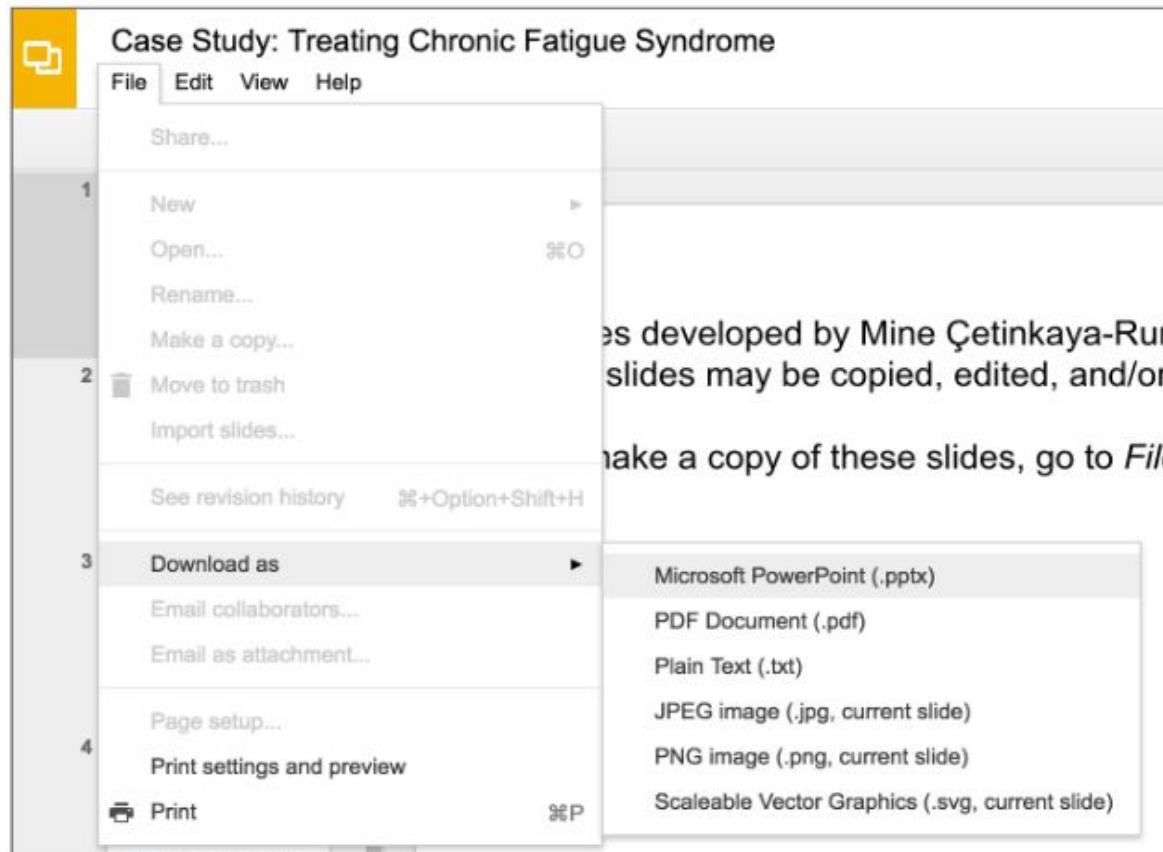


Slides developed by Mine Çetinkaya-Rundel of OpenIntro.
Translated from LaTeX to Google Slides by Curry Hilton of OpenIntro.
The slides may be copied, edited, and/or shared via the [CC BY-SA license](#).

To make a copy of these slides, go to *File > Download as > [option]*,
as shown below. Or if you are logged into a Google account, you can choose
Make a copy... to create your own version in Google Drive.



Observational studies and sampling strategies

Populations and Samples

PHYS ED | AUGUST 29, 2012, 12:01 AM | 21 Comments

Finding Your Ideal Running Form

By GRETCHEN REYNOLDS



David De Lossy/Getty Images

<http://well.blogs.nytimes.com/2012/08/29/finding-your-ideal-running-form>

Research Question: Can people become better, more efficient runners on their own, merely by running?

