Ch. 4: Causation

Can We Say What Caused the Effect?

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4.1: Association and Confounding

Introduction: Association vs. Causation

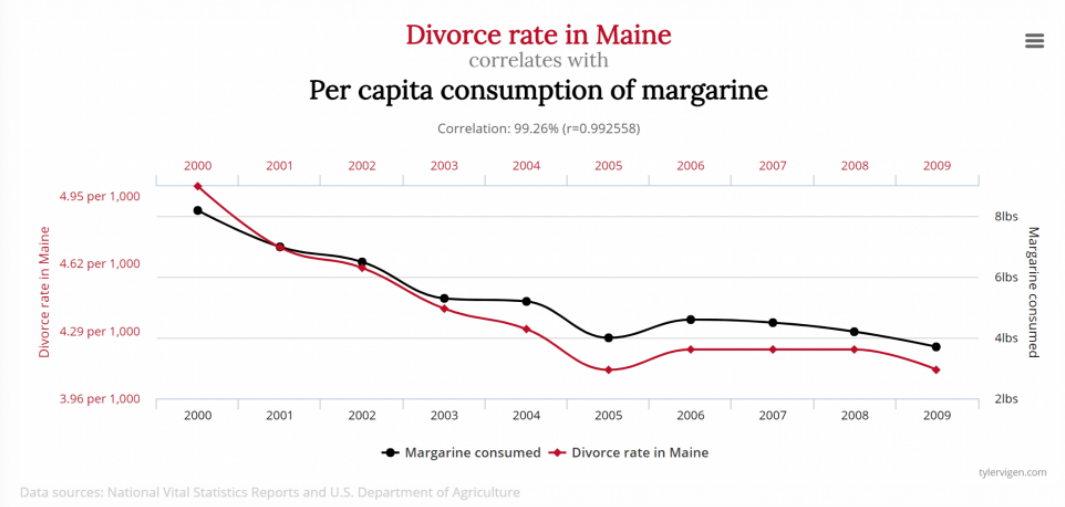
- Association (correlation): Two variables are associated, or related, if the value of one variable gives you information about the value of the other variable.
    - When comparing groups, this means that the proportions or means take on different values in the different groups.
    - Or as one variable decreases, the other variable may decrease too. We'll see other examples in chapter 10.

We Record Two Variables Now

- Explanatory Variable(s): variable(s) that may explain the change in the variable of interest.
  - Called the independent variable.
- Response Variable(s): variable(s) of interest we measure on observational units.
  - Called the dependent variable.
  - Chapter 1 and 2, we did hypothesis tests about the response variable. In chapter 3, we estimated the response variable.
- We hope that changes in the explanatory variable will affect the response variable => **cause-and-effect** relationship
  - **End goal** = find cause-and-effect relationships

Association vs. Causation

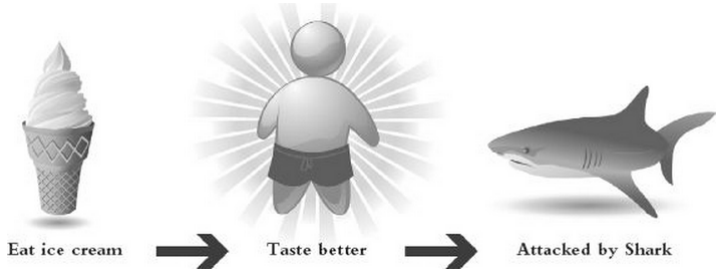
- Often in scientific studies, we see associations.
- Association, alone, is not enough to prove cause-and-effect relationships exist.



See more *spurious correlations* here

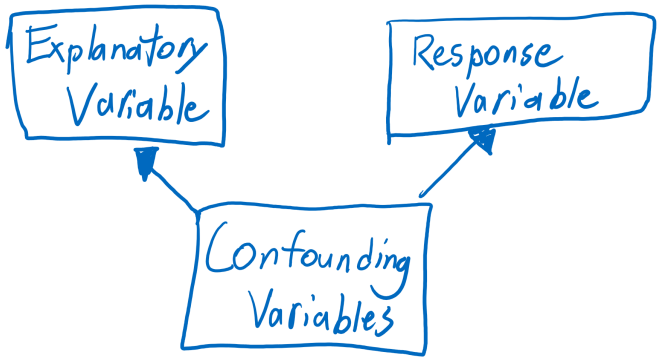
Try to Explain This Association

- For example, try to explain to your group how this association could be a cause-and-effect relationship.



