Types of Probability Distributions Examples and Characteristics

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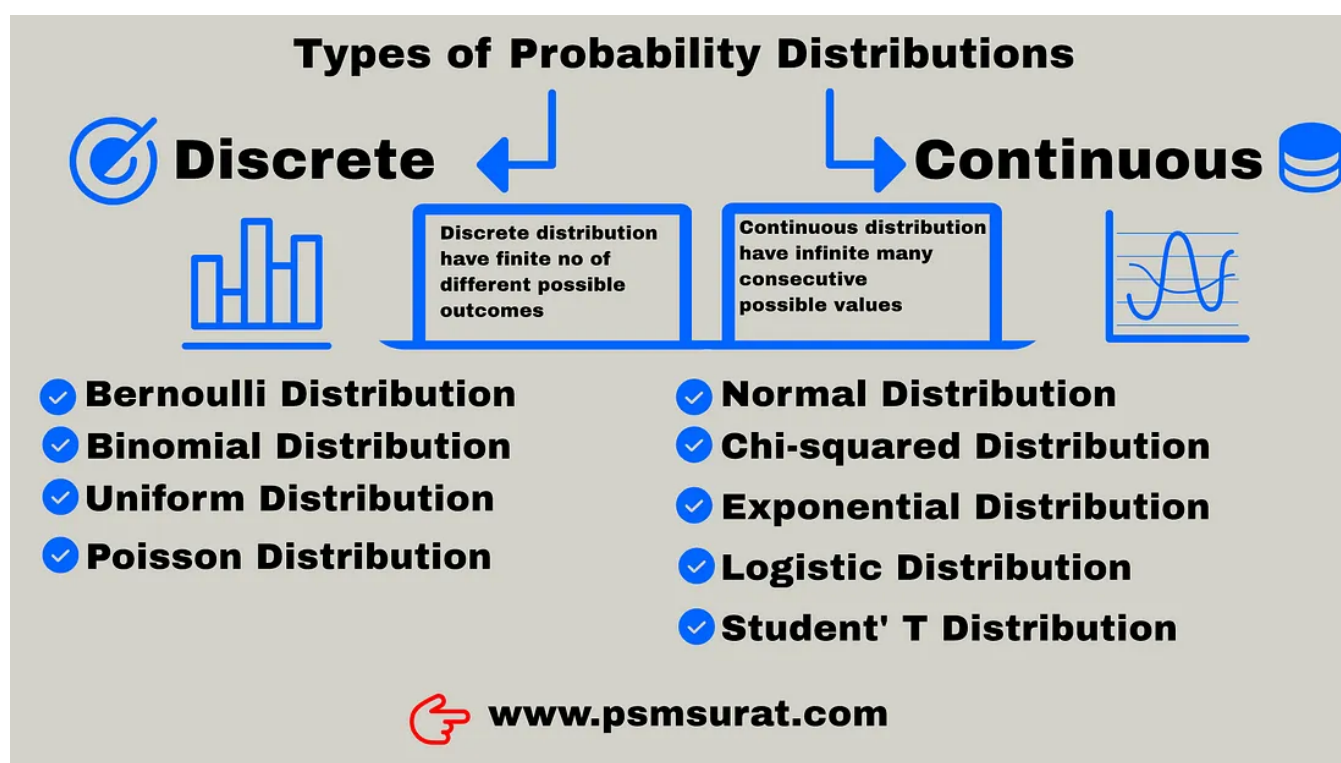▶ Listen   ↥ Share   ••• More

In the following article, we will learn what distribution is, the types of distributions, their examples, and the characteristics of various distributions.

types of probability distributions

What is distribution?

Let us first understand what distribution means using a simple example.

When we flip a coin there are two possible outcomes head or tail, right? In other words, it is the probability or frequency or chance that how many times either event

will happen.

In probability and statistics, **a distribution is a function** that describes the likelihood of different outcomes in a random event. Simply, it is a frequency plotted as a graph or shown as a table.

