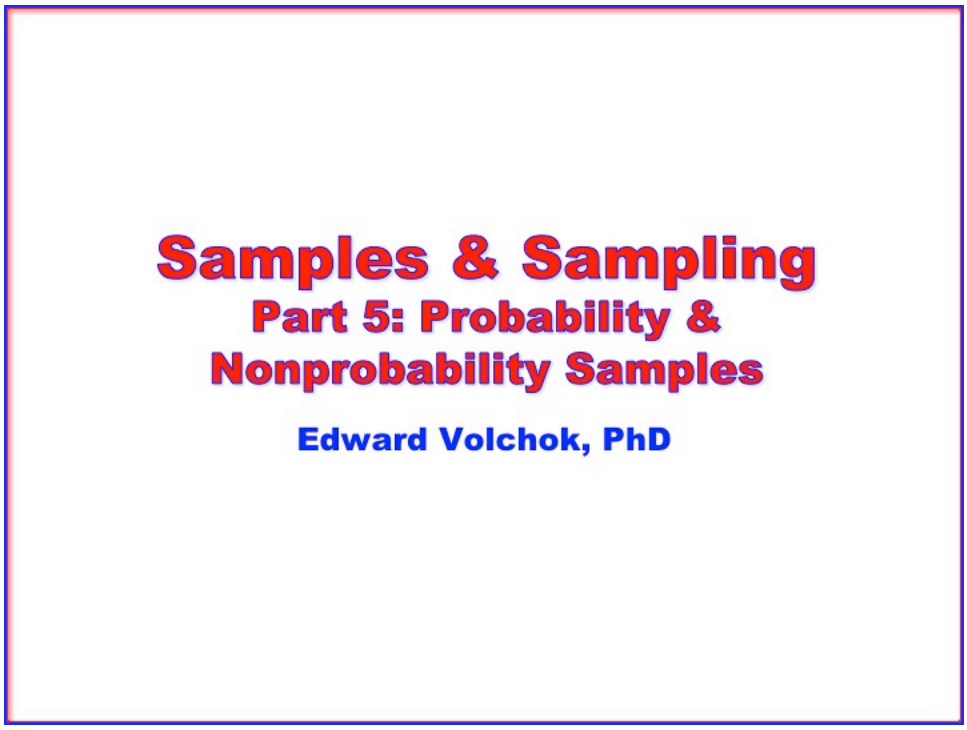
Samples & Sampling

Part 5: Probability &

Nonprobability Samples

Edward Volchok, PhD

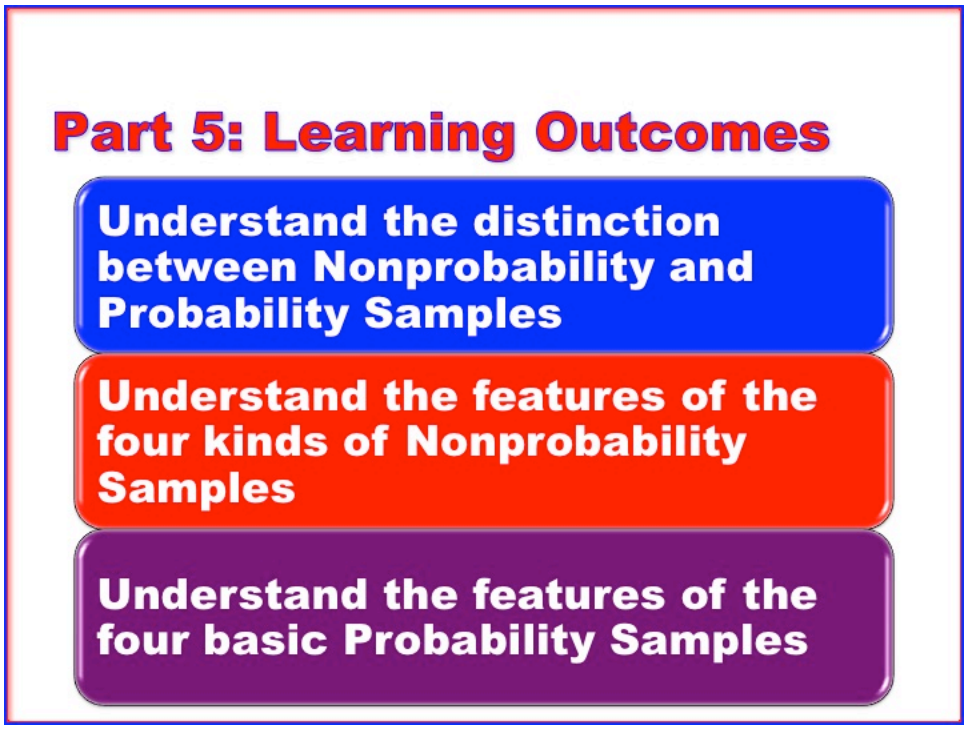


Video

Graphic of the title page.

Audio

Hello, this is Edward Volchok. Welcome to my lecture on Samples and Sampling. This video presents Part 5 of this lecture. In Part 5, we will examine Probability and Nonprobability Samples.

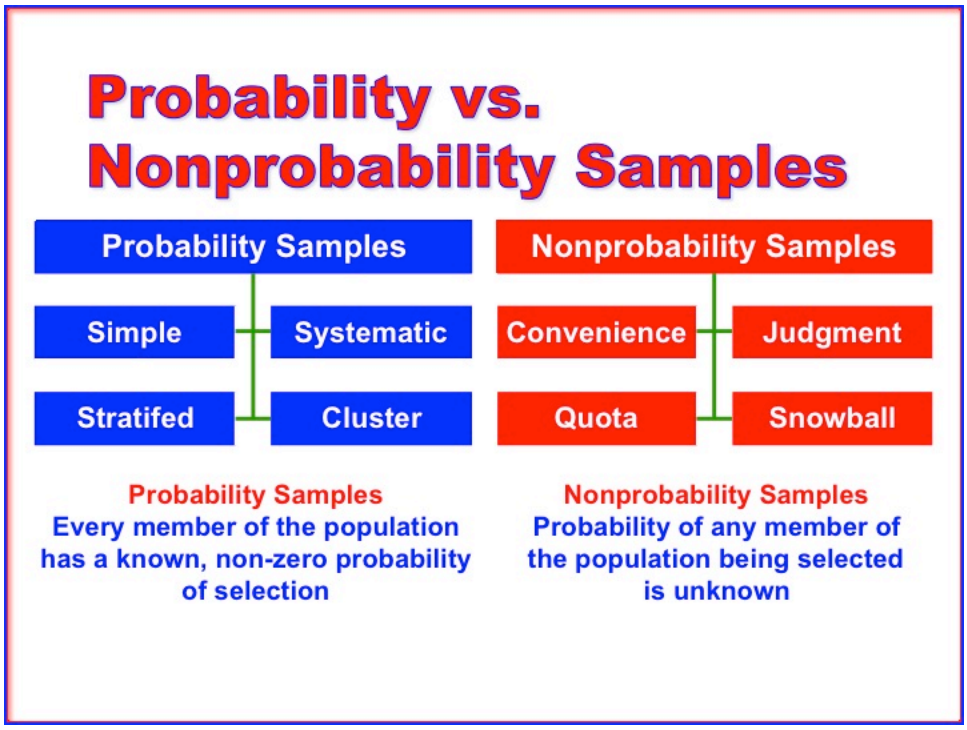


Video

Graphic of the three learning outcomes.

Audio

After reviewing Part 5 of this lecture, you will be able to: Understand the distinction between Probability and Nonprobability Samples; understand the features of the four kinds of Probability Samples; and, understand the features of the four basic Nonprobability Samples.

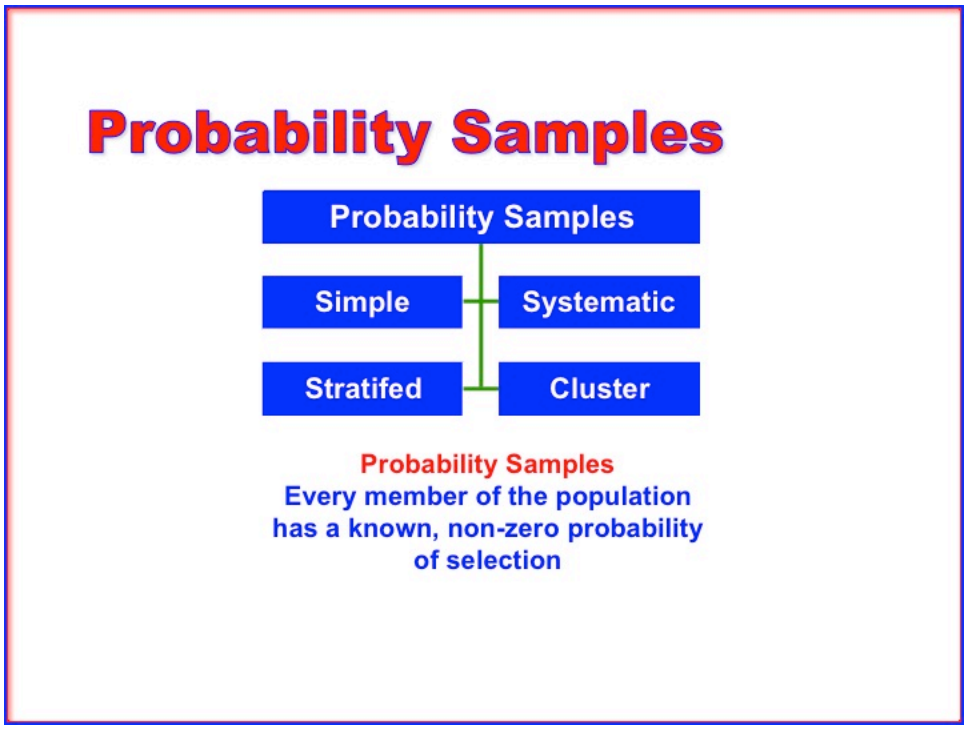


Video

Audio

With Probability Samples every member of the population has a known, non-zero chance of being selected in the sample. There are four basic kinds of Probability Samples: 1) Simple Random Samples, 2) Systematic Samples, 3) Stratified Samples, and .4) Cluster Samples.

With Nonprobability Samples, the probability or chance of any member of the population being selected in a sample is unknown. There are four kinds of Nonprobability Samples: 1) Convenience Samples, 2) Judgment Samples, 3) Quota Samples, and 4) Snowball Samples.



Video

Video shows the four basic Probability Samples.

Audio

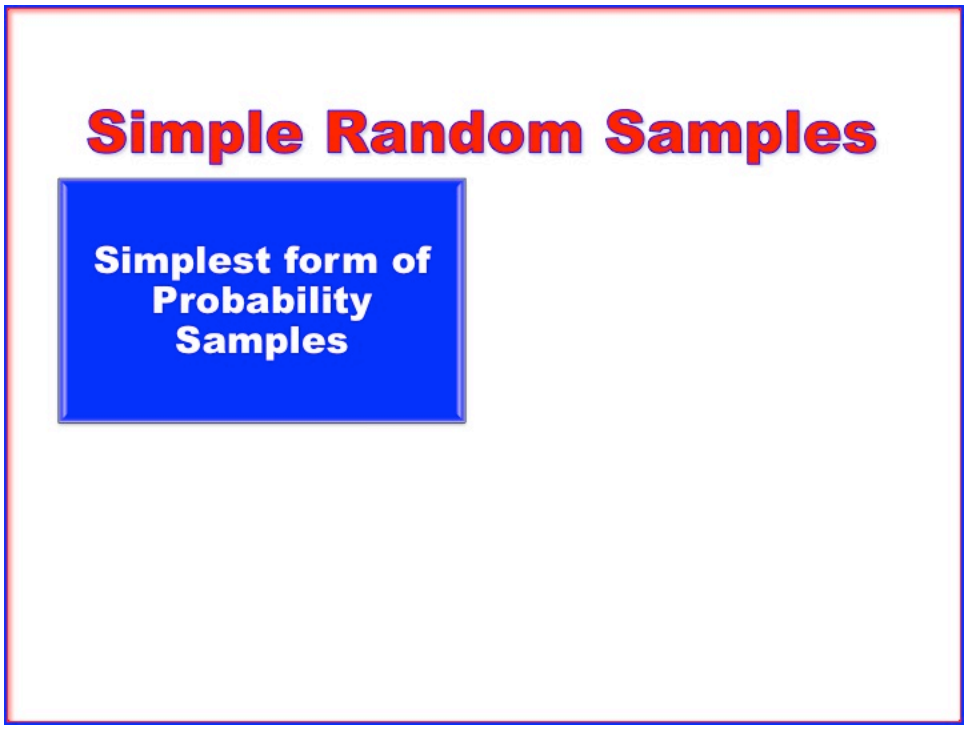
Let's turn to the four basic Probability Samples.

Video

Graphic showing the words, “Simple Random Samples.”

Audio

Let’s start with Simple Random Samples.

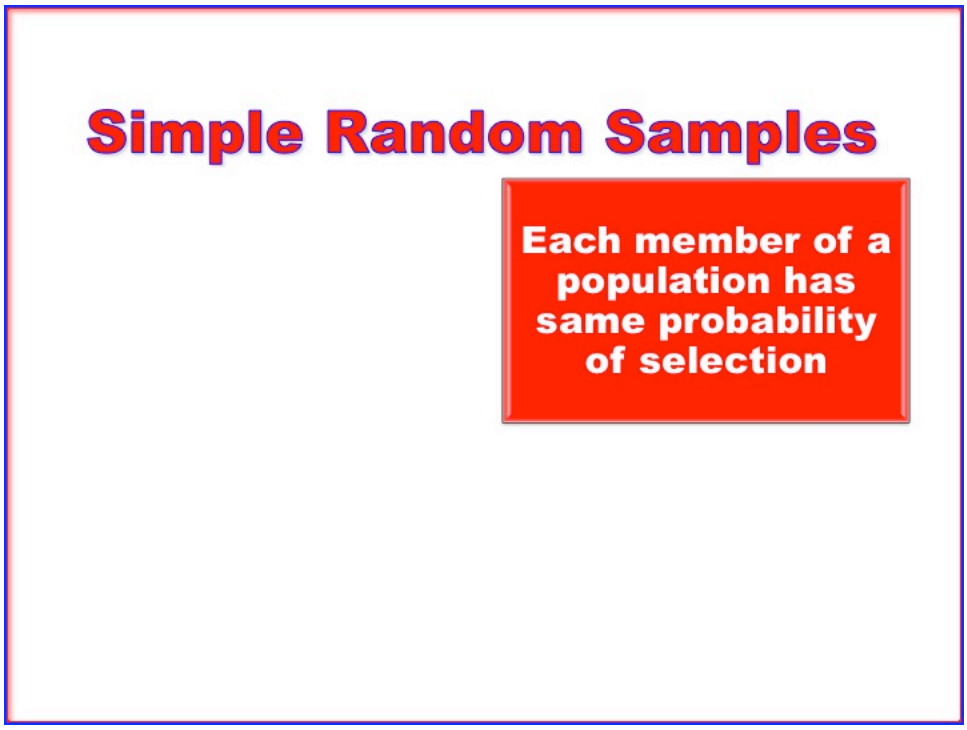


Video

Graphic shows the definition of Simple Random Samples.

Audio

Simple Random Samples, or SRS, are the simplest form of probability samples.

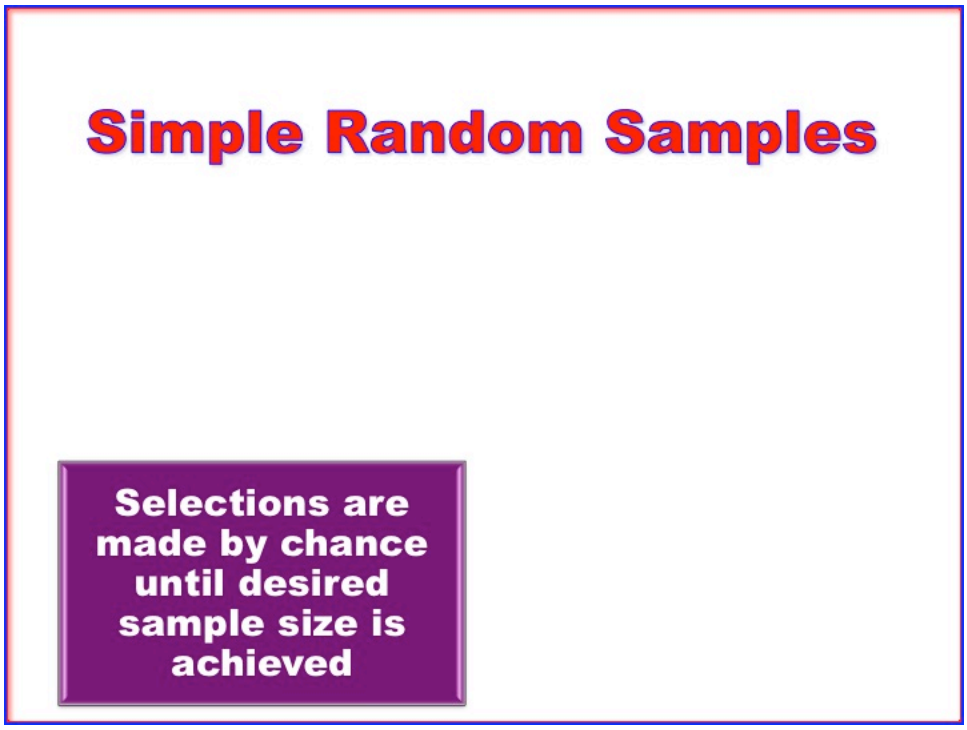


Video

Graphic shows the definition of Simple Random Samples.

Audio

As will all probability samples, each member of the population has the same probability of selection.

