POLI 30 D: Political Inquiry

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(Based on DSS Materials)

Lecture 06 | Measuring Population Characteristics I

Before we start

Announcements:

- Quizzes and Participation: On Canvas.
- Github page:
  https://github.com/umbertomig/POLI30Dpublic
- Piazza forum: https://piazza.com/ucsd/winter2023/17221

Before we start

Recap:

- We learned the definitions of Theory, Scientific Theory, and Hypotheses.
- Data, datasets, variables, and how to compute means.
- Causal effect, treatments, outcomes, randomization, and ATE.

Great job!

- Do you have any questions about these contents?

Plan for Today

- Sample vs. Population
- Representative samples
- Random Sampling
- Random Treatment Assignment vs. Random Sampling

- Exploring One Variable At a Time
  - Table of frequencies
  - Table of proportions
  - Histogram
  - Descriptive Statistics: mean, median, standard deviation, and variance

Why Do We Analyze Data?

1. MEASURE: **To infer population characteristics via survey research**
   - what proportion of constituents support a particular policy?

2. PREDICT: **To make predictions**
   - who is the most likely candidate to win an upcoming election?

3. EXPLAIN: **To estimate the causal effect of a treatment on an outcome**
   - what is the effect of small classrooms on student performance?

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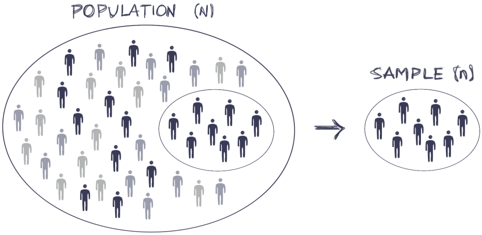
Sample vs. Population

- We often want to know the characteristics of a large **population** such as the residents of a country
- Yet collecting data from every individual in the population is either prohibitively expensive or infeasible.
- In the US, we try to collect data from each individual every ten years
  - The 2020 census cost $14.2 billion, approximately (population at that time was around 331 million)
  - This is not feasible for research purposes!
- We use surveys to collect data from a small subset of observations in order to understand the population

Sample vs. Population

- The subset of individuals chosen for study is called a **sample**



- Researchers typically survey about 1,000 people to infer the characteristics of more than 200 million US citizens
- n=1,000, N=200 million

Representative Samples

- In survey research, it is vital for the sample to be representative of the population of interest
- **Representative sample**: Accurately reflects the characteristics of the population from which it is drawn
- If the sample is not representative, our inferences regarding the population characteristics will be wrong

Representative Samples

- Are you a representative sample of U.S. residents?
- Are you a representative sample of UCSD students?
- Are you a representative sample of UCSD Poli majors?
- Are you a representative sample of POLI 30 D students?
- What would be the best way to draw a representative sample of UCSD students?

Random Sampling

- The best way to draw a representative sample is to select individuals at *random* from the population.

Random sampling makes the **sample** and the **target population** *on average* identical.

- Random sampling: enables us to infer *valid* population characteristics from the sample,

Random Treatment Assignment vs. Random Sampling

- They both use a random process but are different concepts.
- **Random treatment assignment** means that treatment is assigned at random:
  - makes treatment and control groups comparable.
- **Random sampling** means that individuals are selected at random from the population into the sample:
  - makes sample representative of the population.
- For the purpose of this class, we assume that we are always studying a representative sample.

Exploring One Variable At a Time

- Suppose we have collected data from a sample, now what?
- To understand the content and distribution of each variable we can:
  - create a table of frequencies
  - create a table of proportions
  - create a histogram
  - compute descriptive statistics
- Let's return to the voting experiment
  - data collected from a sample of registered voters in the state of Michigan

The *voting* dataset

Unit of observation: registered voters

Description of variables:

variable	description
birth	year of birth of registered voter
message	whether registered voter received message: "yes", "no"
voted	whether registered voter voted: 1=voted, 0=didn't vote

Table of Frequencies

- The **frequency table** shows the values the variable takes and the number of times each value appears in the variable
- R function: `table()`

```
table(voting$voted)
##
##      0      1
## 158276  71168
```

- Interpretation?

Table of Proportions

- The **table of proportions** shows the proportion of observations that take each value in the variable
- The proportions in the table should add up to 1
- R function: `prop.table(table( ))`

```
prop.table(table(voting$voted))
##
##         0         1
## 0.6898241 0.3101759
```

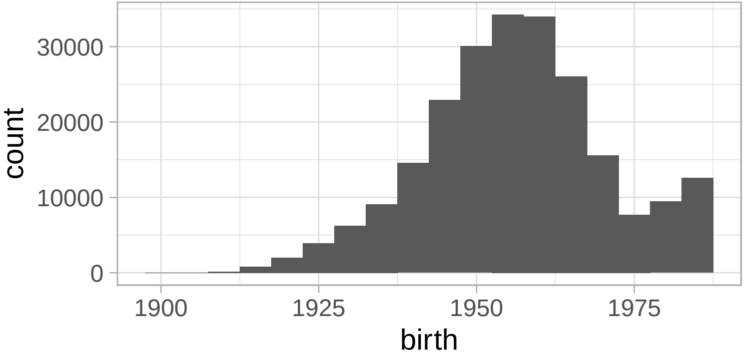
- Interpretation?

