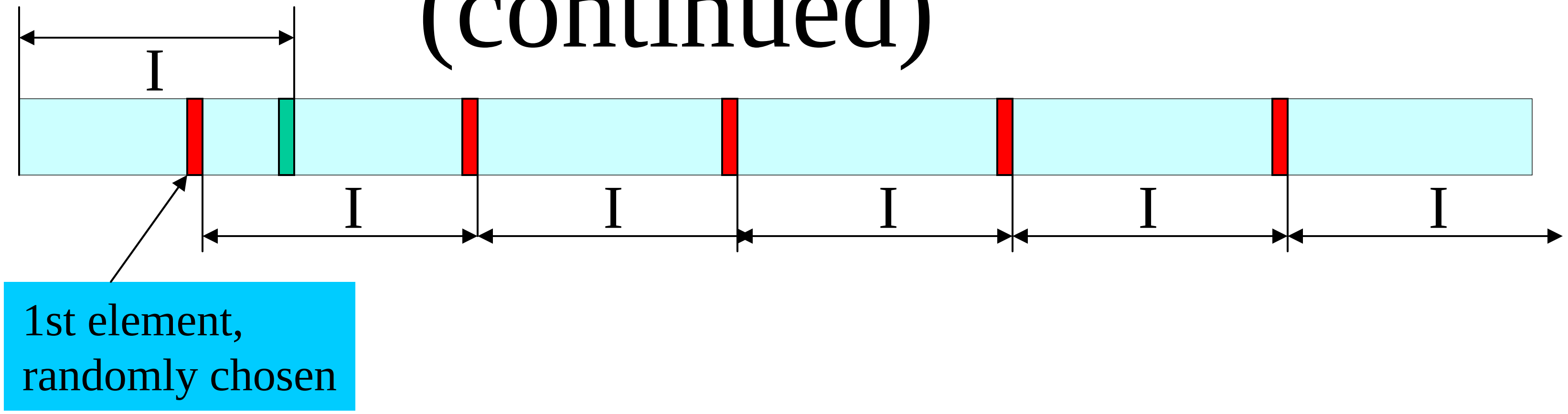
Sampling Designs

- 1. Simple random sampling (SRS)
  Steps:
  - (1) Assign a single number to each element in the sampling frame.
  - (2) Use random numbers to select elements into the sample until the desired number of cases is obtained.
- The method is not very different from winning a lottery.

2. Systematic Sampling

- Steps:
  - (1) Calculate the sampling interval as the ratio between population size and sample size,
    $I = N/n$.
  - (2) Arrange all elements in the population in an order.
  - (3) Select a case in the first interval randomly.
  - (4) Select every i^{th} case from this point.

