Sampling and Representativeness

Department of Government
London School of Economics and Political Science

1 Simple Statistics

2 Research Design Proposal

3 Representativeness

4 Sampling

Relationship

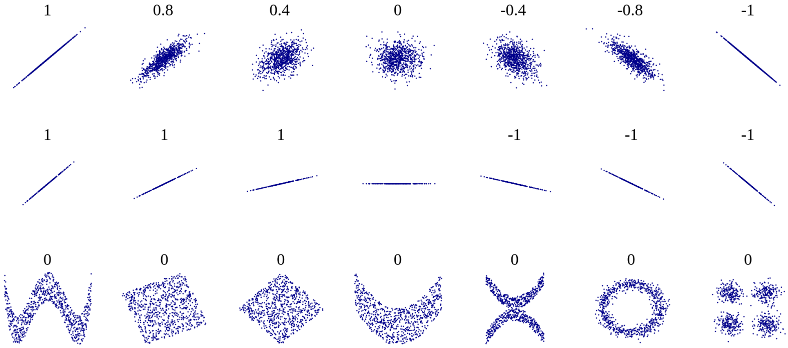
- Covariance:

$$Cov(X,Y) = \Sigma_{i=1}^{n} \frac{(X_i - \bar{X})(Y_i - \bar{Y})}{n-1}$$

Relationship

- Covariance:
  $$Cov(X,Y) = \sum_{i=1}^{n} \frac{(X_i - \bar{X})(Y_i - \bar{Y})}{n-1}$$
- Correlation:
  $$Corr(X,Y) = r_{x,y} = \sum_{i=1}^{n} \frac{(X_i - \bar{X})(Y_i - \bar{Y})}{(n-1)s_x s_y}$$

Correlation is linear!



Source: Wikimedia

Guess the Correlation!

1. Go to:

   `http://guessthecorrelation.com/`

2. Play a few rounds

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Rubric for Research Design Proposal

- Politically interesting and important topic and research question
- Research question, theory, and methods situated in relevant political science literature
- Thorough discussion of theory and explicitly stated, empirically testable hypotheses
- Appropriate, well-designed research methodology
    - Strengths and weaknesses
    - Trade-offs discussed against alternative designs
    - Able to generate data that will allow a test of hypotheses
- Well-written, coherent, well-structured

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Case selection

- Earlier in the course we talked about case selection
- What did we discuss?

Discuss in Pairs!

What does it mean for a sample to be representative of a population?

Different conceptualizations of representativeness

- **Design-based**: A sample is representative because of how it was drawn (e.g., randomly)
- **Demographic-based**: A sample is representative because it resembles in the population some way (e.g., same proportion of women in sample and population, etc.)
- **Expert judgement**: A sample is representative as judged by an expert who deems it "fit for purpose"

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- **Simple random sampling**
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Inference from Sample to Population

- We want to know population parameter θ
- We only observe sample estimate $\hat{\theta}$
- We have a guess but are also uncertain

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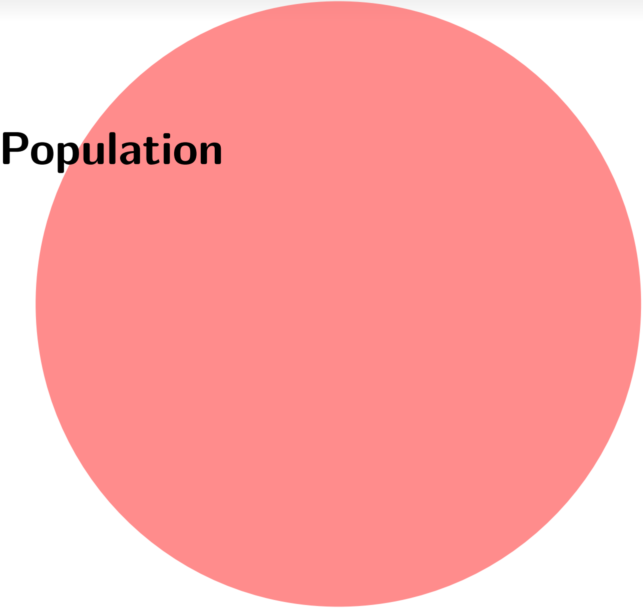
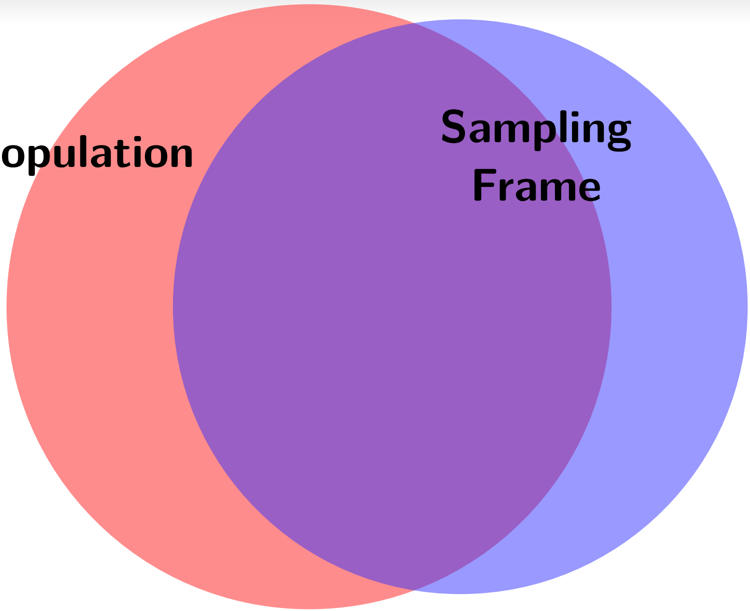
- We want to know population parameter θ
- We only observe sample estimate $\hat{\theta}$
- We have a guess but are also uncertain
- What range of values for θ does our $\hat{\theta}$ imply?