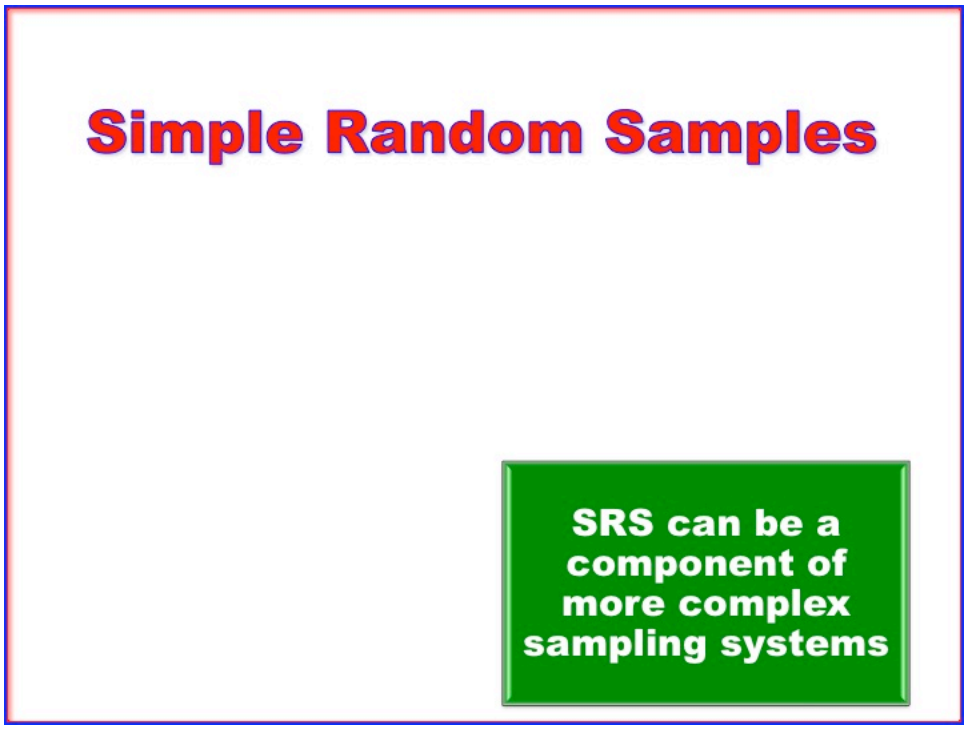


Video

Graphic shows the definition of Simple Random Samples.

Audio

Selections are made by chance, or haphazardly, until desired the sample size is achieved.

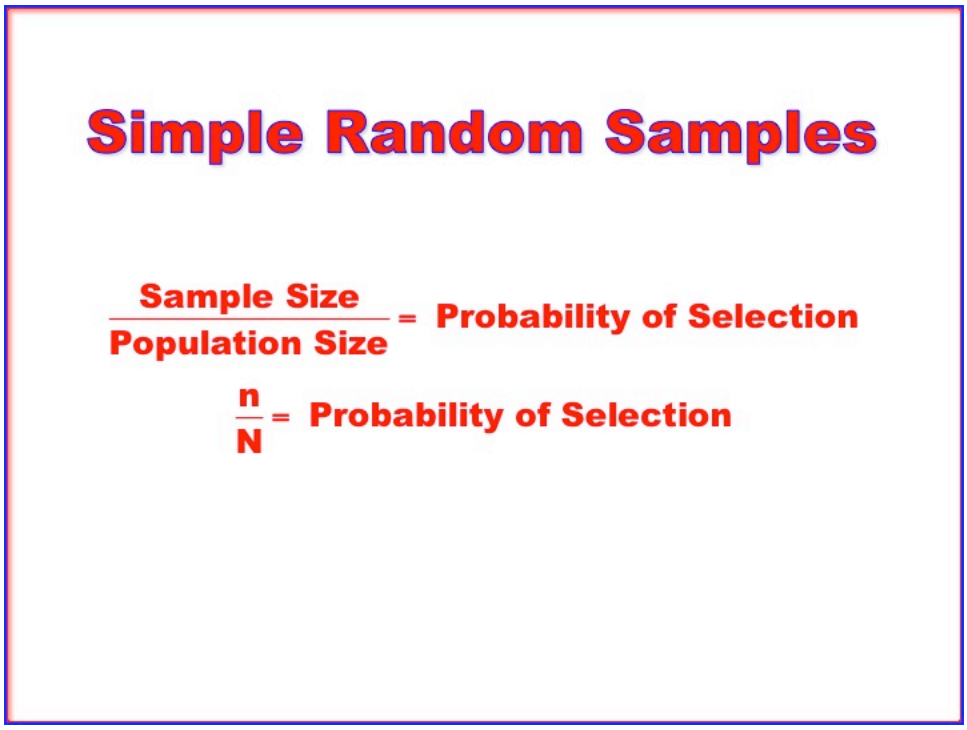


Video

Graphic shows the definition of Simple Random Samples.

Audio

Simple Random Samples are often a component of more complex sampling systems like Stratified and Cluster Samples.



Video

Graphic shows the equation for Simple Random Samples.

Audio

With Simple Random Samples, the probability of selection is defined as the sample size over the population size, or more simply, low case n over upper case N.

Video

Picture of a Mega Millions lottery ticket.

Audio

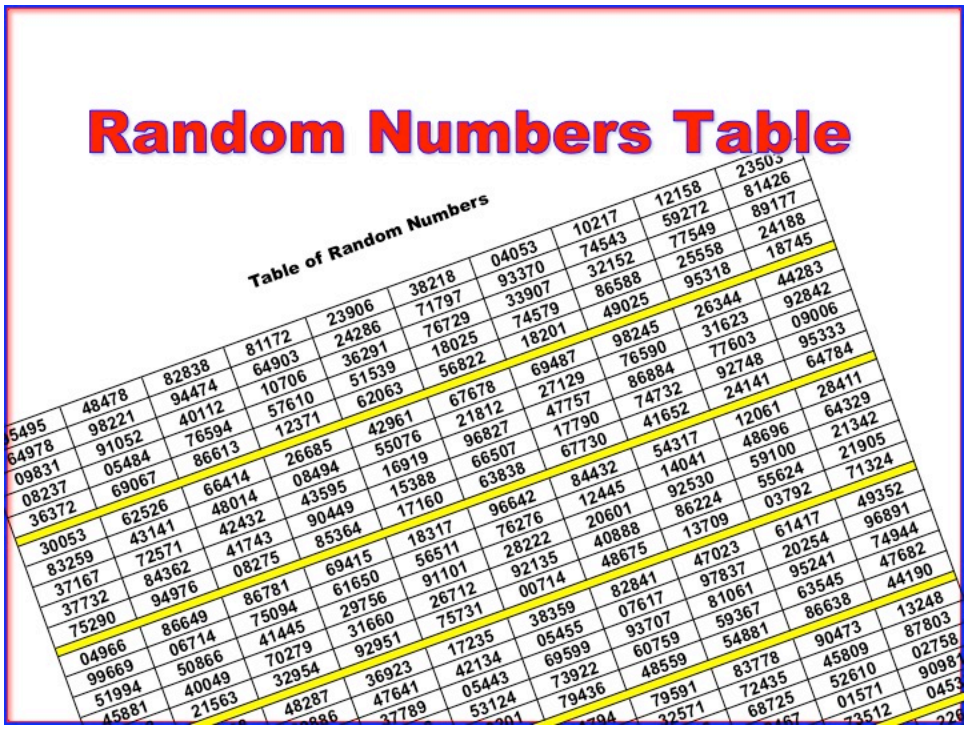
Lotteries use Simple Random Samples. A ball represents each number in the lottery system. The balls are thoroughly mixed and the appropriate number of balls are selected at random. In the extremely unlikely event that your ticket has all the selected numbers, you are the grand prizewinner.

Video

Picture of Newton Baker, Secretary of War during World War I, selecting the names of draftees out of a fish bowl.

Audio

Very often, the U.S. government selected draftees using a lottery method. Here we have Secretary of War, Newton Baker, selecting names out of a fish bowl. Anyone selected had to report for a physical exam. Those who passed this exam were inducted into the Armed Forces.



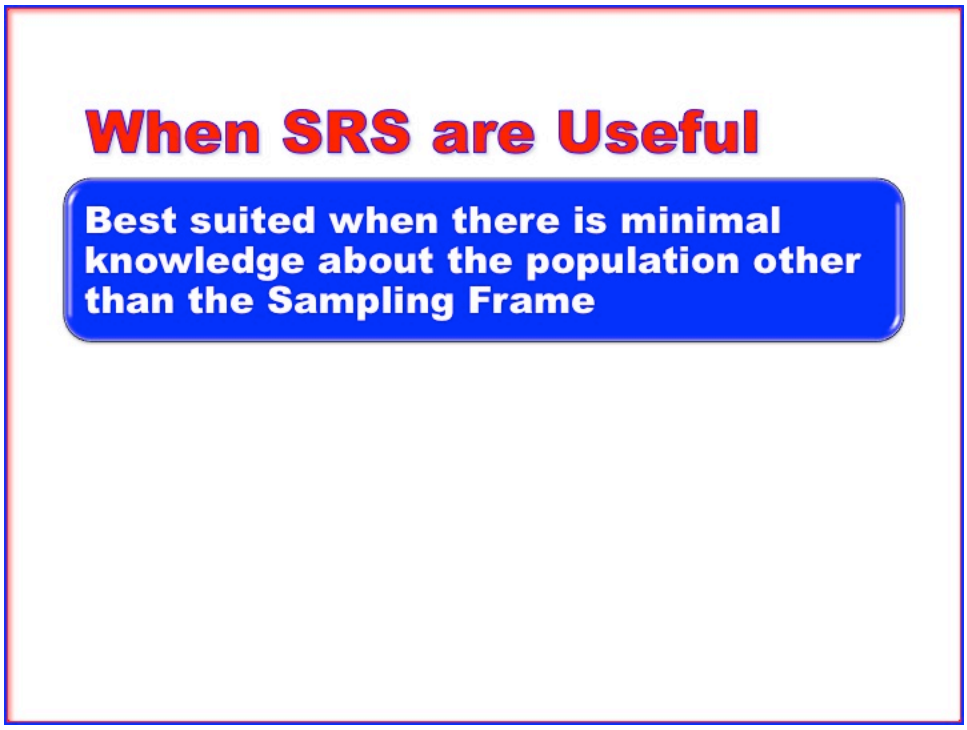
Video

Picture of a Random Numbers Table.

Audio

A table of random numbers generated by a computer can be used to select a Simple Random Sample. Here is how we can do this.

1) Determine a starting point on the table by closing your eyes and placing the point of your pencil somewhere in the table.
2) Using this starting point, begin reading the numbers in the table either across the rows or down the columns.
3) If your population consists of 99 or fewer elements, read the numbers in two-digit units: For 999 or fewer elements in the population, read the numbers in three-digit units, and so forth.
4) If a table number is larger than the number of elements in the population (for example, if the table number is 323 and the your population total is 286), skip that number and read the next.
5) If you come to a number you have already drawn, skip it and go to the next number. Remember, you cannot include any population element more than once.
6) Continue until you have selected as many valid numbers as required to meet your sample size requirement.

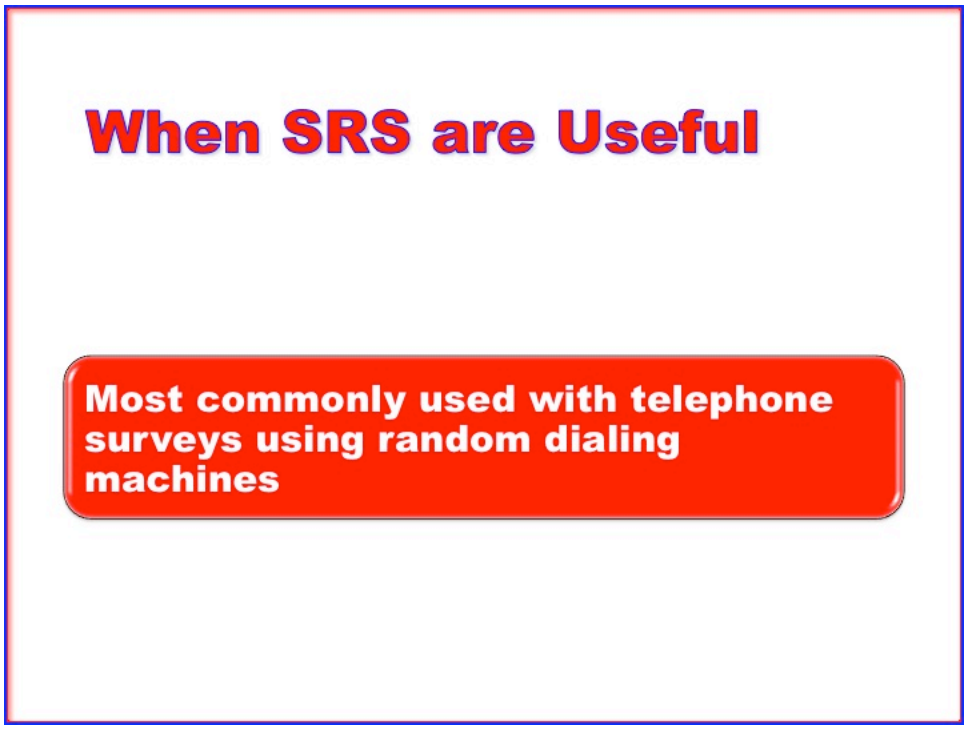


Video

Graphic showing the occasions when Simple Random Samples are useful.

Audio

Simple Random Samples are best suited when there is minimal knowledge about the population other than the Sampling Frame.



Video

Graphic showing the occasions when Simple Random Samples are useful.

Audio

They are most commonly used with telephone surveys using random dialing machines.

Video

Graphic showing the occasions when Simple Random Samples are useful.

Audio

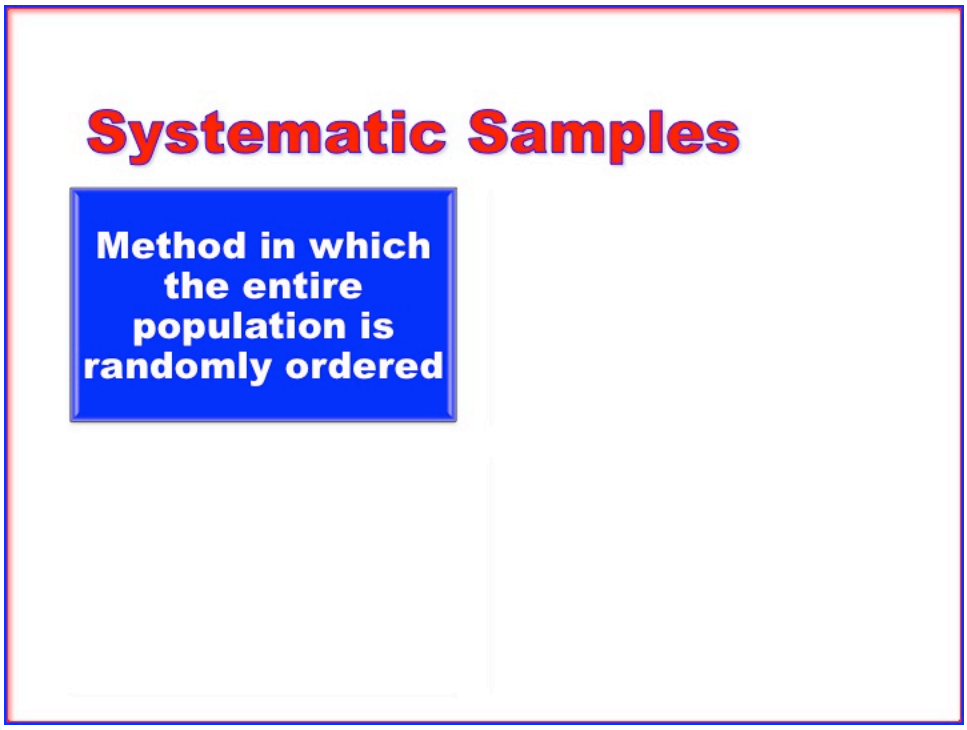
With Simple Random Samples, the selection process can be laborious, so they are best used with small populations.

Video

Graphic with the words, “Systematic Samples.”

Audio

Let’s turn to Systematic Samples.

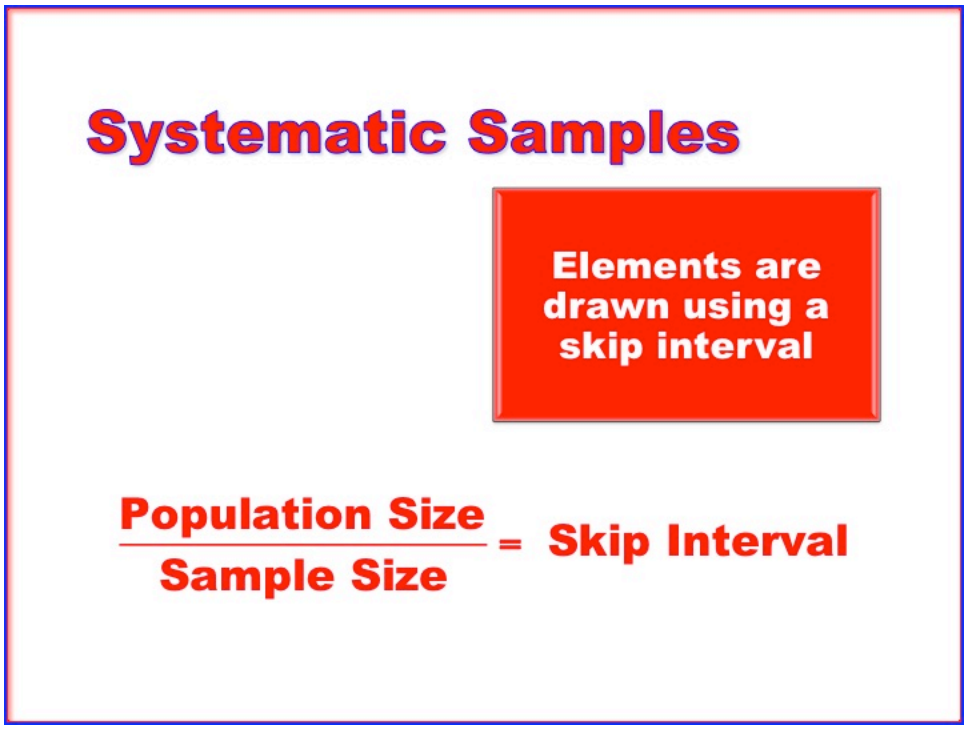


Video

Graphic shows the definition of Systematic Samples.

