

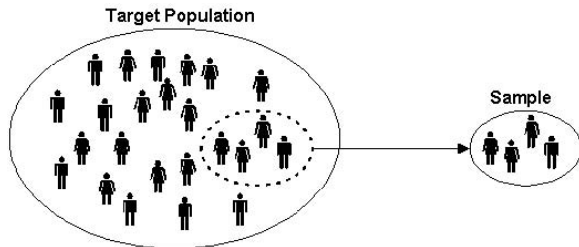
# Lecture 4: Sampling Methods + Design of Experiments

Chapter 1.4.2 + 1.5

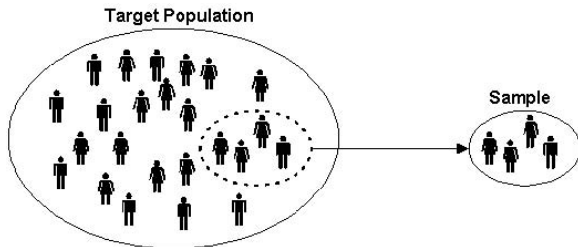
# Goals for Today

- ▶ Discuss different types of sampling
- ▶ Designing experiments
- ▶ Very important example: clinical trials
- ▶ Example of my own designed experiment: Fried Chicken Face Off

## Recall from Lecture 1.3: Population and Samples

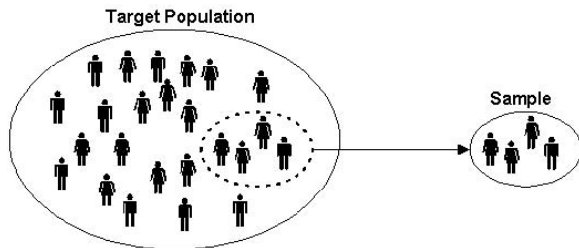


## Recall from Lecture 1.3: Population and Samples



If the sample is representative of the desired population then our results are **generalizable**.

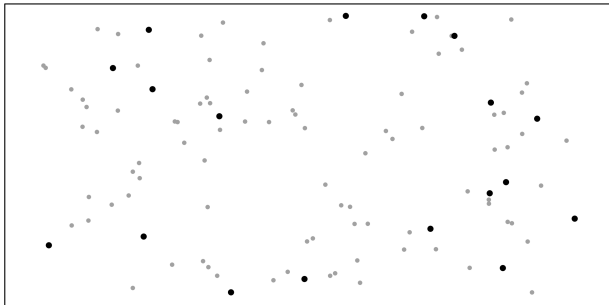
# Recall from Lecture 1.3: Population and Samples



If the sample is representative of the desired population then our results are **generalizable**.

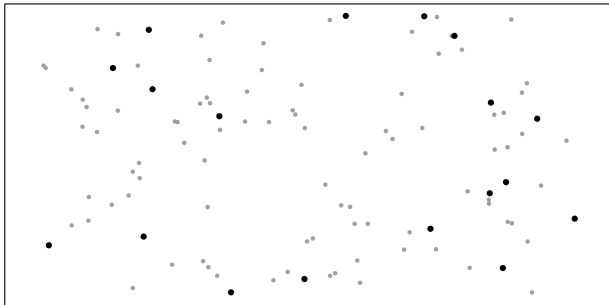
How do we take a representative (i.e. unbiased) sample? You **randomly** sample from the population.

# 1. Simple Random Sampling



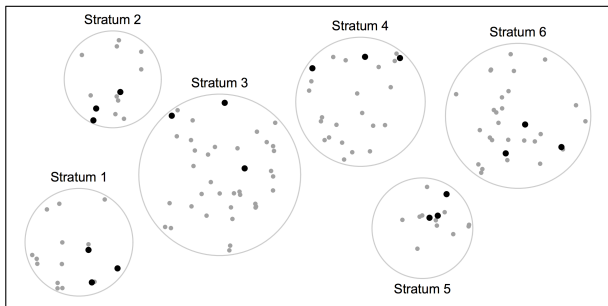
**Most granular sampling:** Where every individual in the population has the same probability of being sampled.