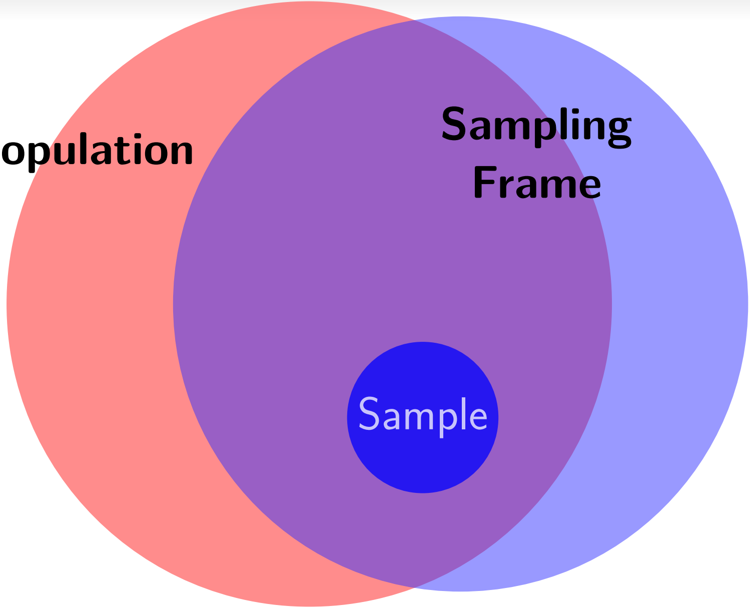
Simple Random Sampling

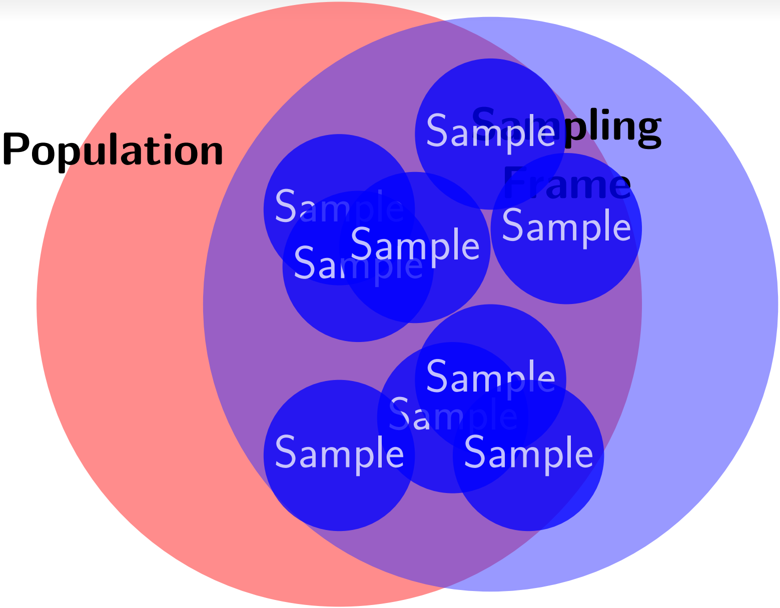
1. Define target population
2. Create “sampling frame”
3. Each unit in frame has equal probability of selection
4. Collect data on each unit
5. Calculate sample *statistic*
6. Draw an inference to the population



Population


Population
Sampling Frame


Population
Sampling
Frame
Sample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Statistical Inference I

To calculate a sample mean (or proportion):

$$\bar{y} = \frac{1}{n} \sum_{i=1}^{n} y_i \tag{1}$$

where $y_i =$ value for a unit, and

$n =$ sample size

Statistical Inference II

- If we calculate $\bar{y}$ in our *sample*, what does this tell us about the $\bar{Y}$ in the *population*?

