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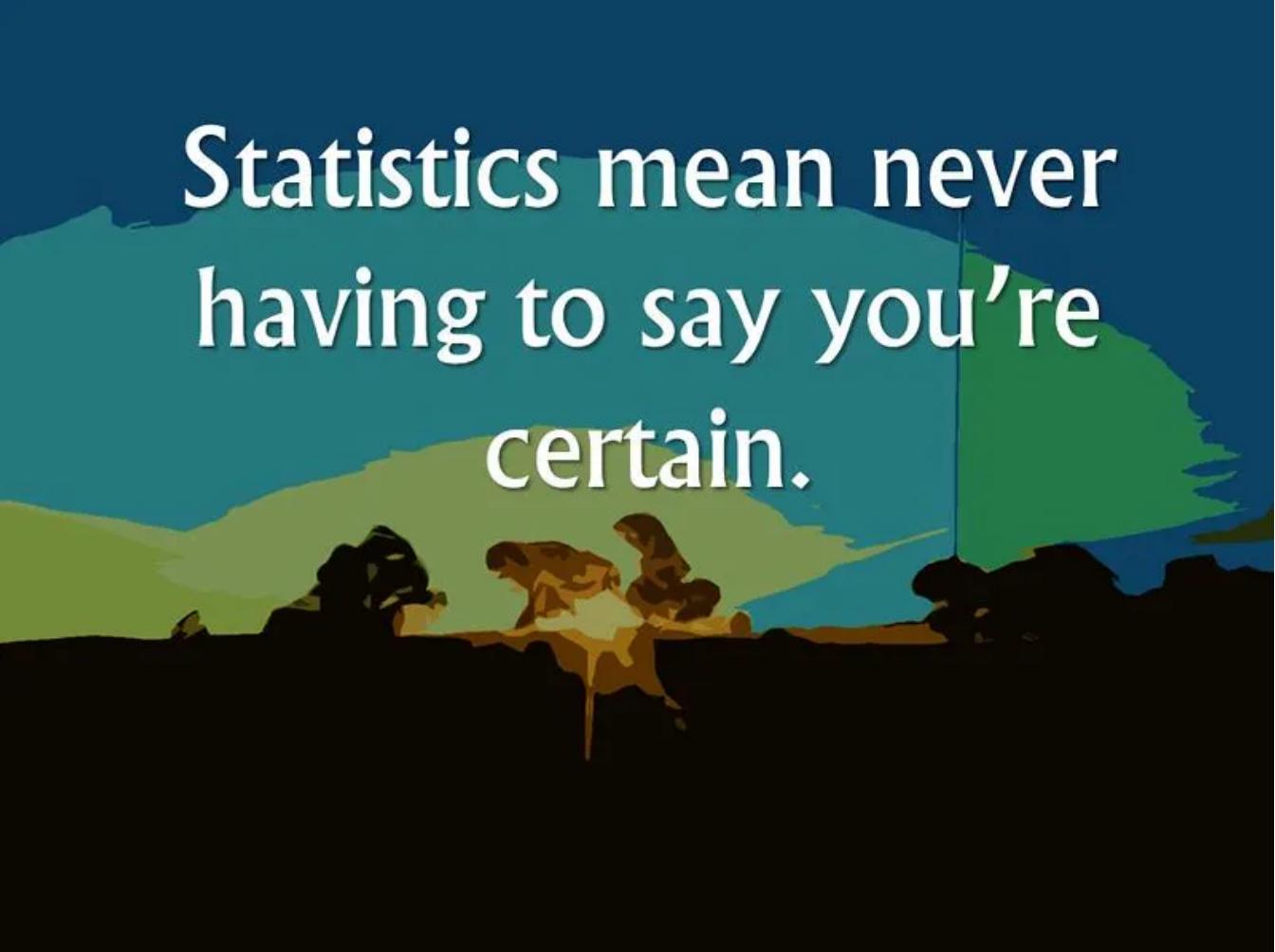


# The Complete Beginner's Guide to Law of Large Numbers|5 Facts about Law of Large Numbers

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Statistics mean never having to say you're certain.

## Law of Large Numbers

Law of Large numbers (LLN) is defined as choosing of individually large numbers or variables and predicting the outcome of it in a definite experiment. As the number of experiment increases, the ratio of result also increases. According to the Law, the average value of the combined result should be close to the expected value and that defines the Law of Large numbers.

### Real-Life Examples of Law of Large Numbers:

Example 1-Suppose David goes to a casino and plays a single game by spinning in a roulette wheel so the outcomes would be definitely less as compared when played numerous times.