Populations and Samples

PHYS ED | AUGUST 29, 2012, 12:01 AM | 21 Comments

Finding Your Ideal Running Form

By GRETCHEN REYNOLDS



David De Lossy/Getty Images

<http://well.blogs.nytimes.com/2012/08/29/finding-your-ideal-running-form>

Research Question: Can people become better, more efficient runners on their own, merely by running?

Population of Interest: All people

Populations and Samples

PHYS ED | AUGUST 29, 2012, 12:01 AM | 21 Comments

Finding Your Ideal Running Form

By GRETCHEN REYNOLDS



David De Lossy/Getty Images

<http://well.blogs.nytimes.com/2012/08/29/finding-your-ideal-running-form>

Sample: Group of adult women who recently joined a running group

Research Question: Can people become better, more efficient runners on their own, merely by running?

Population of Interest: All people

Populations and Samples

PHYS ED | AUGUST 29, 2012, 12:01 AM | 21 Comments

Finding Your Ideal Running Form

By GRETCHEN REYNOLDS



David De Lossy/Getty Images

<http://well.blogs.nytimes.com/2012/08/29/finding-your-ideal-running-form>

Sample: Group of adult women who recently joined a running group

Population to which results can be generalized: Adult women, if the data are randomly sampled

Research Question: Can people become better, more efficient runners on their own, merely by running?

Population of Interest: All people

Anecdotal evidence and early smoking research

- Anti-smoking research started in the 1930s and 1940s when cigarette smoking became increasingly popular. While some smokers seemed to be sensitive to cigarette smoke, others were completely unaffected.
- Anti-smoking research was faced with resistance based on **anecdotal evidence** such as "My uncle smokes three packs a day and he's in perfectly good health", evidence based on a limited sample size that might not be representative of the population.
- It was concluded that "smoking is a complex human behavior, by its nature difficult to study, confounded by human variability."
- In time researchers were able to examine larger samples of cases (smokers), and trends showing that smoking has negative health impacts became much clearer.

Census

- Wouldn't it be better to just include everyone and "sample" the entire population?
 - This is called a *census*.

Census

- Wouldn't it be better to just include everyone and "sample" the entire population?
 - This is called a *census*.
- There are problems with taking a census:
 - It can be difficult to complete a census: there always seem to be some individuals who are hard to locate or hard to measure.
And these difficult-to-find people may have certain characteristics that distinguish them from the rest of the population.
 - Populations rarely stand still. Even if you could take a census, the population changes constantly, so it's never possible to get a perfect measure.
 - Taking a census may be more complex than sampling.

Illegal Immigrants Reluctant To Fill Out Census Form

by PETER O'DOWD

March 31, 2010 4:00 AM



from KJZZ



[Listen to the Story](#)

Morning Edition

3 min. 48 sec

[+ Playlist](#)
[+ Download](#)

There is an effort underway to make sure Hispanics are accurately counted in the 2010 Census. Phoenix has some of the country's "hardest-to-count" districts. Some Latinos, especially illegal residents, fear that participating in the count will expose them to immigration raids or government harassment.

<http://www.npr.org/templates/story/story.php?storyId=125380052>

Exploratory analysis to inference

- Sampling is natural.

Exploratory analysis to inference

- Sampling is natural.
- Think about sampling something you are cooking - you taste (examine) a small part of what you're cooking to get an idea about the dish as a whole.

Exploratory analysis to inference

- Sampling is natural.
- Think about sampling something you are cooking - you taste (examine) a small part of what you're cooking to get an idea about the dish as a whole.
- When you taste a spoonful of soup and decide the spoonful you tasted isn't salty enough, that's *exploratory analysis*.

Exploratory analysis to inference

- Sampling is natural.
- Think about sampling something you are cooking - you taste (examine) a small part of what you're cooking to get an idea about the dish as a whole.
- When you taste a spoonful of soup and decide the spoonful you tasted isn't salty enough, that's *exploratory analysis*.
- If you generalize and conclude that your entire soup needs salt, that's an *inference*.

Exploratory analysis to inference

- Sampling is natural.
- Think about sampling something you are cooking - you taste (examine) a small part of what you're cooking to get an idea about the dish as a whole.
- When you taste a spoonful of soup and decide the spoonful you tasted isn't salty enough, that's *exploratory analysis*.
- If you generalize and conclude that your entire soup needs salt, that's an *inference*.
- For your inference to be valid, the spoonful you tasted (the sample) needs to be *representative* of the entire pot (the population).
 - If your spoonful comes only from the surface and the salt is collected at the bottom of the pot, what you tasted is probably not representative of the whole pot.
 - If you first stir the soup thoroughly before you taste, your spoonful will more likely be representative of the whole pot.