Statistical Inference II

- If we calculate $\bar{y}$ in our *sample*, what does this tell us about the $\bar{Y}$ in the *population*?
- The sample *estimate* is our guess at the value of the population *parameter* within some degree of uncertainty

Law of Large Numbers

- Definition: The *mean* of the $\hat{\theta}$ from each of a number of samples will converge on the population θ, as the number of samples increases

Sampling Variance

- The $\hat{\theta}$ in any particular sample can differ from the population value θ
- This variation is calling “sampling variance” or “sampling error”
- The standard error describes the average amount of variation of the $\hat{\theta}$'s around θ

How Uncertain Are We?

- Our uncertainty depends on sampling procedures
- Most importantly, *sample size*
    - As $n \to \infty$, uncertainty $\to 0$
- We typically summarize our uncertainty as the *standard error*

Standard Errors (SEs)

- Definition: "The standard error of a sample estimate is the average distance that a sample estimate ($\hat{\theta}$) would be from the population parameter (θ) if we drew many separate random samples and applied our estimator to each."

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- Square root of the sampling variance

Sample mean

$$\bar{y} = \frac{1}{n} \sum_{i=1}^{n} y_i \tag{2}$$

where y_i = value for a unit, and
n = sample size

$$SE_{\bar{y}} = \sqrt{(1-f)\frac{s^2}{n}} \tag{3}$$

where f = proportion of population sampled,
s^2 = sample (element) variance, and
n = sample size

Sample proportion

$$\bar{y} = \frac{1}{n}\sum_{i=1}^{n} y_i \tag{4}$$

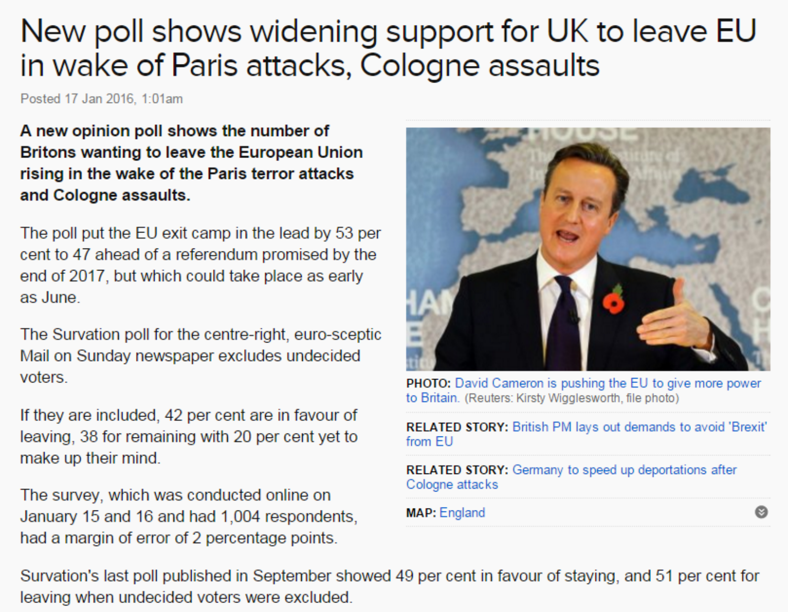
where y_i = value for a unit, and
n = sample size

$$SE_{\bar{y}} = \sqrt{\frac{(1-f)}{n}p(1-p)} \tag{5}$$

where f = proportion of population sampled,
p = sample proportion, and
n = sample size

Margin of Error

- Common to express SE as a “margin of error”
- MoE is twice the Standard Error
- For estimated proportions, expressed as: “+/- MoE percentage points”



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Posted 17 Jan 2016, 1:01am

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If they are included, 42 per cent are in favour of leaving, 38 for remaining with 20 per cent yet to make up their mind.