Sample Survey Vs Census

We can repeat such flipping a coin trial as many times as we wish provided that we have unlimited resources in terms of Men, Money, Material, and Time! Which is seldom true in the real world! So we limit ourselves to N times, what we call a sample -size. Ideally, these N numbers of people are selected randomly and representative of the total population, to minimize the bias in the study. This is called a sample survey, where a subset of the population is studied in contrast to a census survey in which every member of the population is included.

sample vs census
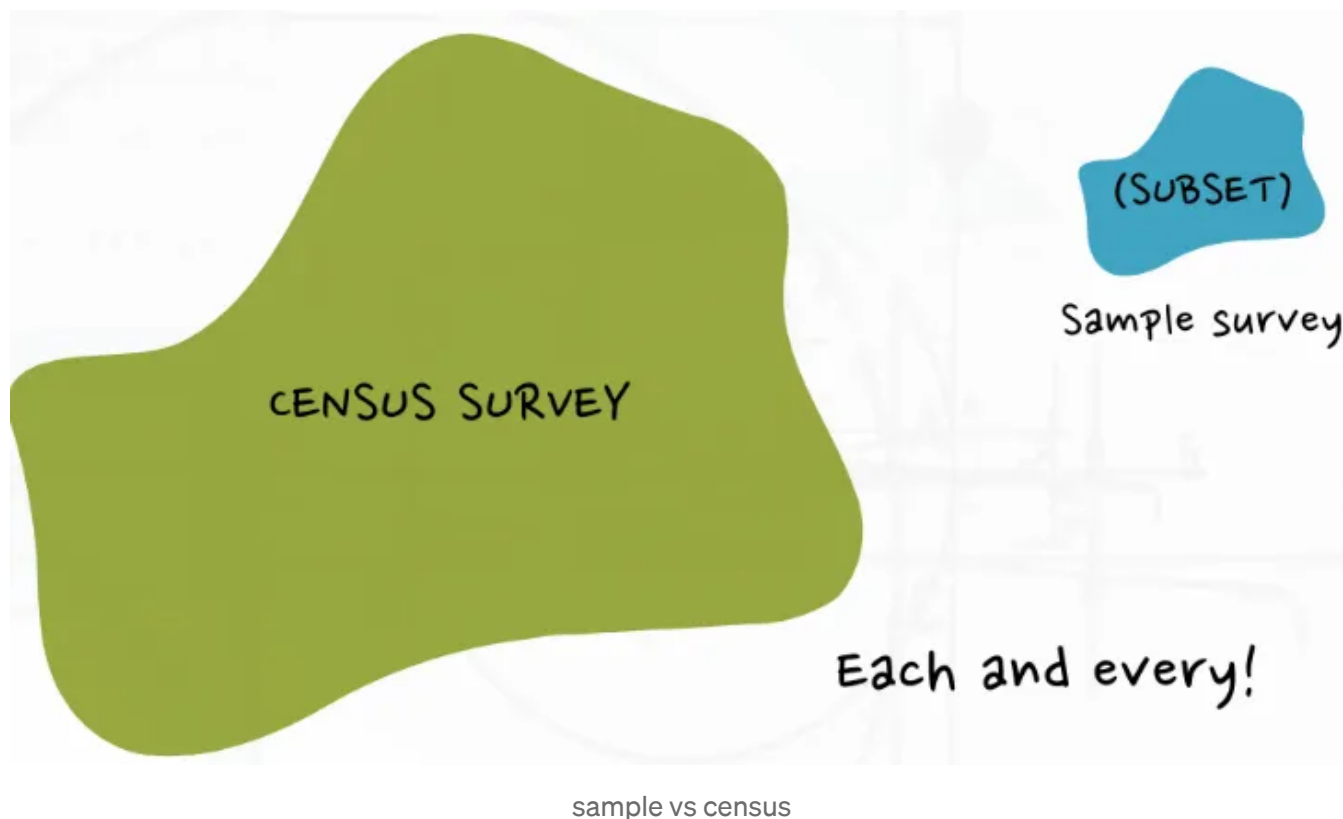
Types of Probability Distributions

