

# Introduction to Statistics

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# Topics

- 1 Introduction
- 2 Collecting Data: Sampling

# Objectives

## Objectives:

- Distinguish between quantitative and qualitative data. Distinguish between discrete and continuous (quantitative) variables. Distinguish between nominal and ordinal (qualitative) variables.
- Identify common types of selection bias in sampling.
- State how non-response can lead to biased survey results.

# Introduction (1.1, 1.2)

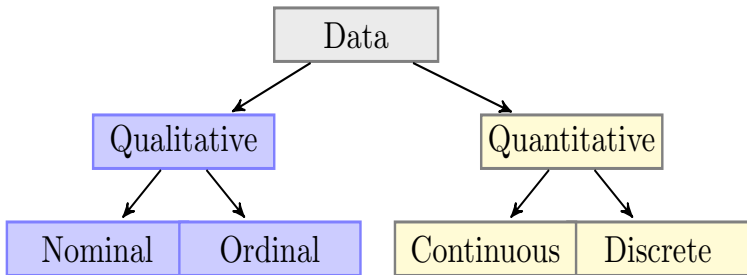
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- **Data** are observations (measurements) of a *variable*.
- A **variable** is a characteristic that varies from one individual to the next (e.g. height, age, income etc.).



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  2. **Qualitative** (also called **categorical**), i.e. possible values of the variable are categories.

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  2. **Continuous**, i.e. the set of possible values of the variable is an entire interval, or continuum, e.g. *all* values greater than 0, such as 47.46231.

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  2. **Nominal**, i.e. the possible values of the variable have no specific ordering (e.g. the colors red, green, and blue, etc.).



## Exercise

Determine whether each of these variables is **quantitative** or **qualitative**. If it's *quantitative*, determine whether it's **discrete** or **continuous**. If it's *qualitative*, determine whether it's **ordinal** or **nominal**.

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- i) The colors (blue, orange, red, etc.) of the shirts worn by students in this class.

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  2. A randomized experiment (so that we can draw conclusions about the effect of a treatment).

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  2. Probability (which is used to quantify uncertainty).
  3. Inferential statistics (which uses probability to express uncertainty in the conclusions that we draw about a population).



Statistics: Given the information in your hand, what is in the pail?



Probability: Given the information in the pail, what is in your hand?

# Collecting Data: Sampling (1.2, 1.3)

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- In a ***census***, data are obtained from *every* individual in the population (e.g. the U.S Census).
- Taking a census is time consuming and expensive. Instead we usually take a *sample* from the population, and then make generalizations (i.e. *statistical inferences*) about the population based on our sample.

## Biased and Unbiased Sampling Schemes

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- In order to generalize from sample data to the population, we'd like our sample to be *representative* of the population.

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- A data collection method that systematically produces data that are *not* representative of the population is called a **biased** data collection method.

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    - **Voluntary response samples** (also called **self-selected samples**) - Sample selection is by "open invitation". Individuals decide for themselves whether or not to be included, and those who do may differ systematically from those who don't. Examples include online surveys conducted from websites, where individuals who have a strong interest in the survey's subject matter are more likely to respond than those who don't.

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Examples include:

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- Phone surveys that take too long. People who are very busy don't participate or they hang up before the survey is completed.
- Surveys that have questions about illegal activities (e.g. drug use) or other sensitive topics (e.g. sex) that some people don't answer.

# Avoiding Selection Bias Via Simple Random Sampling



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- To take a SRS, either:
  1. Place the names of individuals from the population in a hat, and draw  $n$  of them without looking, or
  2. Create a list (called a sampling frame) of all the individuals in the population, and then use a computer random sample generator to select  $n$  individuals from the list.

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The procedures that are used to *compare* two groups can also be used with randomized experiments.

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  - **Stratified random sampling** - The population is first split into subpopulations called **strata** (e.g. based on age group, gender, or income bracket), and then a separate SRS is selected from each stratum. Care should be taken not to *oversample* from any particular stratum.