die is rolled, let's define two events, event A is getting the number 2 and Event B is getting an even number. Are these events mutually exclusive?

Solution:

Sample space for die roll will be, S = {1, 2, 3, 4, 5, 6}

For the event A,
A = {2}

For the event B,
B = {2, 4, 6}

For two events to be mutually exclusive, their intersection must be an empty set

A ∩ B = {2} ∩ {2, 4, 6}
A ∩ B = {2}

Since it is not an empty set, these events are not mutually exclusive.

Event: *An event is a collection of outcomes that share a common characteristic.*

What are the Types of Events in Probability?

The different types of events in probability are as follows:

- *Impossible and Sure Events*
- *Simple Event and Compound Event*
- *Dependent and Independent Events*
- *Mutually Exclusive Events*
- *Exhaustive Events*
- *Equally Likely Events*

What is a Simple Event?

A simple event is an event that consists of a single outcome. Example: if a coin is tossed, the event of getting a head is a simple event.

What is a Compound Event?

A compound event is an event that consists of two or more outcomes. Example: when rolling two dice and getting a sum of 7 which can be achieved either by (1, 6), (2, 5), (3, 4), (4, 3), (3, 4), (5, 2), or (6, 1).

What is the Difference Between a Simple Event and a Compound Event in Probability?

Simple Event: *A simple event in probability is an event that include only a single outcome.*
Compound Event: *A compound event is an event that consists of two or more outcomes.*

The complement of an event in probability is the set of all outcomes in the sample space that are not in the event.

What is the Intersection of Two Events in Probability?

The intersection of two events is the event that consists of all outcomes that are in both events. It is denoted by the symbol ∩.

What is the Union of Two Events in Probability?

The union of two events is the event that consists of all outcomes that are in either of the two events. It is denoted by the symbol ∪.

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Types of Events in Probability

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