Sampling bias

- *Non-response:* If only a small fraction of the randomly sampled people choose to respond to a survey, the sample may no longer be representative of the population.

Sampling bias

- *Non-response*: If only a small fraction of the randomly sampled people choose to respond to a survey, the sample may no longer be representative of the population.
- *Voluntary response*: Occurs when the sample consists of people who volunteer to respond because they have strong opinions on the issue. Such a sample will also not be representative of the population.

Sampling bias

- **Non-response:** If only a small fraction of the randomly sampled people choose to respond to a survey, the sample may no longer be representative of the population.
- **Voluntary response:** Occurs when the sample consists of people who volunteer to respond because they have strong opinions on the issue. Such a sample will also not be representative of the population.

Quick vote

Do you get paid sick days at your job?

Yes No
 What job?

VOTE or view results

Sampling bias

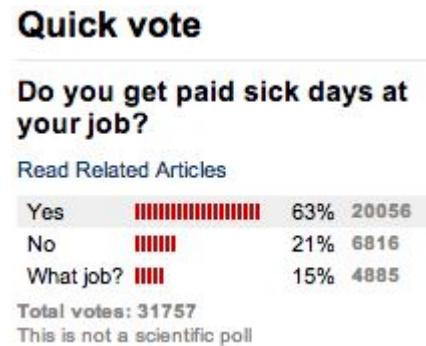
- **Non-response:** If only a small fraction of the randomly sampled people choose to respond to a survey, the sample may no longer be representative of the population.
- **Voluntary response:** Occurs when the sample consists of people who volunteer to respond because they have strong opinions on the issue. Such a sample will also not be representative of the population.

Quick vote

Do you get paid sick days at your job?

Yes No
 What job?

VOTE or view results



Sampling bias

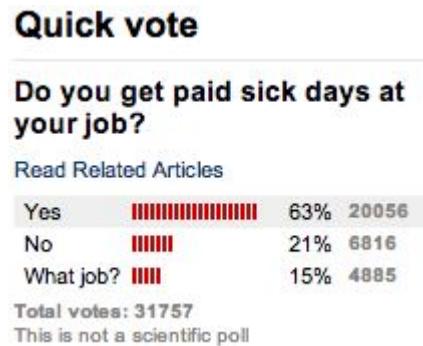
- **Non-response:** If only a small fraction of the randomly sampled people choose to respond to a survey, the sample may no longer be representative of the population.
- **Voluntary response:** Occurs when the sample consists of people who volunteer to respond because they have strong opinions on the issue. Such a sample will also not be representative of the population.

Quick vote

Do you get paid sick days at your job?

Yes No
 What job?

VOTE or view results



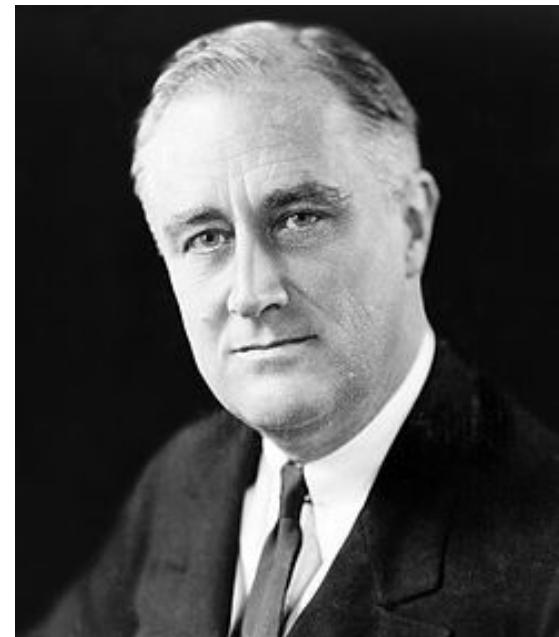
- **Convenience sample:** Individuals who are easily accessible are more likely to be included in the sample.

