Observational Study

Types of Observational Studies

- Prospective: identifies individuals before events of interest take place
  - Example: Nurses Health Study (1976-) recruits registered nurses then gives questionnaires
  - Requires common outcome of interest
- Retrospective: collects data after events of interest have taken place
  - Example: Reviewing past events in medical records
  - More risk of bias, confounding variables

Summary of sampling strategies

- Simple random sampling is mathematically "ideal", especially when samples are large
- Stratified sampling can protect against non-representative samples (especially when smaller)
- Multistage and cluster samples can make the sampling process simpler or less expensive

Experiment

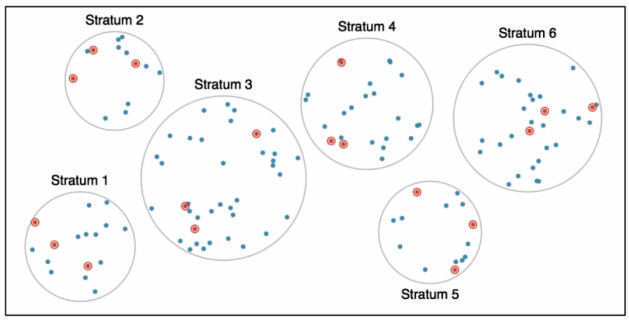
* avoid association but not causation variables.

Experimental design terminology

- Placebo: fake treatment, often used as the control group for medical studies
- Replication: using a large enough number of cases to average out individual variation
- Blinding: subjects don't know whether they are in the control or treatment group
- Double-blind: neither subjects nor researchers who interact with the patients know who is in the control or treatment group

Simple Random ①

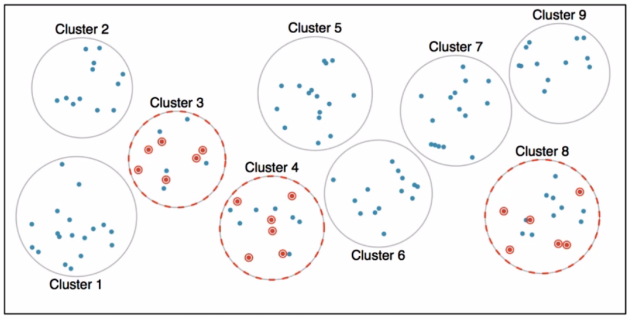
Stratified Sample



Example: regions of country as strata
Benefits: Guard against unrepresentative sample

②

Cluster and Multistage Sample



Example: Arizona high schools as clusters
Benefits: Can be more cost-effective

③

Basic concept: randomized experiment

- Identify an explanatory and response variable
- Assign subjects randomly to two or more groups
- Apply a controlled value of the explanatory variable to each group, e.g.:
  - type of activity assigned
  - dose levels of a drug
- Compare responses between groups

Experimental design: blocking

- Blocking controls potential confounding variables
- Separate subjects into “blocks” by a categorical variable and perform a randomized experiment on each block
- Example:
  - separating subjects by sex in a drug trial
  - separating students by major in a behavioral experiment

Experimental design: matched pair

- Match most similar individuals in treatment/control groups and compare directly
- Used to eliminate confounding variables, but requires availability of pairs
  - Twin studies compare identical twins to eliminate influence of genetics
  - A “matched pair” experiment can be done by performing two treatments on the same subject

Purpose of blocking/matched pair

Blocking and matched pair experiments:

- Reduce the influence of confounding variables
- Reduce variability in the result of the experiment

Blocking in an experiment is similar to stratified sampling in an observational study.

Case Study

Two Competing Claims

“There is nothing going on.” (Null Hypothesis)	“There is something going on” (Alternative Hypothesis)
Promotion and gender are independent.	Promotion and gender are dependent.
There is no gender discrimination.	There is gender discrimination.
The observed difference in proportions is simply due to chance.	The observed difference in proportions is not due to chance.

Court Trial

Person is innocent until proven guilty

Burden of proof is on the prosecution

Collect evidence; determine if there’s enough to convict

Verdict of not guilty does not guarantee innocence

Hypothesis Test

Variables are independent until proven dependent

Burden of proof is on the alternative hypothesis

Collect evidence; determine if there’s enough to decide

Inability to reject null hypothesis does not make alternative hypothesis false

Simulation approach

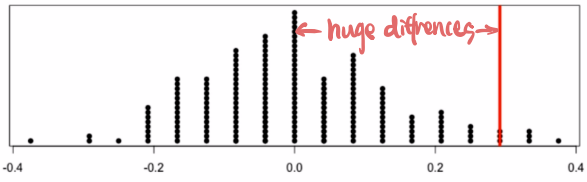
- Consider an imaginary version of this experiment where the null hypothesis is true
- Simulate the results of this experiment
- Compare results of simulation to results of real-life experiment
- How unusual is the real-life result in the null hypothesis world?

Simulation approach

- Null hypothesis says: gender and promotion rates are independent
- Combined promotion rate was 35/48
- So, model promotion as a 35/48 chance independent of gender
- Simulate the experiment many times so we can see how variable the results are

Simulation results

How likely is a 0.88 - 0.58 = 0.30 difference?



more women promoted

our result