

**Faculty of Applied Engineering and Urban Planning**

**Civil Engineering Department**

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**Probabilistic and Statistical**



## Statistics

is the science and art of collecting, summarizing, and analyzing data that are subject to random variation.



## Definitions

### Data

Observations (such as measurements, genders, survey responses) that have been collected

### A variable

a characteristic or attribute that can assume different values.



## Types of Statistics

### **Descriptive Statistics**

Methods of organizing, summarizing and presenting data in an informative way.

### **Inferential Statistics**

The methods used to determine something about a population on the basis of a sample.



## Definitions

### **Population**

the complete collection of all elements (scores, people, measurements, and so on) to be studied; the collection is complete in the sense that it includes all subjects to be studied

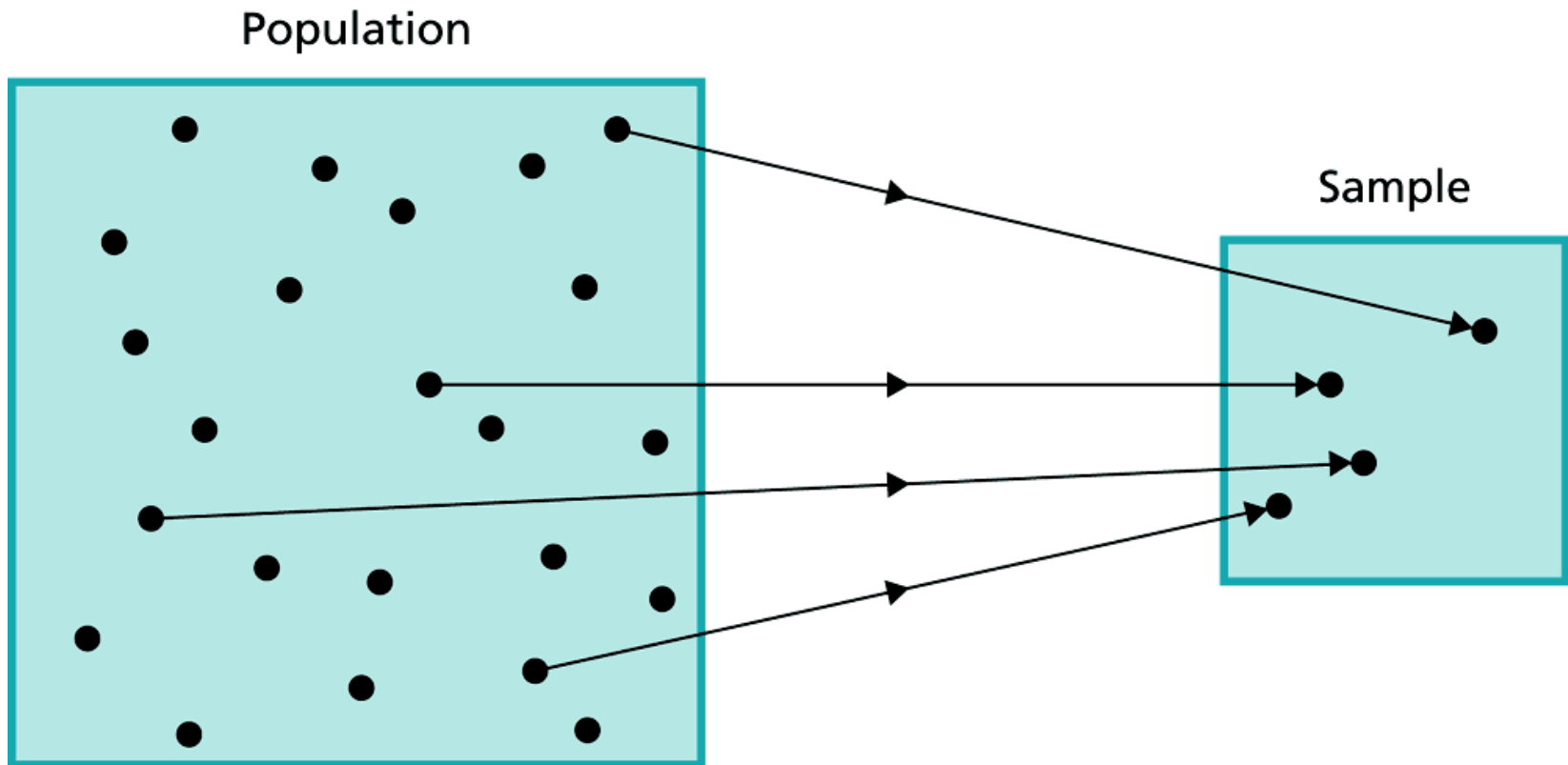
### **Census**

Collection of data from every member of a population

### **Sample**

Sub collection of members selected from a population

# Probabilistic and Statistical Techniques





## Parameter

a numerical measurement describing some characteristic of a population.

**Population**



**Parameter**



## Statistic

a numerical measurement describing some characteristic of a sample.

**Sample**



**Statistic**



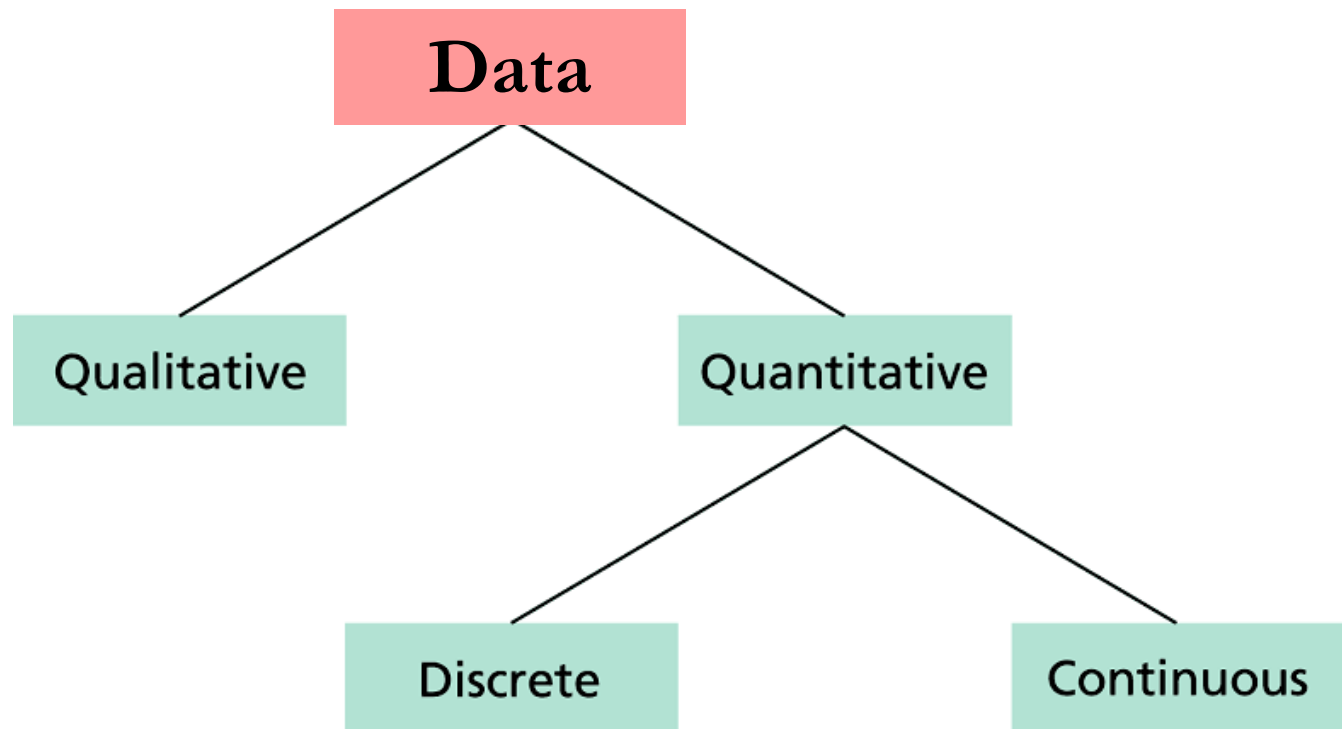


## Common Summary Measures

	Sample Statistic	Population Parameter
Mean	$\bar{X}$	$\mu$
Standard Deviation	$S$	$\sigma$
Variance	$S^2$	$\sigma^2$



## Types of Data





## Quantitative data

When the variable studied can be reported numerically, the variable is called a quantitative variable.