# 1. Simple Random Sampling



**Most granular sampling:** Where every individual in the population has the same probability of being sampled. Here, all dots are members of the population, and the bolder dots are sampled.

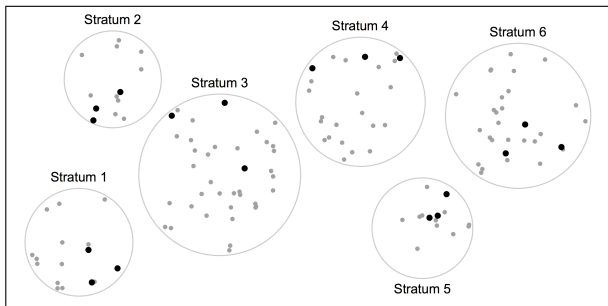
## 2. Stratified Sampling



**Divide and conquer:** The population is divided into strata, and we sample from each strata.

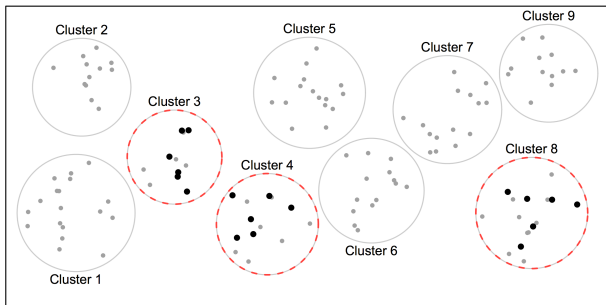


## 2. Stratified Sampling



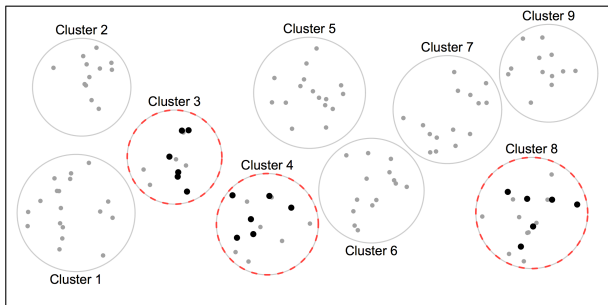
**Divide and conquer:** The population is divided into strata, and we sample from each strata. For example, each strata could be a census tract in Oregon, and we sample 3 individuals from each strata.

### 3. Cluster Sampling



**Two stage sampling:** Very similar to stratified sampling in its process, except that there is no requirement to sample from every cluster.

### 3. Cluster Sampling



**Two stage sampling:** Very similar to stratified sampling in its process, except that there is no requirement to sample from every cluster. First the clusters in red were chosen at random, and then we sample from them.

# Three Different Types of Sampling

1. Simple random sampling: most granular sampling
2. Stratified sampling: divide and conquer
3. Cluster sampling: two-stage sampling

# Three Different Types of Sampling

1. Simple random sampling: most granular sampling
2. Stratified sampling: divide and conquer
3. Cluster sampling: two-stage sampling

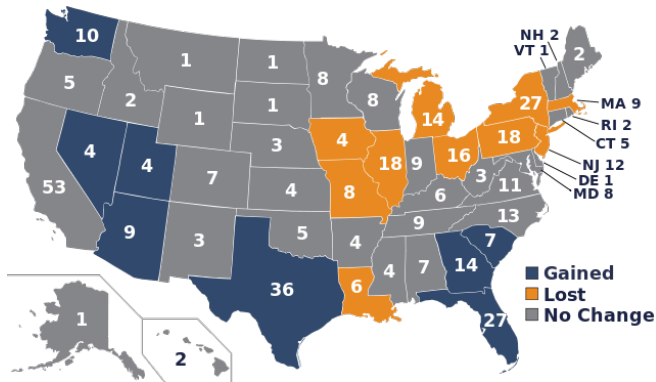
The mathematics behind the stratified and cluster sampling are more complicated to account for the hierarchies involved. Ex: for stratified sampling use the Horvitz-Thompson estimator.

# Statistics in Society: The US Census

The purpose of the decennial US census is **congressional apportionment**: the 435 seats in the US House of Representatives get distributed to the 50 states in proportion to their population.

