PROBABILITY

Before we turn our focus to probability, it is important to understand some basic tools that form essential building blocks to probability.

Counting principles, also known as counting techniques or counting methods, are mathematical methods used to determine the number of possible outcomes, arrangements, or combinations in various situations.

One of the key things that you need to master is the idea of the **two major counting principles** – **permutations and combinations**. Knowing these two concepts will enable you to calculate the probability for a given scenario or events that you are interested in.

We will start by understanding the concept of permutations.

# PERMUTATIONS:

A permutation is a way of arranging a select group of objects in such a way that the **order is of significance**.

For example, imagine you have a group of five friends, and you want to know how many ways they can sit in a row of five chairs for a group photo. You would use permutations to calculate all the possible seating arrangements.

The following list shows some other examples where permutation is used to count the number of ways in which a particular sequence of events can occur:

* Finding all possible four-letter words that can be formed using the alphabets R, E, A and D
* Finding all possible ways that a group of 10 people can be seated in a row in a cinema hall, and so on

Generally speaking, if there are **n** 'objects' that are to be arranged among **r** available 'spaces', then the number of ways in which this task can be completed is **n!/(n-r)!**. If there are **n** 'spaces' as well, then the number of ways would be just **n!**.

**n! = n\*(n-1)\*(n-2)....\*3\*2\*1**

**Question 1:** Find the number of ways in which the letters of the word ‘MOSAIC’ can be rearranged to form different six-letter words.

* 30
* 100
* 720
* 320

**Question 2:** Again, using the letters of the word ‘MOSAIC’, can you find out how many three-letter words can be formed?

* 100
* 300
* 130
* 120

# COMBINATIONS:

The second important counting principle that you need to be aware of is the method of using **combinations**. In the case of permutations, you had considered the 'order' to be an important factor. Now, **in the case of combinations, you need not take the order into account while finding the number of ways to arrange a group of objects.**

When you have to **choose** some objects from a larger set and **the order is of no significance**, then the rule of counting that you use is called **combination**.

Some examples of combinations are as follows.

* The number of ways in which you can pick three letters from the word 'ONEPIECE'
* The number of ways a team can win three matches in a league of five matches.
* The number of ways in which you can choose 13 cards from a deck of 52 cards, and so on.

The formula for counting the number of ways to choose r objects out of a set of n objects is as follows:



HINT: A helpful hint here would be to **look for a keyword** in the given scenario to know which method is needed. If the problem requires you to **order/arrange** a group of objects, then you would most probably use the method of **permutations**. Else, if you are told to **pick/choose** a group of objects, then often you would be using the formula for **combinations**.

# PROBABILITY: DEFINITION AND PROPERTIES:

Now that we have understood the two fundamental rules of counting, we will go ahead and finally establish the formal definition of probability.

**Definition:** Probability is a numerical measure that **represents the likelihood of a particular event or outcome occurring** within a set of possible events. It is typically expressed as a value between 0 and 1.

A close up of a number

Description automatically generated

Probability values have two major properties:

* **Probability values always lie in the range of 0 to 1**. The value is 0 in the case of an impossible event (like the probability of you being in Delhi and Mumbai at the same time) and 1 in the case of a sure event (like the probability of the sun rising in the east tomorrow).
* **The probabilities of all outcomes for an experiment always sum up to 1**. For example, in a coin toss, there can be two outcomes, heads or tails. The probability of both outcomes is 0.5 each. Hence, the sum of the probabilities turns out to be 0.5 + 0.5 = 1

Now, let us see few more definitions which are crucial in understanding probability.

1. **Experiment:**

Any scenario for which you want to compute the probabilities is considered to be an experiment. It is of the following two types:

* **Deterministic**: Outcome is the same every time.
* **Random**: Outcome can take many possible values. Throughout the majority of our business analytics course, we will only be discussing the random experiment.