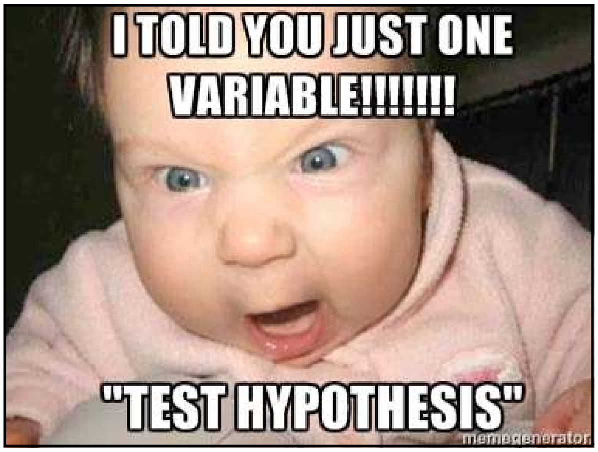

Outline for today…

- **Breathe/Check-In** ✔
- **Review so Far:** Science, Measurements, & Samples
- **Hypotheses**
  - Reminders about Errors, Elements, Steps, & Stats
  - A Walkthrough of All Five Steps
  - 3 Large Sample (n>29) Examples
    - 2 for a mean, 1 for proportion
- **Lab Exercise**

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Review 1 2 3 4 (PICTURE!) 5 Example1 Example2 Prop.

Where we are now…

#	Date	Read (5th)	Due	Area	Lecture Topic	Lab #	Lab Assignment	T Lab	R Lab
1	Tue Aug 26			*Orientation*	Welcome & Orientation	-			
2	Thu Aug 28	1.1 to 1.4			Basic Terms	-		-	-
3	Tue Sep 2	2.1 & 2.5			Measurement Issues	1	Levels / Age 3x	1	-
4	Thu Sep 4	3.1			Data Reduction	2	Heaven & Hell		1, 2
5	Tue Sep 9	-	HW1	*Description*	Display & Analysis (Shapes & SPSS)	3	Total Miles	2, 3	
6	Thu Sep 11	3.2 & 3.5			Central Tendency	4	CT		3, 4
7	Tue Sep 16	3.3 & 3.4			Dispersion	5	Dispersion	4, 5	
8	Thu Sep 18	3.7			Indices & Data Cleaning	6	Music index		5, 6
9	Tue Sep 23	4.2		*Inference*	Probability & Z Scores	7	Standardizing Scores	6, 7	
10	Thu Sep 25	4.3	HW2		Zs & Ps	8	Table A		7, 8
11	Tue Sep 30	3.6 & 5.1			Parameters & Pt Estimation	9	Distances	8, 9	
12	Thu Oct 2	2.2 to 2.4 & 4.3			Sampling (Issues, Methods, Effects)	10	Sampling		9, 10
13	Tue Oct 7	4.4 to 4.6			The Central Limit Theorem	11-EC	CLT/World (EC)	10, 11*	
14	Thu Oct 9	5.3		*Estimation*	Confidence Intervals	12	CI for Intervals		11*, 12
15	Tue Oct 14		HW3		CIs for Proportions	13	CI for Proportions	12, 13	
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]		[illegible]
17	**Tue Oct 21**				**Hypotesting for Large ns**	15	Two Tests	14, 15	
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]		[illegible]
19	Tue Oct 28	5.4			Sample Size Estimation	17	Estimating n Needed	16, 17	
20	Thu Oct 30	7.1, 7.3, & 10.1		*Covariation*	Differences in Means	18	Comparing Means		17, 18
21	Tue Nov 4	7.2	HW5		Differences in Proportions	19	Comparing Proportions	18, 19	
22	Thu Nov 6	12.1			Analysis of Variance	20, 21-EC	ANOVA (+ MODELS EC)		19, 20, 21*
	Tue Nov 11				(Veteran's Day)				
23	Thu Nov 13	9.4 & 9.5			Scatterplots & Correlation	22	Grade Correlations		22
24	Tue Nov 18	9.1 to 9.3	HW6		Regression	23	Regression Lab	20,21*,22,23	
25	Thu Nov 20	10.2 & 11.1			Multiple Regression	24-EC	Multiple Reg (EC)		23, 24*
26	Tue Nov 25	8.1	HW7	*Association*	Crosstabulations	25	TBA (any)	24*, 25	
	Thu Nov 27				(Thanksgiving)				
27	Tue Dec 2	8.2 & p.233			Dependence	26, 27-EC	TBA (SCU) (& 27-EC)	26, 27*	
28	Thu Dec 4	pp.238 to 243	HW8		Association	28-EC	Measures of Assoc (EC)		25,26,27*,28
x	Dec 9				(no lecture - work session only)			28*	
x	Dec 11				(no lecture - work session only)				
x	Thu Dec 18	-	HW9		[illegible]				