Sampling bias example: Landon vs. FDR

A historical example of a biased sample yielding misleading results

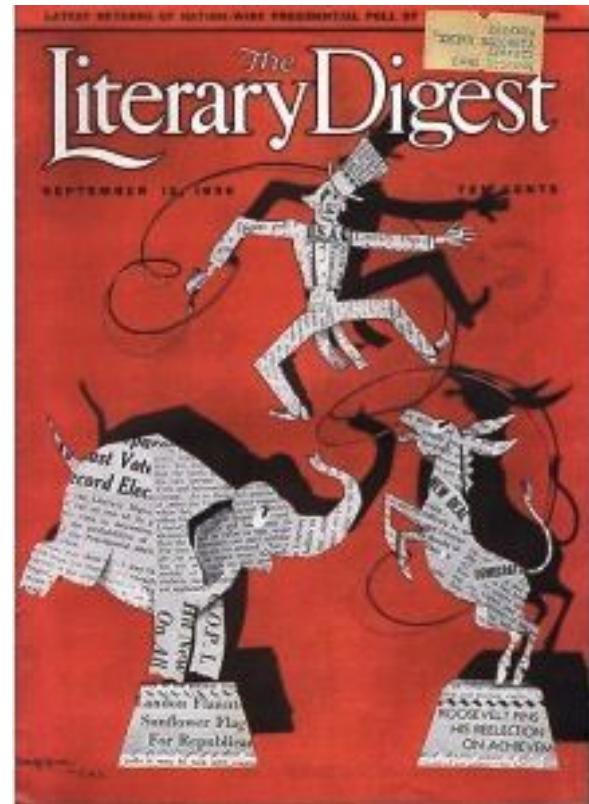


In 1936, Landon sought the Republican presidential nomination opposing the re-election of FDR.



The Literary Digest Poll

- The Literary Digest polled about 10 million Americans, and got responses from about 2.4 million.
- The poll showed that Landon would likely be the overwhelming winner and FDR would get only 43% of the votes.
- Election result: FDR won, with 62% of the votes.
- The magazine was completely discredited because of the poll, and was soon discontinued.



The Literary Digest Poll - what went wrong?

- The magazine had surveyed
 - its own readers,
 - registered automobile owners, and
 - registered telephone users.
- These groups had incomes well above the national average of the day (remember, this is Great Depression era) which resulted in lists of voters far more likely to support Republicans than a truly *typical* voter of the time, i.e. the sample was not representative of the American population at the time.

Large samples are preferable, but...

- The Literary Digest election poll was based on a sample size of 2.4 million, which is huge, but since the sample was *biased*, the sample did not yield an accurate prediction.
- Back to the soup analogy: If the soup is not well stirred, it doesn't matter how large a spoon you have, it will still not taste right. If the soup is well stirred, a small spoon will suffice to test the soup.

Practice

A school district is considering whether it will no longer allow high school students to park at school after two recent accidents where students were severely injured. As a first step, they survey parents by mail, asking them whether or not the parents would object to this policy change. Of 6,000 surveys that go out, 1,200 are returned. Of these 1,200 surveys that were completed, 960 agreed with the policy change and 240 disagreed. Which of the following statements are true?

- I. Some of the mailings may have never reached the parents.
 - II. The school district has strong support from parents to move forward with the policy approval.
 - III. It is possible that majority of the parents of high school students disagree with the policy change.
 - IV. The survey results are unlikely to be biased because all parents were mailed a survey.
- (a) Only I (b) I and II (c) I and III (d) III and IV (e) Only IV

Practice

A school district is considering whether it will no longer allow high school students to park at school after two recent accidents where students were severely injured. As a first step, they survey parents by mail, asking them whether or not the parents would object to this policy change. Of 6,000 surveys that go out, 1,200 are returned. Of these 1,200 surveys that were completed, 960 agreed with the policy change and 240 disagreed. Which of the following statements are true?

- I. Some of the mailings may have never reached the parents.
 - II. The school district has strong support from parents to move forward with the policy approval.
 - III. It is possible that majority of the parents of high school students disagree with the policy change.
 - IV. The survey results are unlikely to be biased because all parents were mailed a survey.
- (a) Only I (b) I and II (c) I and III (d) III and IV (e) Only IV

Observational studies

- Researchers collect data in a way that does not directly interfere with how the data arise.
- Results of an observational study can generally be used to establish an association between the explanatory and response variables.

