

Statistics is Everywhere

Who or what controls  
exposure?

Population of interest

Study design: Sampling

Participation question

Study design: Data  
collection

Temporality

## L08: Samples and Observational studies

February 8, 2019

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## Reminders and announcements:

- ▶ Quick Quiz on Monday
- ▶ Post questions to discussion board, we will have review on wednesday
- ▶ Lab session next week will be review
- ▶ Exam on Friday
- ▶ Both the quiz and exam will be on paper
- ▶ One single sided sheet of notes is allowed (font no smaller than 10pt)
- ▶ No computers, cell phones or graphing calculators
- ▶ You must bring your student ID to the midterm

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# Statistics is Everywhere

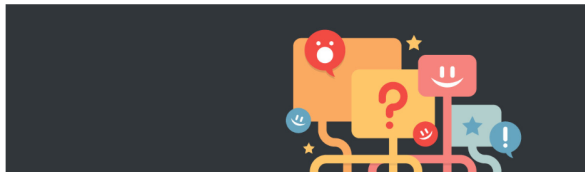
INTERNET

## Online Reviews Are Biased. Here's How to Fix Them

by Nadav Klein, Ioana Marinescu, Andrew Chamberlain, and Morgan Smart

MARCH 06, 2018

SUMMARY SAVE SHARE COMMENT 3 TEXT SIZE PRINT \$8.95 BUY COPIES



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## Statistics is Everywhere

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- ▶ from Harvard Business Review, March 2018:

*Online reviews are a powerful tool for sharing information at scale. But it's important to remember the source — many online reviews today are from those who've voluntarily decided to share opinions, giving a distorted view of products, services and companies.*

# Statistics is Everywhere

- ▶ What happens to the distribution of responses when all observations are from people who volunteer to participate?
- ▶ What kind of a variable is being displayed here?
- ▶ What kind of a visualization is this?

## 8 customer reviews

★★★★☆ 4.5 out of 5 stars ▾



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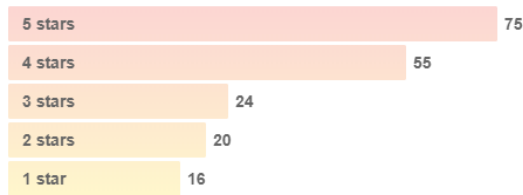
# Statistics is Everywhere

What is the sample size here?

What do we notice about this distribution?

## Overall Rating

Yelping since 2017 with 190 reviews



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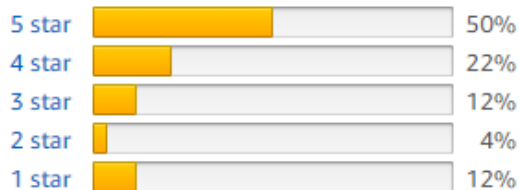
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## 149 customer reviews

★★★★☆ 4.1 out of 5 stars ▼



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### ► More from the article:

*“That problem generalizes to most online reviews. Research shows many of today’s most popular online review platforms — including Yelp business reviews, and Amazon product reviews — have a distribution of opinion that is highly polarized, with many extreme positive and/or negative reviews, and few moderate opinions. This creates a “bi-modal” or “J-shaped” distribution of online product reviews that has been well-documented in the academic literature. This makes it hard to learn about true quality from online reviews.”*”

There are several definitions and descriptions in the book chapter that I disagree with or think are poorly described. Particularly In Edition 4:

- ▶ pg 142: Observation vs. Experiment textbox and following paragraph
- ▶ pg 143: Definition of confounding and conceptual diagram of confounding
- ▶ pg 147: Description of bias

For the concepts around sampling and observational studies and study design in general, for these sections, and for the definitions of causality and confounding, the material presented in lecture takes precedence

# Learning objectives for today

Defining a study by:

- ▶ Whether the treatment or exposure is controlled by an investigator
  - ▶ Experimental vs observational designs
- ▶ The population of interest
  - ▶ Target population
  - ▶ Study population
- ▶ How the sample was drawn from the population
  - ▶ Complete sample (census)
  - ▶ Random sampling
  - ▶ Convenience sampling
  - ▶ Volunteer sampling
- ▶ Was selection conditional on exposure or outcome?
- ▶ Method and timing of data collection

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Who or what controls exposure?

# Types of problems: from our PPDAC framework

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- ▶ Recall the three types of problems we can attempt to answer:
  - ▶ Description
  - ▶ Prediction
  - ▶ Causation/Etiology
- ▶ The book argue that experiments are “the only source of fully convincing data” to study causes and effect. We disagree.
- ▶ Epidemiologists, sociologists, political scientists, economists, and others often use observational data to study cause and effect and have developed a careful theory of causal inference that is sometimes less well understood by others.

# Observation vs. Experimentation

- ▶ A study is observational if we are **observing** what happens and do not have control over the treatments or exposures.
- ▶ A study is generally considered experimental if the investigator is **experimenting** by controlling who is getting the exposure(treatment) and who is not.