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Review 1 2 3 4 (PICTURE!) 5 Example1 Example2 Prop.

Course review…

- **Sociologists – describe world**
  - For Science – what do we know?
  - For Applications – what can we expect?
  - For Methods – how can we learn?
- **Measurements Matter**
  - Values rankable? Equal distances?
  - What's typical? How typical is that?
- **Generalize from Samples**
  - N bound by resources, variance, & demands
  - What do we think the *population* is like?
    - What's common: Point estimates, Interval Estimates
    - Tests: Given our sample, is a claim reasonable?

6 SOC424 w/ Dr. Ellis Godard -- Slide

SOC424 –
Statistics w/ Dr. Ellis Godard

Hypotesting & Z Scores

1st lecture under quarantine….

Review 1 2 3 4 (PICTURE!) 5 Example1 Example2 Prop.

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Not having data to support a "true" idea is frustrating…

… But making a false conclusion is worse!

Hypotesting Elements

- Hypotheses

  Research Hypothesis H_a - claim you want to make/test/examine

  Null Hypothesis H_0 - claim you directly, statistically test

  Test the *lack* of difference or effect or significance (= or =0)

  Treat the null as acceptable and then look to falsify it
- P-value
  - Chance of being wrong if we reject the null (Type I error)
  - Want to minimize that risk as much as possible
  - Typically, willing to accept a 5% (0.05) chance – *no more!*

Hypotesting Steps

Don't go find your own set of steps. Don't make the hypos steps 1&2. The assumptions (as step 1) matter!

1. Assumptions

   Sufficient sample size, normal distribution, etc.
2. Hypotheses

   Null (the one you "want" to reject) & alternate (research)
3. Calculated Value

   Chi-square, Student's "t", F ratio (for ANOVA), r (for correlation) and r-squared (for regression)
4. Compare to Critical Value

   Some standard alpha level, which is ½ of 1 minus the selected confidence coefficient (95%, 99%, etc.) *or*
   Some test value that would *give* you that needed alpha
5. Conclusion

   Either reject the null or fail to reject the null

Test Statistics

- **For large sample (n>29) for $\overline{Y}$, use** z:

$$z = \frac{\overline{Y} - ?}{\hat{\sigma}_{\overline{Y}}} \approx \frac{\overline{Y} - ?}{s/\sqrt{n}}$$

- **What's the "?"…**
  - Could be from another sample, a regulation/guideline, suggested by other research, a common belief, a wild claim in a speech or blog, etc.
  - It's the value in the 2 hypotheses, aka the "null-hypothesized value"

Walkthrough of All 5 Steps

1. State Your Assumptions:

- **A random sample…** (so we can use statistical theory)
- …**of at least 30 cases** (a "large sample" test, of sufficient size for the CLT to apply, so we can assume the *sampling* distribution is normal)
- **measurements are obtained on an interval level** (allowing us to calculate a sample mean).
  - Note: univariate, not yet bivariate – only one variable!
- Note:
  - Every test has mathematical assumptions that let the test "work" – here, 3
  - Hypotheses are NOT assumptions. No sense to ASSUME what you'll TEST.