# Statistics in Society: The US Census

The purpose of the decennial US census is **congressional apportionment**: the 435 seats in the US House of Representatives get distributed to the 50 states in proportion to their population. After the 2010 census:



# Statistics in Society: The US Census

President Bill Clinton's administration planned on using sampling in the 2000 census. In an article dated in 1996:



# Statistics in Society: The US Census

President Bill Clinton's administration planned on using sampling in the 2000 census. In an article dated in 1996:

[HOME PAGE](#) [TODAY'S PAPER](#) [VIDEO](#) [MOST POPULAR](#) [TIMES TOPICS](#) [MOST RECENT](#)

[Login](#) | [Register Now](#) | [Help](#)

**The New York Times** **U.S.**

Search All NYTimes.com

[COLLECTIONS](#) > [STATISTICAL METHODS](#)

**More Like This**  
U.S. CENSUS BUREAU  
REJECTS REVISION TO  
NATION'S TALLY  
  
[The Nation: Sample Case; You  
Fill Up My Census, Even If I...](#)  
  
[Lessons From the Election That  
Shook America](#)

**Find More Stories**  
[Statistical Methods](#)

## In a First, 2000 Census Is to Use Sampling

By STEVEN A. HOLMES  
Published: February 29, 1996

To cut costs and improve accuracy, the Census Bureau said today that it would actually count only 90 percent of the United States population in 2000 and rely on statistical sampling methods to determine the number remaining.

The plans, announced at the Commerce Department, mean that for the first time the official tally of the American population, done every 10 years and used to apportion seats in the House of Representatives, will be based in part on a scientifically determined estimate rather than the actual head count conducted through a mass direct-mail campaign.

Census Bureau officials say the revised method is needed to keep costs down and to avoid a repeat of the 1990 census, which missed record numbers of people that had been traditionally hard to count, mainly members of ethnic and racial minorities.

"What we intend to do to meet our twin goals of reducing costs and increasing accuracy is to make a much greater use of widely accepted scientific statistical methods, and sampling is first and foremost among them," said Martha Farnsworth Riche, the Census Bureau Director.

[SIGN IN TO E-MAIL](#)  
[PRINT](#)

9 / 22

# Statistics in Society: The US Census

However, Article I, Section 2 of the US Constitution states: *The **actual Enumeration** shall be made within three Years after the first Meeting of the Congress of the US, and within every subsequent Term of ten Years...*

# Statistics in Society: The US Census

However, Article I, Section 2 of the US Constitution states: *The **actual Enumeration** shall be made within three Years after the first Meeting of the Congress of the US, and within every subsequent Term of ten Years...*

As such, the Supreme Court ruled 5-4 in 1999 that

# Statistics in Society: The US Census

However, Article I, Section 2 of the US Constitution states: *The **actual Enumeration** shall be made within three Years after the first Meeting of the Congress of the US, and within every subsequent Term of ten Years...*

As such, the Supreme Court ruled 5-4 in 1999 that

- ▶ sampling could not "under any circumstances" be used to reapportion U.S. House seats

# Statistics in Society: The US Census

However, Article I, Section 2 of the US Constitution states: *The **actual Enumeration** shall be made within three Years after the first Meeting of the Congress of the US, and within every subsequent Term of ten Years...*

As such, the Supreme Court ruled 5-4 in 1999 that

- ▶ sampling could not "under any circumstances" be used to reapportion U.S. House seats
- ▶ could be used for other purposes such as redrawing state legislative districts or allocating federal funds to cities and states

# Statistics in Society: The Census

**THE WALL STREET JOURNAL.**  
U.S. EDITION Friday, May 15, 2009 As of 4:42 PM EDT [Subscribe](#) [Log In](#)

[Home](#) [World](#) **[U.S.](#)** [Business](#) [Tech](#) [Markets](#) [Market Data](#) [Your Money](#) [Opinion](#) [Life & Culture](#) [N.Y.](#) [Real Estate](#) [Management](#)

[Self & Wesse](#) **[Politics & Policy](#)** [Washington Wire](#) [Economy](#) [Health Law Rollout](#) [WSJ/NBC News Poll](#) [Journal Report](#) [Columns & Blogs](#)