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- ▶ Baldi & Moore present an example of observational data being misleading in the study of the causal effect of hormone replacement therapy on cardiovascular disease. However, these observational data, analysed in a different way yield the same conclusion as the randomized controlled trial.  
[link](#).



## Observation vs. Experimentation

- Suppose we are interested in whether a certain surgical procedure prolongs life in cancer patients:

`## Warning: package 'dagitty' was built under R version 3.5.3`



- What is disease severity in this DAG?
- How does this DAG change if the surgical procedure is randomly assigned?

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# Lurking variables a.k.a. confounders

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- ▶ Lurking variables/confounders are only important if you are asking a causal/etiologic question.
- ▶ There are no confounders for predictive studies

# Other ways exposure is assigned

- ▶ Pre and post designs
- ▶ Randomized roll out (stepped wedge)
- ▶ Natural experiments

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## Population of interest

# Target Population

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- ▶ The entire group of individuals about which we want information, and to whom we would like to apply our estimates and conclusions.
- ▶ Identifying the target population is part of setting up your “problem” in our PPDAC framework

# Study population

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The part of the population from which we can actually select/recruit individuals and collect information.

# Study sample

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Individuals we were able to select/recruit and gather data from.

We use a sample to draw conclusions about the entire population.

## Example: Predictors of longevity

Brandts L, van den Brandt PA Body size, non-occupational physical activity and the chance of reaching longevity in men and women: findings from the Netherlands Cohort Study J Epidemiol Community Health Published Online First: 21 January 2019

**Introduction** The rising number of obese and/or physically inactive individuals might negatively impact human lifespan. This study assessed the association between height, body mass index (BMI) and non-occupational physical activity and the likelihood of reaching 90 years of age, in both sexes separately.

**Methods** Analyses were conducted using data from the Netherlands Cohort Study. The NLCS was initiated in 1986 as a large prospective cohort study and included 120,852 men and women aged 55–69 years from 204 Dutch municipalities. Participants born in 1916–1917 ( $n=7807$ ) completed a questionnaire in 1986 (at age 68–70 years) and were followed up for vital status information until the age of 90 years (2006–2007).

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# Example: Predictors of longevity

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Discuss with your neighbor:

- ▶ what is the target population?
- ▶ What is the study population?
- ▶ To whom might we be trying to generalize these results?

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## Study design: Sampling

# Study design: Sampling

How a sample is chosen from the population.

This is part of the “Plan” part of PPDAC

- ▶ When you are designing a study you need to decide how you will sample individuals (observations):
  - ▶ Who belongs to the target population
  - ▶ How you will identify the study population (sometimes called identifying a sampling frame)
  - ▶ How will you take a sample of the target population. Or whether you can assess everybody (a census)
  - ▶ How many will you sample?
- ▶ Think about what you want your data frame to look like.

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# Representative(ness)

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- ▶ Does the sample represent the population? Can we make conclusions based on the sample that will apply to the population as a whole?
- ▶ Representativeness is also called **external validity**.

# Study sampling designs that generally do not give representative samples

- ▶ Case series
- ▶ Convenience samples
- ▶ Voluntary response samples
- ▶ Generally, non-probability designs

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# More representative designs: Probability samples

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- ▶ Simple random sample (SRS): A sample chosen by chance, where each individual in the data set has the same chance of being selected.
- ▶ We can easily choose SRS of data frames using R

## Example of SRS in R

- First read in the hospital cesarean data

```
## Warning: package 'readxl' was built under R version 3.5.3
```

```
## # A tibble: 6 x 8
```

```
##   Births HOSP_BEDSIZE cesarean_rate lowrisk_cesarea~ ...5 `Cesarean rate`
##   <dbl>      <dbl>      <dbl>      <dbl> <lg1>      <dbl>
## 1    767          1      0.344      0.107  NA         34.
## 2    183          1      0.454      0.186  NA         45.
## 3    668          1      0.430      0.195  NA         43.
## 4    154          1      0.279      0.0844 NA         27.
## 5    327          1      0.306      0.119  NA         30.
## 6   2356          1      0.301      0.0662 NA         30.
## # ... with 2 more variables: `Low Risk Cearean rate*100` <dbl>, ID <int>
```

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## Participation question



# Example of SRS in R

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```
CS_100_1 <- CS_data %>% sample_n(100)
CS_100_2 <- CS_data %>% sample_n(100)
```

Do you expect `head(CS_100_1)` to equal `head(CS_100_2)`?

## Example of SRS in R

```
head(CS_100_1 %>% select(Births, HOSP_BEDSIZE, cesarean_rate, ID))
```

```
## # A tibble: 6 x 4
##   Births HOSP_BEDSIZE cesarean_rate   ID
##   <dbl>      <dbl>      <dbl> <int>
## 1    194          1      0.418     42
## 2   1305          2      0.392    138
## 3    418          1      0.184     95
## 4    361          1      0.319     96
## 5  10546          3      0.439    562
## 6    589          3      0.329    331
```

## Example of SRS in R

```
head(CS_100_2 %>% select(Births, HOSP_BEDSIZE, cesarean_rate, ID))
```

```
## # A tibble: 6 x 4
##   Births HOSP_BEDSIZE cesarean_rate   ID
##   <dbl>      <dbl>      <dbl> <int>
## 1    274          2      0.354    176
## 2    958          1      0.246     9
## 3    685          1      0.277   107
## 4    138          1      0.290   125
## 5    198          1      0.288    61
## 6    744          2      0.294   172
```

# Example of SRS in R

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```
identical(CS_100_1, CS_100_2)
```

```
## [1] FALSE
```

# Example of SRS in R

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Why are these first six lines different?

