# STA-1380 – Elementary Statistics
# Week #10

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Hello! Welcome to the additional online **Weekly Resources** for the course of **STA-1380**. Following a traditional calendar semester, these will be some of the topics your professors will go over. If you do not see material your section is going over for the week, please look at the other resources listed for this course. In addition to these resources, there might be **Group Tutoring** for this course, please see our website for more details. These sessions will go over these materials in more detail as well as any questions about the material.

Any additional help or services can be found through the **Baylor Tutoring Website.** Visit to schedule a free 30-minute private tutoring session, drop-in times for your course, the Baylor Tutoring YouTube channel, or any additional tutoring resources.

Contacts: Sid Rich M-Th 9am-8pm (Fall and Spring class days) Office Phone: 254-710-4135

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## Topic of the Week:
### "Hypothesis Tests Continued"

**Key Points:**

- Hypothesis Testing for Means
- CIs vs Hypothesis Test

In the previous chapters, we accepted Normal Distribution as the basis of our tests. These are sometimes referred to as Z-tests in reference to the Z-Scores used. However, similar to CIs for means, the Hypothesis Test for means will use the Student T-Distribution for when the population standard deviation is not known. These will be known as T-tests in reference to the T-Distribution.

Recall that the T-Distribution is a normal curve that has an infinite number of iterations depending on the number of individuals in a sample size. To create a Test Statistic (T.S.), the formula is the same as a Hypothesis Test (H.T.) for proportions, the exception to this being that the SE is calculated with the Sample Std. Dev ($s$).

Most problems will give you raw sample data that requires you to compute $\bar{x}$ and $s$ as well as the Hypothesis Test. A QQ-Plot might also be required if the data is not known to be normally distributed. Re-familiarize yourself with how one is structured and what it is designed to show.

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# Highlight #1
## "Hypothesis Testing for Means"

**Definition:** A single sample T-test or Z-test designed to identify if a Population Parameter is still accurate.

**Formulas:** $SE = \frac{s}{\sqrt{n}}$ $\quad$ $\text{T-test:} \frac{SS - PP}{SE}$

The Hypothesis Test for means functions the same way that it does for proportions, declare the Ho and Ha, find the Observed Value from the Test statistic, and compare it with the RR bound to see whether or not Ho can be rejected. The difference between these two parameters is that for means, we have two potential options.

There is the Z-test, for when the Std. Dev. for the population is known. Instead of using the sample data, the population parameters are used for calculating as well as a Normal Distribution. However, this is almost never the case in the real world and as such, hardly ever tested on.

The T-test as mentioned above, is used for when the Std. Dev. is not known and uses a Student T-Distribution to account for the variability between the two curves. This test is used far more often and is based solely on sample data to arrive at conclusions. Here, the SE shown above in Formula #1 will be used for the majority of this guide. Recall that $n$ is the sample size, $s$ is the sample standard deviation, and $\bar{x}$ is the sample mean as well as the point estimate used for the CI if Ho proves false.

This chapter will be when you need to become accustomed to JMP or whichever program you choose. JMP will compute every test and calculation for you and will end up with a p-value for you to interpret. The contextualization and conclusions are up to you, but the formulas built into JMP, and other software will make the application of statistical inference much easier.

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# Highlight #2
## "Similarities between CIs and HTs"

**Definition:** How to read a Confidence Interval to conclude a Hypothesis Test.

**Rule:** If Ho is in the CI, fail to reject, If Ha is in the CI, reject Ho.

Due to the fact that α is shared between a CI and Hypothesis Tests, this means that the bounds outside of the Confidence Intervals are the Reject Regions of the Ho for a T or Z test. Every value within the CI, regardless of if Ha is expected to be higher, lower, or not equal to Ho, can be used to either reject or fail to reject Ho.

This concept is focused on a student demonstrating their knowledge and using elevated thinking to connect concepts from previous chapters. You may not be expected to compute an entire T-test, instead, you may be asked only to use a resulting CI to answer whether or not Ho can be rejected. Remember that for proportions, the population Std. Dev. is used for Confidence Intervals but not Hypothesis Testing. A helpful tip would be to write out a list of equations for all possible H-Tests and CIs so you can identify how each formula is distinct from the other.