Why Can't Associations Determine Cause-And-Effect?

- Confounding Variable(s) affect both the explanatory and response variables enough to make cause-and-effect impossible to determine.
    - These are other variables that you may not know about, or aren't measured in your study.
    - What are possible confounding variables in the association between ice cream sales and shark attacks?



Another Example

- Phil Sokolof, an Omaha native, caused McDonalds to change their french fries. http://revisionisthistory.com/episodes/19-mcdonalds-broke-my-heart

Possible Confounding Variables Phil Could Have Considered

4.2: Observational Studies Vs. Experiments

Observational Study

- The values of the explanatory variable are simply observed. Researchers cannot change or assign them to observational units. Examples are:
    - Does your child sleep with a night light?
    - Which NBA team does a player play for?
    - Which country were you born in?
    - An animal's gender
    - Number of social media profiles
    - Amount of video games a person owns
    - Commute to work in minutes

Experiment

- Researchers can assign the values of the explanatory variable to observational units.
    - In experiments, we can say observational units are called experimental units
- Examples:
    - Treatment vs. Control (do nothing or give a placebo)
    - Did you use the internet to play a game or pencil and paper?
    - Amount of days a plant doesn't have any water

Setting Up a Good Experiment

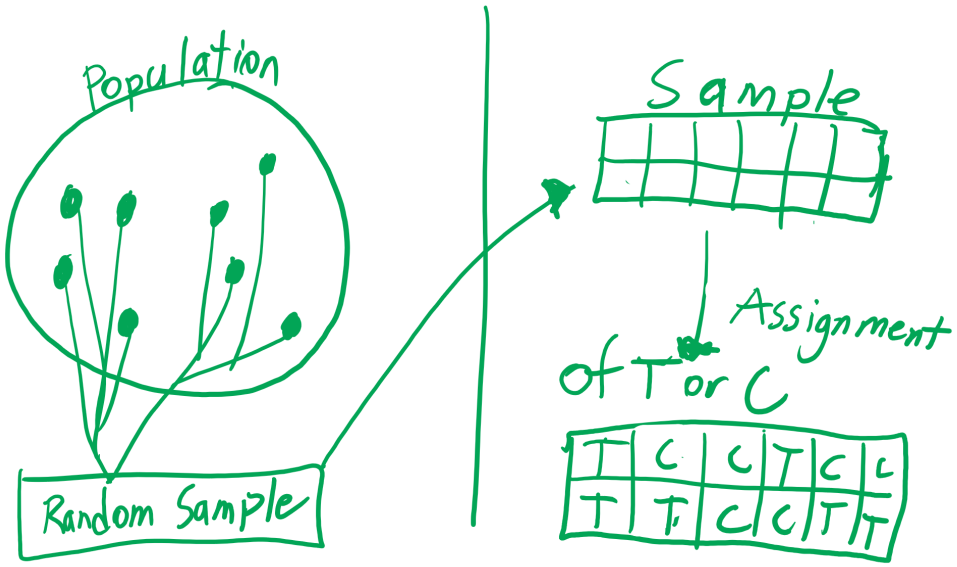
- We want to avoid two things:
    - **Sampling Bias**
    - **Confounding Variables**

We use two strategies in STAT 218

- Simple Random Sampling
- Random Assignment: Use a random/chance device to assign values of the explanatory variable to experimental units
    - Randomly assign groups (categorical explanatory variable)
    - Randomly assign a measurement (quantitative explanatory variable)

Random Sampling and Random Assignment

- You can use neither, one of them, or both to do your experiment.



Example and Benefits

- I need some random students from the class…
- I will randomly assign them a group
- Benefits:
  - Random sampling gets rid of sampling bias. We can **generalize our conclusions** to the whole population.
  - Random assignment removes the effect of confounding variables. We can determine **cause-and-effect** if we have enough evidence to reject H_0.

Types of Experiments

- No random assignment
  - quasi-experiment (observational study)
- Random assignment
  - randomized experiment
- Random assignment and neither the researcher or experimental unit know what group or measurement they have
  - double-blind experiment

Answer These Questions with your Group

Suppose you want to measure the average daily weight gain of steers. You assigned each steer dry-rolled corn or wet (fermented) corn. Then, you measured their average daily weight gain. You gathered a sample of 60 steers.

- What is the explanatory variable?
- What is the response variable?
- How could you gather a random sample of steers?
- How would you do random assignment in this study?
- Can you identify a confounding variable?

Exploration 4.2

- Do questions 1 through 11 with your group