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Conducting a One-Sample t Test

Now that you understand the language of hypothesis testing and statistical decision-making, let's revisit the hypothesis test we conducted in the previous lesson. Remember that your team has been working on improving the dimensional conformance of a small metal part.

Your primary goal is to bring the thickness to a target of 40 hundredths of an inch. Before fully implementing changes, you want to make sure that the changes will, in fact, shift the process mean to the target. You test the changes during a pilot period and collect data on 20 parts. Here are the null and alternative hypotheses for the pilot metal parts scenario.

This test is called a one-sample t test. Let's walk through the analysis results and some of the mechanics behind the test. The hypothesized value is 40, and Actual Estimate is the sample mean, 40.345. DF is the degrees of freedom. For a one-sample t test, the degrees of freedom is the sample size, n, minus 1. The standard deviation, 1.28, is the standard deviation for this sample of 20 parts.

This graph gives a visual representation of the test results. The curve represents the distribution of sample means that you can expect under the null hypothesis. Note that this curve is conceptually the same as the distribution of simulated sample means that you saw earlier. It is centered at the hypothesized value, and ranges from about 39 to about 41. The red line in the graph is drawn at the observed sample mean. The blue shaded area is the probability of observing a sample mean as extreme, or more extreme than, the sample mean that we observed under the null hypothesis.

The alternative hypothesis is that the mean thickness is not 40 hundredths of an inch. This is called a two-tailed test. We would reject the null hypothesis if the observed sample mean is much larger than, or much smaller than, the null hypothesis. To reflect this, there is shading in both tails, the same distance from the hypothesized value. This shading represents the first p-value reported in the output. That is, the combined area, in both tails, is 0.2426.

What if your alternative hypothesis is that the mean is greater than 40? This is called a one-tailed test. The p-value for this test is 0.1213. This is the area under the curve greater than the observed sample mean. You can see that this is exactly half of the p-value for the two-tailed test. Likewise, if your alternative hypothesis is that the mean is less than 40, the p-value is 0.8787. This is the area under the curve below the observed sample mean. This value is simply the complement of the previous p-value: 1 minus 0.1213 is 0.8787.

The value we haven't discussed yet is the test statistic. For a one-sample t test, the test statistic is the t ratio. The numerator is the difference between the sample mean and the hypothesized value and the denominator is the standard error. Here's the calculation for the t ratio for this example. This t ratio measures the distance between our sample mean and the null hypothesized value, in units of standard error. In the Estimation lesson, you learned that sample means follow the t distribution.

The t ratio, which is based on sample means, also follows the t distribution. This distribution is centered at zero, and the unit of measure for the x axis is standard errors. For our test, the t ratio is 1.206. In this graph, we've shaded the area in the tails of the t distribution beyond + and − 1.206. Here's how you interpret this value: The sample mean, from the pilot data, is 1.2 standard errors away from the target. This would be a fairly typical value under the null hypothesis.

Note that the p-values reported in JMP are expressed relative to the t distribution. For example, the notation "Prob > t" represents the probability of observing a t ratio greater than 1.2 under the null hypothesis. For the two-tailed test, we're looking at the combined area in both tails. There is both a negative and a positive t value. The notation "Prob > |t|" reflects this.

You'll see similar notation throughout JMP. Anytime you see the notation "Prob > something," you know that some type of hypothesis test has been performed. Let's take another look at the graph that is provided with the t test. Notice that this graph looks a lot like the graph of the t distribution, but the X axis is different.

In JMP, the graph is centered at the null hypothesis to make it easier to interpret the test results. If you see a lot of blue shading, you know that the sample mean is close to the hypothesized value. However, if you see very little shading, or no shading at all, you know that the sample mean and the hypothesized value are far apart. This would tell you that, given the data, the null hypothesis is improbable.

For more information about the one-sample t test, and the interesting history of the Student's t distribution, see the Read About It for this lesson. (Hint: It involves beer.)

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