Example 2- Imagine you *toss a coin*, the outcome of head & tails would be  $1/2$  but experimenting a number of times the outcome would be different. So if you flip a coin 50 times, there is a possibility of 25 times heads as well as 25 times tail.



Flip a coin

## 5 Facts about the Law of Large Numbers:

**1- History:** This Theorem was first proved by the Swiss mathematician Jakob Bernoulli in 1713 and continued till date.

**2 - Game:** Law of Large Numbers is mainly used to determine the strategy of Baseball & Cricket by keeping a track on the numerous outcomes and the number of matches as well as scores.

**3 - Artificial Intelligence:** Computers & Supercomputers are highly dependent on millions of data by using machine learning through the Law of Large Numbers. With the help of Statistics, several platforms like Healthcare, Science, Self-driving cars are gaining huge popularity as well as getting better day by day.

**4 - Statistics:** This theorem can help you prove to get numerous statistics and probability.

**5 - Prediction:** Predictions can be done by using the Law of Large Numbers. One of the biggest examples is Gambling.

## Types of Law of Large numbers

There are two versions Law of Large numbers Weak Law and Strong Law.

What is the Weak Law of Large Numbers?

Weak Law is also known as Khinchin's law or Bernoulli's theorem states that if the sample average of variable increases the probability of sample means the probability converges to the expected mean. Weak Law is easy to prove when compared to the Strong Law it does give a result which is close to the precise outcomes and not so accurate.

**Weak law of large numbers.** Suppose that the first moment  $\mathbb{E}|X|$  of  $X$  is finite. Then  $\bar{X}_n$  converges in probability to  $\mathbb{E}X$ , thus  $\lim_{n \rightarrow \infty} \mathbb{P}(|\bar{X}_n - \mathbb{E}X| \geq \varepsilon) = 0$  for every  $\varepsilon > 0$ .

### Illustration of the Weak Law of Large Numbers

What is the Strong Law of Large Numbers?

*Strong Law of Large Numbers can be defined as the sample average mean is almost accurate to the expected mean. It is almost similar to the Law of Large Numbers and the theorem given is very accurate. Strong Law is a bit difficult & lengthy and mostly used in calculating advanced theorems. Now mathematicians have brought the law more simple.*

**Strong law of large numbers.** Suppose that the first moment  $\mathbb{E}|X|$  of  $X$  is finite. Then  $\bar{X}_n$  converges almost surely to  $\mathbb{E}X$ , thus  
 $\mathbb{P}(\lim_{n \rightarrow \infty} \bar{X}_n = \mathbb{E}X) = 1$ .

### Illustration of the Strong Law of Large Numbers

## What is the Law of averages?

*Law of averages* is a probability or a belief that events or end results occur anytime any soon, maybe or maybe not. It is an expectation which is believed to come near the precise outcome. It can rain tomorrow or maybe not, you can be sad or maybe not. It is not definite nor permanent in a real scenario.

## What is Gambler's fallacy?

*Gambler's fallacy* is a misconception followed by gamblers believed to follow the Law of Average just because the outcome has not recently happened and there is a probability to happen in future. It is pure luck while playing and no such calculation. Kindly do not follow this method as the amygdala (neuron) inside the brain of a Human being gets activated when we fail especially while gambling and losing then comes to the role of Gambler's fallacy of taking a risk.

