Law of Large Numbers/Law of Averages

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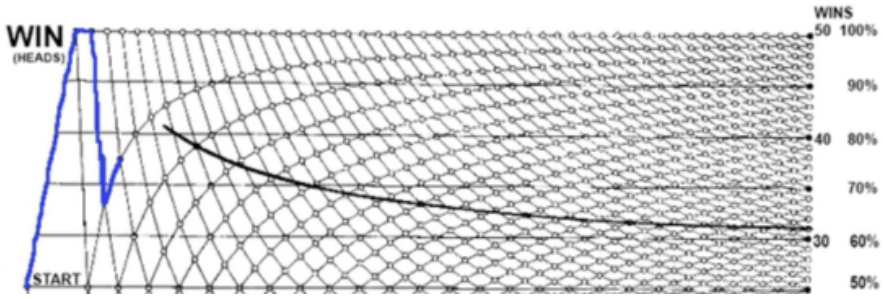
WHAT'S COVERED

This tutorial will cover two important statistical concepts, through the definition and discussion of:

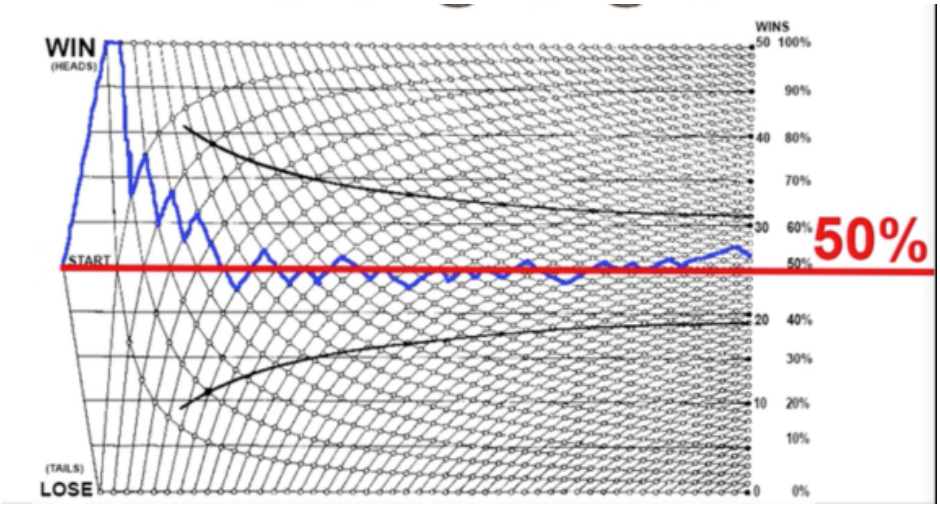
1. Law of Large Numbers
2. Law of Averages

1. Law of Large Numbers

Suppose you flip a coin and determine the long-term relative frequency of heads. You're going to determine heads to be a win. Let's assume the first coin you flip is heads. You'll go up to the first dot in the chart below, as high as you can go. If you flip heads again, you'll go to the second dot.



Suppose the third time, you flip tails. That means you will follow the blue line down. Next, if you flip heads again, you will follow it back up. You can continue looking at what happens in the long term by simulating the rest. You will start to notice that these swings at the beginning are fairly extreme--they're very large shifts, whereas over to the right, the shifts are less dramatic.



You may also notice that the long term relative frequency of heads seems to be settling in right around 50%.

The **law of large numbers** states that the more times you run a chance experiment, the relative frequency of an event approaches the true probability of that event. You're going to get closer and closer to the right answer the larger the number of trials becomes. So, if you keep going, you would probably get closer and closer and closer to 50% as you kept going to the right.

Now, this isn't to say that odd things don't happen. Look closely at the chart. You did have runs of three and four heads during our experiment, so it's possible that unusual things may happen. Four heads in a row is fairly unusual, but it happens. You also had a couple of different runs of three tails in a row.

Unusual things can happen in the short term, but predictably, what will happen in the long term is that the blue line will start to settle in right around 50%.

TERM TO KNOW

Law of Large Numbers

A mathematical rule that states that as the number of trials of a chance experiment increase, the experimental probability of an event becomes closer to the true probability of that event.

2. Law of Averages

The **law of averages** is not actually a mathematical term. It's a psychological game people play with themselves to convince themselves that favorable outcomes are just over the horizon.

On the radio, you might hear a sports announcer say one or both of these two things:

"He hasn't gotten a hit in his last 4 at-bats; he's due"

"He's gotten hits in his last four at-bats, he's on a hot streak! He'll certainly get a hit this time, too!"

This first saying states that he's due to get a hit this time because he hasn't gotten a hit so far. The second one states that he's going to get a hit this time because he has gotten hits in his last four turns at bat. None of these make any sense--both of these logically are fallacies.

They apply the law of large numbers, which means that maybe this player gets a hit one out of every three times he's at bat in the long term. They're trying to apply the law of large numbers to these five at-bats that this player has had.

BIG IDEA

You see the "law of averages" a lot in the casino. Remember, it's not actually a mathematical term, but rather a way for individuals to convince themselves of a favorable outcome.

One person may say, "I've won five in a row! I can't lose!", while another person may say, "I've lost five in a row! I must be due to win!"

The law of averages--the false law of averages--is also called the **gambler's fallacy** or the **gambler's ruin**. People can convince themselves that favorable outcomes are about to happen even when they're not necessarily going to happen because they're applying the law of large numbers to small numbers of trials.

TERM TO KNOW

Law of Averages/Gambler's Fallacy/Gambler's Ruin

A misapplication of the Law of Large Numbers, where people try to apply long-run probabilities to short-run events. The false "Law of Averages" is not a mathematical phenomenon, but rather a psychological trick people play on themselves to convince themselves that favorable outcomes are about to occur, using past behavior to influence their reasoning.

SUMMARY

The **law of large numbers** states that over the long term, the relative frequency of an event is the probability of that event. The key is distinguishing long term from short term. The law of large numbers sometimes will be inappropriately applied to short term events. This is called the **law of averages** (or gambler's fallacy/gambler's ruin). It's important not to fall into the trap of applying the predictable nature of large numbers to the unpredictable nature of short term events.

Good luck!

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TERMS TO KNOW

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