Some common types of probability distributions include:
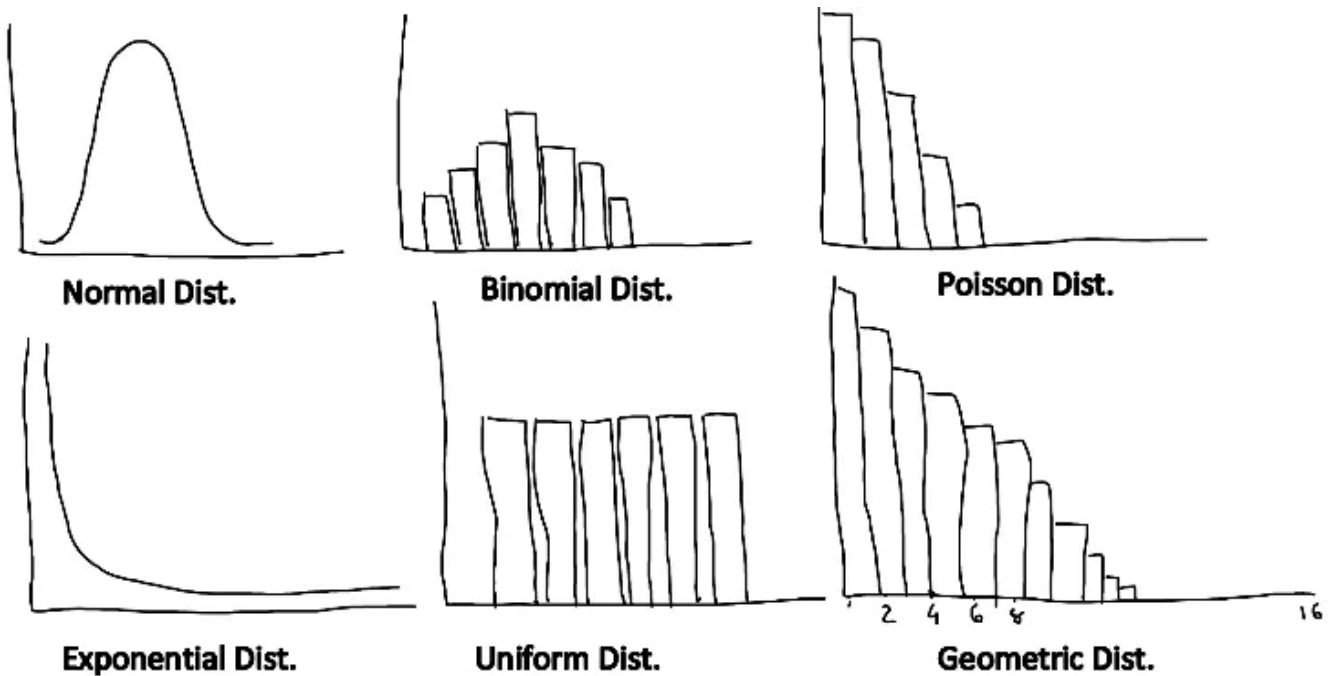
types of distributions

Normal distribution:

This distribution is also known as the Gaussian distribution or the bell curve because of its resemblance to the bell. It is a symmetric distribution with a single peak, and the values are distributed evenly around the mean.

Binomial distribution:

This distribution is used to model the probability of a specific number of successes in a fixed number of trials. It is often used to model the probability of events that have two possible outcomes, such as the probability of getting heads or tails when flipping a coin.

Poisson distribution:

This distribution is used to model the probability of a certain number of events occurring within a specified time period or area. It is often used to model the probability of rare events, such as the probability of a specific number of accidents occurring in a given year.