Histogram

- The **histogram** is the visual representation of a variables distribution through bins of different heights
- The position of the bins along the x-axis indicate the interval of values
- The height of the bins indicate the frequency (or count) of the interval of values
- R functions: `hist()`or `ggplot() + geom_histogram()`
- Great for `quantitative` variables (the numeric R data types)

Histogram

```
ggplot(voting, aes(x = birth)) +
  geom_histogram(binwidth = 5) + theme_light()
```



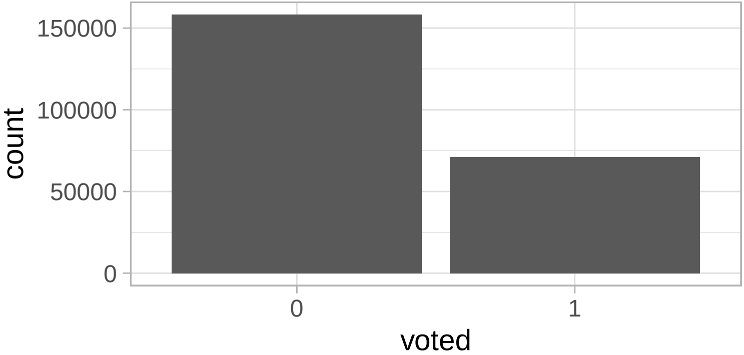
- Interpretation?

Barplots

- The **barplot** is similar to a histogram, but discretizes the variation
- The position of the bins along the x-axis indicate a value
- The height of the bins indicate the frequency (or count) of the values
- R functions: `barplot(table())`or `ggplot() + geom_bar()`
- Great for `qualitative` variables (numeric binary or character)

Barplots

```
ggplot(voting, aes(x = voted)) +
  geom_bar(aes(x = as.character(voted))) + theme_light()
```



- Interpretation?

Descriptive Statistics

- The **descriptive statistics** of a variable numerically summarize the main characteristics of its distribution

- Measures of centrality
  (center of the distribution):
  - mean
  - median

- Measures of spread
  (amount of variation from the center):
  - standard deviation
  - variance

Mean

- The **mean** of a variable equals the sum of the values across all observations divided by the total number of observations
- What is the function in R?
- Example:

```
mean(voting$birth)
## [1] 1956.18
mean(voting$voted)
## [1] 0.3101759
```

- Interpretations?

Median

- The **median** of a variable is the value at the midpoint of the distribution that divides the data into two equal-size groups
- When the variable contains an odd number of observations, the median is the middle value of the distribution
- When the variable contains an even number of observations, the median is the average of the two middle values

Median

- Example, if X={10, 4, 6, 8, 22}, what is the median of X?
  - First, we need to sort the values of X in ascending order (as they would be in the distribution): $\{4, 6, 8, 10, 22\}$
  - The value in the middle of the distribution is 8 so the median is 8.

- R function: `median()`

```
median(voting$birth)
## [1] 1956
```

- Interpretations?

Standard Deviation

- The **standard deviation** of a variable is a measure of the spread of its distribution

$$\text{sd(X)} = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \overline{X})^2}{n}}$$

- $sd(X)$ stands for the standard deviation of X
- X_i is a particular observation of X
- $\overline{X}$ stands for the mean of X
- n is the total number of observations in the variable
- $\sum_{i=1}^{n}(X_i - \overline{X})^2$ means the sum of all $(X_i - \overline{X})^2$ from $i = 1$ to $i = n$

Standard Deviation

The **standard deviation** of a variable measures the average distance of the observations to the mean.

- The larger the standard deviation, the `flatter` the distribution
- It gives us a sense of the range of the data, especially when dealing with bell-shaped distributions
- In bell-shaped (normal) distributions, 95% of the observations fall within two standard deviations from the mean

Standard Deviation

- R function: `sd()`

```
sd(voting$birth)
## [1] 14.46019
```

- If *birth* were normally distributed, about 95% of the register voters would have been born between 1927 and 1985:
  - $\overline{X}$ - 2 $\times$ sd(X) = 1956 - 2 $\times$ 14.5 = 1927
  - $\overline{X}$ + 2 $\times$ sd(X) = 1956 + 2 $\times$ 14.5 = 1985

Variance

- Another measure of spread of the distribution
- The **variance** of a variable is simply the square of the standard deviation

$$\mathrm{var}(X) = [\mathrm{sd}(X)]^2$$

- $var(X)$ stands for the variance of X
- $sd(X)$ stands for the standard deviation of X

Variance

- R function: `var()`

```
var(voting$birth)
## [1] 209.0971
```

- Alternatively: `sd()^2`

```
sd(voting$birth)^2
## [1] 209.0971
```

- We are usually better off using standard deviations as our measure of spread:
- Same unit of measurement as the variable

Summary

- **Today's Class:**
  - Sample vs. Population
  - Representative Samples and Random Sampling
  - Exploring a single variable
- **Next class:**
  - Correlations
  - Scatter-plots

Questions?

See you in the next class!