Audio

Systematic Samples are a variant of Simple Random Samples. With Systematic Samples the population is randomly ordered because the researcher must be certain that the order does not contain hidden biases. The order of a telephone directory would be unacceptable Sample Frame because a person's last name is highly associated with ethnicity. A better solution would be to assign each population element a random number and sort the population on that random number.

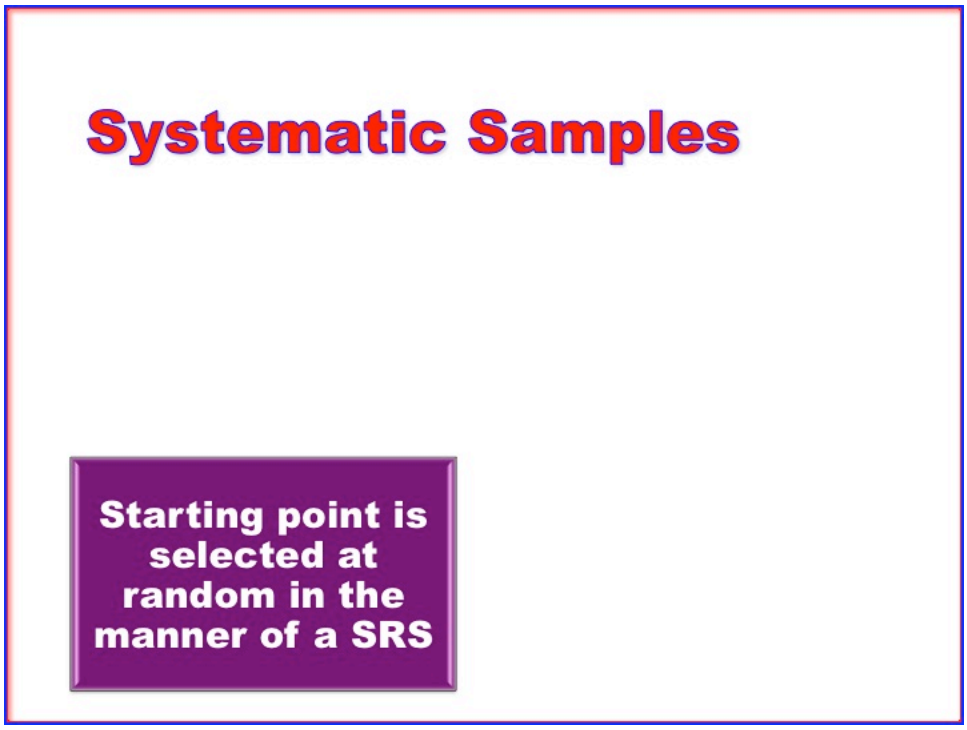


Video

Graphic shows the formula for Systematic Sample "Skip Intervals."

Audio

Population Elements are drawn using a skip interval. The skip interval is defined as the Population Size over the Sample Size.

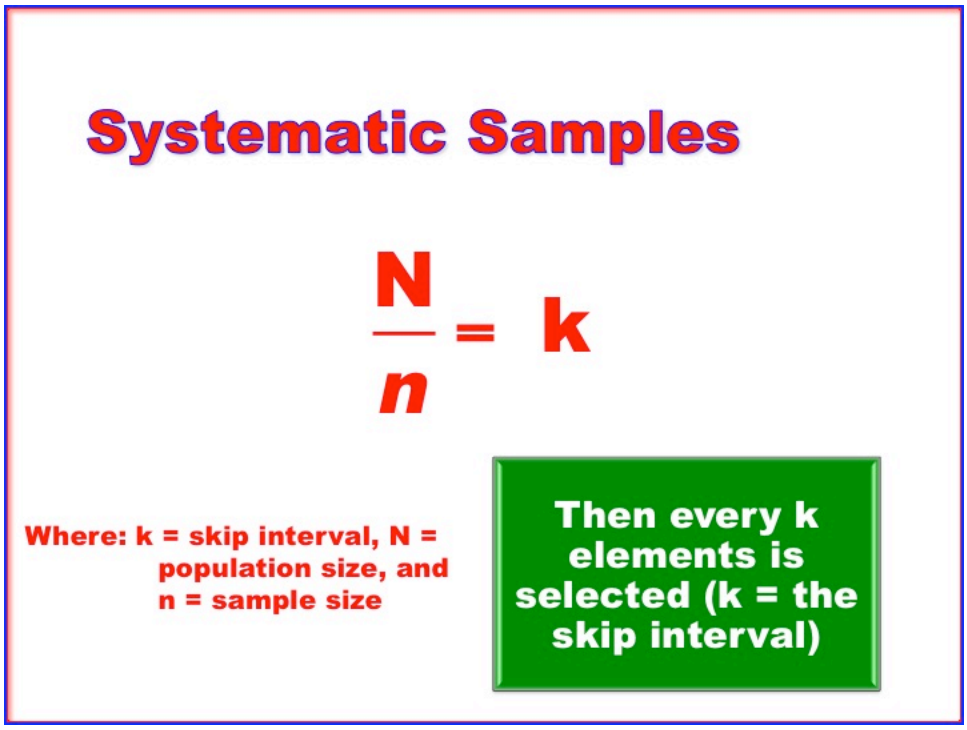


Video

Graphic shows the definition of Systematic Samples.

Audio

The starting point is selected at random in the manner of a Simple Random Sample.

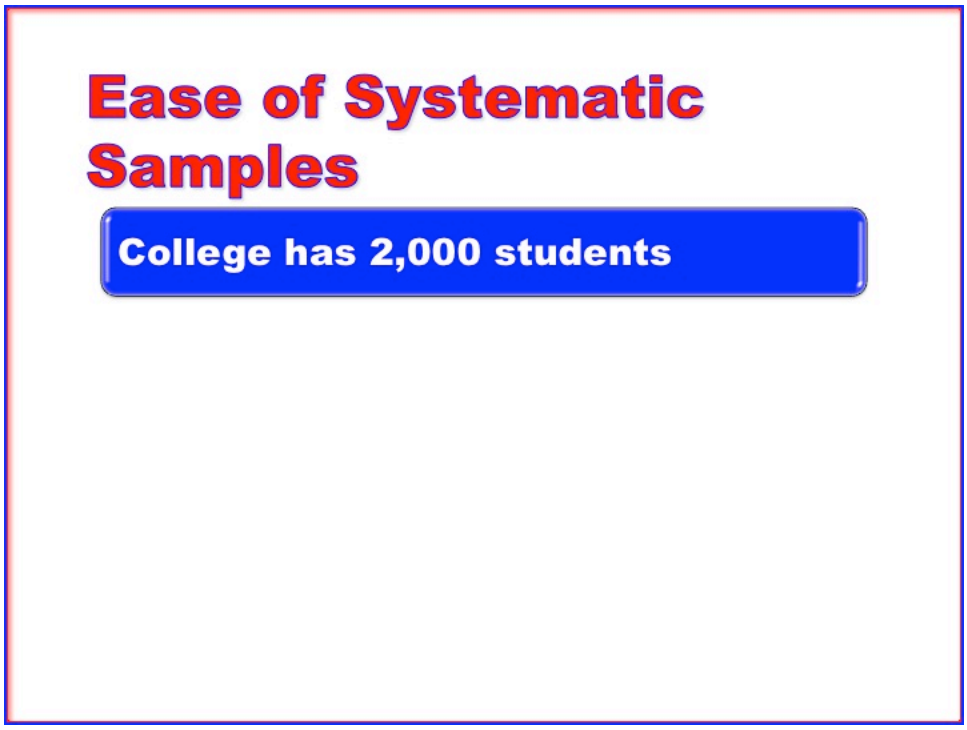


Video

Graphic shows the definition of Systematic Samples.

Audio

Then every k element is selected where k = the skip interval.

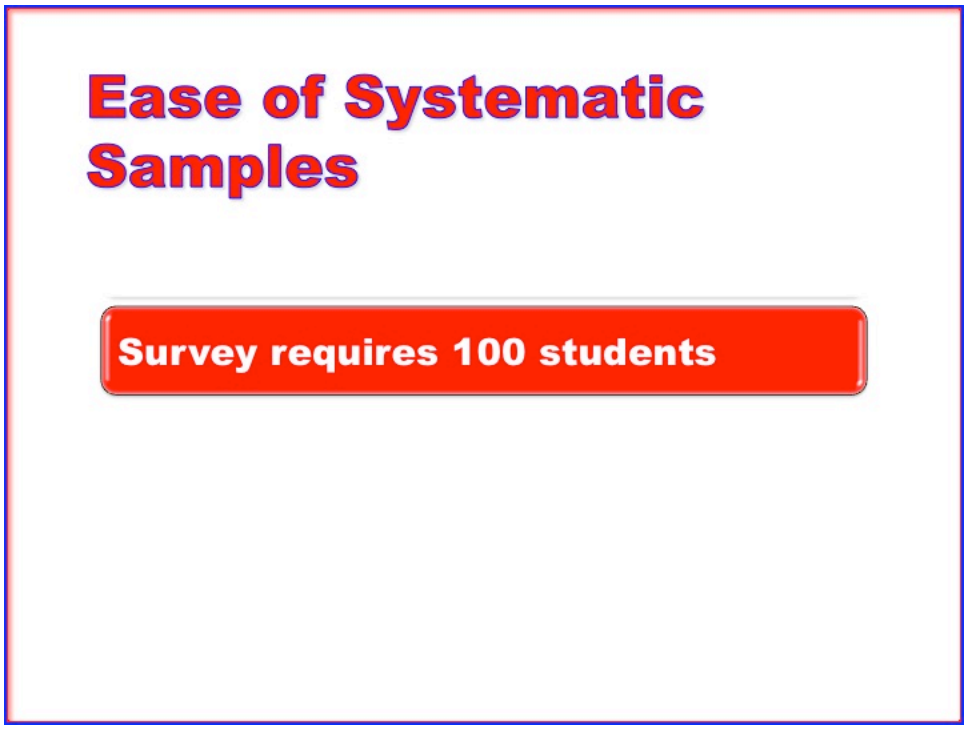


Video

Graphic shows an example of Systematic Samples.

Audio

Here is an example of a Systematic Sample. Let's say we want to sample students in a college that has 2,000 students.

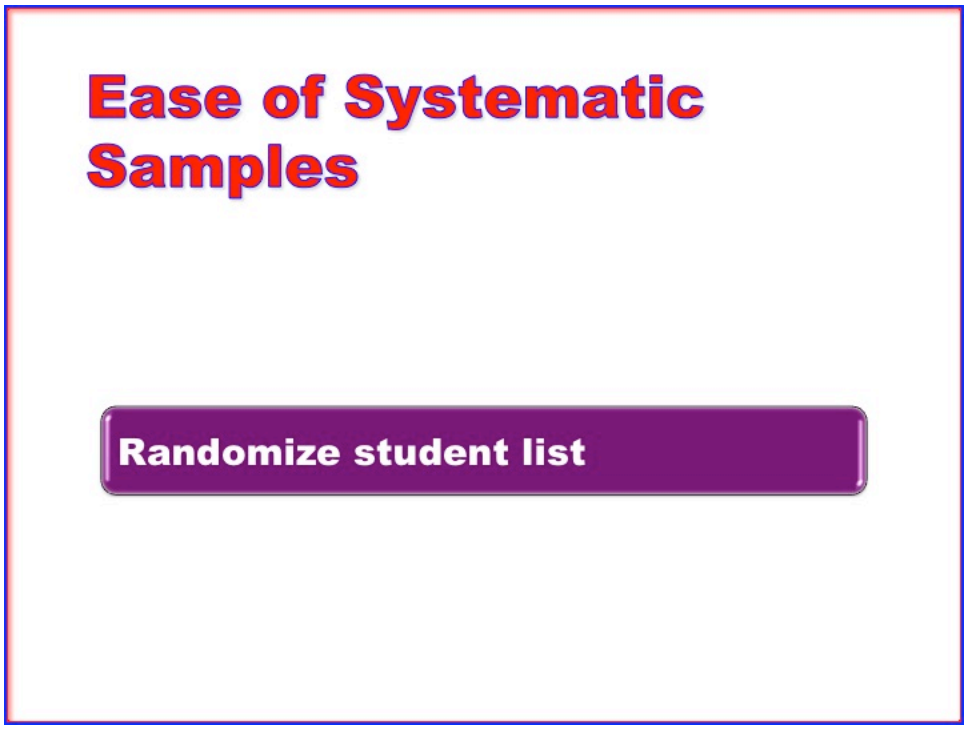


Video

Graphic shows an example of Systematic Samples.

Audio

And, we want a sample of 100 students.

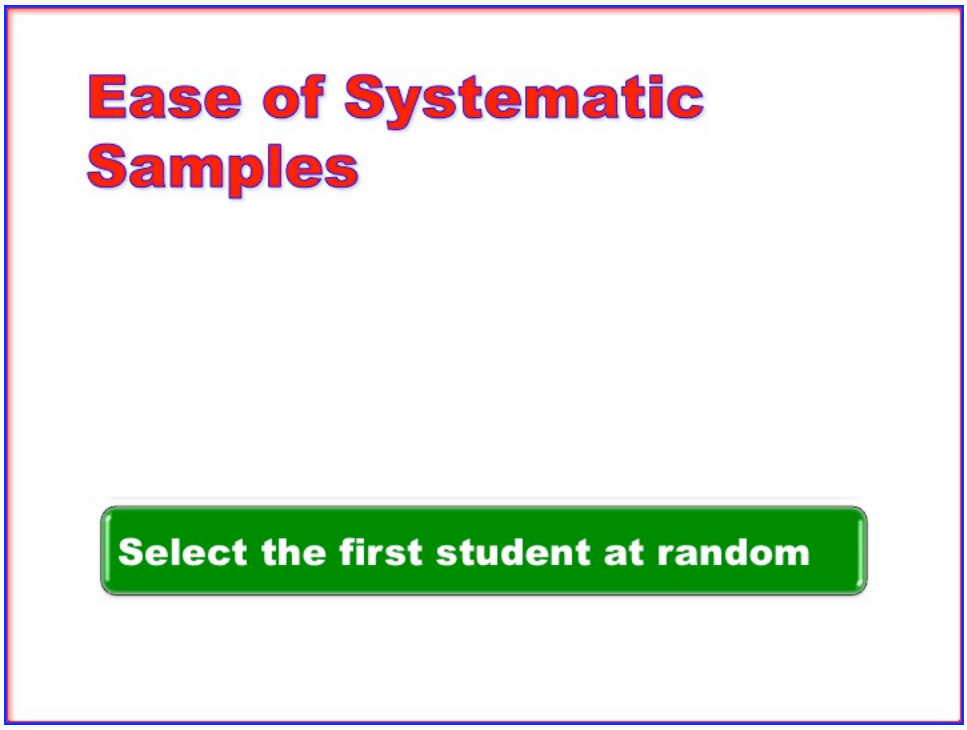


Video

Graphic shows an example of Systematic Samples.

Audio

We randomize the order of students in our Sample Frame using random numbers.



Video

Graphic shows an example of Systematic Samples.

Audio

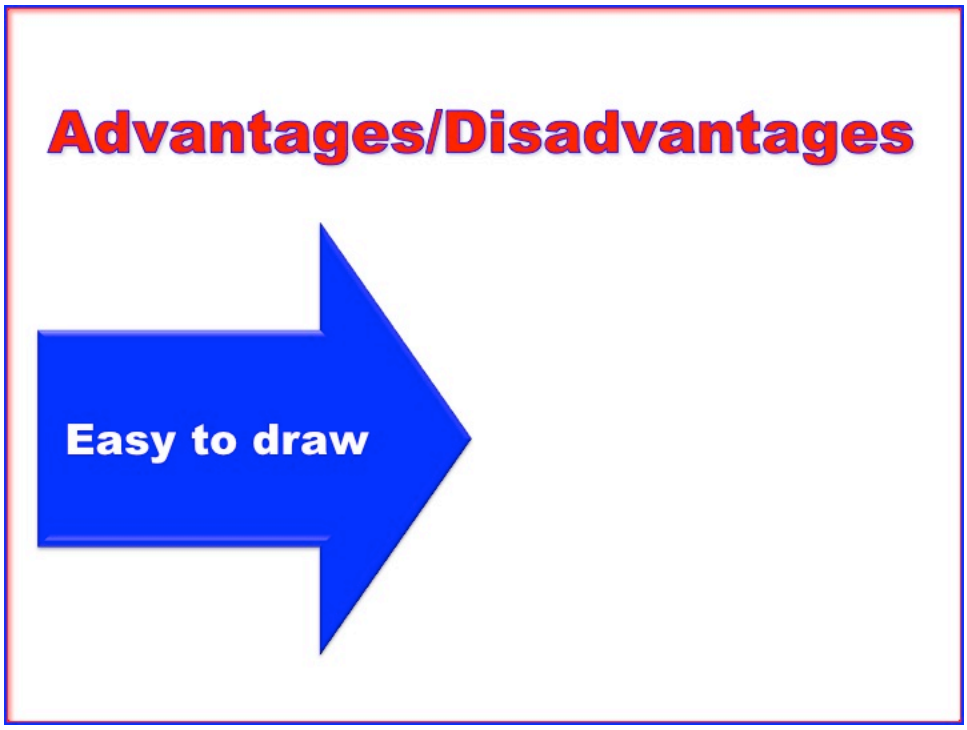
We then select the first student at random using a lottery or random number table system.