Exponential distribution:

This distribution is used to model the probability of the time between events occurring in a continuous process, such as the time between customers arriving at a store. Exploring the growth of covid-19 cases

Uniform distribution:

This distribution represents an equal probability of all outcomes within a given range. For example, the probability of rolling any number from 1 to 6 on a die is uniformly distributed.

Probability in Statistics: Types of Probability Distributions & Examples

Geometric distribution:

This distribution is used to model the probability of the number of failures before the first success in a series of independent trials.

So basically it can be divided into discrete probability distribution and a continuous probability distribution for discrete and continuous random variables respectively.

A discrete random variable is a variable that can take on only a specific set of values, rather than any value within a range, just like our flipping a coin example. On the other hand, a continuous random variable is a variable that can take on any value within a given range, rather than only specific, discrete values, Age for example.

Some common types of discrete probability distributions include:

Bernoulli distribution: This distribution is used to model the probability of a single binary event, such as the probability of flipping a coin and getting heads.

Binomial distribution

Poisson distribution:

Geometric distribution:

Multinomial distribution: having multiple categories

Discrete probability distributions have some characteristics that are common to all of them. For example, the sum of the probabilities of all possible outcomes of a discrete random variable must always be equal to 1.

Some common types of continuous probability distributions include:

Normal distribution

Chi-square distribution

Exponential distribution

Uniform distribution

Weibull distribution: This distribution is often used to model the probability of failure in engineering and reliability and survival analysis.

Beta distribution: This distribution is often used to model probabilities that are bounded between 0 and 1. It is commonly used in Bayesian statistics and in modeling probabilities in health economics.

Continuous probability distributions have some characteristics that are common to all of them. For example, the probability of taking any one specific value is always 0, since a continuous random variable can take on an infinite number of values within a given range. Instead of assigning a probability to specific values, the probability of a continuous random variable is described by a probability density function, which describes the probability of the variable falling within a specific range of values.

Examples and Characteristics of Common Probability Distribution:

The normal distribution is a continuous probability distribution that is defined by its mean (m)and standard deviation(s). It is often referred to as the "bell curve" because of its characteristic shape. Some characteristics of the normal distribution include:

1. **Symmetry:** The normal distribution is symmetrical about its mean. This means that the probability of observing a value that is a certain number of standard deviations above the mean is equal to the probability of observing a value that is the same number of standard deviations below the mean.
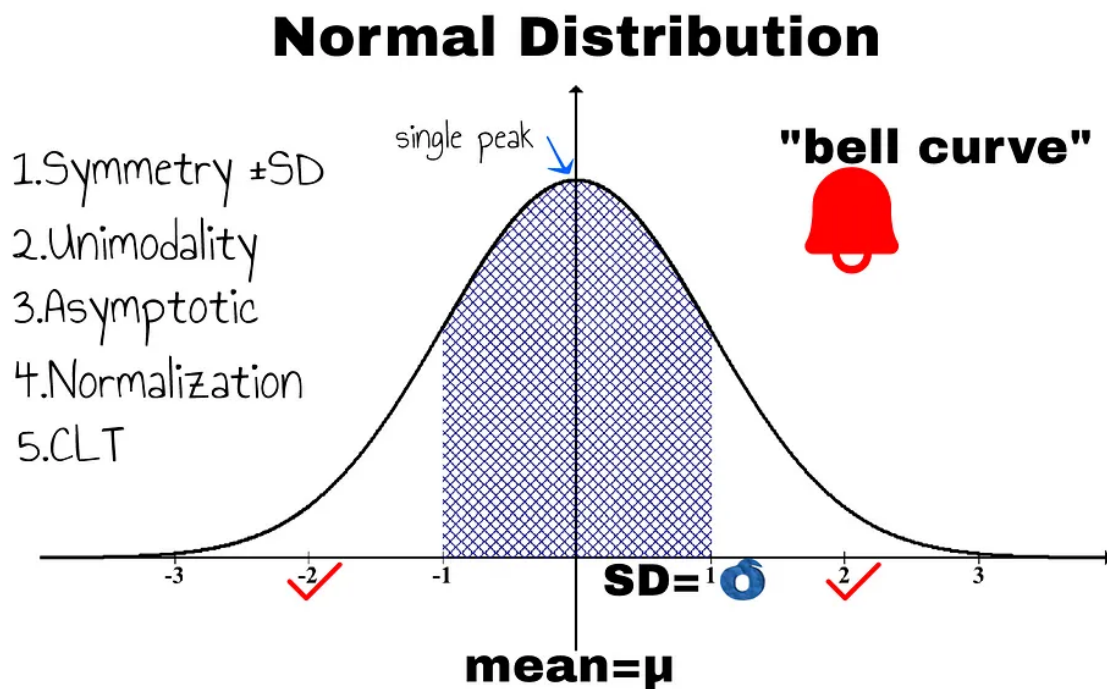
normal curve aka normal distribution