Obtaining good samples

- Almost all statistical methods are based on the notion of implied randomness.
- If observational data are not collected in a random framework from a population, these statistical methods – the estimates and errors associated with the estimates – are not reliable.
- Most commonly used random sampling techniques are *simple*, *stratified*, and *cluster* sampling.

Prospective vs. Retrospective Studies

A **prospective study** identifies individuals and collects information as events unfold.

- Example: The Nurses Health Study has been recruiting registered nurses and then collecting data from them using questionnaires since 1976.

Retrospective studies collect data after events have taken place.

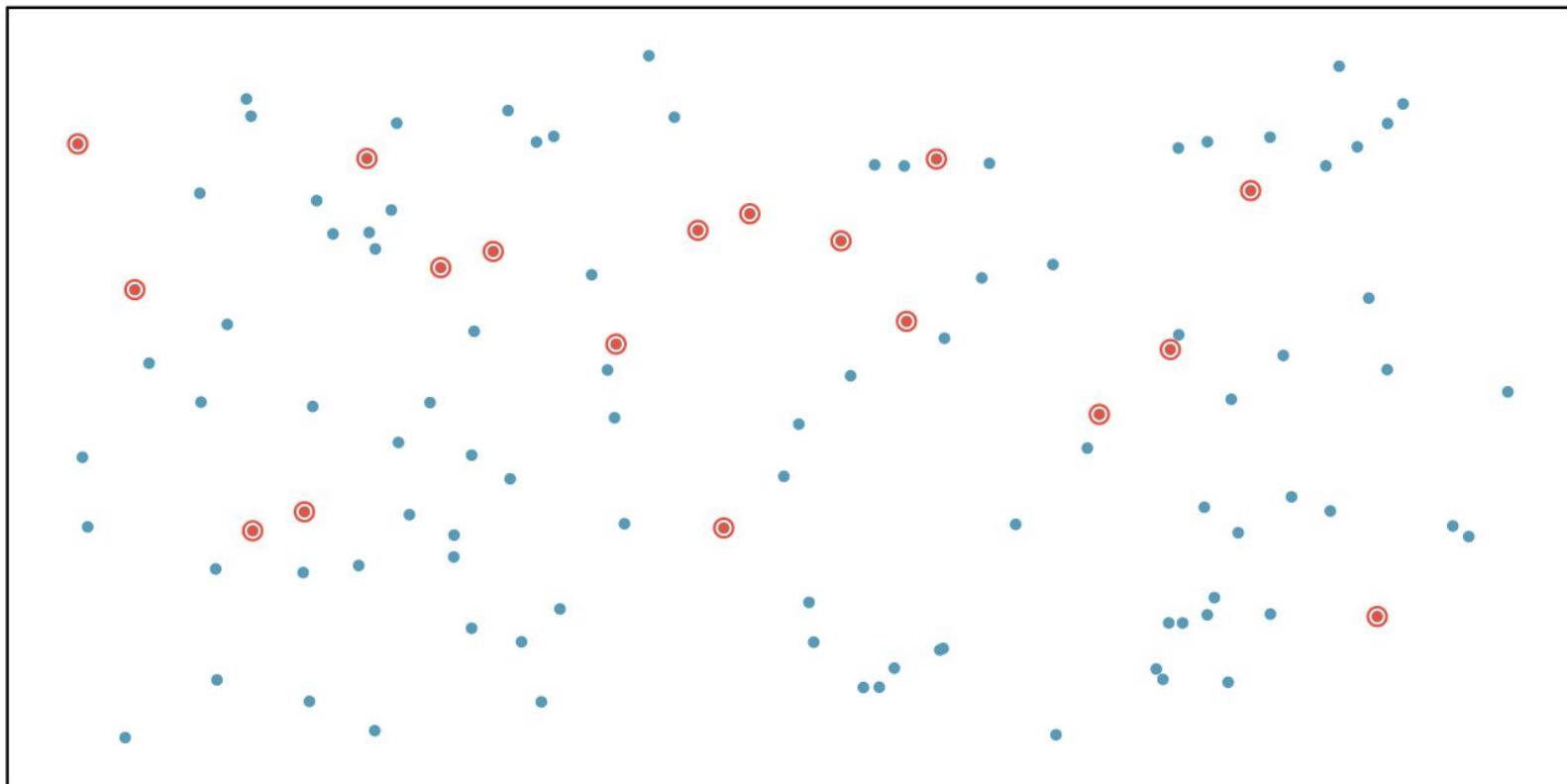
- Example: Researchers reviewing past events in medical records.