Video

Graphic shows an example of Systematic Samples.

Audio

Then we select every 20th student on the list, 100/2,000 = 20.



Video

Graphic showing the Advantages and Disadvantages of Systematic Samples.

Audio

The big advantage of Systematic Samples is that they are easy to draw, easier than Simple Random Samples.

Video

Graphic showing the Advantages and Disadvantages of Systematic Samples.

Audio

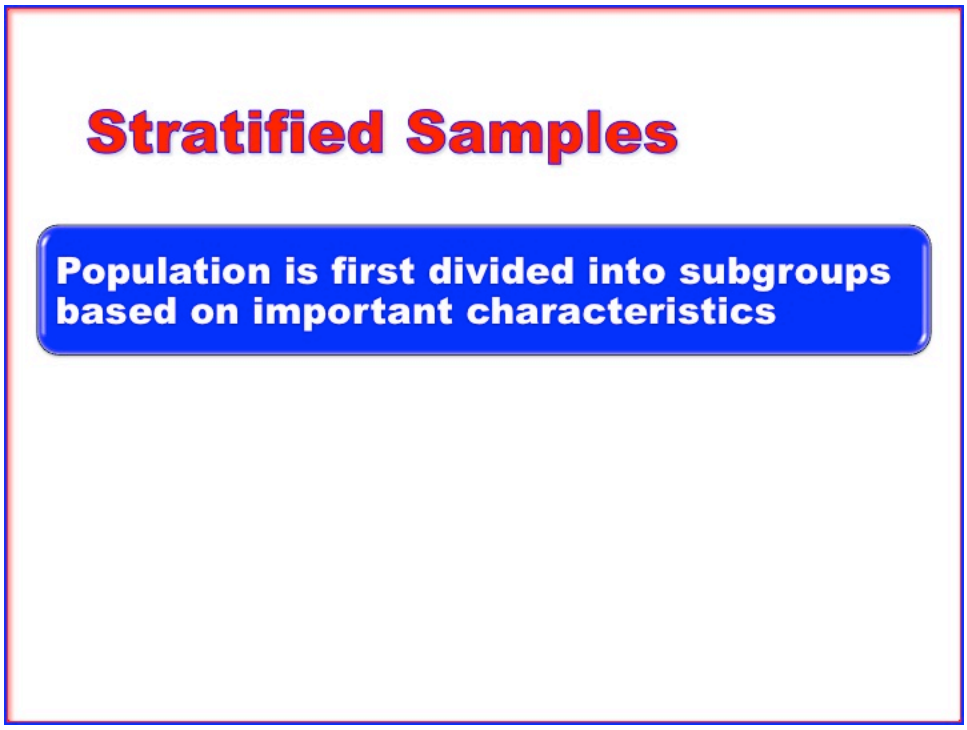
The disadvantage of Systematic Samples is that the population order may introduce bias.

Video

Graphic showing the words, “Stratified Sample.”

Audio

The next Probability Sample is Stratified Samples.

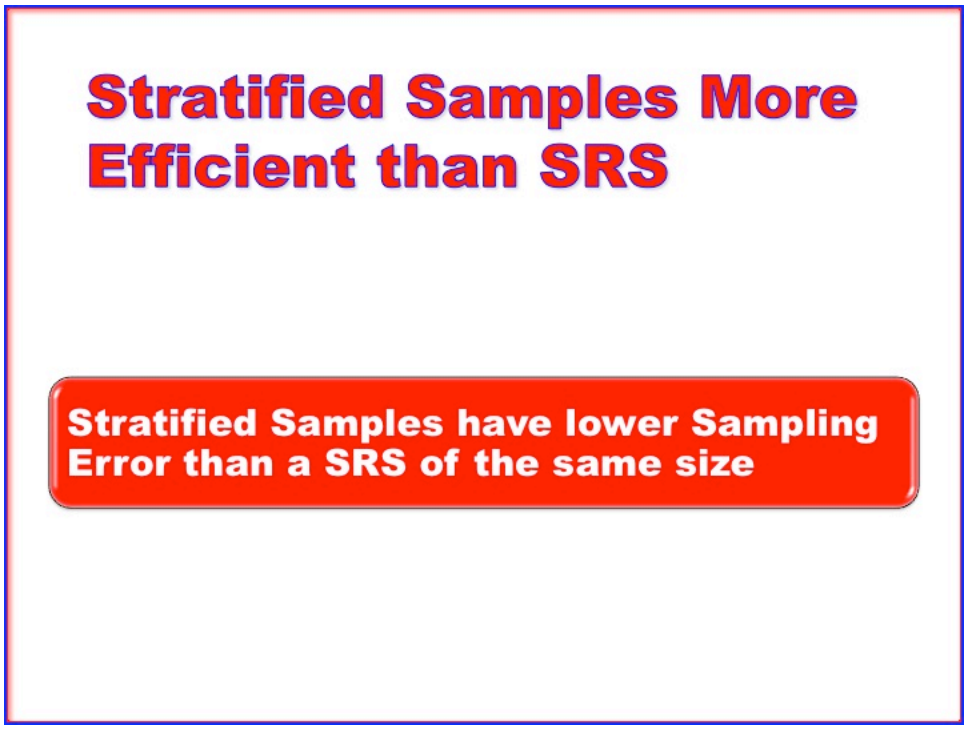


Video

Graphic should the steps to draw a Stratified Sample.

Audio

To draw a Stratified Sample, the population is first divided into subgroups or strata based on important characteristics. These sub-groups are mutually exclusive and collectively exhaustive. Mutually exclusive means that no population element can be in more than one stratum, and collectively exhaustive means that every population element must belong in one stratum.



Video

Graphic should the steps to draw a Stratified Sample.

Audio

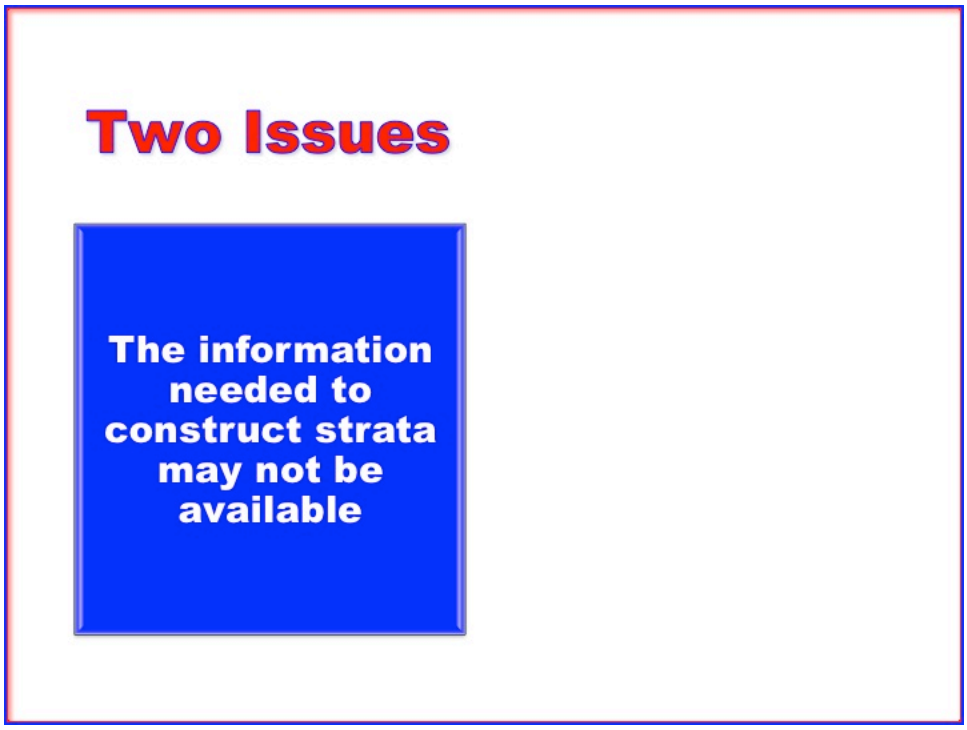
Stratified Samples have lower Sampling Error than an Simple Random Sample of the same size.

Video

Graphic should the steps to draw a Stratified Sample.

Audio

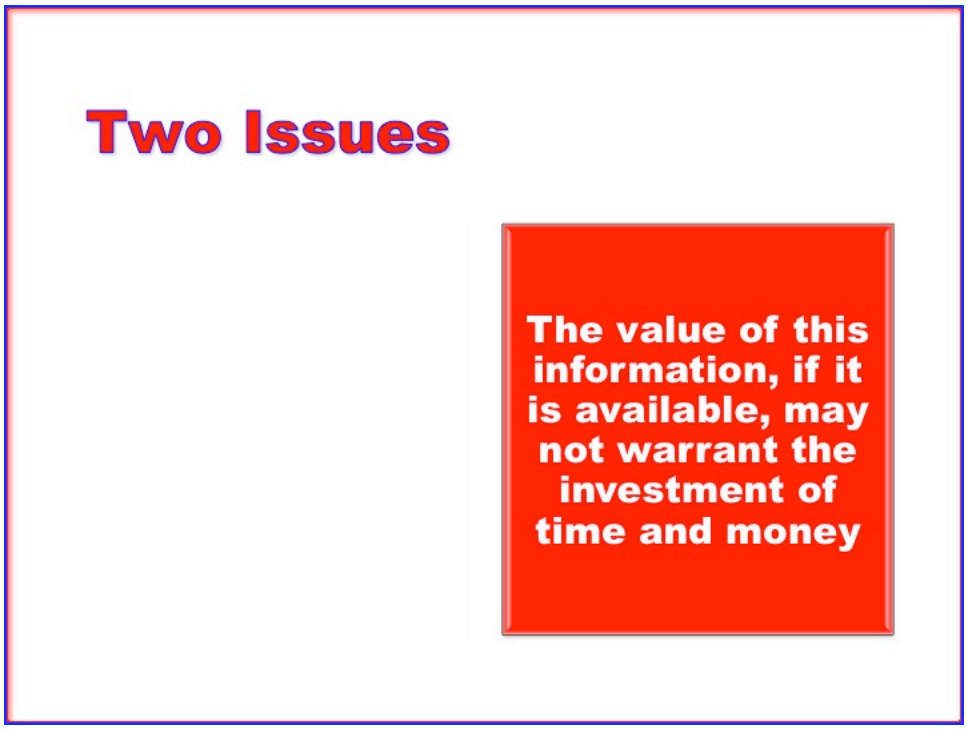
Reduced Sampling Error, therefore, can be achieved with smaller sample sizes.



Video
Graphic show issues related to Stratified Samples.

Audio
There are two critical issues with Stratified Samples.

1) The information needed to construct strata may not be available. The demographic, psychographic, or usage patterns needed to define the strata can be difficult or impossible to obtain.



Video
Graphic show issues related to Stratified Samples.

Audio
2) The value of this information, if it is available, may not warrant the investment of time and money.

Stratified Samples cannot be based on hunches or guesswork. This why is this sampling method is not widely used in marketing research. Stratified Samples are more often used in political polling and media audience research because the necessary information is more likely to be available.

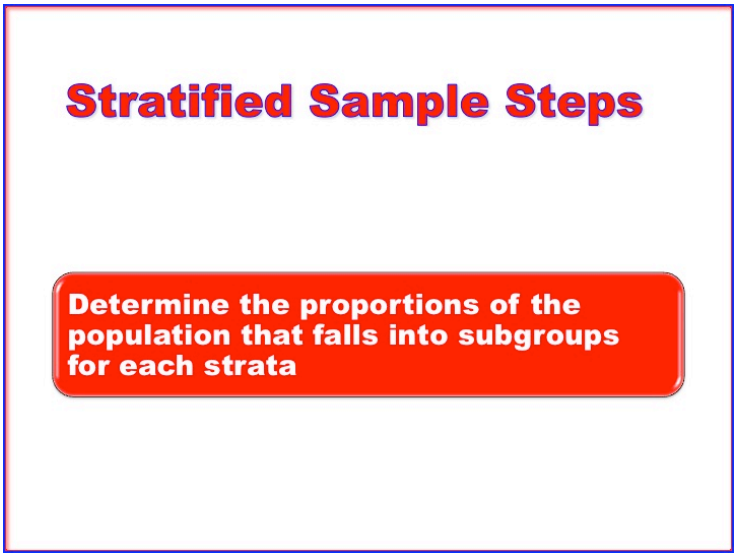
Video

Graphic should the steps to construct a Stratified Sample.

Audio

There are three steps required to produce a stratified sample.

1) Identify important factors to construct the stratum.

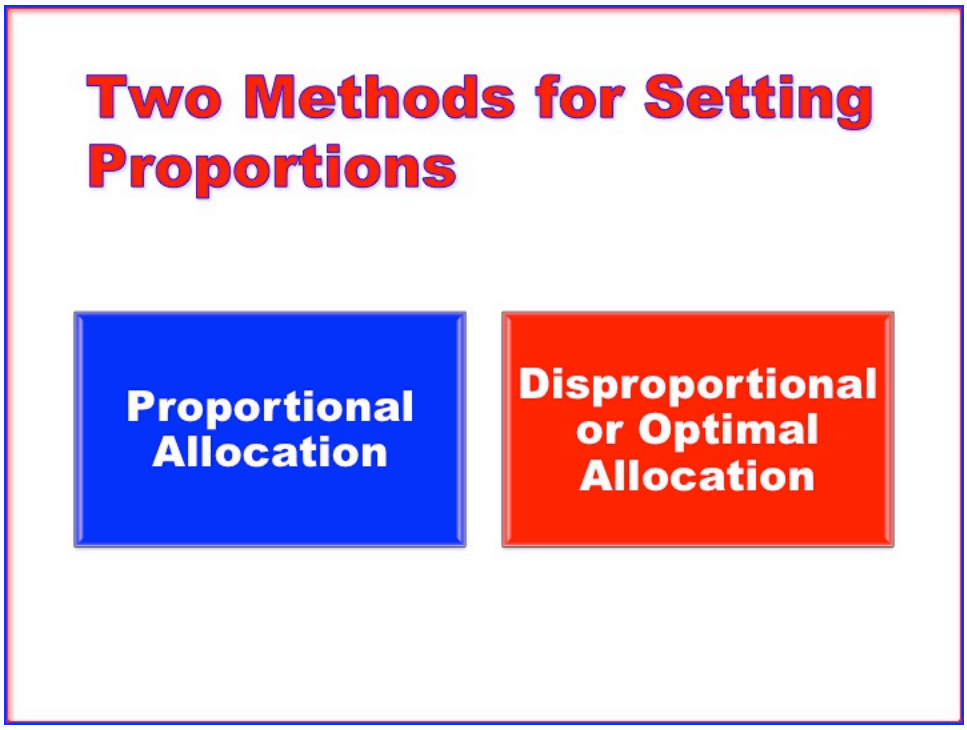


Video

Graphic should the steps to construct a Stratified Sample.

Audio

2) Determine the proportions of the population that fall into subgroups for each stratum.



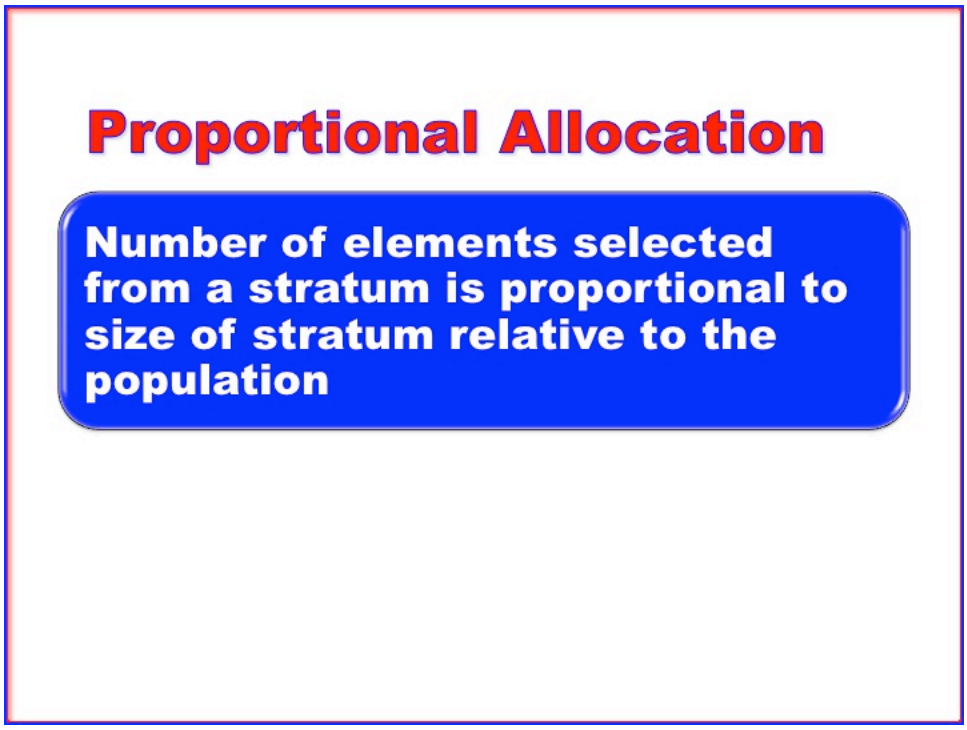
Video

Graphic should the two methods for setting proportions used in Stratified Samples.

