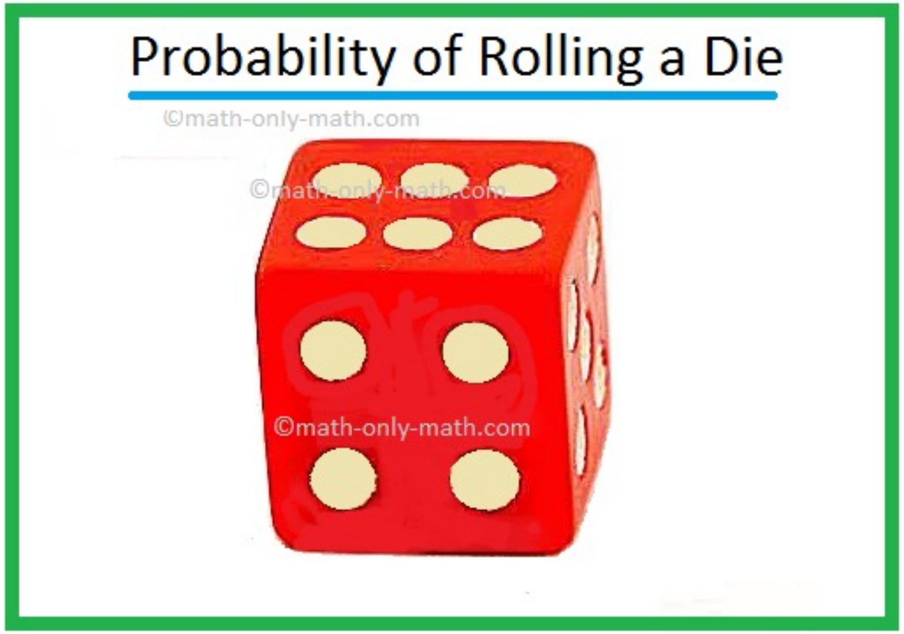
Probability concepts

- ✓ Random experiment
- ✓ Outcome
- ✓ sample space
- ✓ Event

Random experiment

Before rolling a die you do not know the result. This is an example of a **random experiment**



In particular, a random experiment is a process by which we **observe something uncertain.** After the experiment, the result of the random experiment is known

Random experiments

An experiment is *random* if although it is repeated in the same manner every time, can result in different outcomes:

It can be repeated as many times as we want always under the same conditions (leading to different outcomes).

An **outcome** is a result of a random experiment.

The set of all possible outcomes is called the **sample space**.

Thus in the context of a random experiment, the sample space is our **universal set.**

Examples :

1)Random experiment: **toss a coin**;
sample space: S={heads,tails}

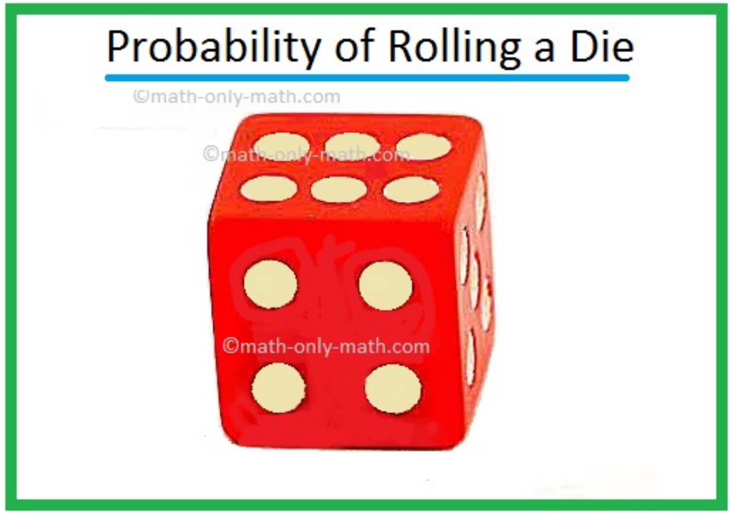
2)Random experiment: **roll a die**;
sample space: S={1,2,3,4,5,6}

Event

Random experiment: roll a die;
Sample space: S={1,2,3,4,5,6}

Probability that the outcome of rolling a fair die is an even number!