2 . **Unimodality:** The normal distribution is unimodal, which means that it has a single peak.

3. **Asymptotic:** The normal distribution approaches, but never touches, the x-axis as the values become more extreme.

4 **Normalization:** We can convert any normal distribution into a standard normal distribution. Normal distribution could be standardized to use the Z-table.

5 **Central limit theorem:** The central limit theorem states that the sum of a large number of independent, identically distributed random variables will tend to be normally distributed, regardless of the distribution of the individual variables. This makes the normal distribution a useful model for understanding the statistical behavior of many real-world phenomena.

The normal distribution is used to model many real-world phenomena, such as IQ scores, height, weight, and test scores, and is used in many statistical tests, such as

the t-test and ANOVA, to determine the probability of a given outcome.

The chi-square distribution

The chi-square distribution is a continuous probability distribution that is defined by a single parameter called degrees of freedom (df). It is often used in statistical tests to determine whether there is a significant difference between the expected values and the observed values in a dataset. Some characteristics of the chi-square distribution include:

1. The graph obtained from the Chi-Squared distribution is asymmetric and skewed to the right
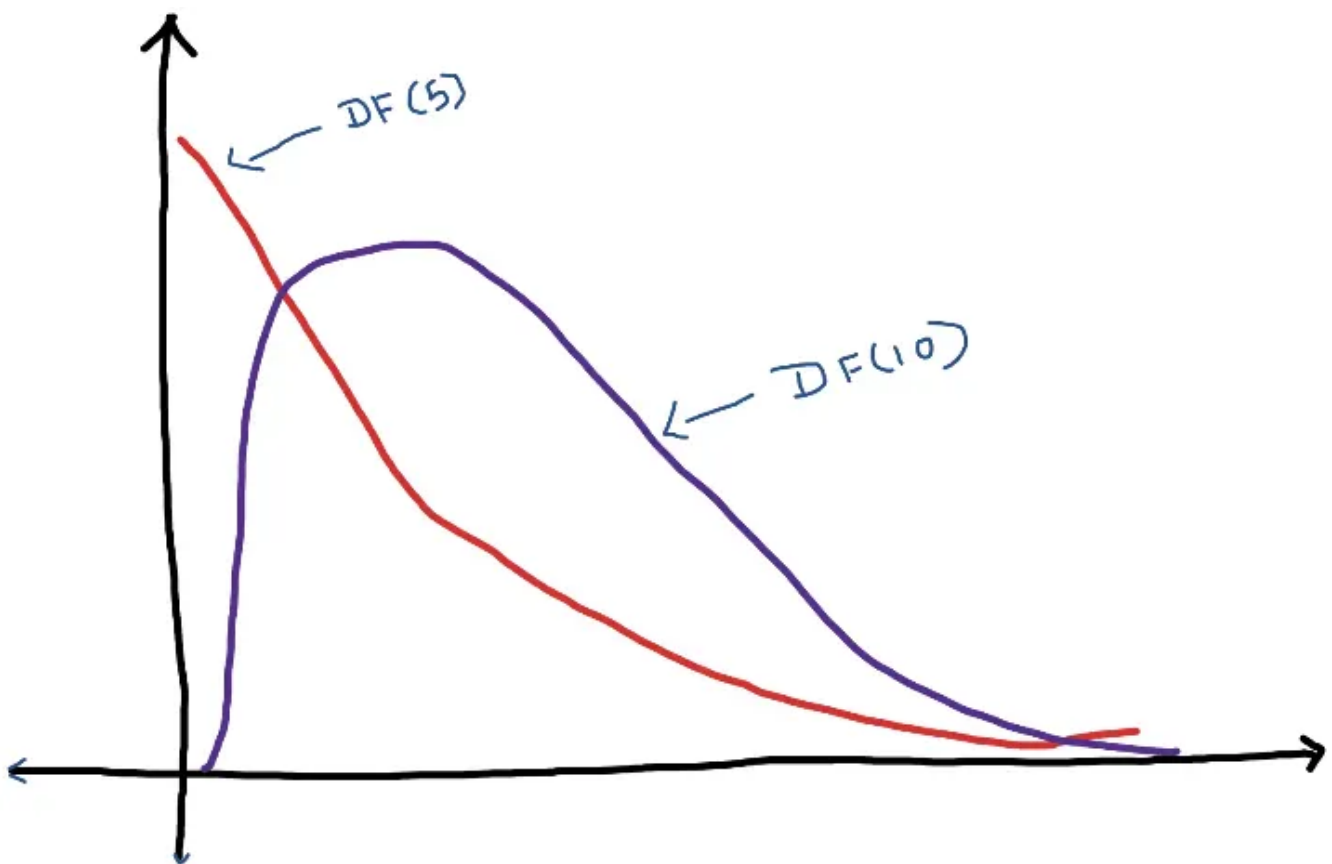
chi-square distribution