2. Formulate the null and alternative hypothesis and determine whether a one- or two-tail test is appropriate:

a. Consider a claim that the population mean is equal to a specific value, say *a*. Then write:

$H_o: \mu = a$

$H_a: \mu \neq a$

This is a two-tail test

b. Alternatively, if the prediction states that the population mean is *greater than* some value *a*, then write

$H_o: \mu = a$

$H_a: \mu > a$

This is a *one-tail* test

c. Similarly, if the prediction states that the population mean is *less than* some value *a*, then write

$H_o: \mu = a$

$H_a: \mu < a$

This is also a *one-tail* test

3. Compute the Test Statistic, e.g. z

$$z = \frac{\overline{Y} - a}{s_{\overline{Y}}}$$

Computed Sample Mean

Hypothesized Population Mean, aka M_0 (the null hypothesized mean, vs the one in the actual sample) but sometimes a in text (which isn't the same as "alpha", e.g. in $z_{\alpha/2}$)

Test Statistic

Estimated Standard Error of the mean

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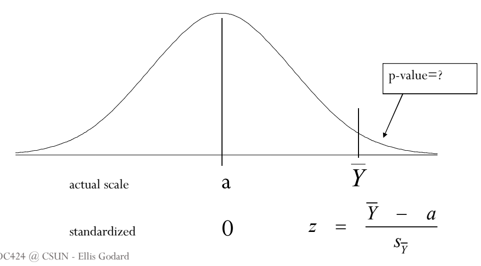
Draw a Picture!



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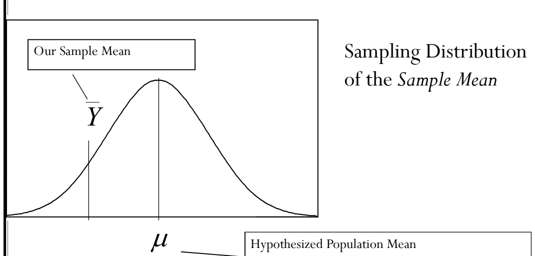
If the null hypothesis were true, how likely is it we would obtain the computed test statistic?



Sampling Distribution of the *Sample Mean*

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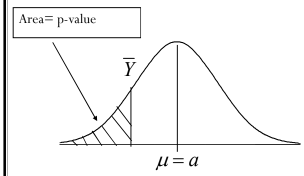
If the null hypothesis were true, how likely is that we would obtain our sample mean?



Sampling Distribution of the Sample Mean

If H_0 were correct, the probability of obtaining a sample mean, greater than (or less than) the test statistic $\overline{Y}$ is equal to the p-value of the test.

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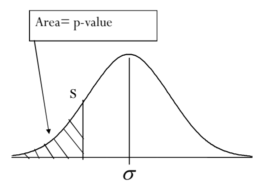
Of course, the sample mean is just one of many statistics of possible interest …



Sampling Distribution of the Sample Standard Deviation

We could also make predictions about the dispersion of a variable in the population, medians, proportions, and so forth.

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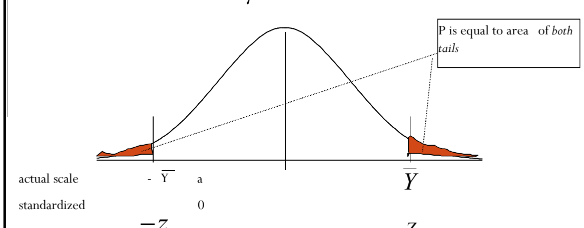
Review 1 2 3 4 (PICTURE!) 5 Example1 Example2 Prop.