Anytime you do something *randomly* in R, the results will be different. This is a good thing! This allows you to pick many different random samples. In future weeks we will do this a lot.

## Example of SRS in R

What if you want to ensure that you pick the same SRS as a friend?

Then you need to use `set.seed()`:

```
set.seed(123)  
CS_100_1 <- CS_data %>% sample_n(100)
```

```
set.seed(123)  
CS_100_2 <- CS_data %>% sample_n(100)
```

```
identical(CS_100_1, CS_100_2)
```

```
## [1] TRUE
```

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# SRS a fraction in R

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```
CS_5percent <- CS_data %>% sample_frac(0.05)
```

# Proportionate Stratified sampling in R

- ▶ Group *and then* sample the same fraction from each group

```
CS_10percent_grouped <- CS_data %>%  
  group_by(HOSP_BEDSIZE) %>%  
  sample_frac(0.1)  
dim(CS_10percent_grouped)
```

```
## [1] 58 8
```

- ▶ Proportionate stratified SRS assembles a sample that maintains the relative proportions of HOSP\_BEDSIZE in the chosen sample compared to the population

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# Proportionate Stratified sampling in R

How to check you really did sample 10% of each HOSP\_BEDSIZE group?

First see how many hospitals fall into each category in the original data

```
CS_data %>% group_by(HOSP_BEDSIZE) %>% tally()
```

```
## # A tibble: 3 x 2
##   HOSP_BEDSIZE      n
##         <dbl> <int>
## 1             1    131
## 2             2    179
## 3             3    270
```

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# Proportionate Stratified sampling in R

then in the sample

```
CS_10percent_grouped%>%group_by(HOSP_BEDSIZE) %>% tally()
```

```
## # A tibble: 3 x 2
##   HOSP_BEDSIZE      n
##         <dbl> <int>
## 1             1     13
## 2             2     18
## 3             3     27
```

Statistics is Everywhere

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# Disproportionate Stratified sampling in R

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Temporality

- ▶ When might you want to over represent certain groups?
- ▶ Example: Estimating infant mortality by race/ethnicity when some race/ethnic groups are very small (e.g., indigenous groups in U.S./Canada)
- ▶ Then, you may want to over sample certain groups so you can better estimate infant mortality in those groups than if you sampled proportionately

# Multistage sampling

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- ▶ SRSs inside SRSs
- ▶ For example, sampling schools using a SRS, and then sampling students within those schools.

# Conditional selection?

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- ▶ Was selection conditional on exposure or outcome?
  - ▶ If we are choosing people to participate in our study based on their exposure status this is generally a **cohort** design
  - ▶ If we are choosing people to participate in our study based on their outcome status this is generally a **case-control** design
  - ▶ Matched pairs are a special case of study design where participants are chosen conditional on multiple factors
- ▶ We will not go into much detail here about these types of designs, however you should know that if we selected participants conditional on exposure then the marginal distribution of exposure is not meaningful, likewise if we selected participant conditional on outcome then the marginal distribution of outcome is not meaningful.

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**Study design: Data  
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## Study design: Data collection

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- ▶ Part of your study design is also about how you will collect the variables:
  - ▶ By survey? (self reported information)
  - ▶ Measured by device?
  - ▶ Collected from health records?
  - ▶ Google search?
- ▶ What are the types of variables and levels of each variable?
  - ▶ Continuous?
  - ▶ Categorical? How many categories? Ordinal or nominal?
- ▶ Think about what you want your data frame to look like.

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## Temporality



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- ▶ Method and timing of data collection
  - ▶ One timepoint only (**cross sectional**)
  - ▶ Multiple timepoints (**longitudinal**)
  - ▶ Moving forward in time (**prospective**)
  - ▶ Collecting data from previous times (**retrospective**)

# Putting it together

Reading an article title:

What does the title tell you about the design? About what the target population might be? What would you ask about the methods?

From the American Journal of Epidemiology Volume 188, Issue 2, February 2019

- ▶ Associations of a Healthy Lifestyle Index With the Risks of Endometrial and Ovarian Cancer Among Women in the Women's Health Initiative Study
- ▶ Death and Chronic Disease Risk Associated With Poor Life Satisfaction: A Population-Based Cohort Study

and from New England Journal of Medicine 2019; 380:415-424

-Partial Oral versus Intravenous Antibiotic Treatment of Endocarditis a randomized, noninferiority, multicenter trial

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**Temporality**

- ▶ More about trials
- ▶ Sources of Bias
- ▶ Review for midterm
- ▶ Intro to probability (start of midterm 2 material)

# Parting humor

From PhDcomics.com



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