

# Hypothesis Testing

- Left, Right, and Two Tails
- Type I and Type II Errors
- P-Values
- Rejection Regions
- Hypothesis Testing Procedure

# Left, Right, and Two Tails

- **Left Tailed Hypothesis:** Involves the hypothesis that the statistic is less than a number:  $H_0: \mu=10, H_1: \mu < 10$
- **Right Tailed Hypothesis:** Involves the hypothesis that the statistic is greater than a number:  $H_0: \mu=10, H_1: \mu > 10$
- **Two Tailed Hypothesis:** Involves the hypothesis that the statistic is not equal to a number:  $H_0: \mu=10, H_1: \mu \neq 10$

# Determine the Null and Alternative Hypotheses

- A. You want to find out if more than 50% of voters support a candidate.
- B. You want to find out if the mean number of snow boards rented is greater than 60 per day.
- C. You want to find out if the average speed that people drive on highway 50 is different than 40 mph.

# Type I and Type II Errors

- **Type I Error:** Rejecting  $H_0$  when  $H_0$  is true:  $P(\text{Type I}) = \alpha$
- **Type II Error:** Failing to reject  $H_0$  when  $H_0$  is false:  $P(\text{Type II}) = 1 - \beta$

**Example:** Suppose a hypothesis is done to see if a proposed vaccination for HIV is effective in reducing the chance of a person getting infected. Discuss the implications of Type I and Type II errors.

# P-Value

**P-Value:** The probability that if  $H_0$  is true, and a sample is taken with the same sample size, then the result will be at least as extreme as the result obtained for our sample.

# P-Value Example

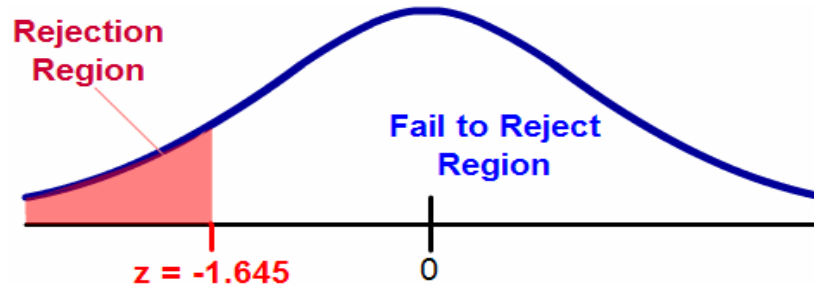
A hypothesis test was conducted with  $n = 200$  students to see if more than 70% of all college students gain weight in their first year of college ( $H_0: p = 0.7$ ,  $H_1: p > 0.7$ ). The sample proportion was found to be .76 and the P-Value was 0.03. Then if the proportion is really 0.7 and if many samples of size 200 students are taken, 3% of these samples will produce a sample proportion at least as large as 0.76.

# Rejection Region

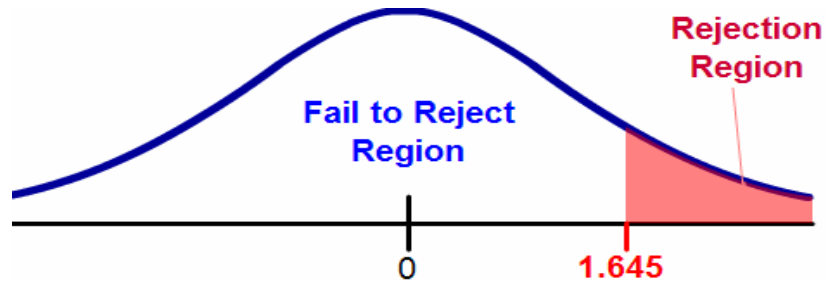
**Rejection Region:** The region under the  $z$  (or  $t$ ) graph such that a test statistics in that area will result in  $H_0$  being rejected ( $H_1$  accepted). A test statistics outside of that region will result in failing to reject  $H_0$ .

# Rejection Region Examples

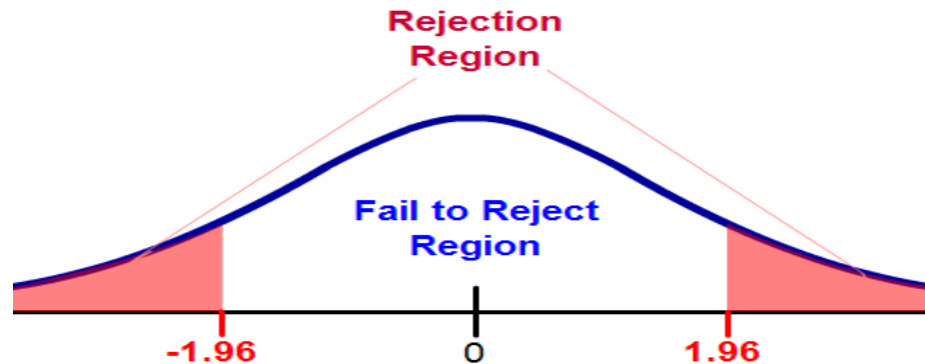
Left Tailed Test:



Right Tailed Test:



Two Tailed Test:





# Hypothesis Testing Procedure

- Determine the hypotheses in words
- Write down  $H_0$  and  $H_1$  in symbols
- Determine the level of significance
- Conduct the survey or experiment
- Calculate the test statistic
- Calculate the p-value
- Make a conclusion

# Hypothesis Test for a Proportion

- State  $H_0$  and  $H_1$  (involving  $p$ ).
- Find  $z = \frac{\hat{p} - p}{\sqrt{pq/n}}$
- Get the *P-value*.
- If  $P < \alpha$  reject  $H_0$  accept  $H_1$  and state the conclusion.
- If  $P > \alpha$  fail the reject  $H_0$  and make no conclusion, there is no evidence.

# Example

- A candidate for the upcoming election has done a survey of registered voters to see if she will win (receive more than **50%** of the votes). Of the **300** registered voters surveyed, **170** of them indicated that they would vote for this candidate. What can be concluded at the **0.05** level of significance?
- **1-PropZTest**

# Example

- Twelve percent of Tahoe residents were born in Tahoe. A researcher wants to see if the proportion at LTCC is different. She surveys 300 LTCC students and finds that 29 of them were born in Tahoe. What can be concluded at the 0.05 level of significance.
- Both the P-Value and level of significance represent probabilities. Compare and contrast what these probabilities represent.