6.1 Statistically Significant

- A phrase that we hear a lot in any statistics course.
  - And used very loosely on television a lot.

- Has a very technically meaning, but we will start by introducing the concept of something being statistically significant.

- See Television clips on "Statistical Significance".

Definition

A set of measurements or observations in a statistical study is said to be **statistically significant** if it is <u>unlikely to have occurred by chance</u>.

Do you have a fair coin?

- Suppose you want to flip a coin to see who goes first.

- How can you tell if a coin is fair?
  - 'Fair' means equal chance of getting a head or tail.

- Can you test the coin first? Maybe flip it a bunch of times and see if about half are heads and half are tails?

Do you have a fair coin?

- Let's flip the coin 100 times…

- Possible outcome 1:
  - You get 52 heads (and 48 tails).
    - Do you think it's a fair coin?

- Possible outcome 2:
  - You get 20 heads (and 80 tails).
    - Do you think it's a fair coin?

Do you have a fair coin?

- **Possible outcome 1:**
  - You get 52 heads.
    - We know there's going to be some variation, so it's not unreasonable to think we could get 52 heads when it's a fair coin.

- **Possible outcome 2:**
  - You get 20 heads.
    - This outcome just doesn't seem likely if the coin is truly a fair coin. I'd be skeptical and be thinking that this coin is perhaps unfair.

Do you have a fair coin?

- Possible outcome 1:
  - You get 52 heads.
    - Likely to have occurred by chance.

- Possible outcome 2:
  - You get 20 heads.
    - **Unlikely to have occurred by chance**.

    This set of 100 flips (where you got 20 heads) is said to be *'statistically significant'*.

    This result is a *'statistically significant' result.*

Definition

A set of measurements or observations in a statistical study is said to be **statistically significant** if it is <u>unlikely to have occurred by chance</u>.

Example 'Pass rate':

- Suppose someone tells you that half the students who take *Stat:1010* do not pass.

- For now, let's assume this person is right, but let's **pick a random sample** of 50 past students to verify their statement.

  - If the true pass rate is 0.5, how many of the 50 students do we expect to have failed?

Example 'Pass rate':

- Suppose this is what we found…

  - Our sample of 50 students contained 2 people who **did not** pass and 48 students who **did** pass.

  - Do you still believe this person's statement about a 50% pass rate?

We say this sample of 50 students is *'statistically significant'* because <u>it is very **unlikely** to occur by chance</u> *if that the person's statement was true.*

Example 'Defect rate':

- Suppose a manufacturing company says they have a defect rate of 1%.

- At the store, we sample 100 devices from the company and find that 2 of the devices are defective (note that we did not look at EVERY single device, just a sample).

  - Do you still believe the stated defect rate?

This sample of 100 devices (with 2 defects) is *'NOT statistically significant' because it is very **likely** to occur by chance (if the defect rate is truly 0.01).*

Example 'New teaching method':

- Suppose the overall pass rate for a company test is 70%.

- A teacher introduces a new way to teach the topic and her students pass at a rate of 95%.

We say these findings are *'statistically significant'* because *it is very **unlikely** to occur by chance if the new curriculum actually had no effect (it's possible they got that lucky, but there's evidence that the teacher has a good plan).*

EXAMPLE   'global warming'

In terms of the global average temperature, five of the years between 1990 and 1999 were the five hottest years in the 20th century (a 100 year span). Having the five hottest years in 1990–1999 is **statistically significant**.

By chance alone, any particular year in a century would have a 5 in 100, or 1 in 20, chance of being one of the five hottest years. Having five of those years come in the same decade is very unlikely to have occurred by chance alone.

This **statistical significance** suggests that the world may be warming up.

Quantifying statistical significance

- In general, we determine statistical significance by using a **probability** to quantify the likelihood of an event occurring.

- We ask a question like this:

    "Is the probability that the observed sample occurred by chance small? Is it less than or equal to 0.05 (i.e. 1 in 20)?

Quantifying statistical significance

- If the answer is *yes* (the probability is less than or equal to 0.05), then we say that the difference is ***statistically significant*** *at the 0.05 level*.

- If the answer is *no*, then the observed event is reasonably likely to have occurred by chance, so we say that it is ***not* statistically significant**.