Comparing Two Means

Thus far, you've seen statistical tests involving one mean. But you might want to use statistical tests to compare the means of two populations or processes.

For example, a pharmaceutical researcher might want to compare cholesterol levels among patients following two different diets in a controlled study. Or, using a more familiar example, you might want to compare the average thickness of parts before and after improvements are implemented.

In such cases, the question is not about the mean of one population, but the difference between the means of two populations. Consider Michelson's speed of light experiments. Recall that Michelson took a total of 100 velocity measurements, in a series of five trials.

In the estimation lesson, we assumed that he used the same process to take all of his measurements. But, this was a new process, and Michelson might have refined his instrumentation and techniques as he gained more experience.

Is it possible that the measurements in the second trial had a different mean than the measurements in the first trial? We'll think of each set of measurements as a random sample, and assume, at least initially, that the instruments and process have not changed.

Hence, we'll assume that the two samples come from two identical distributions, with the same shape, center, and spread. In our testing, we are only asking about whether the center has changed. Later, we'll consider the possibility that the spread might have changed as well.

We'll call the mean of the measurements in the first trial μ1 (mu-sub-1), and the mean of the measurements in the second μ2 (mu-sub-2). Note that we're assuming that the measurements in the two trials are independent. That is, readings in the first trial do not influence readings in the second trial. This is an important assumption.

In a future video, you learn how to compare means for measurements that are not independent. We might express the null hypothesis like this. But instead of hypothesizing that the two means are the same, we'll express it this way, and hypothesize that the difference between the means is zero. The alternative hypothesis, then, is that the difference is not equal to zero. To compare two population means based on independent samples, we use a two-sample t test. There are two versions of this test.

The pooled two-sample t test is a test for differences in means for two populations that have the same population variance. The unequal variances, or unpooled, two-sample t test does not make this assumption of equal population variances. Like the one-sample t test, the test statistic for these two-sample tests is the t ratio.

In this case, the numerator is the difference between the two sample means, minus the hypothesized difference (zero). The formula used to compute the standard error is based on the type of test you are running: pooled or unpooled.

In either case, the t ratio is a measure of how big the difference is between the means, in units of standard error. In the next video, you learn more about these tests. We omit the technical details and the computations and focus on the interpretation and practical application of these tests. You revisit the Michelson scenario in a practice.

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