4. Compute the p-value

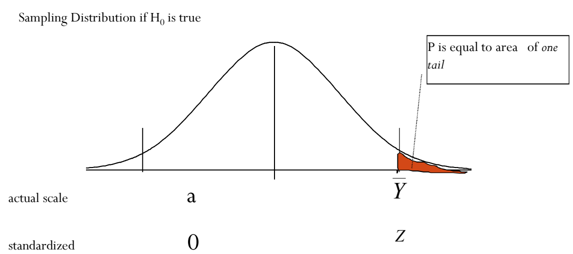
If you are conducting a two-tail test, P is the probability of obtaining, in either direction, a sample mean as favorable to the alternative hypothesis that

$$\mu \neq a$$



Alternatively, if you are conducting a one-tail test, P is the probability of obtaining a sample mean as favorable to the alternative hypothesis that

$$\mu > a \quad (or \quad \mu < a)$$



Understanding the "p" value

- Assesses the strength of evidence against the null hypothesis
  - The further observed/sample data is from the null hypothesized value, the less likely we think it is that the null value actually does describe the population
  - The larger the p, the more *likely* the null *might* be "true"
    - (though never use the words "true" or "truth" to describe inferences)
- How strong does that evidence need to be?
  - For most social sci, a p under 0.05 is sufficient to reject the null
  - **If the p is over 0.05, there is a greater than 5% chance of being wrong *if* we reject the null.**

5. State Your Conclusion

Use the magnitude of the p-value to reach a conclusion about the acceptability of the null hypothesis. Unless instructed otherwise, use the following rules:

- **if $p < 0.05$, reject H_0 (and support H_a)**
  Do NOT say "accept H_0" or "prove H_0" or "support H_0" or "reject H_a" – see previous lecture notes!
- **otherwise, fail to reject H_0 (& cant support H_a)**
  - Do NOT say "prove H_a" or "can't support H_0"

Example 1…

Claim we are interested in testing:

Has the mean age at first marriage of men in a particular community *changed* from the 1900 value of 28 years? *(Note: This phrasing implies a two-tail test is appropriate).*

1. Assumptions of Test

- large random sample (n=36 > 30);

- Since age is measured as an interval variable, a test for a mean is appropriate.

2. State the null and alternative hypotheses

H_o: $\mu = 28.0$ Yrs (mean age hasn't changed since 1900)

H_a: $\mu \neq 28.0$ Yrs (mean age has changed)

3. Compute the Test Statistic

Available Information:

n = 36

$\bar{Y} = 26.0$

$\hat{\sigma} = s = 9.0$

$s_{\bar{Y}} = 9.0/\sqrt{36} = 1.5$

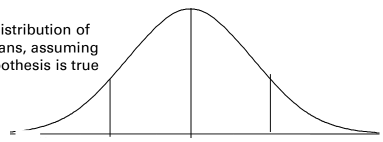
$$z = \frac{\bar{Y} - a}{s_{\bar{Y}}}$$

$$z = \frac{26.0 - 28}{9.0/\sqrt{36}}$$

$$\boxed{z = \frac{-2.0}{1.5} = -1.33}$$

4. Find the corresponding p-value

Sampling Distribution of Sample Means, assuming the null hypothesis is true



Age (in Years)	26.0	28.0	(30.0)
standardized (z)	-1.33	0	(1.33)

p= sum of tail areas

= 2(.0918)

= *0.1836*

Review 1 2 3 4 (PICTURE!) 5 Example1 Example2 Prop.

5. State your conclusion

The evidence from our sample is not sufficient to reject the null hypothesis that the mean age at first marriage for married men has not changed since 1900. A p-value of 0.18 implies that, with repeated sampling , we would obtain a sample mean age lower than 26 or greater than 30 about 18 percent of the time. Conventions in the social sciences require that the p-value would have to be lower than 0.10 or 0.05 in order to reject the null hypothesis.

Review 1 2 3 4 (PICTURE!) 5 Example1 Example2 Prop.

Example 2…

Regional Differences in Schooling

- **A Claim:** In the United States, adults have completed a mean of 12.88 years of schooling. Due to uneven socio-economic development across regions, we would expect that mean years of schooling is lower in the southern states than in the U.S. as a whole.
- First step is to **restate** this claim as null and alternative **hypotheses**…

Review 1 2 3 4 (PICTURE!) 5 Example1 Example2 Prop.

1. Assumptions

- For a mean, it has to be interval; for a proportion, it has to be nominal.
- In either case, we don't need to make any assumptions about the shape of population distribution. (We know that the sampling distributions are normal.)
- We assume that the sample size is at least 30 (n>29). Otherwise, the sampling distributions would *not* be normal.