Audio

There are two methods for setting proportions for Stratified Samples:

1) Proportional Allocation
2) Disproportional, or Optimal, Allocation

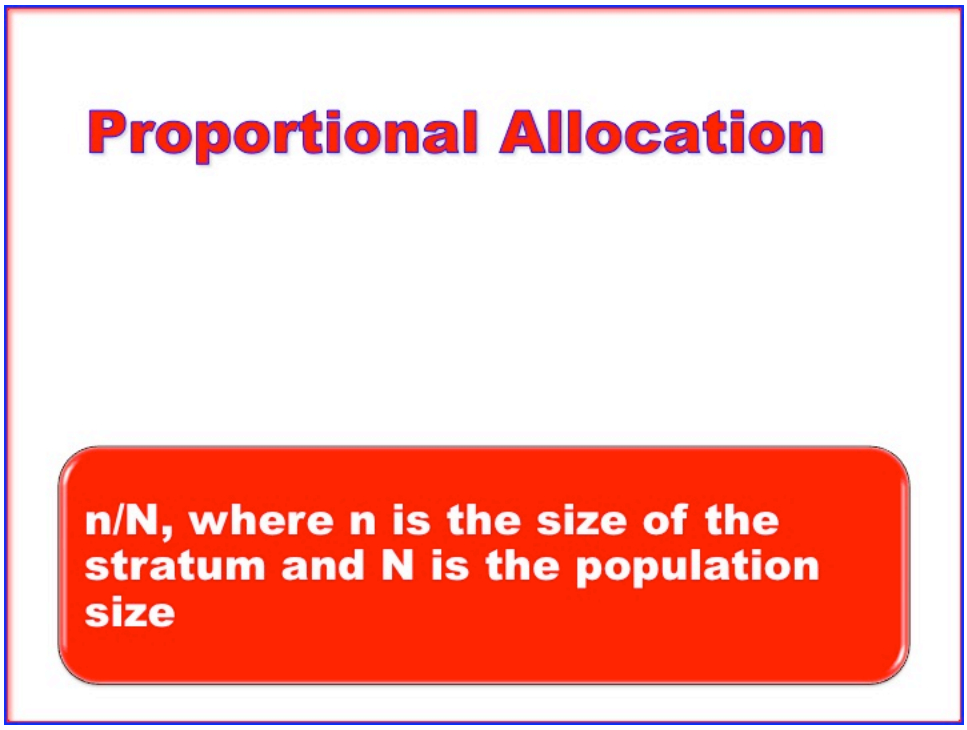


Video

Graphic shows the definition of Proportional Allocation.

Audio

With Proportional Allocation the number of elements selected from a stratum is proportional to size of stratum relative to the population.

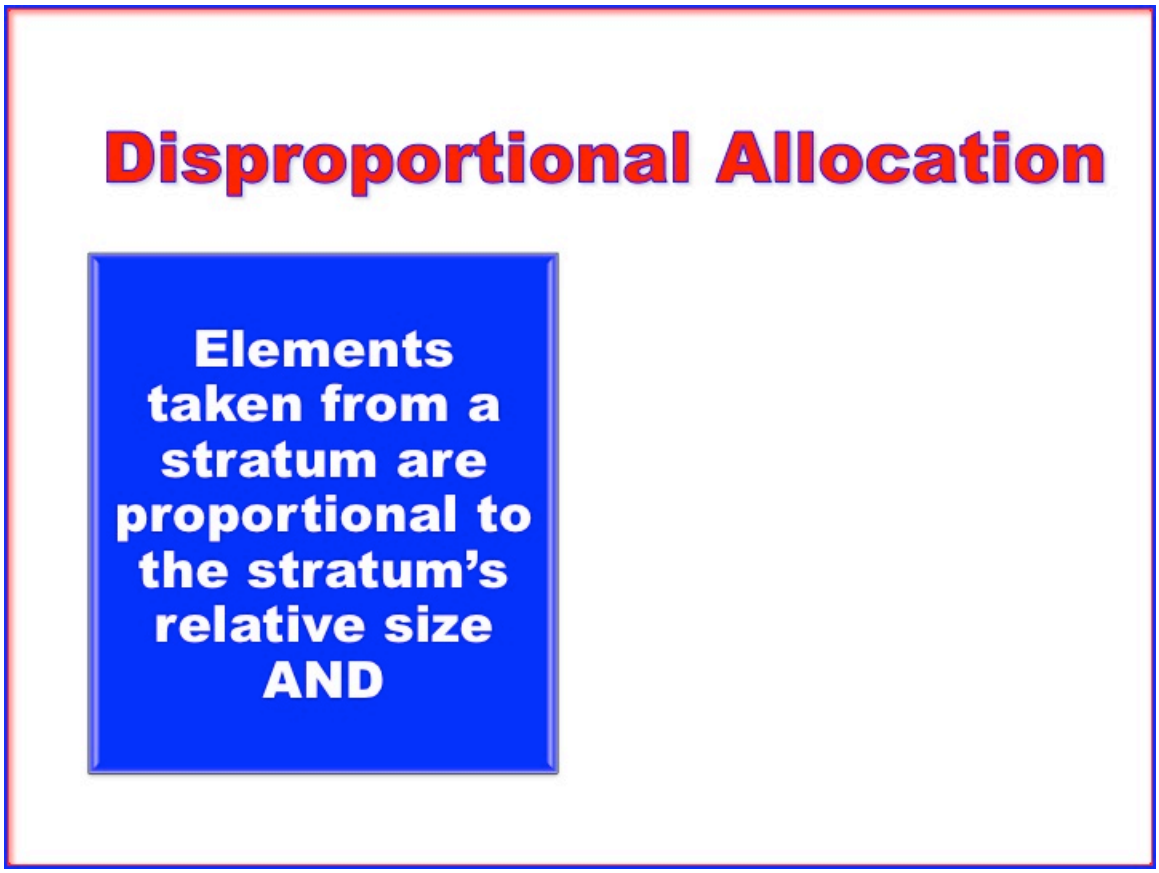


Video

Graphic shows the formula for Proportional Allocation.

Audio

This is represented by the formula lower case n/upper case N, where lower case n is the size of the stratum and upper case N is the population size.

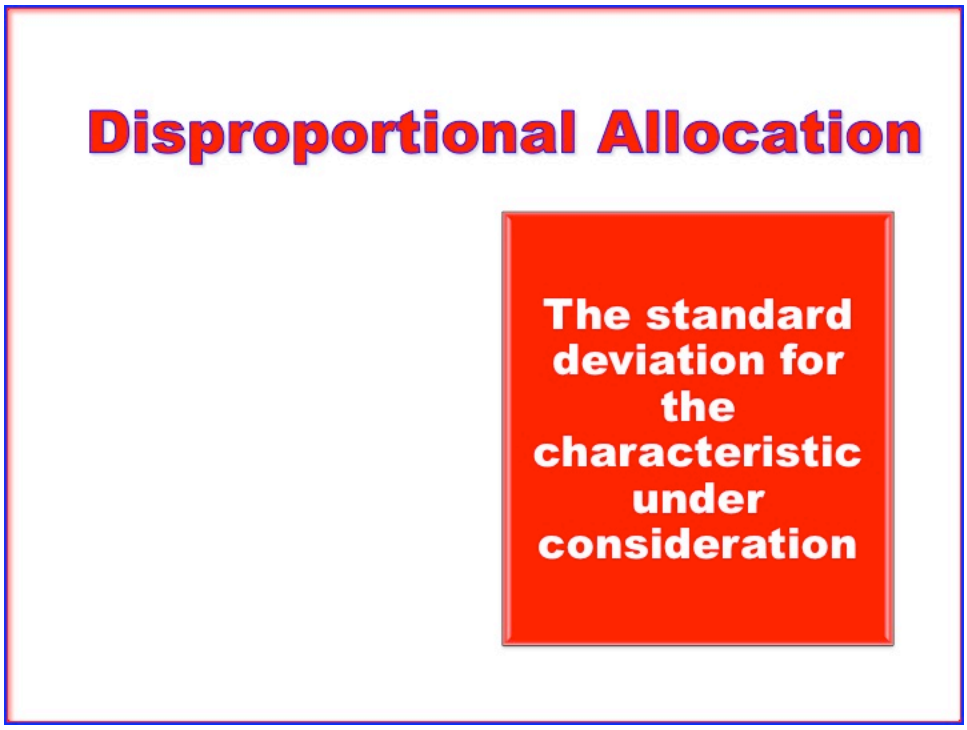


Video

Graphic shows the definition of Disproportional Allocation.

Audio

Like Proportional Allocation, elements taken in a Disproportional Allocation are proportional to the stratum's relative size, and …

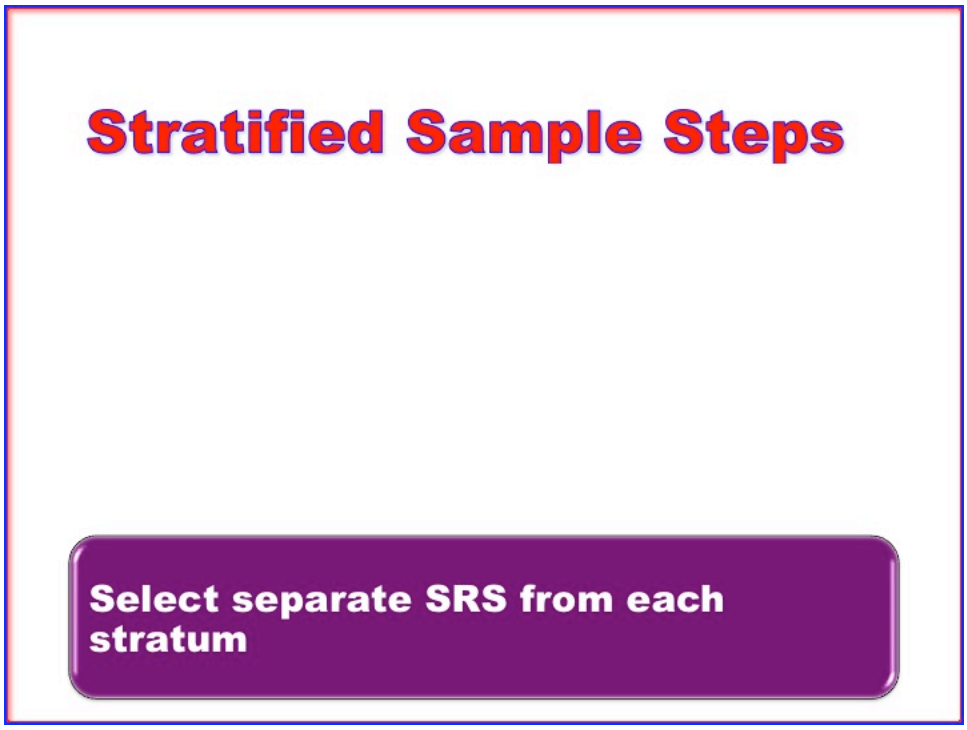


Video
Graphic shows the definition of Disproportional Allocation.

Audio
…the standard deviation for the characteristic under consideration.

This method provides a more reliable estimate for a given sample size. Allocating more of the sample from strata with more variability—higher standard deviations—means that these strata will have a greater number of elements. This makes sense because strata with greater variability are more likely to distort the sample. Adding to this strata will reduce the likelihood of such distortion.

If each strata has roughly equal standard deviations, there is no practical difference between Proportional and Disproportional allocations.

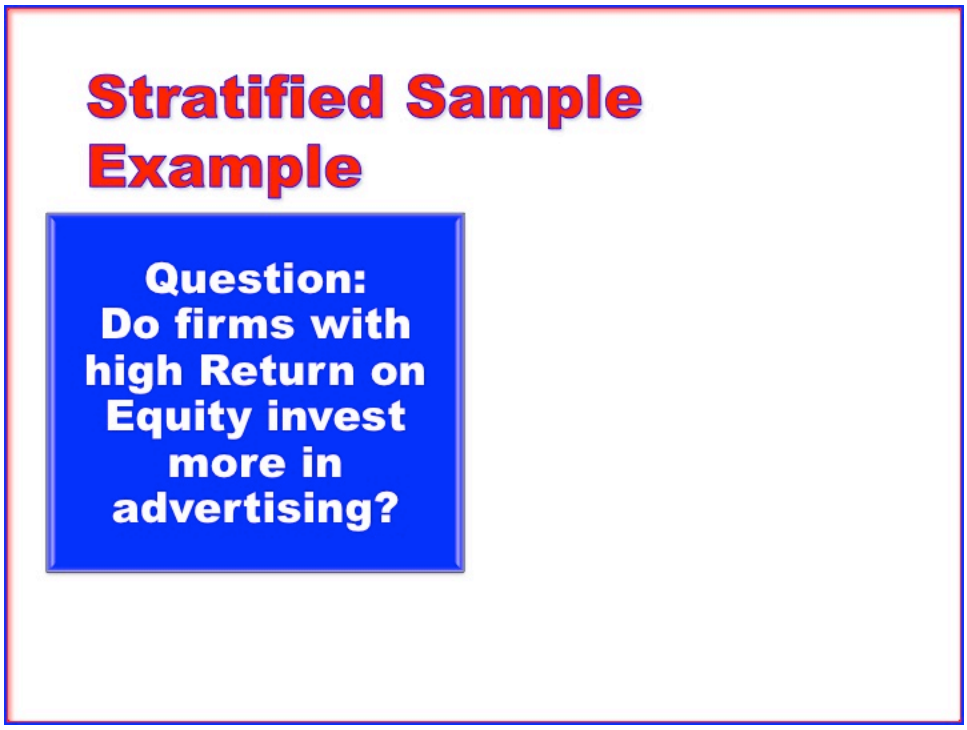


Video

Graphic should the steps to construct a Stratified Sample.

Audio

3) Select separate Simple Random Samples from each stratum.



Video

Graphic shows an example of a Stratified Sample.

Audio

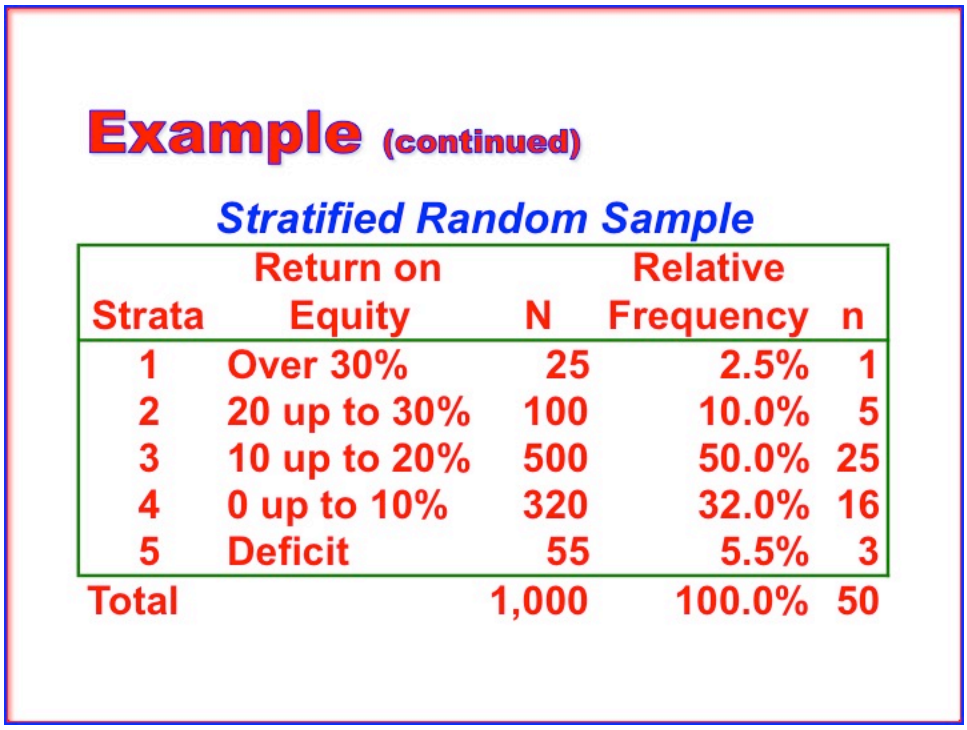
Let's look at an example. The question we want to answer is: Do firms with high Return on Equity invest more in advertising?

Video

Graphic shows an example of a Stratified Sample.

Audio

To make the sample representative, companies are grouped or stratified by Return on Equity



Video

Graphic shows an example of a Stratified Sample.