Obtaining Good Samples

- Almost all statistical methods are based on the notion of implied randomness.
- If observational data are not collected in a random framework from a population, these statistical methods -- the estimates and errors associated with the estimates -- are not reliable.
- Most commonly used random sampling techniques are *simple*, *stratified*, and *cluster* sampling.

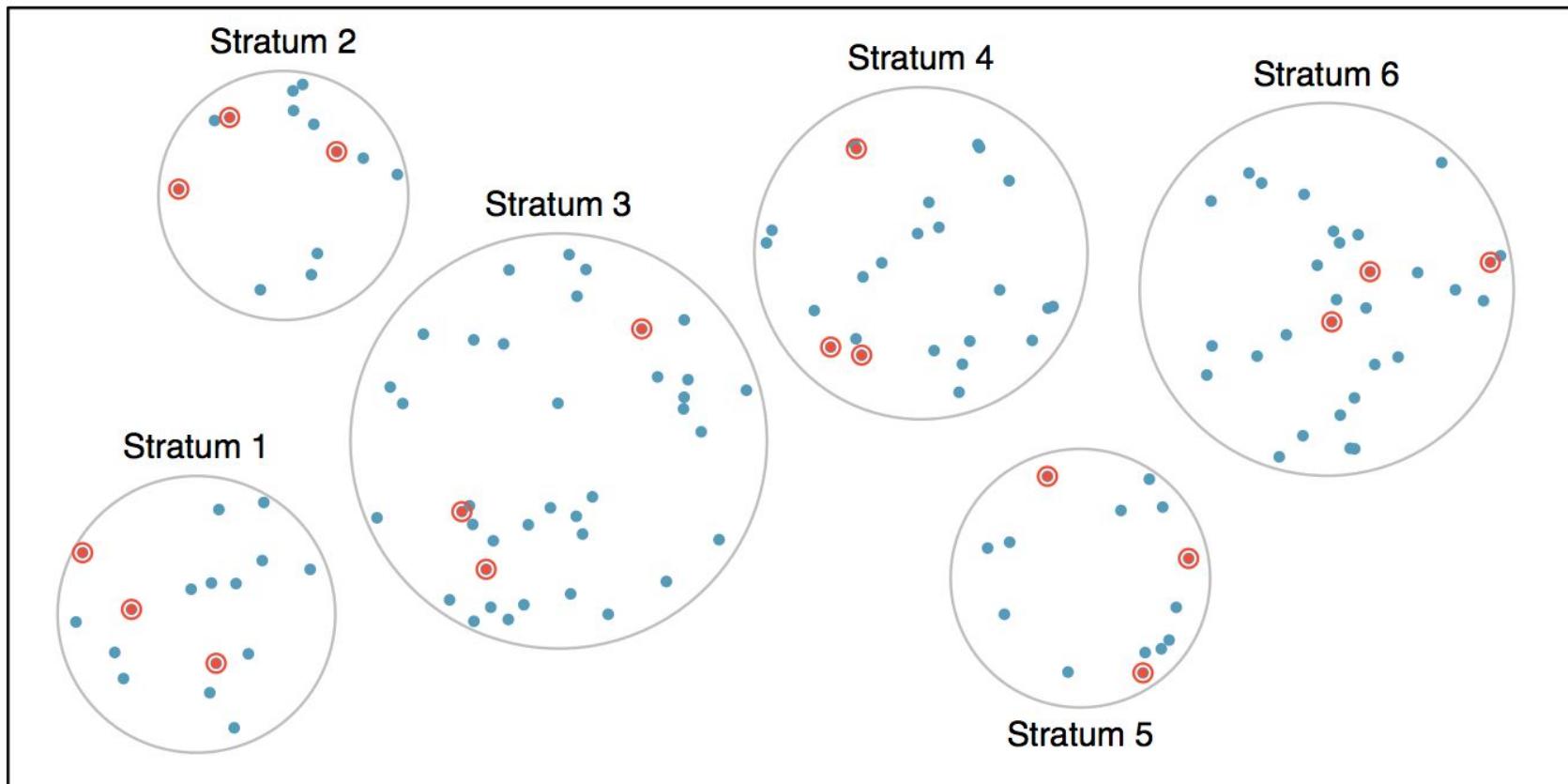
Simple Random Sample

Randomly select cases from the population, where there is no implied connection between the points that are selected.