**TOP STORIES IN POLITICS**  
1 of 12  **How Serious Are Risks If U.S. Doesn't Act?**  
2 of 12  **White House Wants 'Hard Look' at Syria Weapons Offer**  
3 of 12  **Senators Factor Voters Into Their Syria Equation**  
**Discord Over Military Strike Imperils President's Agenda**

[POLITICS](#) | May 15, 2009, 4:42 p.m. ET

## Census Nominee Rules Out Statistical Sampling in 2010

**Article**

**Comments**

[Email](#) [Print](#) [Save](#) [Twitter](#) [Facebook](#) [Google+](#) [LinkedIn](#) [A](#) [A](#)

By TIMOTHY J. ALBERTA

WASHINGTON—President Barack Obama's nominee to head the Census Bureau on Friday ruled out using statistical sampling to adjust the results of the 2010 census, quelling Republican concerns and making his confirmation likely next week.

Robert Groves, director of the University of Michigan's Survey Research Center and a former Census Bureau official, is an expert on statistical sampling, the practice of extrapolating a larger population from a smaller slice of it. Proponents of sampling say it helps produce a more accurate tally of the population, especially when it comes to traditionally undercounted groups, such as minorities living in urban areas.

But many Republican lawmakers insist that sampling violates the Constitution, which calls for an "actual Enumeration" of the population every 10 years. Critics also say the use of sampling would politicize the traditionally nonpolitical Census Bureau.

**Available to WSJ.com Subscribers**

[Life on Wall Street Grows Less Risky](#) 

[Icahn Throws In the Towel on Dell](#) 

[Hedge Funds Cut Back on Fees](#)

[Lessons of the Rescue: A Drama in Five Acts](#)

# Principles Of Designing Experiments

Switching gears...

(Wikipedia) In general usage, [design of experiments \(DOE\)](#) or [experimental design](#) is the design of any information-gathering exercises where variation is present, whether under the full control of the experimenter or not.

# Principles Of Designing Experiments

Switching gears...

(Wikipedia) In general usage, [design of experiments \(DOE\)](#) or [experimental design](#) is the design of any information-gathering exercises where variation is present, whether under the full control of the experimenter or not.

However, in statistics, these terms are usually used for [controlled experiments](#): experiments where there is a control and treatment group.



# Principles Of Designing Experiments

# Clinical Trials

To evaluate the efficacy of a drug, they must be subject to a clinical trial.

# Clinical Trials

To evaluate the efficacy of a drug, they must be subject to a **clinical trial**. The gold standard for a clinical trial is **randomized controlled trial**. i.e. randomized control and treatment groups.



# Example of Mine: Ezell's Famous Chicken

In Seattle's Central District lies



From Wikipedia: Oprah Winfrey called it her favorite fried chicken. There are a number of photos of her on the wall of the original restaurant proclaiming her love of the chicken. It is also said she has the chicken flown to her in Chicago when she has a craving.

## Example of Mine: Ezell's Famous Chicken

One day I was raving about Ezell's Chicken. My friend Nick accused me of being another person “buying into the hype”; that if people were subjected to a blinded taste test, Ezell's would fare no better than KFC. So...

## Example of Mine: Ezell's Famous Chicken

One day I was raving about Ezell's Chicken. My friend Nick accused me of being another person "buying into the hype"; that if people were subjected to a blinded taste test, Ezell's would fare no better than KFC. So...



VS



We set up a "Fried Chicken Face Off" where we would have individuals try both kinds of chicken and rate which one they liked more.

# Design of Experiment Principles in Place

**Goal:** Evaluate which kind of chicken, Ezell's or KFC, that people prefer in a blinded taste test. (Not if participant can determine which chicken came from which restaurant.)

**Question:** What principles of the design of experiments should be put in place to this end?



# Design of Experiment Principles in Place

The design principles we put in place:

# Design of Experiment Principles in Place

The design principles we put in place:

- ▶ **Single blinded**: The taster doesn't know which (Ezell's or KFC) chicken they are eating, but the server does.