2 Unimodality: The chi-square distribution is unimodal, which means that it has a single peak.

3 Chi-squared distribution is always greater than 0 because all of the negative values are squared.

4 The word squared is important as it means squaring the normal distribution

5 **Degrees of freedom:** The shape of the chi-square distribution is determined by the degrees of freedom, which represents the number of independent observations or variables in the dataset. As the degrees of freedom increase, the chi-square distribution becomes more symmetrical and bell-shaped, resembling the normal distribution.

Applications: The chi-square distribution is commonly used in hypothesis testing, particularly in the test of goodness of fit and independence. It is also used to test the significance of differences between observed and expected values in statistical experiments and to estimate the variance of a population based on a sample.

Student's T Distribution

1. The t-distribution is a type of probability distribution that is used to estimate population parameters when the sample size is small and/or when the population variance is unknown.
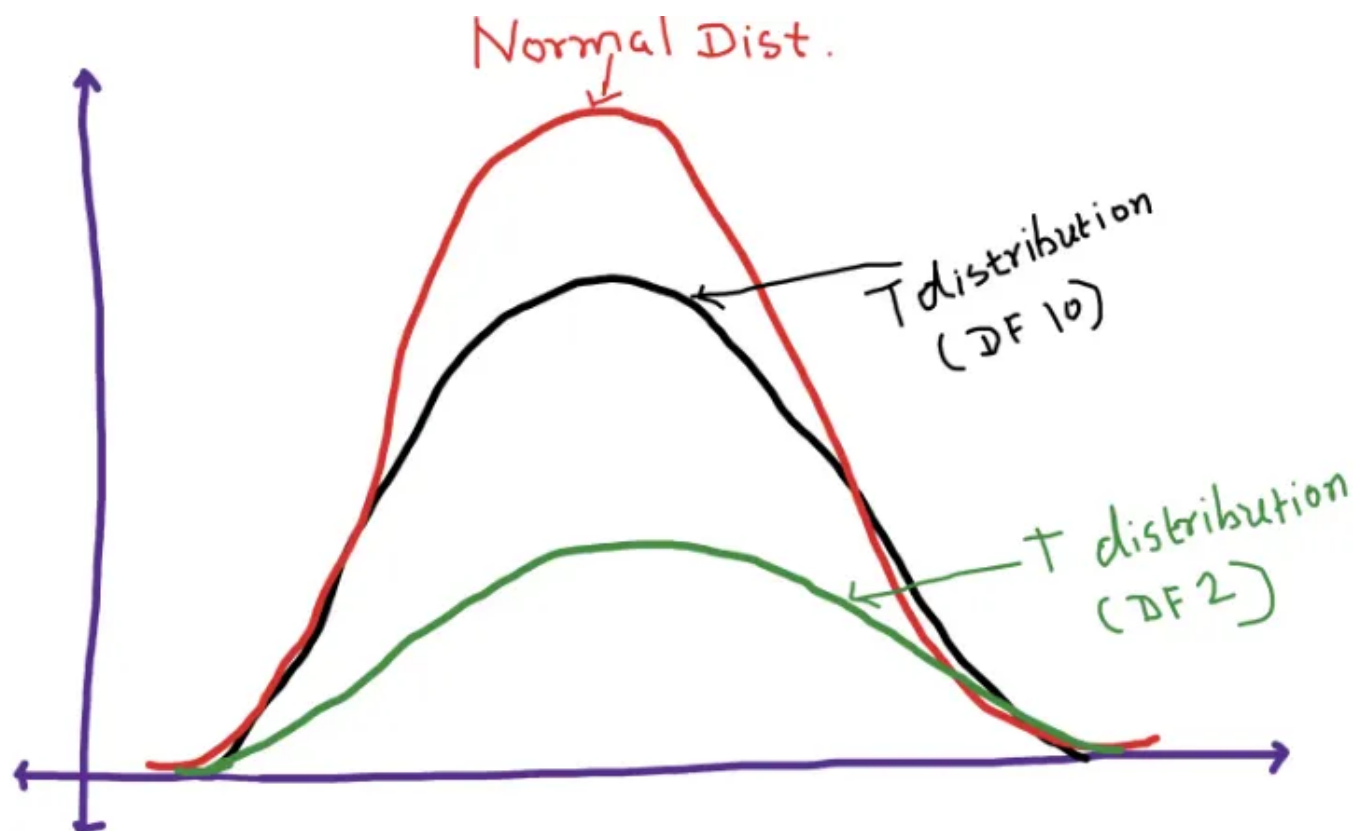

student' t distribution

2. The t-distribution is similar to the normal distribution but has heavier tails, meaning that it is more likely to produce extreme values than the normal distribution.

3. The t-distribution is used in hypothesis testing to calculate the probability that a sample mean is significantly different from the population mean.

4. The shape of the t-distribution is determined by the degrees of freedom, which is the number of observations in the sample minus one.

5. The t-distribution is used in a variety of statistical tests, including the Student's t-test, the one-sample t-test, and the paired t-test.

6. The t-distribution can be used to calculate confidence intervals, which are used to estimate the range of values that a population parameter is likely to fall within.

Characteristics of exponential distribution

- Probability and Cumulative Distributed Functions (PDF & CDF) plateau after a certain point.

- We do not have a table to know the values like the Normal or Chi-Squared Distributions, therefore, we mostly used natural logarithms to change the values of exponential distributions.