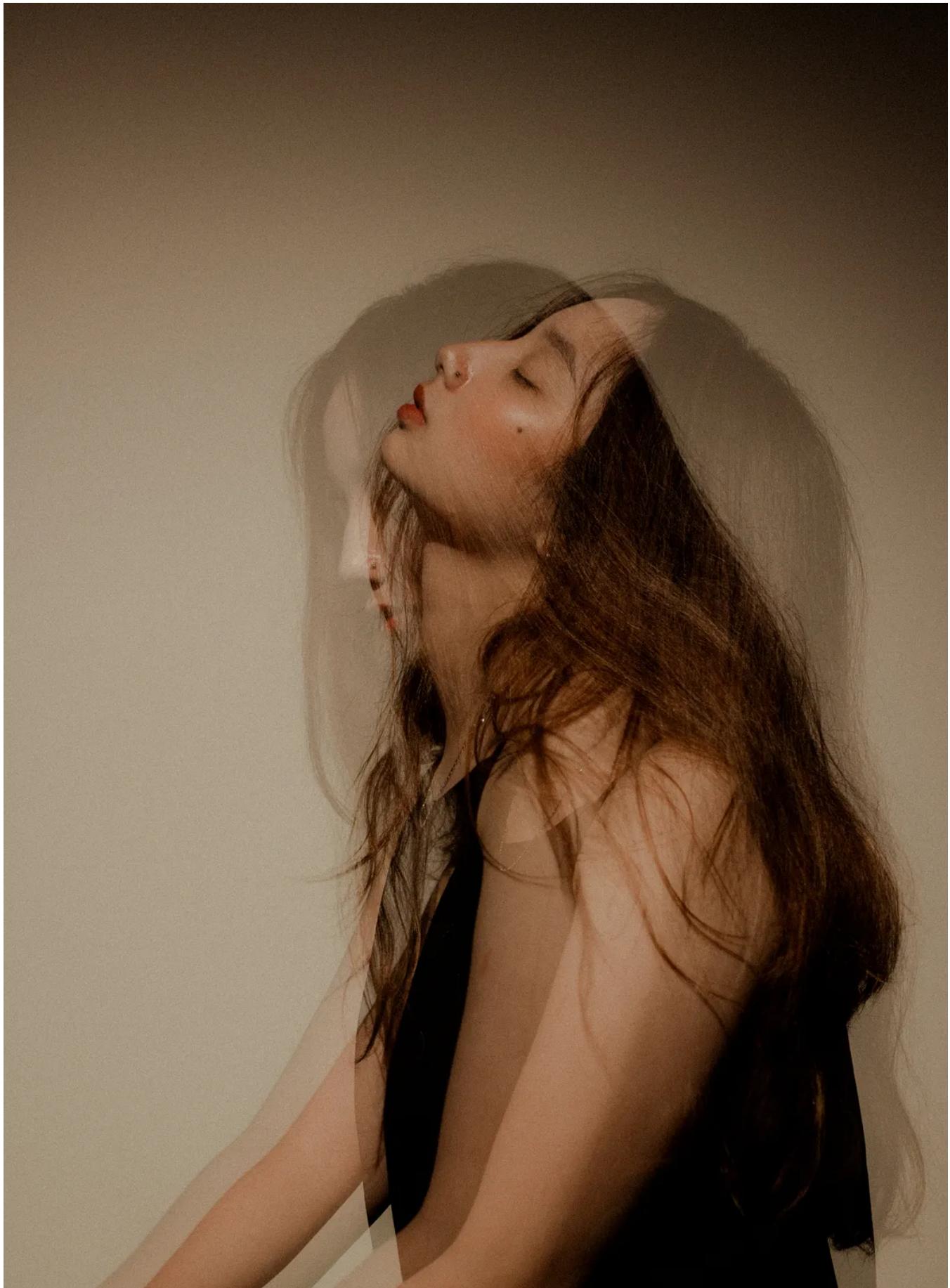
## Difference between Central Limit Theorem (CLT) vs Law Of Large Numbers (LLN)

1-In Layman's terms, Central Limit Theorem requires less data when compared to the Law of Large numbers.

2-Central Limit Theorem does not converge to the number but converges to a distribution.

3- Convergence would imply for me that with time the probability that the mean takes a value which is not the expected value is almost zero, hence the distribution would not really be a normal but almost zero everywhere except at the expected value.

## **Law of large numbers in Psychology**



**Law of large numbers in Psychology**

People often think that the theorem of Law of Large Numbers can often work in the real-life, I agree that up to some extent because practically when you work on something numerous times you find the end result very fruitful. So it is very obvious to practice anything several times in order to become a master.

**Example — *The law of large numbers and the stock market.***

It is very common that 8 out of 10 people think that stocks should only be purchased when the prices go down and to sell when the prices go up. But it does not happen, you should always purchase on the Breakeven point and one should always calculate their risk management subject to market risk. That's how Law of large numbers work, so basically when a trader trades numerous times and keeps a track on different outcomes of using his skilled techniques & calculation until unless he creates his own data set, pattern & technique.