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## Check Your Learning

**1.** Barbara has several fish tanks to which she keeps over 100 fish. She has been feeding her fish the same brand of food but has recently noticed that her fish are growing significantly bigger. She has kept the portions the same of 12 pellets per fish and believes the manufacturer has changed the portions to make each pellet bigger than previous iterations of the formula. She takes a sample of 33 pellets and weighs them before she feeds her fish. The pellets are reported to have a mean weight of 8.0 milligrams. Her data is presented as such:

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 8.23 | 8.25 | 8.38 | 8.43 | 8.34 | 8.48 | 8.68 | 8.13 | 8.54 | 8.20 | 8.44 |
| 8.29 | 8.44 | 8.42 | 8.37 | 8.54 | 8.29 | 8.26 | 8.57 | 8.08 | 8.17 | 8.68 |
| 8.37 | 8.20 | 8.45 | 8.53 | 8.24 | 8.59 | 8.14 | 8.87 | 8.39 | 8.48 | 8.23 |

**a.** Compute a Hypothesis Test at the 1% level and offer a conclusion in the context of the problem

**b.** Declare the potential Error you could have committed with your decision and present the CI for the Hypothesis Test.

**2.** Lisa is a librarian and repairs books in her spare time. She wonders if the number of books that are becoming damaged has decreased in the past few years. In the past she used to repair on average 9 books per month. She runs a 95% CI to see where the mean lies now and finds an interval of (4.3, 7.8).

**a.** Explain what the SS, PP, Ho, and Ha are in terms of the problem.

**b.** Using the CI, can Lisa support her claim that the number of books damaged in her library each month has decreased

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# Things Students Struggle With

1. Understanding Errors:

    a. In last week's guide, there was a section on the Type I and II errors that exist with Hypothesis Testing. However it can be difficult to remember which error is which. Remember that a Type I error is when a true Ho is rejected, and Type II error is when a false Ho has failed to be rejected. One way to remember this is Type II error, "Type-two" has two 'F's. Failing to reject the False Ho. And a Type I error has only one true Ho.

2. How to read a stats output for T-tests:

    a. When the calculations are done for you by software like JMP, usually the data will result in an output that produces either a Test Statistic, or 3 p-values.

| T-Tests | |
|---|---|
| Test Statistic: | -2.941 |
| Probability: > *t* | 0.9961 |
| Probability: < *t* | 0.0039 |
| Probability: > \|*t*\| | 0.0078 |

As shown by the applets results, when calculating a Ho test, the software will not know which test you are trying to compute and will create a result for every possible test. You the statistician will know what answer to look for based on what you set Ho vs Ha to be. If you said that Ha would have μ higher than the PP, then chose the portion of the applet that shows where you are looking for higher than the Test statistic ( Ha > Ho = Prob > *t*). If you said that Ha would be lower than the PP, the chose the opposite value (Ha < Ho = Prob < *t*). If you are using a two tailed test in which you test for Ha ≠ Ho, use the part of the probability that has absolute values (Prob > |*t*|). It is also good to note that the not equals Ha has already doubled the probability compared to a one tailed test. Using P-values, you can determine which T-tests can be proof to reject Ho. If α = .05, then then the last two p-values can reject Ho. If the p-value is at or above α, fail to reject Ho, if not, reject it.

## Concluding Comments

That's it for this week! Please reach out if you have any questions and don't forget to visit the Tutoring Center website for further information at https://www.baylor.edu/tutoring

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## Answers to CYL

**1.** **a.** Ho: $\mu = 8.0$ mg vs Ha: $\mu > 8.0$ mg T.S.= 12.249, p-value = .00001. Because .00001<<.01, we have enough evidence to reject Ho in favor of concluding that the pellet weights of the fish food are above the previously depicted 8 milligrams.
**b**. The potential error is a Type I error in which Barbara rejected a true Ho. The chance of this occurring was 1%. CI = (8.385 - (2.449)*(.0314)) = (8.385) – (.0769) = (8.3079, ∞) (check the sign, make sure you subtracted the margin of error)

**2.** **a.** The Sample Statistic (SS) is 6.05, which is the sample mean for how many books Lisa has repaired on average in the sampled months. The Population Parameter (PP) is 9, which was the assumed standard of how man books needed repair per month. The Ho of the problem is Ho: $\mu = 9$. The Ha of the problem is Ha: $\mu < 9$.
**b.** Because 9 is not within the bounds of the CI and that every value within the interval is below 9, Lisa can use this CI to prove that Ho is false and reject it.