Audio

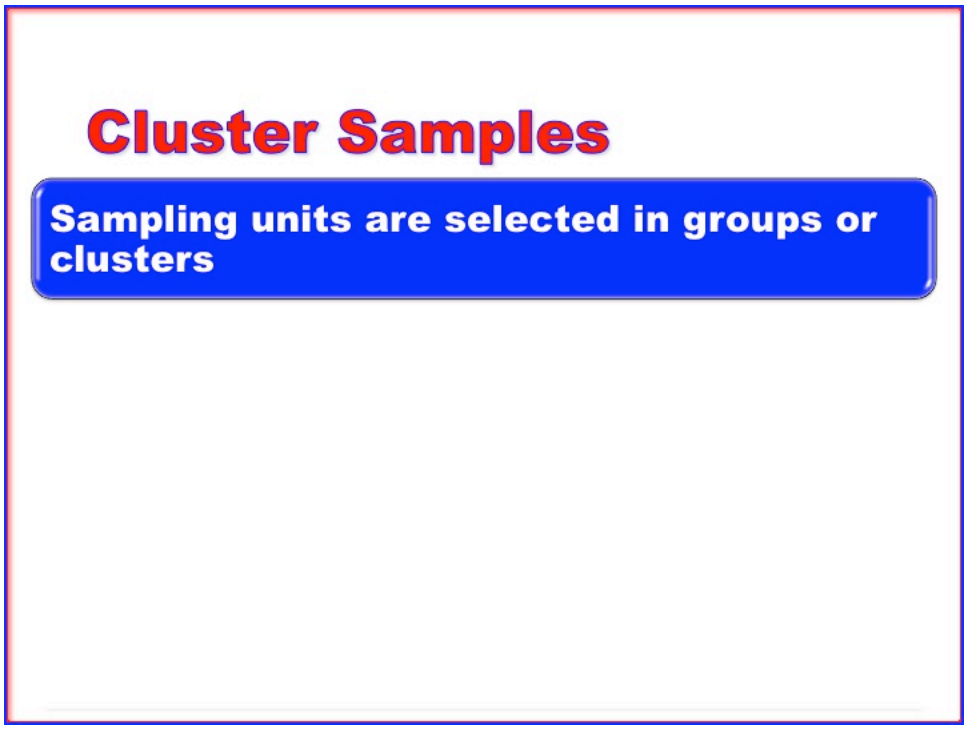
We have a population of 1,000 firms stratified by Return on Equity. We have determined that we need a sample of 50 companies. Based on the relative frequencies for each strata, we determined number of companies we sample from each strata. We then conduct a Simple Random Survey from each strata to fill our quota.

Video

Graphic shows the word, “Cluster Samples.”

Audio

Now let’s review the last of the four Probability Samples, Cluster Samples.

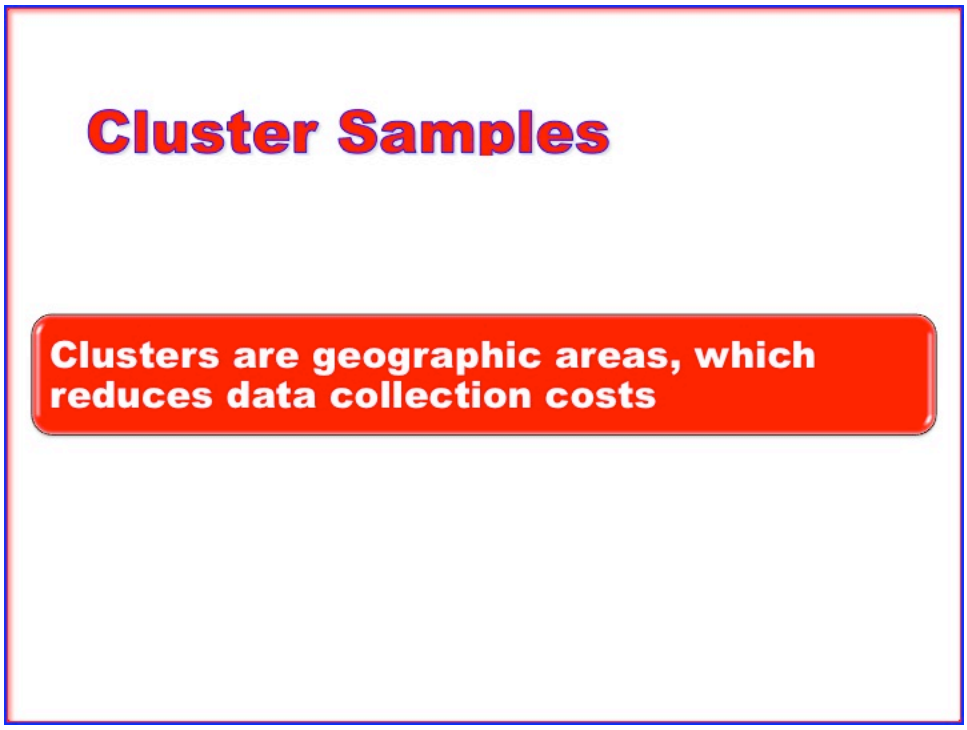


Video

Graphic shows the definition of Cluster Samples.

Audio

Cluster Samples are based on sampling units selected in groups or clusters. But, unlike Stratified Samples, not all the clusters are used in the sample.

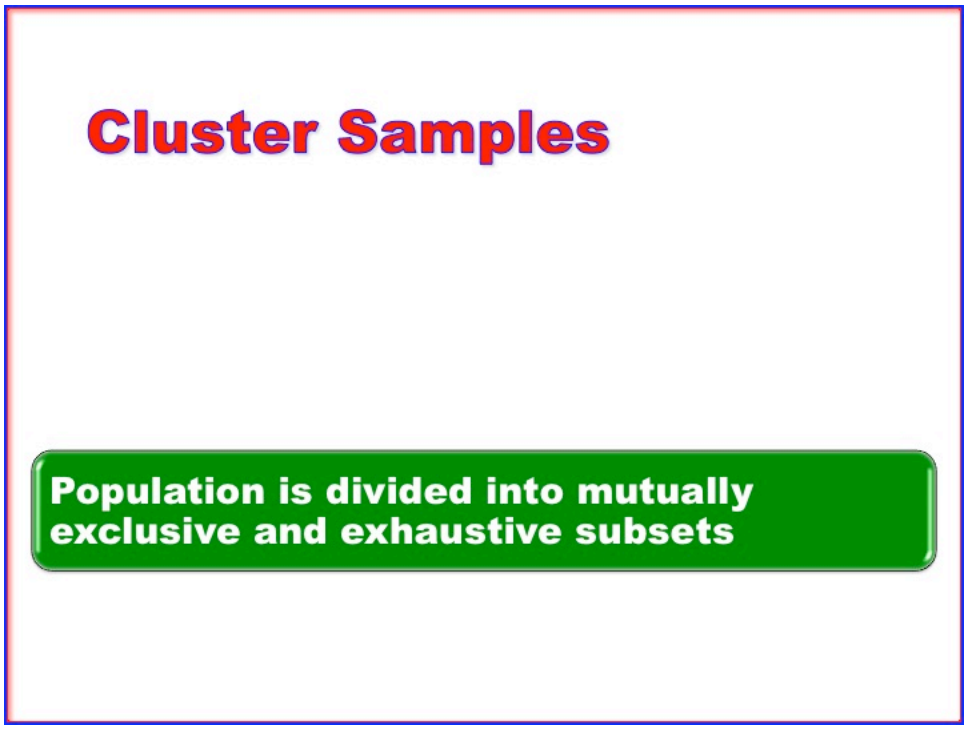


Video

Graphic shows the definition of Cluster Samples.

Audio

Typically, clusters are geographic units. Geographic clusters have the important advantage of reducing data collection costs.

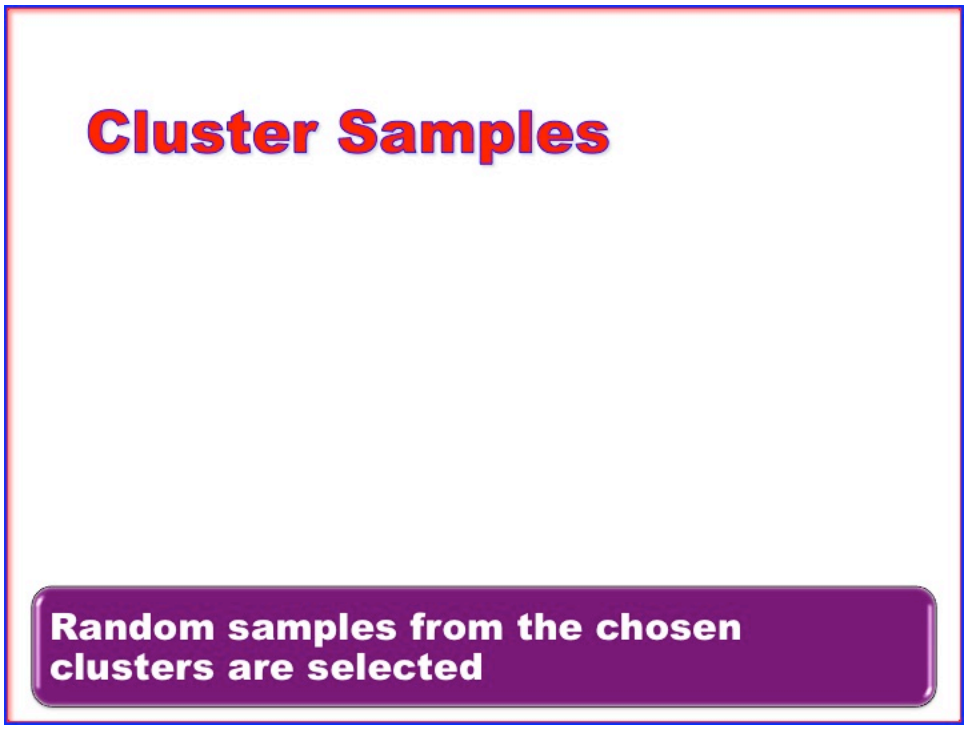


Video

Graphic shows the definition of Cluster Samples.

Audio

The population of interest is divided into mutually exclusive and exhaustive clusters.

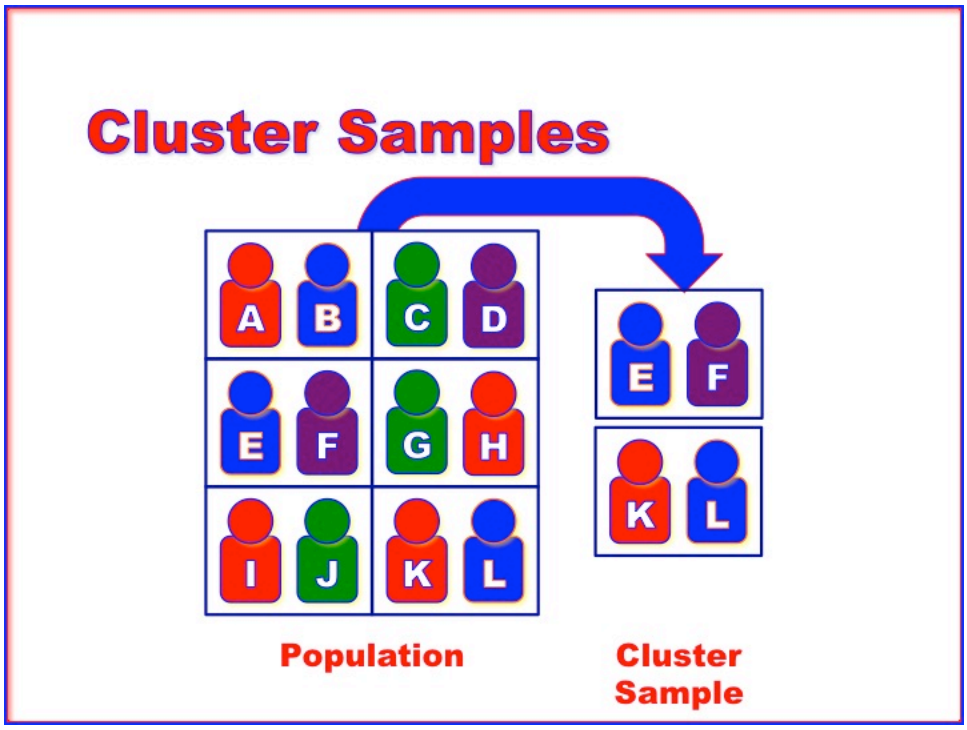


Video

Graphic shows the definition of Cluster Samples.

Audio

Random samples from chosen subsets are selected.

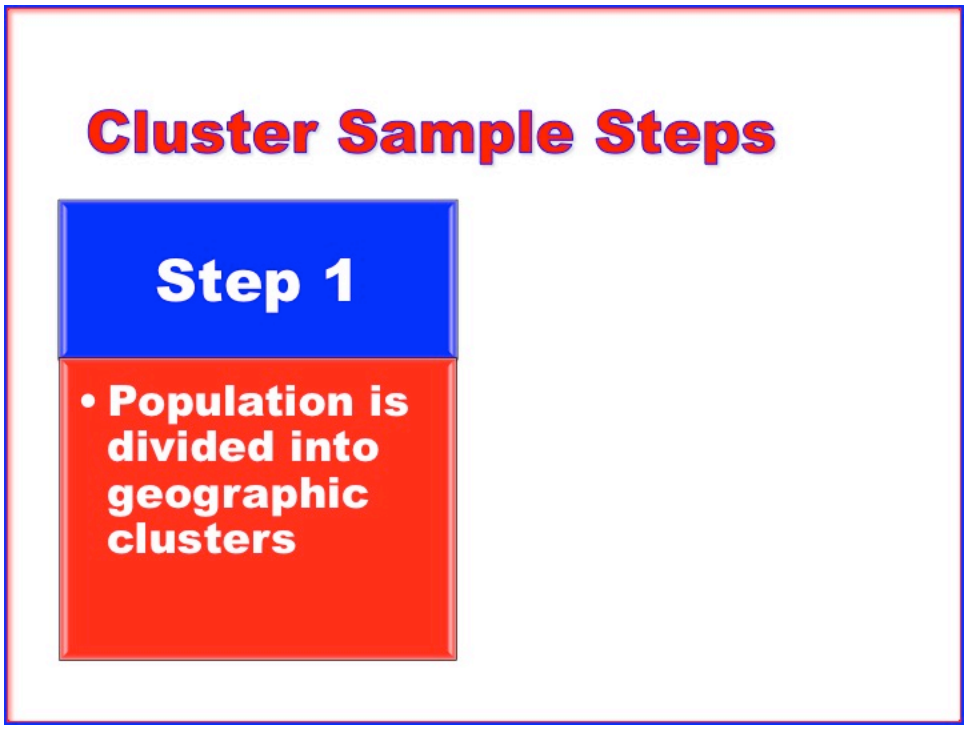


Video

Graphic shows an image of Cluster Samples.

Audio

Not all the clusters are selected for sampling.



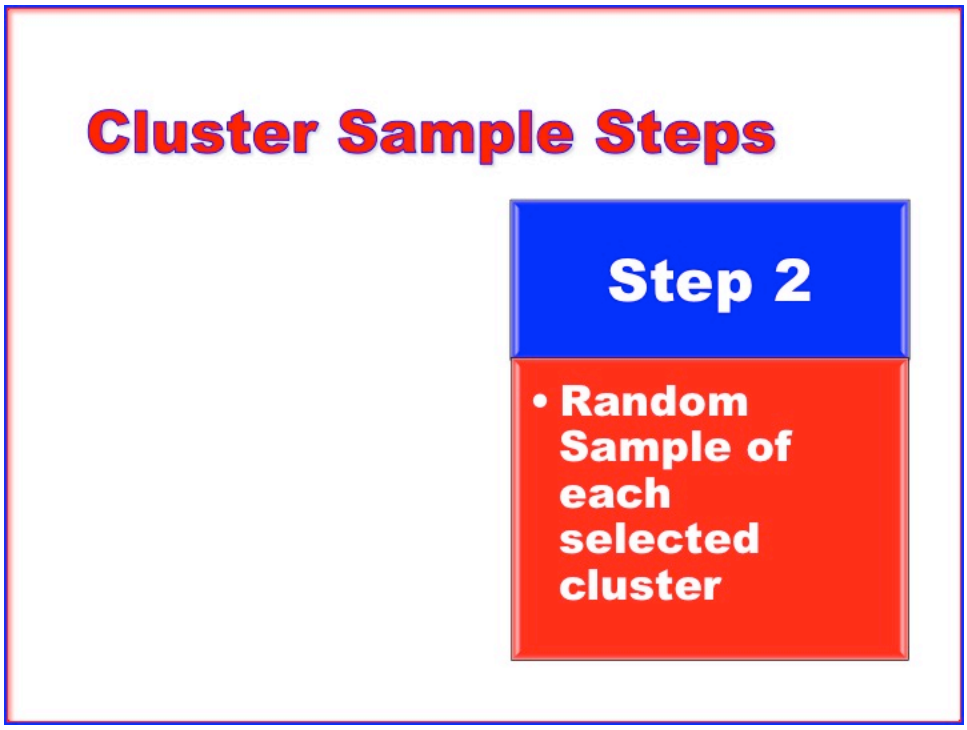
Video

Graphic shows the steps to construct a Cluster Sample.

Audio

Here are the steps for constructing a Cluster Sample.

Step 1: Divide the population into mutually exclusive and collectively exhaustive geographic clusters.



Video

Graphic shows the steps to construct a Cluster Sample.

Audio

Step 2: Conduct a Random Sample of each chosen geographic cluster.

Video

Graphic shows the various Staged Clusters.

Audio

Cluster Samples can have multiple stages. With a One-Stage Cluster Sample the sample consists of all the elements in the selected clusters.

Video
Graphic shows the various Staged Clusters.

Audio
With a Two-Stage Cluster Sample the sample of elements is selected in some probabilistic manner from the selected subsets.

Cluster sampling assumes each cluster is as heterogeneous as the population of interest.

Video

Graphic shows the various Staged Clusters.