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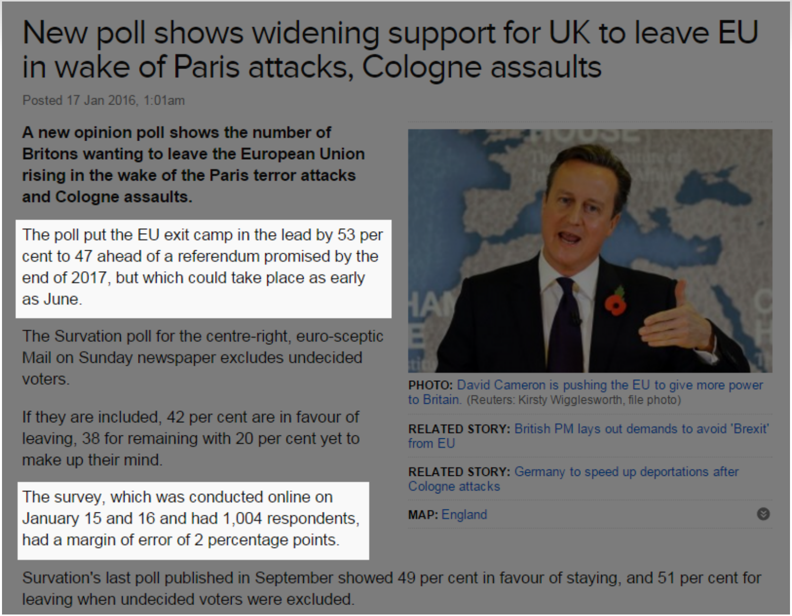
PHOTO: David Cameron is pushing the EU to give more power to Britain. (Reuters: Kirsty Wigglesworth, file photo)

RELATED STORY: British PM lays out demands to avoid 'Brexit' from EU

RELATED STORY: Germany to speed up deportations after Cologne attacks

MAP: England

Source: `http://www.abc.net.au/news/2016-01-17/new-poll-show-widening-support-for-uk-to-leave-eu/7093730`



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Questions?

Activity!

What proportion of all Haribo Starmix gummies are ♡s?

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4. Calculate element variance: $p(1-p)$

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1. Everyone collect a random sample
2. Calculate $\hat{p} = \frac{\heartsuit}{n}$
3. Report $\hat{p}$
4. Calculate element variance: $p(1-p)$
5. What is your margin of error?

How large of a sample do we need?

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- Uncertainty is influenced by:
    - Sample size
    - *Element* variance
    - Population size?

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  - Decide on desired uncertainty
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How large of a sample do we need?

- Uncertainty is influenced by:
  - Sample size
  - *Element* variance
  - Population size?
- So what do we do?
  - Decide on desired uncertainty
  - Guess at element variance
  - Adjust sample size based on feasibility

Estimating sample size

Determining sample size requires:

- A possible value of p
- A desired precision (SE)

So:

$$n = \frac{p(1-p)}{SE^2} = \frac{0.5(1-0.5)}{SE^2} = \frac{0.25}{SE^2} \tag{6}$$

Note: Element variance is highest when $p = 0.5$.

Estimating sample size

What precision (margin of error) do we want?

- +/- 2 percentage points: $SE = 0.01$

$$n = \frac{0.25}{0.01^2} = \frac{0.25}{0.0001} = 2500 \tag{7}$$

Estimating sample size

What precision (margin of error) do we want?

- +/- 2 percentage points: $SE = 0.01$

$$n = \frac{0.25}{0.01^2} = \frac{0.25}{0.0001} = 2500 \qquad (7)$$

- +/- 5 percentage points: $SE = 0.025$

$$n = \frac{0.25}{0.000625} = 400 \qquad (8)$$

Estimating sample size

What precision (margin of error) do we want?

- +/- 2 percentage points: $SE = 0.01$

$$n = \frac{0.25}{0.01^2} = \frac{0.25}{0.0001} = 2500 \tag{7}$$

- +/- 5 percentage points: $SE = 0.025$

$$n = \frac{0.25}{0.000625} = 400 \tag{8}$$

- +/- 0.5 percentage points: $SE = 0.0025$

$$n = \frac{0.25}{0.00000625} = 40,000 \tag{9}$$

How do we reduce uncertainty?

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- Increase sample size

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- Increase sample size
- Reduce element variance

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- Increase sample size
- Reduce element variance
- Change sampling design
    - Stratified sampling (tends to decrease SEs)
    - Cluster sampling (tends to increase SEs)

Big Caveat!

- Calculations from today assume SRS
- Lots of data comes from other kinds of samples
- Think of SRS as a baseline

Preview

- Feedback on PS5 this week
- PS6 due Feb. 23
- Next week we'll discuss hypothesis testing
- Remember Reading Week assignment!