2. Systematic Sampling (continued)

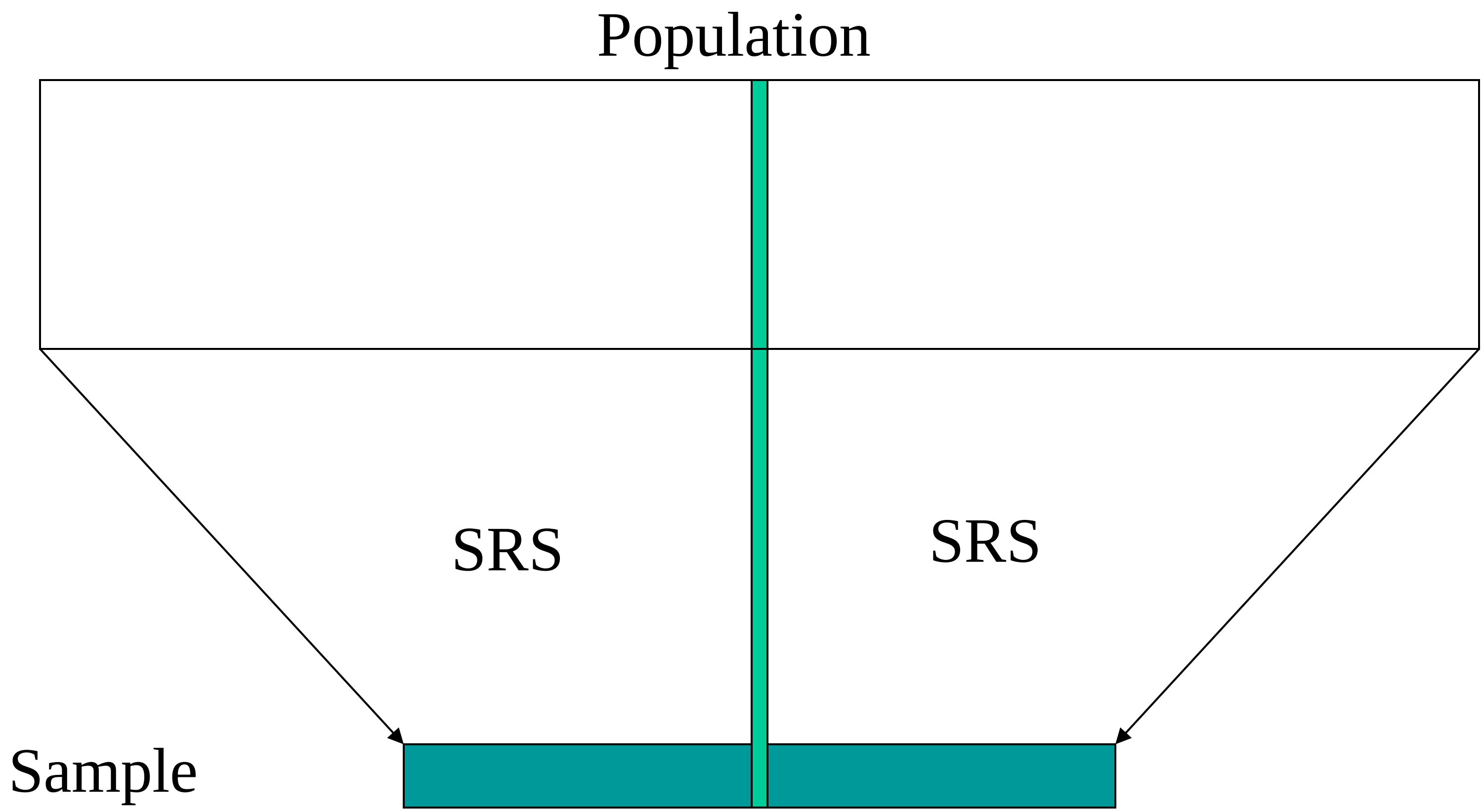


- Systematic Sampling is easier and simpler than SRS
- The text warns of a danger to this method. What is it?

3. Stratified Sampling

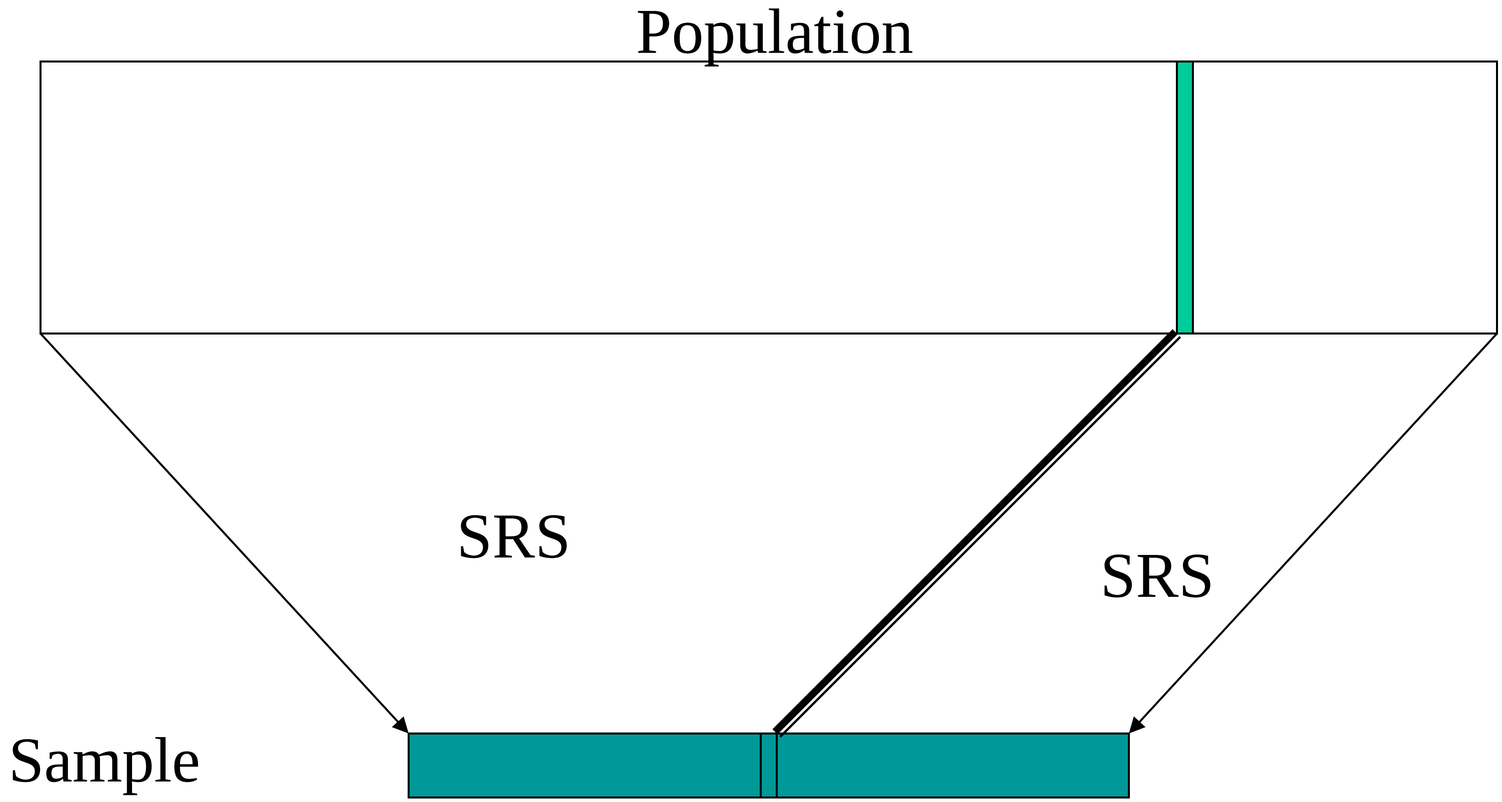
- Stratified sampling is more complicated than SRS. The advantage is the guaranteed representativeness in some important characteristics.
- For example, say that we want to select a sample of 100 individuals. Sex ratio in the sample is up to chance if we do SRS. We can guarantee the 50-50 split if we do stratified sampling:

Stratified Sampling, Graphic Representation



- Stratified sampling is often used to reduce the variability of a sample.

Oversampling, Graphic Representation

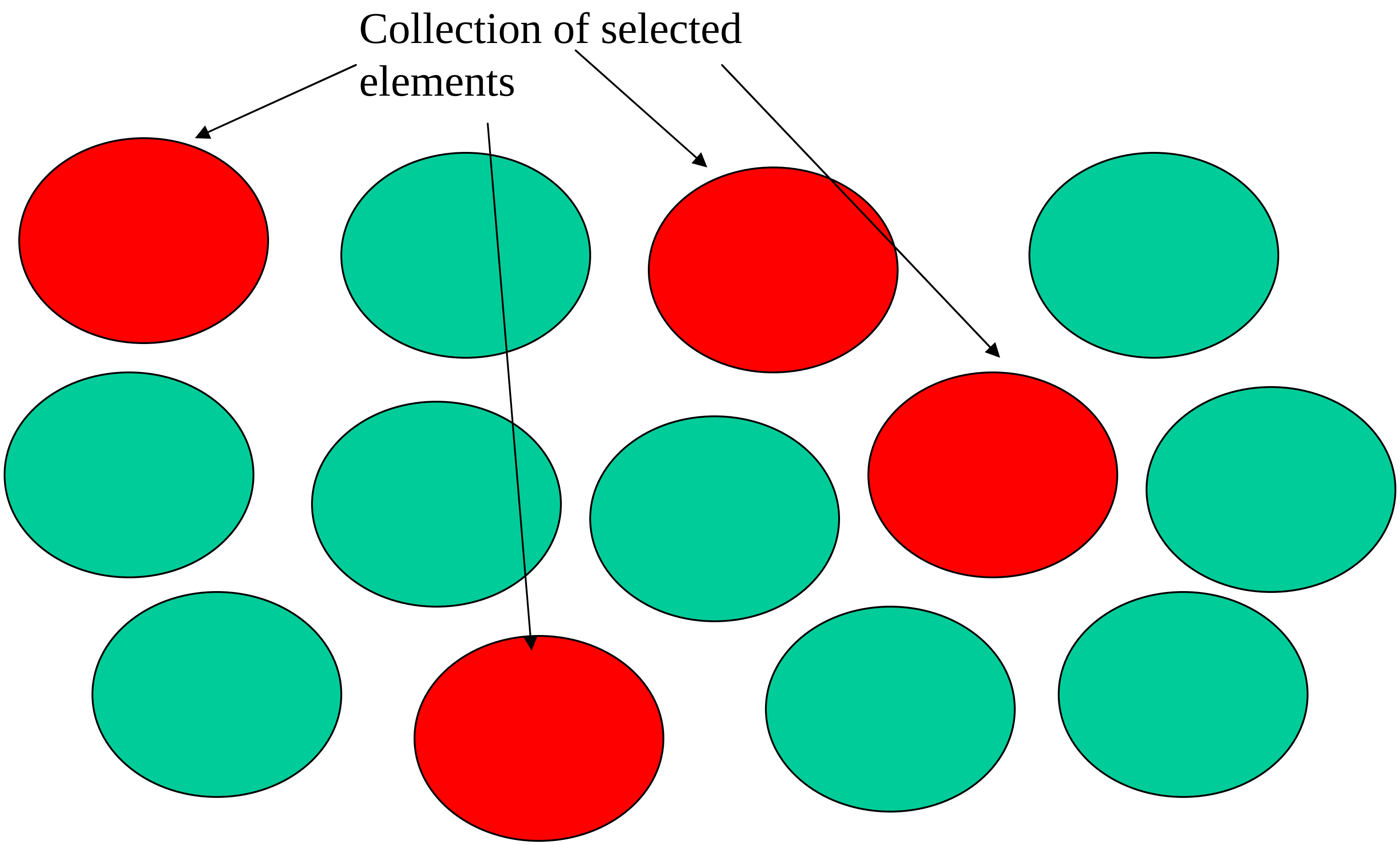


- Increasing the representation of a group in a sample. This is often done when groups are very different in size – e.g., race

4. Cluster Sampling

- Cluster sampling is desirable from an economic point of view:
- It saves money, at the expense of lowering the quality of data.
- e.g.: we are interested in studying students' experiences at the University of Wisconsin, the unit of analysis is the student. An economic way is to sample classes. Once a class is selected, everyone in the class is selected.

Cluster Sampling, Graphic Representation



Cluster Sampling, Loss of Efficiency

- For cluster sampling to work well, we assume clusters do not differ radically from each other.
- If this assumption is not true, => the sample has more variability than a sample obtained by SRS, resulting in inefficiency.
- In general, we can only lose efficiency with cluster sampling.

Sources of Variability in a Sample Statistic

- 1. Population Variability
  All elements in a population are inherently variant.
- 2. Random Selection
  Precisely because elements in the population have different values on a variable, random selection is meaningful and necessary.

Decomposing Variability

- 1. ANOVA: Analysis of Variance

  Total variation =

  between-group variation + within-group variation.
- Internal homogeneity => external heterogeneity => between-group variance is large (e.g., gender and height).
- Internal heterogeneity => external homogeneity => between-group variance is small (e.g., gender and GPA).

Effects of Stratification

- Stratification reduces sampling variation.
- Total variation - between-strata variation = within-strata variation.
- The more heterogeneous are the strata externally (or equivalently, the more homogeneous internally), the greater the gain in precision arising from stratification.
- Example of gun control law and region.

Design Effect

- The ratio of the variance of the estimator based on the complex design to the variance of the estimator based on simple random sampling of the same size.
- $D^2(z) = V(z)/V(z_0)$
- For stratified samples, $D^2 \leq 1$. That is, stratified samples cannot be less efficient than simple random samples. $D^2 = 1$ if strata do not differ from each other.

Effects of Clustering

- Clustering increases sampling variation.
- For a cluster sample, the Design Effect (D^2) ≥ 1. That is, cluster samples cannot be more efficient than simple random samples. $D^2 = 1$ if clusters do not differ from each other.
- Example of cluster sampling of individuals based on state of residence.

Cluster sampling vs. Stratification.

- Since strata are all represented in the sample, it is advantageous if they are internally homogeneous (i.e., externally heterogeneous).
- With cluster sampling, it is best when the clusters are internally heterogeneous in the characteristics being studied.
- The cluster size also affects the design effect. The larger the cluster size, the less efficient is the sample (i.e., the higher the variance).

Practical Matters

- 1. Implicit Stratified Sampling
  Combining systematic sampling with stratified sampling.
- 2. Multi-stage Cluster Sampling
  Combining cluster sampling at one level with cluster sampling at another level.

Combination of Clustering and Stratification

- You may have cluster sampling at a higher level and have stratification at a lower level. e.g., cluster sampling of counties first, and then stratification by race and sex second.
- Or, you may have stratified sampling at a higher level and have cluster sampling at a lower level. e.g., stratify regions, and then cluster sampling of counties.

Probability Proportionate to Size Sampling

- A type of cluster sampling where a cluster's probability of being selected is proportional to its size. That is, the larger a cluster, the higher its probability of being selected.
- Within each cluster, a fixed number of cases are selected. For individual i in cluster j (by the rule of conditional probability):
- $P(ij) = P(i|j)\ p(j) = (1/N_j) \times N_j / N = 1/N$, equal probability for the element.

Disproportionate Sampling and Weighting

- Disproportionate sampling usually is a kind of stratified sampling where strata have different sampling ratios. Example: oversampling of American Indians.
- Weighting is necessary. Weight is usually the inverse of the sampling ratio (e.g., if blacks sampled at three times population representation we would weight each black respondent by 1/3).

Alternative Ways of Sampling

- 1. Convenience Sampling
  Soc. 357 class in 2009.
- 2. Quota Sampling
  Matching overt characteristics. No random selection.
  - Problem: bias in other characteristics.
- 3. Purposive sampling
- 4. Snowball Sampling