Audio

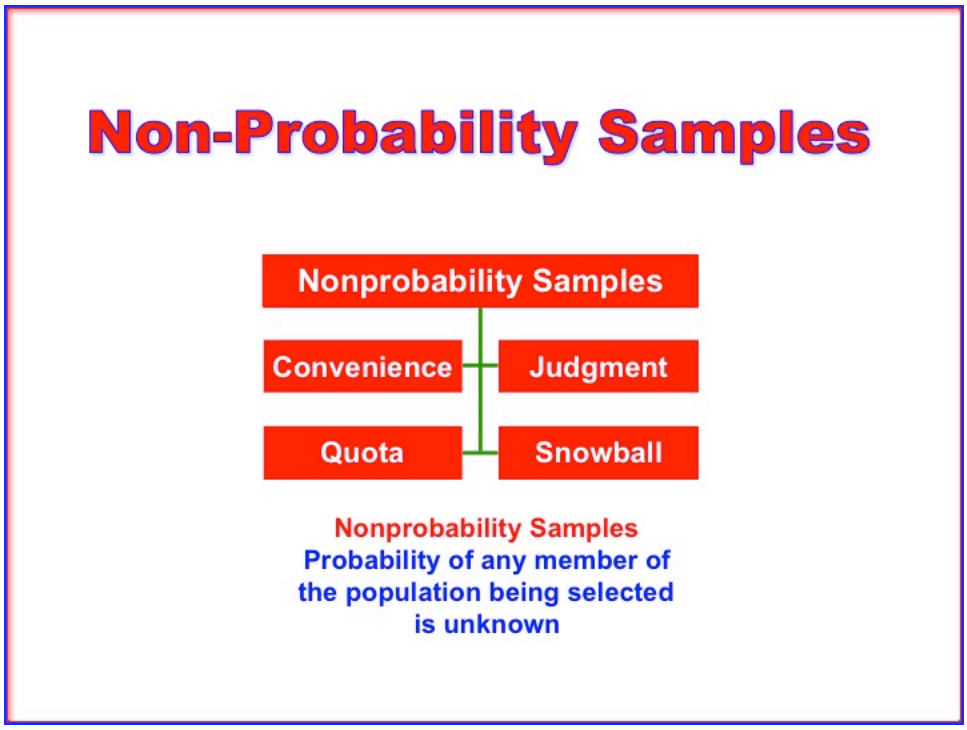
With Multi-Stage Cluster Samples the geographic clusters are broken into progressively smaller units: Counties, then neighborhoods, then residential blocks, and finally houses.

Video

Graphic shows the advantages and disadvantages of Cluster Samples.

Audio

Cluster sampling involves an important trade-off. Cluster Samples have greater Sampling Error than other Probability Samples of the same size. But, Cluster Samples are more cost-effective given their lower data collection costs. This is often considered an acceptable trade-off and Cluster Samples are used frequently.

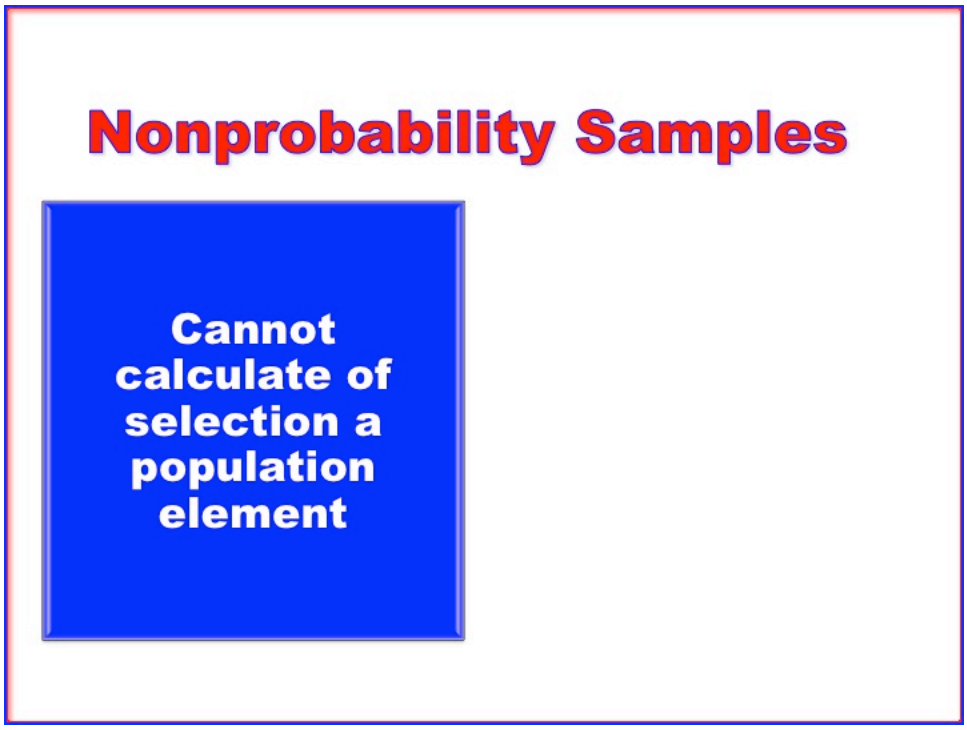


Video

Graphic show the four kinds of nonprobability samples.

Audio

Let's turn to the four Non-Probability Samples: Convenience, Judgment, Quota, and Snowball.

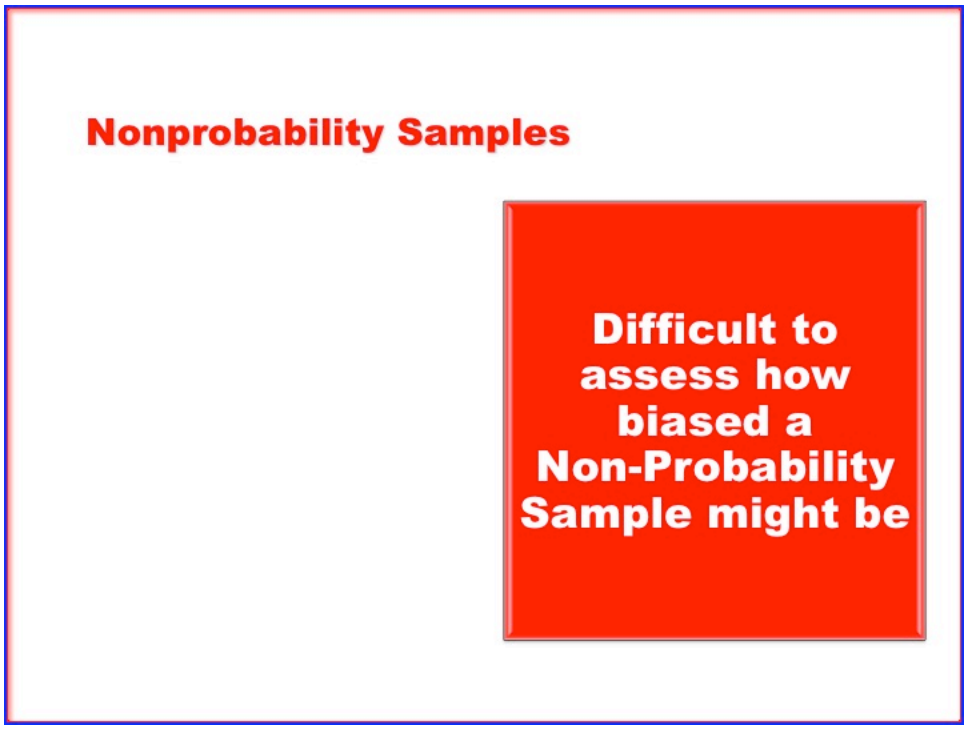


Video

Graphic presents the definition of Nonprobability samples.

Audio

With Non-Probability Samples we cannot calculate the probability of selecting any particular population element.



Video

Graphic presents the definition of Nonprobability samples.

Audio

We cannot, therefore, assess how biased a Non-Probability Sample might be.

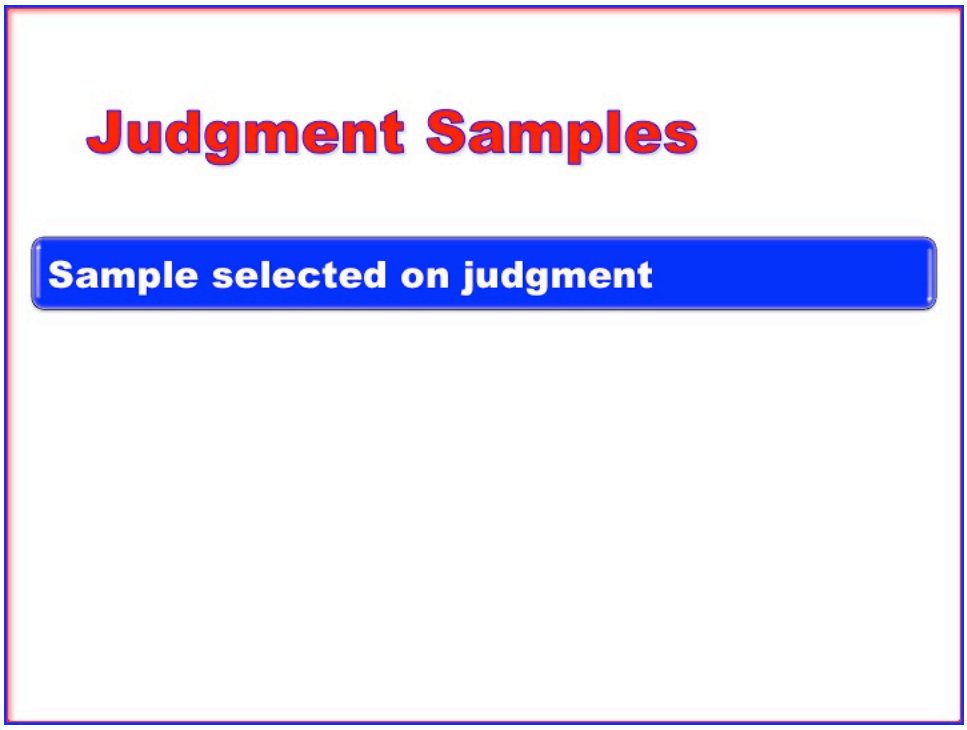
Video
Graphic shows the words, "Subjects are selected because they are easily accessible."

Audio
The first type of Nonprobability Sample is Convenience Samples. These samples are selected because they are easily accessible to the researcher.

Suppose we want to determine college students' attitudes toward the school bookstore. Across the hallway is a large Accounting class. We decide to conduct our survey among these students because they are readily available. Of course, the accounting students may not be a good representation of the college's student body. But, we selected them because they are convenient.

Convenience Samples are often used in pilot studies because they allow researchers to collect data without the cost and time constraints of a Probability Sample.

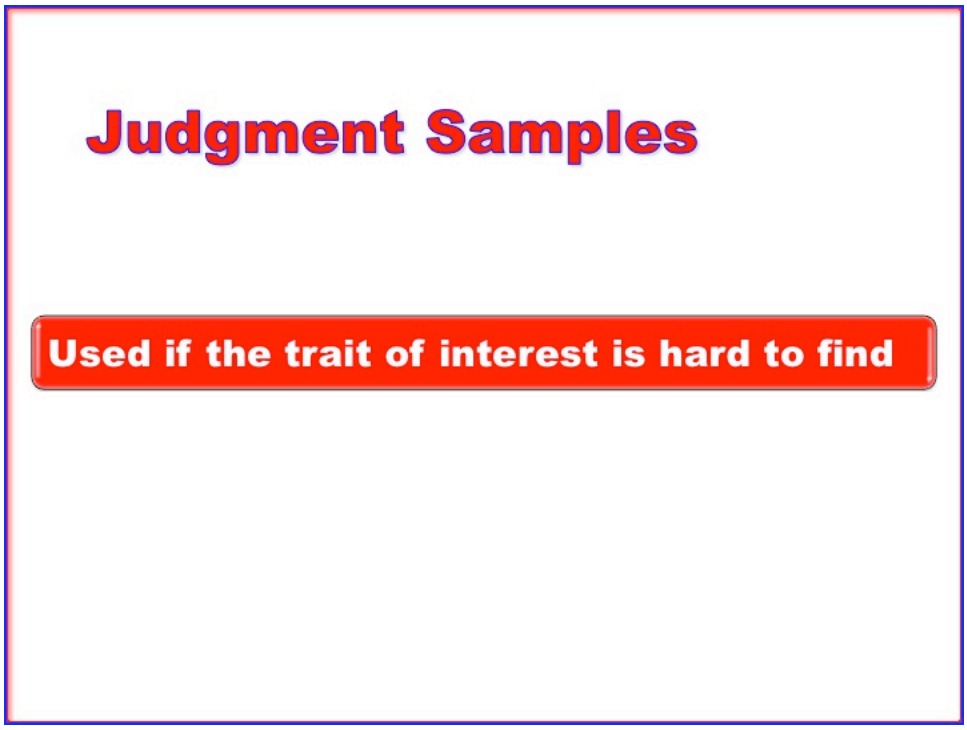
Qualitative research—focus groups, in-depth interviews—use Convenience Samples. Mall intercept surveys are frequently considered Convenience Samples too. When using a Convenience Sample, the researcher should describe how his or her sample differs from an ideal Probability Sample.



Video
Graphic shows the definition of Judgment Samples.

Audio
The next kind of Nonprobability Sample is Judgment Samples, which are also known as Expert's Samples.

With Judgment Samples, the researcher selects samples based on knowledge and judgment.



Video

Graphic shows the definition of Judgment Samples.

Audio

Judgment samples are used when the trait of interest is hard to find.

Video

Graphic shows the definition of Judgment Samples.

Audio

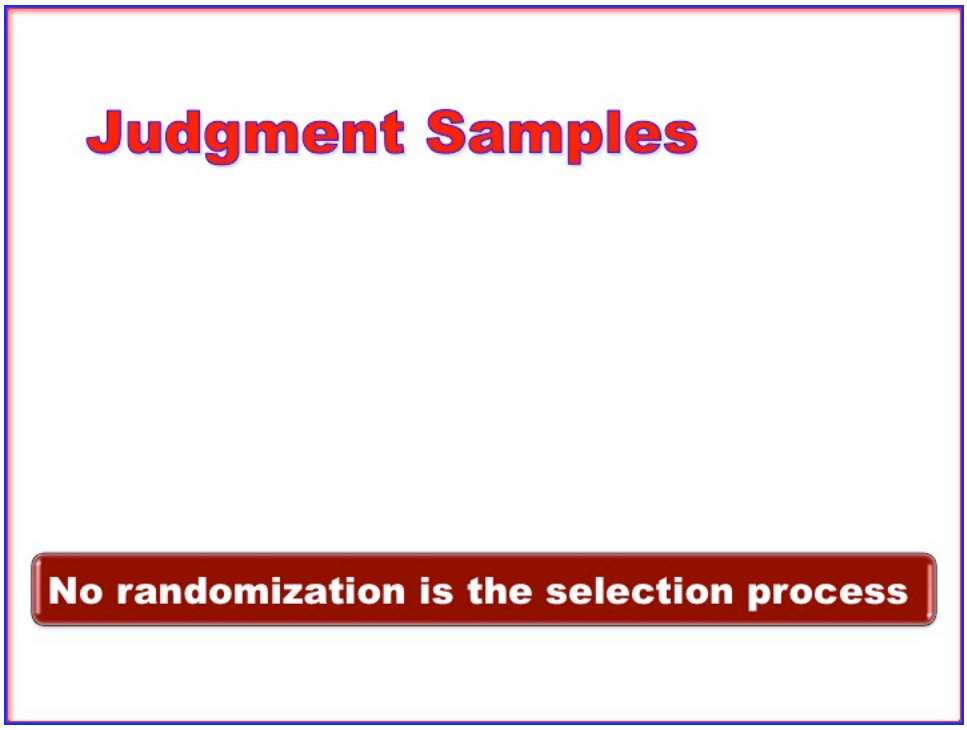
With Judgment Samples, a researcher uses his or her judgment, or that of an expert.

Video

Graphic shows the definition of Judgment Samples.

Audio

A weakness of Judgment Samples is that there is no reliable way to assess this judgment.

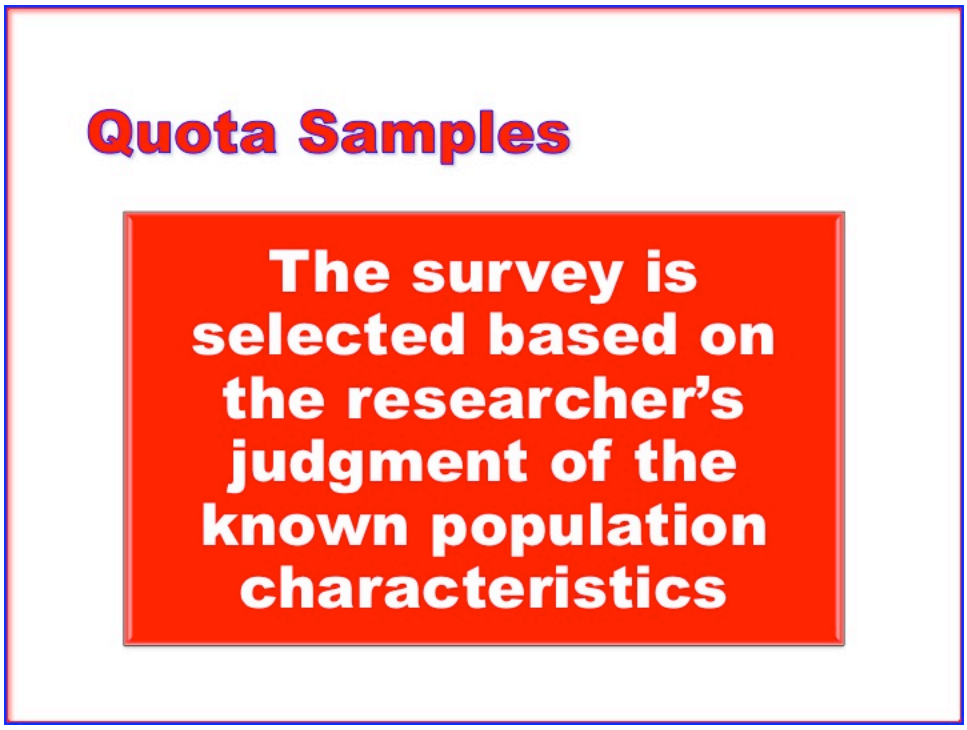


Video

Graphic shows the definition of Judgment Samples.

Audio

And, with Judgment Samples there is no statistical randomization in the selection process.