## **Law of large numbers in Insurance**

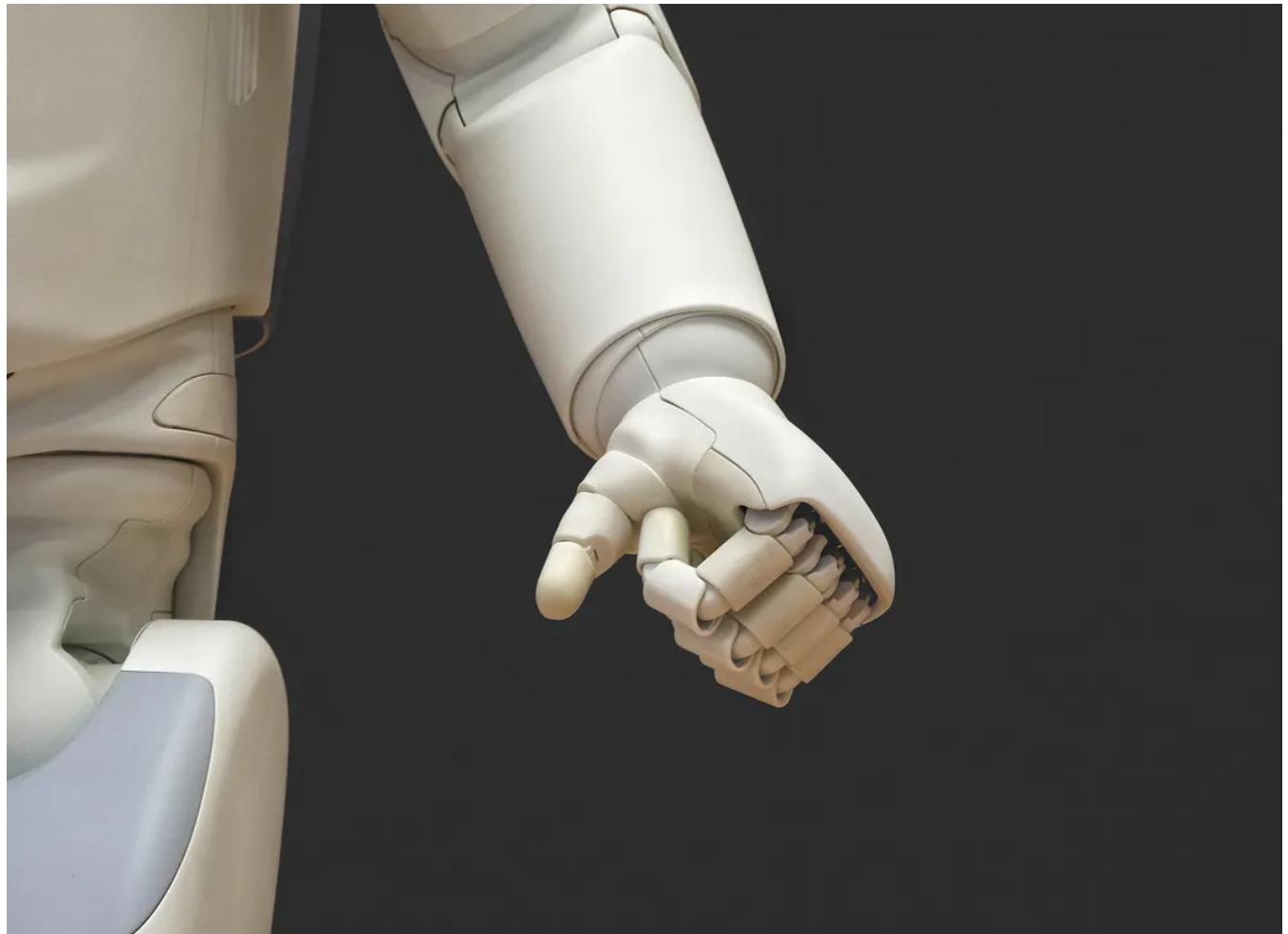


**Law of large numbers in Insurance**

Insurance Companies are highly dependable on the Law of Large Numbers, by following this theorem these companies can calculate their future risk, profit, loss following the stability to run these big companies.

*Let us take an example- Imagine 500 people paying a premium for his property to the Metlife Insurance. Even though they pay you for the property damage that was caused by fire to 10% of the subscriber i.e. 50 people they have the premium of 450 people still. And that's how they calculate their risk management and the Law of Large Numbers comes in the role.*

## **Law of large numbers in Artificial Intelligence**



**Law of large numbers in Artificial Intelligence**

**Artificial Intelligence** is a big Hype nowadays but when you talk about the Law of large numbers it definitely comes into role especially the Strong Law of large numbers in processing millions of **BIG DATA** and **Machine Learning**. It helps in processing & organising of data in day to day life. Even the IBM Watson has built by the help of the law of large numbers which concluded to defeat the world champion Garry Kasparov in chess.

What is the implication of the Law of large numbers in **Machine Learning**?

1- Training Data

## 2- Test Data

## 3- Model Skill Evaluation

**Conclusion:** The ultimate theory is to make accurate predictions. Even Einstein took 4 years to prove before a full solar eclipse revealed that light passing near the sun curved later proved as Gravity. In the 1930's Sir Ronald Fisher, a British scientist laid out guidelines for designing experiments using statistics & probability as a way of judging results. So now if you see everything in this world has been calculated and related to Mathematics from blackhole to molecules. It depends upon you how you see it.

Machine Learning

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Law Of Large Number



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