Example: The income of college graduates, children in a family, height of a student.

## Qualitative (or attribute) data

When the characteristic being studied is nonnumeric, it is called a qualitative variable.

Example: The genders (male/female), eye color, type of cars owned, marital status.



## Working with Quantitative Data

Quantitative data can further be described by distinguishing between discrete and continuous types.



## Discrete data

Can assume only certain values, and there are usually gaps between the values.

Example: The number of Lumps that a factory can produce, the number of bedrooms in a house.



## Continuous (numerical) data

Observations of continuous variables can assume any value within a specific range.

Examples: The air pressure in a tire, and the weight of a shipment of tomatoes



## Uses & Abuses of Statistics



## Misuse # 1- Bad Samples

Voluntary response sample (or self-selected sample), one in which the respondents themselves decide whether to be included

In this case, valid conclusions can be made only about the specific group of people who agree to participate.





## Misuse # 2- Small Samples

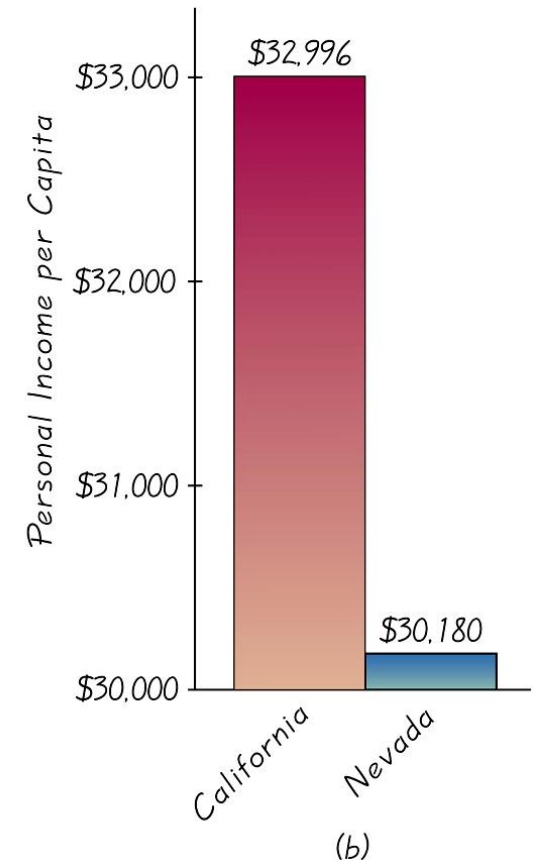
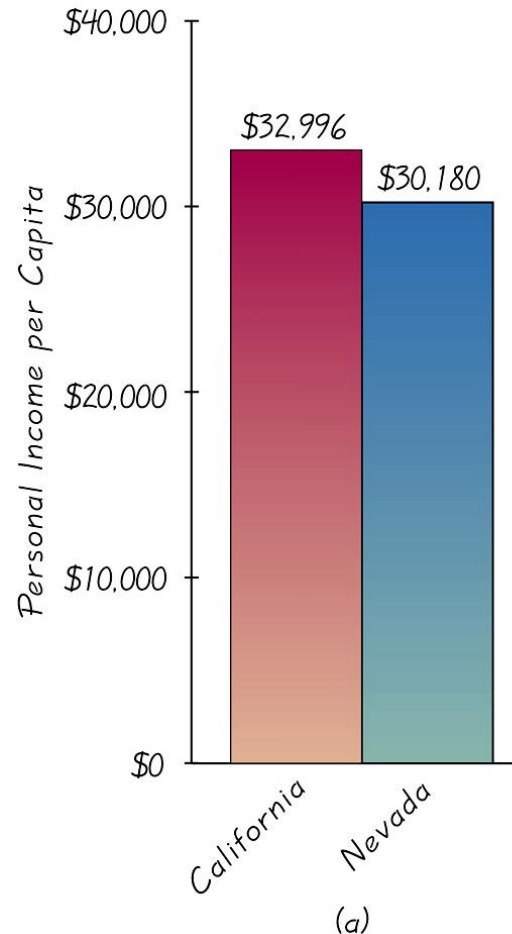
Conclusions should not be based on samples that are far too small.