Review 1 2 3 4 (PICTURE!) 5 Example1 Example2 Prop.

2. Null and Alternative Hypotheses:

H_o: $\mu_s = 12.88$ (No difference in schooling b/w South and US)

H_a: $\mu_s < 12.88$ (Mean Years of schooling lower in South)

Then go get…

Output from GSS

Education - Highest Year of School Completed

Region	Mean	Std Dev	Std. Error
U.S. (n=1510)	12.884	2.984	0.077
South (n=411)	12.460	3.352	0.165
Non-South (n=1099)	13.043	2.819	0.085

Review 1 2 3 4 (PICTURE!) 5 Example1 Example2 Prop.

Calculate, Report, & Interpret…

3.Test Statistic:

$$z = \frac{\overline{Y}_s - 12.88}{s_{\overline{Y}_s}} = \frac{12.46 - 12.88}{0.165}$$

Note that I used the standard error for mean education in the South!

$$z = -2.54$$

Interpretation: The mean of the south is 2.54 standard errors away from the mean of the entire U.S.

4. P-value:

If z = -2.54, then p=0.0055, or $z_{0.0055} = 2.54$. Since that p-value is very small (0.0055 < 0.05), it is highly improbable that we would be wrong in rejecting the null hypothesis. The risk is only 0.55%!

5. Conclusion:

- Since the assessed risk (0.0055, or 0.55%) is far below the risk we're willing to take (0.05, or 5.0%), we can be confident in **rejecting the null hypothesis**.
- We thereby find **support for our alternative** (research) hypothesis, and can therefore conclude that educational attainment is lower in the South than in the U.S. as a whole.

Test for a Proportion (n > 29)

Slides here are briefer, but

Steps are the same:

- State Assumptions
- Construct Hypotheses
- Compute the Test Statistic
- Determine the p-value
- State your Conclusion

Hypotheses

$H_o: \ \pi = a$

$H_a: \ \pi \neq a \quad (\ or \ \ \pi < a \quad or \quad \pi > a)$

Test Statistic

$$z = \frac{a - p}{\sqrt{\frac{p(1-p)}{n}}}$$

Once the test statistic z is calculated, then the following steps -- finding the p-value and stating your conclusion -- are the same as for a test for a mean.

Hypotheses

$H_o: \ \pi_S = 0.223$ (Dropout Rate is Same in South & US)

$H_a: \ \pi_S > 0.223$ (Dropout Rate is Higher in South)

Output from GSS
Regional Differences in Dropout Rates

Region	Proportion	Std Error
U.S. (n=1510)	0.223	0.011
South (n=411)	0.292	0.022
Non-South (n=1099)	0.197	0.012

3. Test Statistic

$$z = \frac{a - p}{\sqrt{\frac{p(1-p)}{n}}} = \frac{0.292 - 0.223}{0.022} = 3.13$$

4. P-value:

z=3.13 not in Table A. use the smaller z, & larger p

If z = 3.0, then p=0.00135, or $z_{.00135}$ = 3.0.

It is *extremely* unlikely (about one chance in a thousand!) that we would be wrong in rejecting the null hypothesis

5. Conclusion:

We can reject the null, find support for the alternative, and conclude that the dropout rate is higher in the South than in the US as a whole.

For Your Next Lab…

- **Two claims to consider. I hypothesize that…**
  - People in Korea tend to have more than 1 child.
  - More than a third of Koreans smoke cigarettes daily.
- **Using Korean GSS** (KoreanGSS-2003to2016-Trimmed)
  - Two variables: KIDNUM10 (84th) & FREQSMOK (326th)
- **Test both of those claims**
  - Note that each has a hypothesized value.
  - Perform all 5 steps (all five – 1, 2, 3, 4, ALL FIVE) of each test
  - Be sure to interpret the values (the test and sample statistics, the calculated differences, & the standard errors, but esp. the t & p)
  - Be explicit in your conclusions about the claims (Ha, not just Ho)