exponential distribution
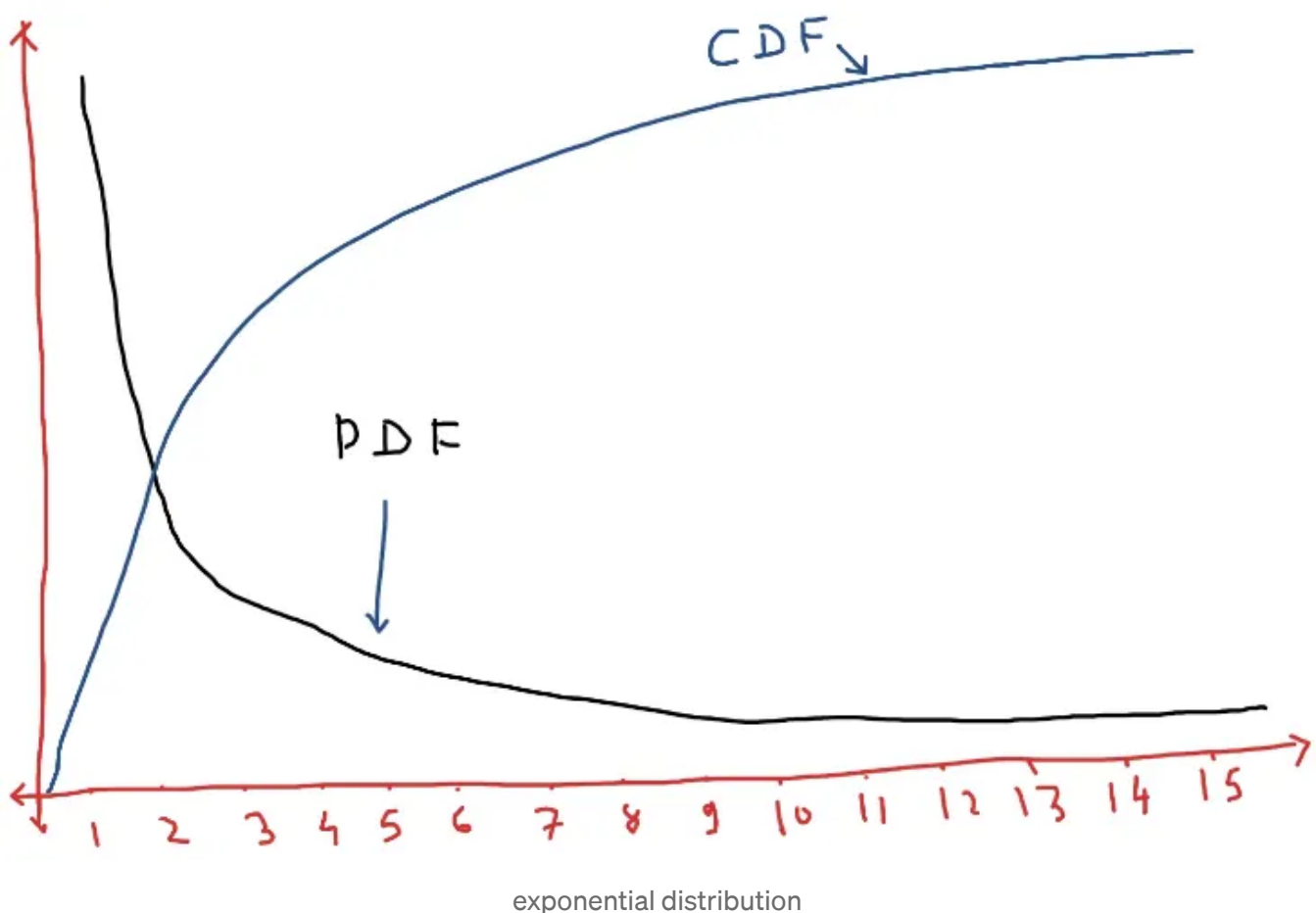
Examples and Uses

- It is mostly used with dynamically changing variables, such as online website traffic.

Discrete Distribution Vs Continuous Distribution

	Discrete Distributions	Continuous Distribution
Range of possible values	only take on a specific set of values	any value within a given range
Probability of specific values	probability of a specific value occurring in a discrete probability distribution is non-zero	probability of a specific value occurring in a continuous probability distribution is always zero.
Probability function	probability mass function	probability density function
Sum of probabilities	sum of the probabilities of all possible outcomes must equal to 1	sum of the probabilities cannot be calculated

discrete vs continuous probability

Take a Quiz on Normal Distribution