Now event is the set **E={2,4,6}**



if the result of our random experiment belongs to the set E, we say that the event EE has occurred. In other words, an **event is a subset of the sample space**

Outcome: A result of a random experiment.

Sample Space: The set of all possible outcomes.

Event: A subset of the sample space

Axioms

meaning !

a rule or principle that most people believe to be true

Three Axioms of probability

Axiom 1: The probability of an event is a **real number** greater than or equal to 0.

Real numbers are **numbers that include both rational and irrational numbers**.
Rational numbers such as integers (-2, 0, 1), fractions(1/2, 2.5)
Irrational numbers such as √3, π(22/7), etc., are all real numbers.

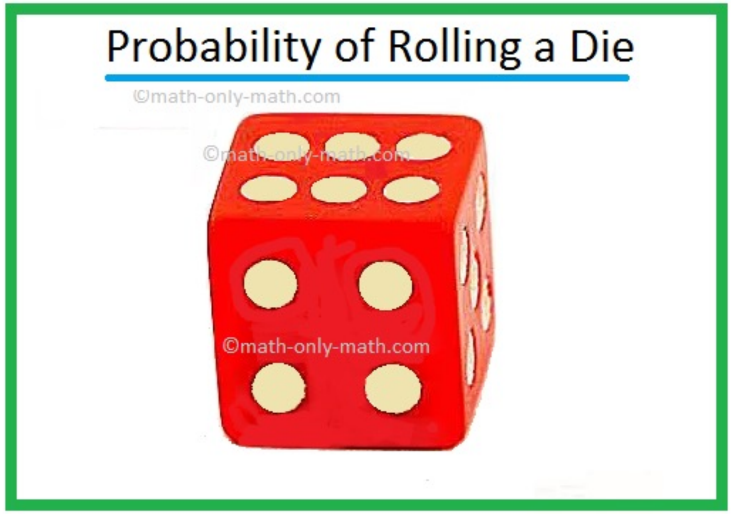
event A, $P(A) \geq 0$

Axiom 2: The probability that at least one of all the possible outcomes of a process (such as rolling a die) will occur is 1.

Example:rolling a fair die

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

$$P(S)=1$$



LEAVE ANYTHING

Axiom 3: If two events A and B are mutually exclusive, then the probability of either A or B occurring is the probability of A occurring plus the probability of B occurring.

$A1, A2, A3, \cdots$ are disjoint events, then

$P(A1 \cup A2 \cup A3 \cdots) = P(A1) + P(A2) + P(A3) + \cdots$

Why to look on these axioms ?

Because we have to decide that which event has occurred more likely .

Axioms of Probability Every Data Scientist Should Know!

https://www.analyticsvidhya.com/blog/2021/03/axioms-of-probability-every-data-scientist-should-know/

Multiplication theorem on probability:

The probability of happening an event can easily be found using the definition of probability. But just the definition cannot be used to find the probability of happening of both the given events. A theorem known as "Multiplication theorem" solves these types of problems.

if *A* and *B* are any two events of a sample space such that
$P(A) \neq 0$ and $P(B) \neq 0$, then
$P(A \cap B) = P(A) * P(B|A) = P(B) * P(A|B)$.

B given A and is written as $P(B|A)$, where the probability of B depends on that of A happening.

if *A* and *B* are any two events of a sample space such that $P(A) \neq 0$ and $P(B) \neq 0$, then
$P(A \cap B) = P(A) * P(B|A) = P(B) * P(A|B)$.

Example: If $P(A) = 1/5$ $P(B|A) = 1/3$ then what is $P(A \cap B)$?
Solution: $P(A \cap B) = P(A) * P(B|A) = 1/5 * 1/3 = 1/15$

Probability formula

The probability formula defines the likelihood of the happening of an event. The formula to calculate the probability of an event is equivalent to the ratio of favourable outcomes to the total number of outcomes. Probabilities always range between 0 and 1. The general probability formula can be expressed as:

Probability = Number of Favorable Outcomes / Total Number of Outcomes

or

P = n / N

Where:

- P = Probability of an event occurring
- n = Number of ways an event can occur
- N = Total number of outcomes

Q1)Three dice are thrown simultaneously. What is the probability of obtaining a total of 17 or 18?