# Design of Experiment Principles in Place

The design principles we put in place:

- ▶ **Single blinded**: The taster doesn't know which (Ezell's or KFC) chicken they are eating, but the server does.
- ▶ **Randomizing** which kind of meat (wing, breast, leg) between tasters. Each taster would try two kinds of meat.

# Design of Experiment Principles in Place

The design principles we put in place:

- ▶ **Single blinded**: The taster doesn't know which (Ezell's or KFC) chicken they are eating, but the server does.
- ▶ **Randomizing** which kind of meat (wing, breast, leg) between tasters. Each taster would try two kinds of meat.
- ▶ **Controlling for which kind of meat within a taster**: i.e. if you eat a KFC wing, you will necessarily eat an Ezell's wing

# Design of Experiment Principles in Place

The design principles we put in place:

- ▶ **Single blinded**: The taster doesn't know which (Ezell's or KFC) chicken they are eating, but the server does.
- ▶ **Randomizing** which kind of meat (wing, breast, leg) between tasters. Each taster would try two kinds of meat.
- ▶ **Controlling for which kind of meat within a taster**: i.e. if you eat a KFC wing, you will necessarily eat an Ezell's wing
- ▶ **Randomizing** which order of chicken you eat: KFC first or not

# Design of Experiment Principles in Place

The design principles we put in place:

# Design of Experiment Principles in Place

The design principles we put in place:

- ▶ **Controlling for temperature:** hence we're picking a place that is central to both Ezell's and KFC given the traveling required.

# Design of Experiment Principles in Place

The design principles we put in place:

- ▶ **Controlling for temperature:** hence we're picking a place that is central to both Ezell's and KFC given the traveling required.
- ▶ **Controlling for visual look:** We thought blind-folds were a bit excessive



# Design of Experiment Principles in Place

The design principles we put in place:

- ▶ **Controlling for temperature:** hence we're picking a place that is central to both Ezell's and KFC given the traveling required.
- ▶ **Controlling for visual look:** We thought blind-folds were a bit excessive
- ▶ **Controlling for kind of batter:** we can't do KFC crispy chicken b/c Ezell's doesn't have that type of batter. This is a limitation of the study b/c some feel the crispy chicken is better, but we have no choice.

# Design of Experiment Principles in Place

The design principles we put in place:

- ▶ **Controlling for temperature:** hence we're picking a place that is central to both Ezell's and KFC given the traveling required.
- ▶ **Controlling for visual look:** We thought blind-folds were a bit excessive
- ▶ **Controlling for kind of batter:** we can't do KFC crispy chicken b/c Ezell's doesn't have that type of batter. This is a limitation of the study b/c some feel the crispy chicken is better, but we have no choice.
- ▶ Just one **replicate** of each kind of meat.

# Results

Final score: KFC 8, Ezell's 4.

Some notes:

# Results

Final score: KFC 8, Ezell's 4.

Some notes:

- ▶ Even though people were “blinded”, most knew which the two pieces were from KFC.

# Results

Final score: KFC 8, Ezell's 4.

Some notes:

- ▶ Even though people were “blinded”, most knew which the two pieces were from KFC.
- ▶ People generally felt the chicken meat from Ezell's was better, and this was magnified as the chicken went cold.

# Results

Final score: KFC 8, Ezell's 4.

Some notes:

- ▶ Even though people were “blinded”, most knew which the two pieces were from KFC.
- ▶ People generally felt the chicken meat from Ezell's was better, and this was magnified as the chicken went cold.
- ▶ However, they felt the skin was better at KFC. Given that fried chicken is what it is b/c of the skin, people voted for KFC.

# Results

Final score: KFC 8, Ezell's 4.

Some notes:

- ▶ Even though people were “blinded”, most knew which the two pieces were from KFC.
- ▶ People generally felt the chicken meat from Ezell's was better, and this was magnified as the chicken went cold.
- ▶ However, they felt the skin was better at KFC. Given that fried chicken is what it is b/c of the skin, people voted for KFC.
- ▶ Future metrics need to consider the chicken and the skin separately, as well as the “overall experience” scores. i.e. this face off should be viewed as a **pilot study**

## Caution: Grad Students NOT at Work





## Next time

Examining and visualizing numerical data