

- Must include at least following items:
- Clearly state the null hypothesis to be tested, and the alternative hypothesis.
- What kind of data you want to collect? How many data you want? (yes, more data is always better, but be reasonable)
- Pick an alpha level.
  - -- For each item, give some discussion of why you think this is the right choice.
  - -- there is an example of "home field advantage" in book. Read it

# Example: compare 2 proportions

- A nation wide study: an aspirin every other day can sharply reduce a man's risk of heart attack. (New York Times, reporting Jan. 27, 1987)
- Aspirin group: 104 Heart Att. in 11037
- Placebo group: 189 Heart Att. in 11034

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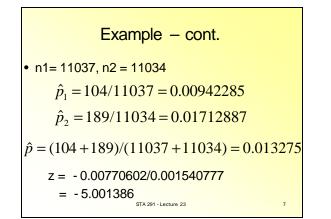
• Randomized, double-blinded study

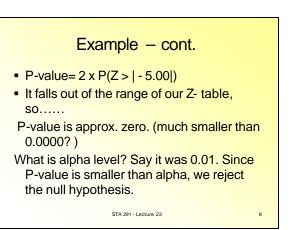
Example – cont. • Let aspirin = group 1; placebo = group 2 p1 = popu. proportion of Heart att. for group 1 p2 = popu. proportion of Heart att. for group 2  $H_0: p_1 = p_2$  which is equivalent to  $H_0: p_1 - p_2 = 0$   $H_A: p_1 \neq p_2$  or  $H_A: p_1 - p_2 \neq 0$ STA 291 - Lecture 23

### Example - cont.

- We may use software to compute a pvalue
- p-value = 7.71e-07 = 0.000000771 Or we can calculate by hand:

$$Z_{obs} = \frac{\hat{p}_{1} - \hat{p}_{2}}{\sqrt{\frac{\hat{p}(1 - \hat{p})}{n_{1}} + \frac{\hat{p}(1 - \hat{p})}{n_{2}}}}$$
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### Example 2

- Let **p** denote the proportion of Floridians who think that government environmental regulations are too strict
- Test *H<sub>0</sub>: p=0.5* against a two-sided alternative using data from a telephone poll of 834 people conducted in June 1995 in which 26.6% said regulations were too strict
- Calculate the test statistic
- Find the *p*-value and interpret
- Using alpha=0.01, can you determine whether a majority or minority think that environmental regulations are too strict, or is it plausible that p=0.5?
- Construct a 99% confidence interval. Explain the advantage
   of the confidence interval over the test.

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# Example 3: KY Kernel Jan 17, 2007

- UK researcher developed a blood substitute. A total of 712 trauma patients in the study. 349 receive PolyHeme (a blood substitute), 363 receive regular blood.
- 46 died in the PolyHeme group
- 35 died in the regular group.
- Is there any difference in the two rates of death?

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• This is very similar to the heart attack example.

- The only place we need to be careful: our formula only work well for large n (here n1 and n2)
- Usually we check np > 10, and n(1-p) > 10

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## Decisions and Types of Errors in Tests of Hypotheses

• Terminology:

- The alpha-level (significance level) is a *threshold number* such that one rejects the null hypothesis if the *p*-value is less than or equal to it. The most common alpha-levels are .05 and .01
- The choice of the alpha-level reflects how cautious the researcher wants to be (when it come to reject null hypothesis)

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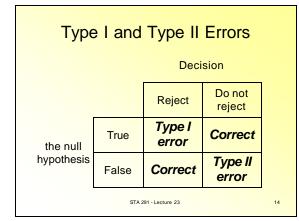
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# Type I and Type II Errors

- Type I Error: The null hypothesis is rejected, even though it is true.
- Type II Error: The null hypothesis is not rejected, even though it is false.
- Setting the alpha-level low protect us from type I Error. (the probability of making a type I error is less than alpha)

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# Type I and Type II Errors

- Terminology:
  - Alpha = Probability of a Type I error
  - Beta = Probability of a Type II error
  - Power = 1 Probability of a Type II error
- For a given data, the smaller the probability of Type I error, the larger the probability of Type II error and the smaller the power
- If you set alpha very small, it is more likely that you fail to detect a real difference (larger Beta).

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# When sample size(s) increases, both error probabilities could be made to decrease. Our Strategy: keep type I error probability small by pick a small alpha. Increase sample size to make Beta small.

# Type I and Type II Errors

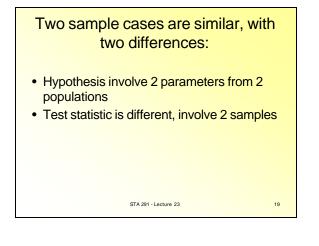
- In practice, alpha is specified, and the probability of Type II error could be calculated, but the calculations are usually difficult (sample size calculation)
- How to choose alpha?
- If the consequences of a Type I error are very serious, then chose a smaller alpha, like 0.01.
- For example, you want to find evidence that someone is guilty of a crime.
- In exploratory research, often a larger probability of Type I error is acceptable (like 0.05 or even 0.1)

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Alternative and p -value computation $H_0: p = p_0$  $\boxed{M_0: p = p_0}$  $\boxed{M_0: p = p_0}$  $\boxed{M_1: p < p_0}$  $H_A: p < p_0$  $H_A: p > p_0$  $H_A: p > p_0$  $H_A: p < p_0$  $P(Z < z_{obs})$  $P(Z > z_{obs})$  $2 \cdot P(Z > |z_{obs}|)$  $z_{obs} = \frac{\hat{p} - p_0}{\sqrt{p_0(1 - p_0) / n}}$ STA 291 - Lecture 23





Alternative and p -value computation $H_0: p_1 - p_2 = 0$			
	One-Sided Tests		Two-Sided Test
alternative Hypothesis	$H_A: p_1 - p_2 < 0$	$H_A: p_1 - p_2 > 0$	$H_A: p_1 - p_2 \neq 0$
<i>p</i> -value	$P(Z < z_{obs})$	$P(Z > z_{obs})$	$2 \cdot P (Z >  z_{ds} )$
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