Final Review

Jacob M. Montgomery

Quantitative Political Methodology

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- Poster session

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- 1% Extra credit for completing.

Exam checklist

- Peer evaluation form
- Pencils/erasers
- One sheet of paper
- Calculator with memory cleared

Overview of today

- Big picture overview of the class
- What test do I use here again?
- Questions?
- In-class review problems (answers will be posted to BB)

What is statistics?

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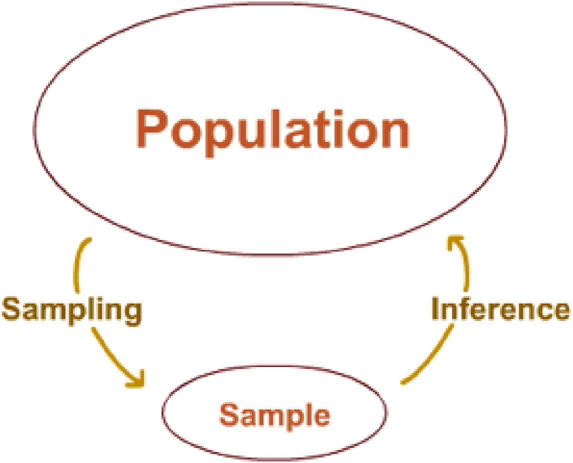
Let's break that down.

- **Research design**: Gathering data that will allow us to answer research questions by testing empirical hypotheses.
- **Description**: Summarizing the *data*.
- **Inference**: Using data to make (probabilistic) statements about the *real world*. Testing our hypotheses.


Population
Sampling
Inference
Sample

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	Quantitative		**Qualitative (categorical)**	
	Continuous	*Discrete*	*Continuous*	*Discrete*
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Nominal	NA	NA	NA	ex., Eye color

(2) Now that we have this data, how can we summarize it?

Sample mean

$$\bar{y} = \frac{y_1 + y_2 + \ldots + y_n}{n} = \frac{1}{n}\sum_{i=1}^{n} y_i$$

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Median

The observation that falls in the center of an ordered sample.

Mode

The most frequently occurring value

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Range

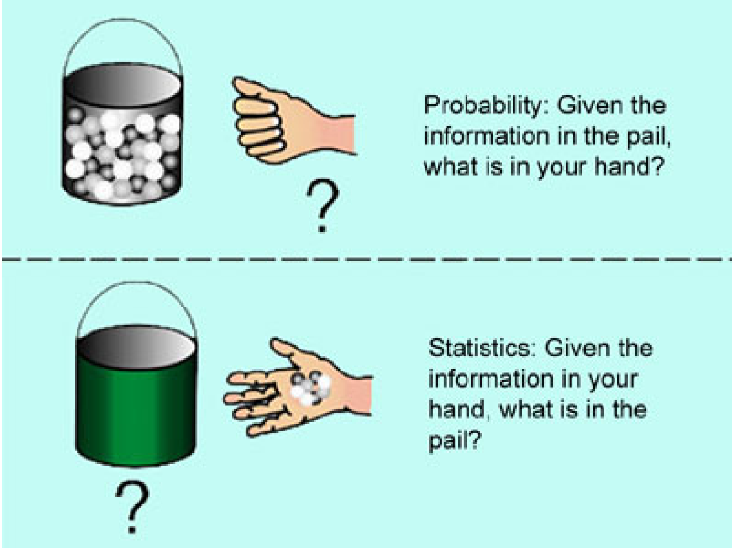
$$(max(y) - min(y)) \equiv |min(y) - max(y)|$$

Standard deviation

$$S = \sqrt{S^2} = \sqrt{\frac{\sum_{i=1}^{n}(y_i - \bar{y})^2}{n-1}}$$

Interquartile range (IQR)

75^{th} *percentile* - 25^{th} *percentile*


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

(3) Now that we have these statistics, how can we make inferences? Sampling distributions

Sampling distributions

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- $\hat{\beta}$, $\hat{\alpha}$, F, χ^2, $\bar{y}_2 - \bar{y}_1$

(3) Now that we have these statistics, how can we make inferences? Confidence intervals

We want to say something useful about the unknown population parameter. One way to do this is to set up a confidence interval.