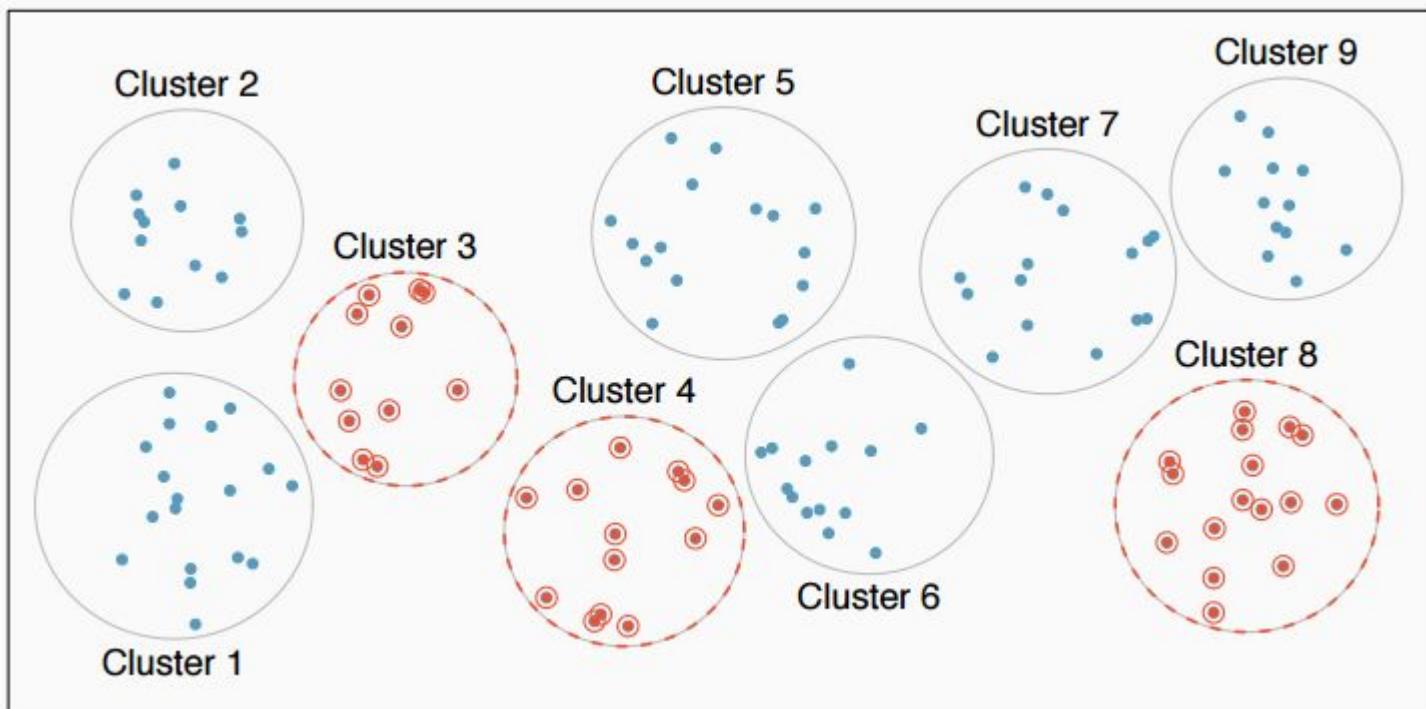
Stratified Sample

Strata are made up of similar observations. We take a simple random sample from each stratum.