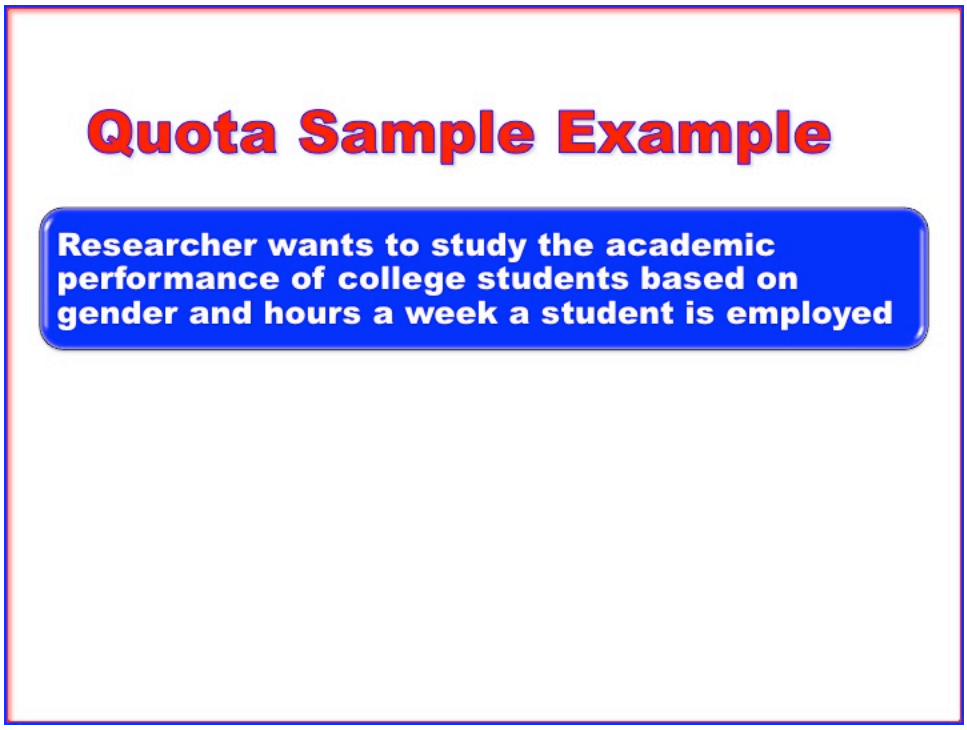


Video

Graphic presents the definition of Quota Samples.

Audio

Quota Samples are selected based on the researcher's judgment of the known characteristics of the population.

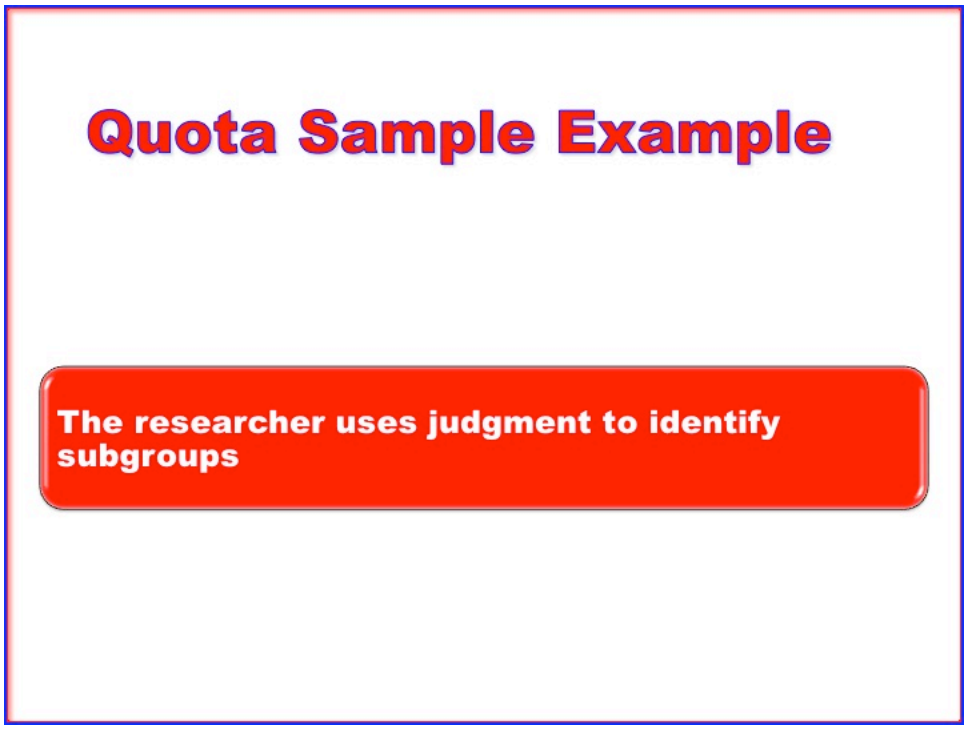


Video

Graphic presents an example of a Quota Samples.

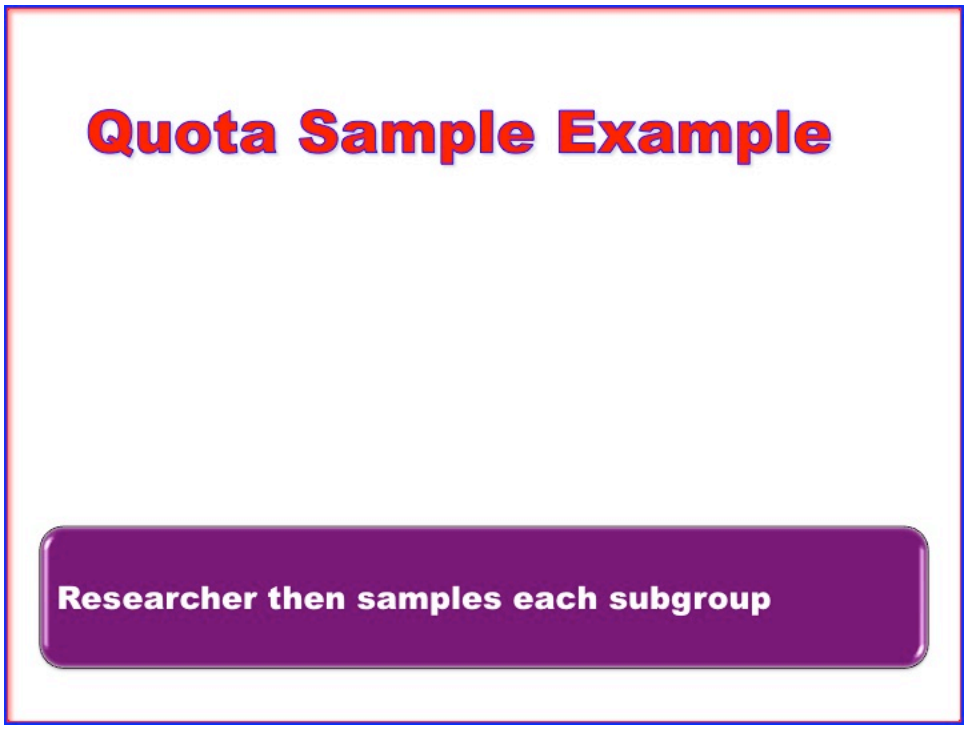
Audio

Suppose a researcher wants to study the academic performance of college students based on gender and the number of hours a week a student is employed.



Video

The researcher uses judgment to identify subgroups.

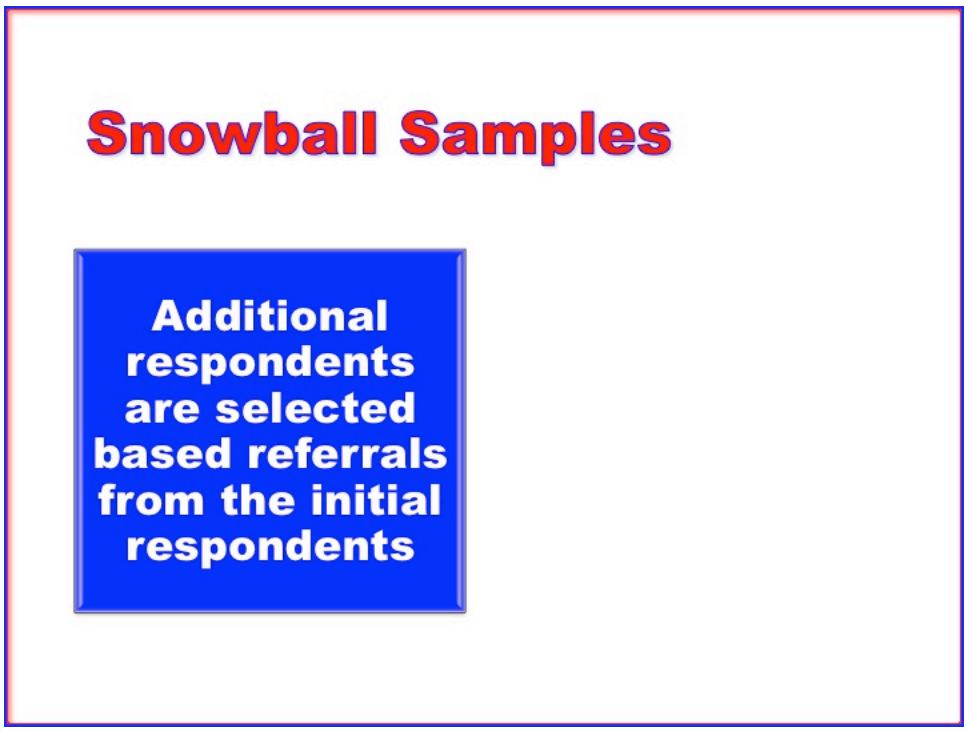


Video

Graphic presents an example of a Quota Samples.

Audio

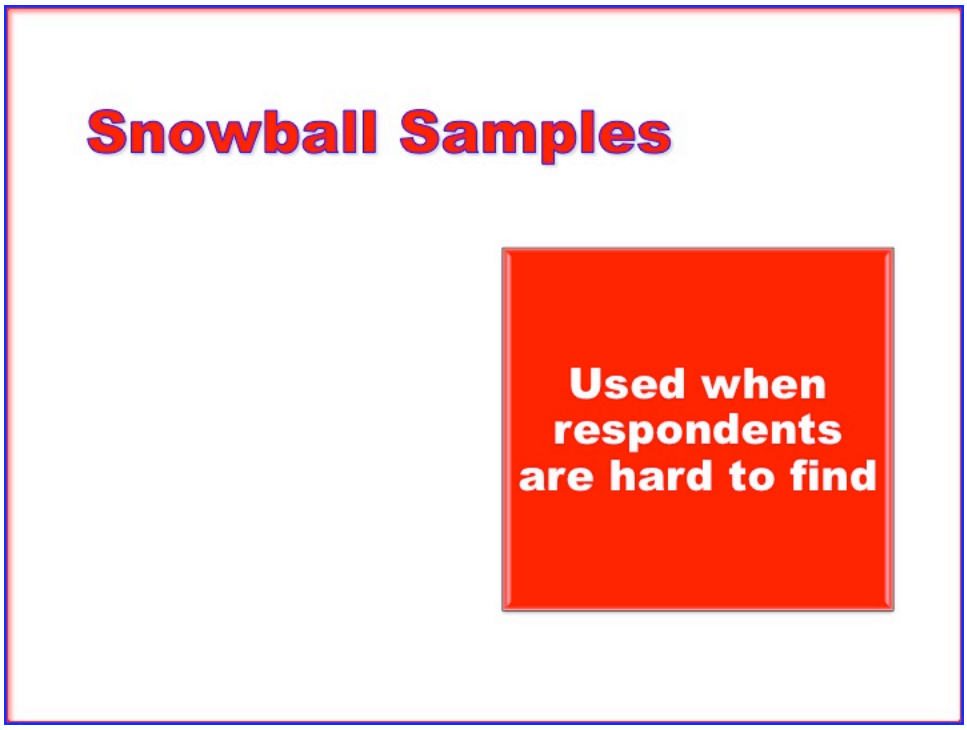
And, then samples each subgroup based on a quota.



Video
Graphic presents the definition of Snowball Samples.

Audio
The last of the Nonprobability Samples are Snowball samples, which are sometimes called “chain referral” samples.

With a Snowball Sample existing subjects refer additional respondents to the researcher. In essence, the early responders nominate later subjects.



Video

Graphic presents the definition of Snowball Samples.

Audio

Snowball Samples are used when respondents are hard to find.

Video

Graphic shows the advantages of Snowball Samples.

Audio

Snowball Samples have two major advantages:

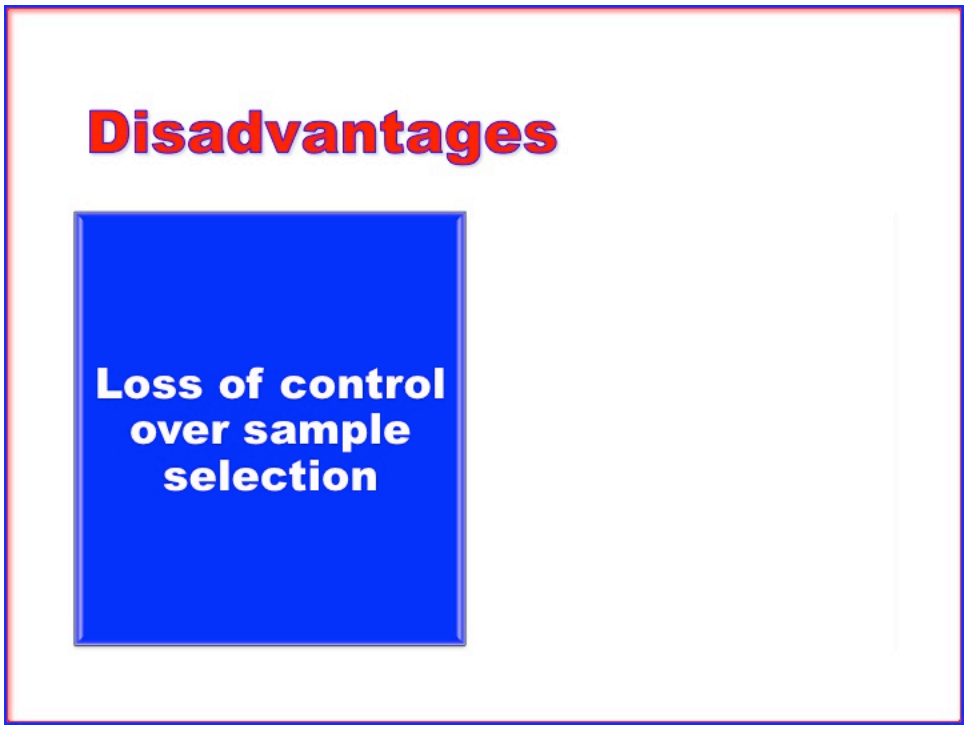
1) They allow researchers to reach hard to find respondents.

Video

Graphic shows the advantages of Snowball Samples.

Audio

And, 2) the “snowball” process is fast, simple, and cheap.



Video

Graphic shows the disadvantages of Snowball Samples.

Audio

But, Snowball Samples have two notable disadvantages:

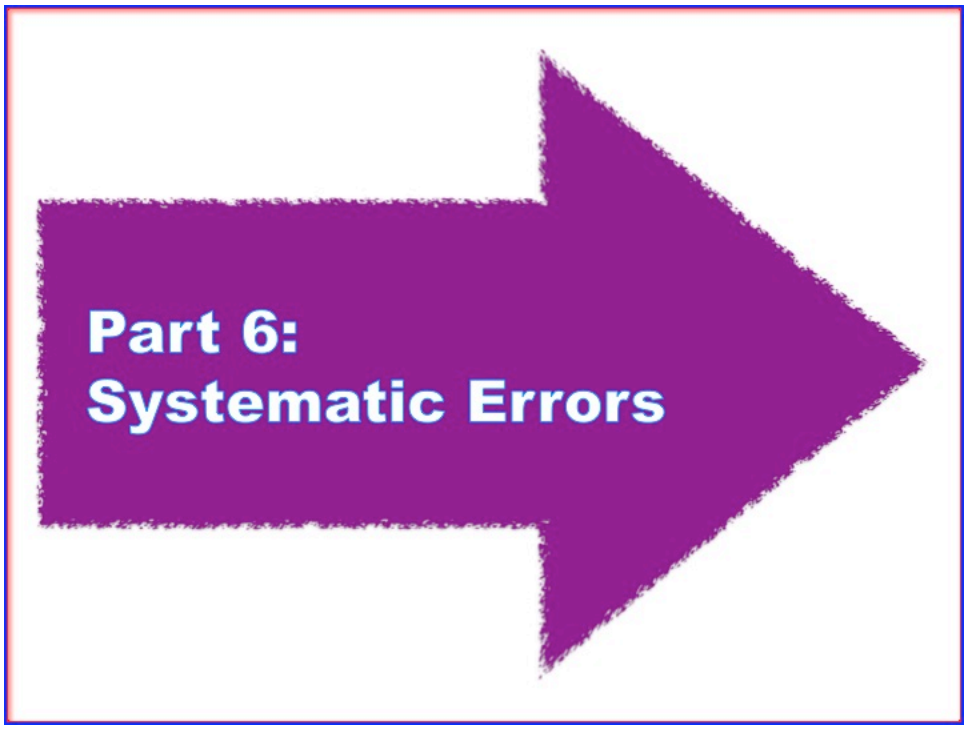
1) The researcher can lose control over the sample to his or her respondents.

Video

Graphic shows the disadvantages of Snowball Samples.

Audio

2) The sample may not represent the population of interest, as respondents typically refer people they know well. And, these people are often like themselves.



Video

Graphic shows an arrow with the words, "Part 6: Systematic Errors."

Audio

Let's turn to Part 6, where we will review Systematic Errors.