Point estimation

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Confidence coefficient

The probability that an interval would contain the parameter with repeated sampling.

This is calculated as: Point Estimate $\pm$ (Z or T) $\times$ Standard error

(4) Now that we have these statistics, how can we make inferences? Hypothesis tests

We calculate statistics with known sampling distributions to:

- Make systematic statements about population parameters for a single population.
- Make systematic statements about how population parameters are related to explanatory variables

(5) Now that we have these statistics, how can we make inferences? Hypothesis tests

Five steps of hypothesis testing:

1. Make/state assumptions about our data
2. Formulate null and alternative hypotheses
3. Calculate the appropriate test statistic
4. Calculate the p-value
5. Draw a conclusion

P-value

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P-value

> *A P-Value is a measure of surprise. We ask, "If the null hypothesis is true, how likely is it that we would observe a test-statistic this extreme* ***or more?"***

(6) Using the appropriate test for your data

Resp. Variable	Explanatory Variables	Measure	Statistical Test(s)	Sample Size
Interval	None (population estimate)	Mean	One-sample z-test (1)	large

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3	$\frac{\hat{\pi} - \pi_0}{\sqrt{\frac{\pi_0(1-\pi_0)}{n}}}$	Standard normal (Z)

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4	$\dfrac{(\bar{y}_2 - \bar{y}_1) - 0}{\sqrt{\frac{S_2^2}{n_2} + \frac{S_1^2}{n_1}}}$	Standard normal (Z)

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4	$\dfrac{(\bar{y}_2 - \bar{y}_1) - 0}{\sqrt{\frac{S_2^2}{n_2} + \frac{S_1^2}{n_1}}}$	Standard normal (Z)
5	$\dfrac{(\bar{y}_2 - \bar{y}_1) - 0}{\hat{\sigma}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$	t-dist, $df = n - 2$

$$\hat{\sigma} = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}}$$

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6	$\chi^2 = \sum \dfrac{(f_0 - f_e)^2}{fe}$	χ^2, $df = (rows - 1)(cols - 1)$

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6	$\chi^2 = \sum \dfrac{(f_0 - f_e)^2}{fe}$	χ^2, $df = (rows - 1)(cols - 1)$
7	F-statistic	F, $df_1 = k, df_2 = n - (k + 1)$

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8 (bivariate)	$\frac{\hat{\beta}}{\hat{\sigma}/\sqrt{(X_i - \bar{X})^2}}$	$t - dist$, $df = n - 2$

$$\hat{\beta} = \frac{\sum_{i=1}^{n} \left((X_i - \bar{X})(Y_i - \bar{Y}) \right)}{\sum_{i=1}^{n} (X_i - \bar{X})^2}$$

$$\hat{\sigma} = \sqrt{\frac{SSE}{n-2}} = \sqrt{\frac{\sum (Y_i - \hat{Y}_i)^2}{n-2}}$$

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	$\hat{\sigma} = \sqrt{\frac{SSE}{n-2}} = \sqrt{\frac{\sum(Y_i - \hat{Y}_i)^2}{n-2}}$	
	$\hat{\alpha} = \frac{\bar{Y} - \hat{\beta}\bar{X}}{\hat{\sigma}_{\hat{\alpha}}}$	$t - dist$, $df = n - 2$

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	$\hat{\alpha} = \frac{\bar{Y} - \hat{\beta}\bar{X}}{\hat{\sigma}_{\hat{\alpha}}}$	$t - dist$, $df = n - 2$
9 (multivariate)	$\frac{\hat{\beta}}{\hat{\sigma}_{\hat{\beta}}}$	$t - dist$,$df = n - (k + 1)$
	$\frac{\hat{\alpha}}{\hat{\sigma}_{\hat{\alpha}}}$	$t - dist$, $df = n - (k + 1)$

Using regression to establish causality

1. Experiments (Dummies)
2. Statistical control
3. Statistical control (Fixed effects dummies)
4. Difference-in-differences (Dummies with interactions)
5. Regression discontinuity
6. Instrumental variables

Parting thoughts

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  3. polls,
  4. rhetoric,
  5. and common wisdom.