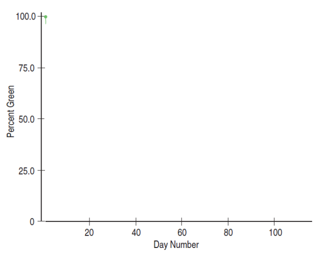
Lesson 24: How unusual must the observed results be in order to be considered statistically significant?

Dealing with random phenomenon

textbook reading

Day	Light	% Green
1	Green	100



The overall percentage of times the light is green settles down as you see more outcomes.

How unusual must the observed results be in order to be considered statistically significant?

The route to the answer requires an understanding of probability. We need to be able to determine the probability of getting the results we observe just by chance alone. If that probability is so low that it's implausible to believe the results were an accident, then we can decide that something meaningful has happened.

Definitions:

Trial: A single attempt or realization of a random phenomenon.

Outcome: The outcome of a trial is the value measured, observed, or reported for an individual instance of that trial.

Event: A collect of outcomes. Usually, we identify events so that we can attach probabilities to them. Use bold capital letters for events **A**, **B**, **C.**

Sample Space: collection of all outcomes.

Law of large numbers:

we believe that over the long run (the very long run), events will occur with a certain relative frequency, and we call that the probability of the event.

What do we mean when we say that a coin has a 50% chance of landing heads?

When we say a coin has a 50% chance of landing heads. We are not saying that it must land heads one of every two times you toss it, or exactly 50 times in 100. We are saying that we believe that over many, many tosses we will see about 50% heads.

short-run anomalies get drowned out in the long run

Out walking in Gotham, you run into the villain Two-Face. He's captured Batman and is about to throw him in a shark tank. Two-Face pulls out a coin and tells you it is fair, which means there is an equal probability it will land on heads or tails. He will flip his coin to decide whether or not to throw Batman in the tank. Accompanied by some suitably villainous banter, he flips his coin five times, and gets the following results: *heads, tails, tails, tails, tails.*

Two-Face is about to flip the coin to make his final decision, and asks you to decide whether heads or tails will put Batman in the shark tank.

Law of Averages is False

The so-called Law of Averages assumes that the more something has not happened, the more likely it becomes.

We hear such reasoning frequently. A baseball player who is recently 0 for 12 is "due" for a hit.

Many people believe that if a coin has landed heads 5 times in a row they should now bet on tails. Such reasoning overlooks the fact that unusual outcomes are just that – unusual, not impossible.

Reminder: We believe in the law of large numbers

NOT

~~Law of Averages~~

argument for hot hand

There are at least three reasons why people believe in the "Law of Averages."

1. They misunderstand the Law of Large Numbers, thinking it suggests that randomness compensates for anomalies instead of just ignoring and overwhelming them.

2. They confuse situations involving independent events with what they know about events that aren't independent, like drawing a card from a deck without replacement. The longer we go without seeing an ace, the more likely it is that the next card will be one. This is not the same situation as the coin or the baseball player.

3. They sense that things actually do happen that way. They see a coin land heads five times in a row and think it will probably be tails next. When it's heads again, they become even more sure it will be tails the next time. And so on. When the coin finally does land tails, their reaction is "I KNEW IT!," thus confirming the "Law of Averages."

No such thing as a Hot Hand either!

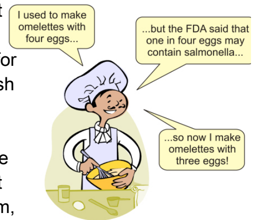
The "**hot-hand** fallacy" (also known as the "**hot hand** phenomenon" or "**hot hand**") is the fallacious belief that a person who has experienced success with a random event has a greater chance of further success in additional attempts.

JUST CHECKING

One common proposal for beating the lottery is to note which numbers have come up lately, eliminate those from consideration, and bet on numbers that have not come up for a long time. Proponents of this method argue that in the long run, every number should be selected equally often, so those that haven't come up are due. **Explain why this is faulty reasoning.**

Bureaucrat's Math Makes Dizzy Dozen

The menu at the Coffee Garden at 900 East and 900 South in Salt Lake City has included a scrumptious selection of quiche for about 10 years. The recipe calls for four fresh eggs for each quiche. A Salt Lake County Health Department inspector paid a visit recently and pointed out that research by the Food and Drug Administration indicates that one in four eggs carries *Salmonella* bacterium, so restaurants should never use more than three eggs when preparing quiche. The manager on duty wondered if simply throwing out three eggs from each dozen and using the remaining nine in four-egg-quiches would serve the same purpose.



Salt Lake City Tribune of Friday, October 11, 2002