Example: Basing a school suspension rate on a sample of only three students



## Misuse # 3- Graphs

To correctly interpret a graph, you must analyze the numerical information given in the graph, so as not to be misled by the graph's shape.





## Misuse # 4- Percentages

Misleading or unclear percentages are sometimes used. For example, if you take 100% of a quantity, you take it all. 110% of an effort does not make sense.



## Sample Size



## Sample Size

use a sample size that is large enough to see the true nature of any effects and obtain that sample using an appropriate method, such as one based on randomness



## Methods of Sampling - Summary

Random

Systematic

Convenience

Stratified

Cluster



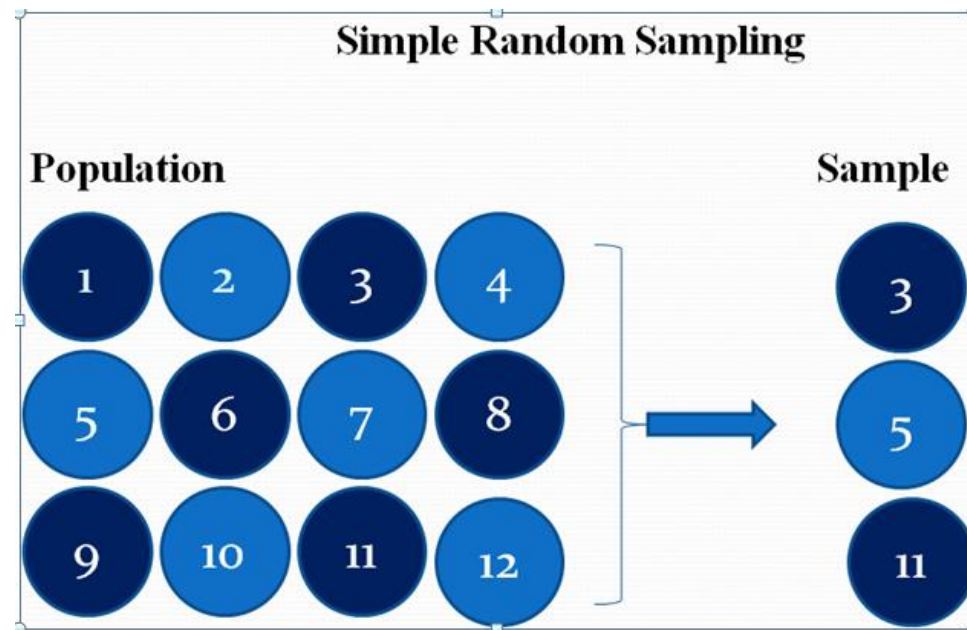
## Random Sample

Members of the population are selected in such a way that each individual member has an equal chance of being selected



## Methods of Sampling

**Random Sampling**  
selection so that each individual member has an **equal chance** of being selected







## Systematic Sampling

Select some starting point and then select every  $k^{\text{th}}$  element in the population