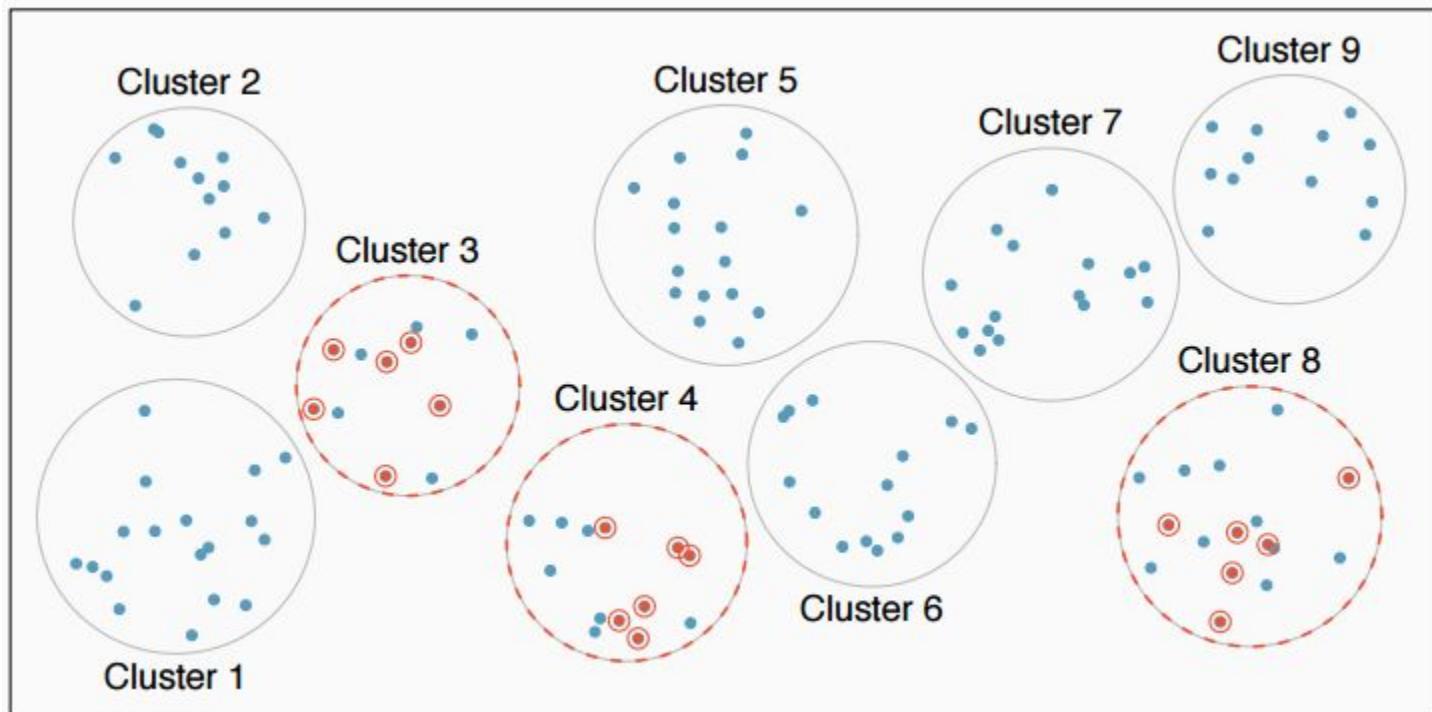
Cluster Sample

Clusters are usually not made up of homogeneous observations. We take a simple random sample of clusters, and then sample all observations in that cluster. Usually preferred for economical reasons.



Multistage Sample

Clusters are usually not made up of homogeneous observations. We take a simple random sample of clusters, and then take a simple random sample of observations from the sampled clusters



Practice

A city council has requested a household survey be conducted in a suburban area of their city. The area is broken into many distinct and unique neighborhoods, some including large homes, some with only apartments. Which approach would likely be the *least effective*?

- (a) Simple random sampling
- (b) Cluster sampling
- (c) Stratified sampling
- (d) Blocked sampling

Practice

A city council has requested a household survey be conducted in a suburban area of their city. The area is broken into many distinct and unique neighborhoods, some including large homes, some with only apartments. Which approach would likely be the *least effective*?

- (a) Simple random sampling
- (b) *Cluster sampling*
- (c) Stratified sampling
- (d) Blocked sampling

Find more resources at openintro.org/os, including

- Slides
- Videos
- Statistical Software Labs
- Discussion Forums (free support for students and teachers)
- Learning Objectives

Teachers only content is also available for [Verified Teachers](#), including

- Exercise solutions
- Sample exams
- Ability to request a free desk copy for a course
- Statistics Teachers email group

Questions? [Contact us.](#)