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Two-Sample t Tests

To illustrate how to use and interpret two-sample t tests to compare the means for two independent samples, we use the file Diameter Test.jmp in the course data folder. In this scenario, the characteristic of interest is the diameter in millimeters. Parts can be run on two different machines. You are concerned that the mean diameter for parts produced on the two machines might be different. You've measured the diameter of 25 randomly selected parts from each of the machines.

Your null hypothesis is that the mean diameter for the two machines is the same. Or, in other words, that the difference in the mean diameters between the two machines is zero. The alternative hypothesis is that the difference in the means is not zero.

First, we'll conduct an unequal variances t test. The curve is similar to what you saw in the one-sample t test. It represents the distribution of the differences between the sample means, under the null hypothesis that the average difference between means is zero. The red line is drawn at the mean difference, which is the sample mean for machine B minus the sample mean for machine A. This difference is -0.0372. That is, the mean for machine B is about 0.037 mm lower than the mean for machine A. The t ratio is -2.98.

The observed difference is nearly 3 standard errors below zero. Notice how far this red line is from the hypothesized value of zero. Also, notice that you don't see any shading in the tails of the distribution. This visual provides a good indication that the difference between the two means is significant. Three p-values are reported: one for the two-tailed test, and two for the potential one-tailed tests. Here, we're conducting a two-tailed test. The p-value is much smaller than a significance level of 0.05. From this, you conclude that the difference in means is not zero. That is, the machines are not producing parts with the same average diameter.

Remember that you can also use a confidence interval to evaluate your null hypothesis. In fact, you might find this more intuitive. The 95% confidence interval for the difference in means is the likely range of values for the average difference between the machines. Our hypothesized value, zero, doesn't fall within this interval. This is additional evidence that there is a difference between the machines.

The estimated difference in means is between 0.012 and 0.062 mm. Note that these results are based on the unequal variances t test. This test is used when there is a difference in the variances for the populations.

In this example, the spread of the data is similar, so we'll conduct the equal variances t test. In this test, the two sample variances are pooled to provide one overall estimate of the variance. The equal variances, or pooled, t test produces very similar results to the unpooled t test. However, additional statistical output is provided with this test, which you learn about in the ANOVA videos.

The test also produces an additional graphical tool to help you interpret the statistical test: mean diamonds. Each diamond is a 95% confidence interval for the population mean. If the short "hash" marks within the diamonds do not overlap, as we see here, the groups are significantly different.

In this video, we conducted both the pooled and unpooled two-sample t test for illustration. Note that you usually dont need to run both versions of the tests. Unless you see a very large difference in the spread for the two samples, you can use the pooled t test. Also, if you want to assert that the null hypothesis is true, rather than find evidence against the null hypothesis, you can conduct an equivalence test for the difference between two means. You explore an equivalence test for two means in a practice. To learn more about these tests and when to use them, see the Read About It for this module.

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