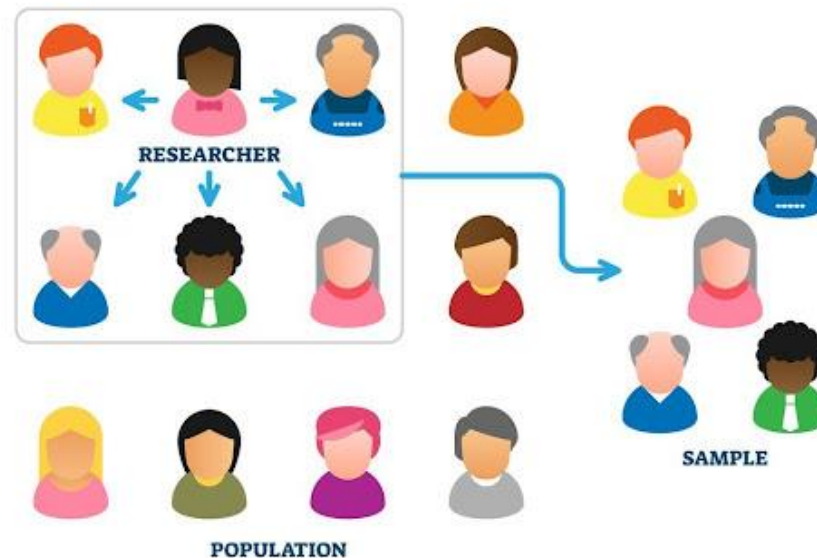


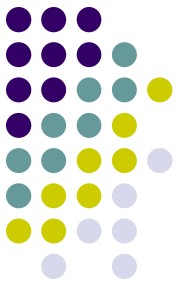


## Convenience Sampling

use results that are easy to get

### CONVENIENCE SAMPLING





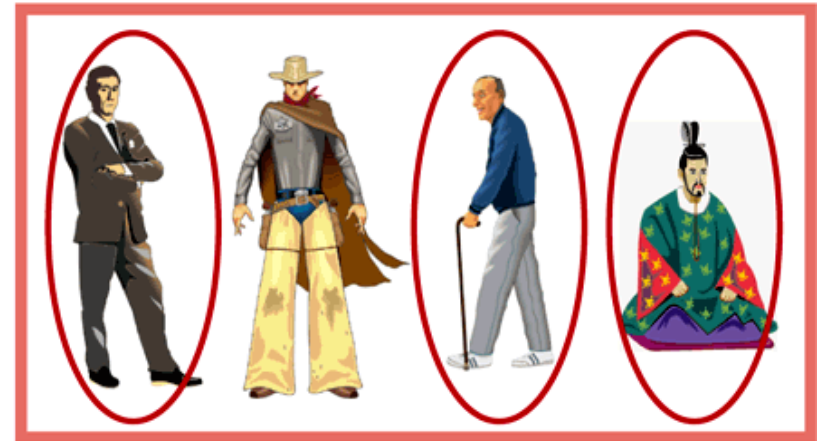
## Stratified Sampling

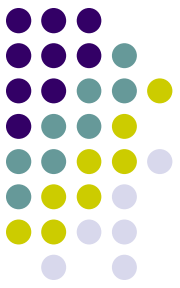
subdivide the population into at least two different subgroups that share the same characteristics, then draw a sample from each subgroup

*Women*



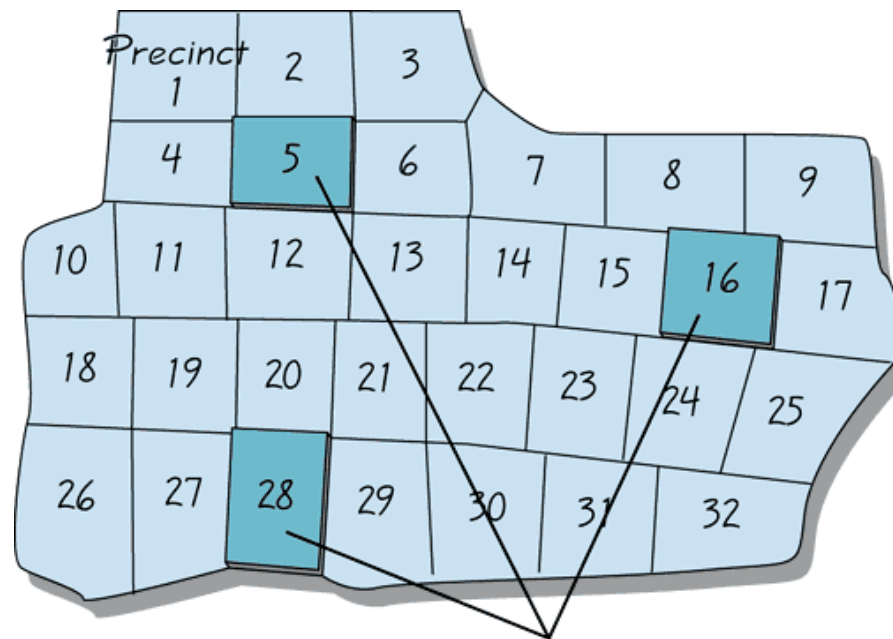
*Men*





## Cluster Sampling

divide the population into sections (or clusters); randomly select some of those clusters; choose all members from selected clusters



*Interview all voters in shaded precincts.*

# Probabilistic and Statistical Techniques

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