Three dice can be thrown in 6×6×6=216 ways.

A total of 17 can be obtained as (5,6,6),(6,5,6), (6,6,5).
A total of 18 can be obtained as (6,6,6).
Hence the required probability =4/216 =1/54.

Conditional Probability

Conditional probability is defined as the **likelihood**(**how likely it is to happen or there is chance that something can be possible)**of an event or outcome occurring, based on the occurrence of a previous event or outcome. Conditional probability is calculated by **multiplying the** [probability]() **of the preceding event** by the updated **probability of the succeeding**, or conditional, event.

Succeeding(previous) **Event A**
Preceding(Present) **Event B**

It is written as P(B|A) (B depends on A)

$$P(B|A) = P(A \cap B) / P(A)$$

$P(B|A) = P(A \cap B) / P(A)$

Where

$P = Probability$

$A = Event\ A$

$B = Event\ B$

Bayes' theorem

Bayes' theorem describes the probability of occurrence of an event related to any **condition**. Bayes theorem is also known as the formula for the probability of "**causes**".

Condition or Cause

For example: if we have to calculate the probability of taking a **blue ball** from the **second bag** out of **three different bags of balls**, where each bag contains three different **colour balls viz. red, blue, black**. In this case, the probability of occurrence of an event is calculated depending on other conditions is known as conditional probability.

Bayes Theorem Derivation

1)From the definition of **conditional probability**, Bayes theorem can be derived for events as given below:

$P(A|B)$ $= P(A \cap B)/ P(B)$, where $P(B) \neq 0$

P**$(B|A)$** $= P(B \cap A)/ P(A)$, where $P(A) \neq 0$

2)Here, the **joint probability** $P(A \cap B)$ of both events A and B being true such that,

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

$P(A \cap B) =$ **$P(A | B) * P(B) =$** **$P(B | A) * P(A)$**

$P(A|B) = [P(B|A) P(A)]/ P(B)$, where $P(B) \neq 0$

Applications of bayes theorem

1) Spam Filtering

The first and foremost application of Bayes is its ability to classify texts and in particular, spam emails from non-spam ones.

It is one of the oldest spam filtering methodology, with the Bayes spam filtering dating back to 1998. It takes two classes – Spam and Ham and classifies data accordingly.

2)Sentiment Analysis

It is a part of natural language processing that analyzes if the data is positive, negative or neutral. Another terminology for Sentiment Analysis is opinion mining. Using Bayes, we can classify if the text is positive or negative or determine what class the sentiment of the person belongs to.

3)Recommendation Systems

Using Bayes we can build recommendation systems. A recommendation system measures the likelihood of the person watching a film or not, given the past watches. It is also used in conjunction with collaborative filtering to filter information for the users

4)Bayesian Neural Networks

Recently, Bayes' Theorem has been extended into Deep Learning where it is used to design powerful Bayesian Networks. It is then used in complex machine learning tasks like stock forecasting, facial recognition etc. It is a currently trending topic and has revolutionized the field of **deep learning**.

5) Bayes Theorem weather forecasting

The scientific process is built on the foundations of observation, knowledge gathering, and prediction. The precision of our predictions is determined by the quality of our current knowledge and the precision of our observations.

6) cardiovascular nursing

Nurses are frequently called upon to make clinical decisions for complex problems in the face of uncertainty and unpredictability. This decision-making is frequently based on best guesses based on available evidence.

7) In Business and Finance

In business and life, making the right decision the right decision is the most essential thing you can do with the Bayes Theorem. Wrong judgments can haunt you for the rest of your life, but the right decision can mean billions of dollars, years of happiness, serenity, riches, and health, among other things. It's always beneficial to plan for a bright future.