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Statistical Decision Making

To describe the statistical decision-making process, we revisit a scenario you saw in the Quality Methods module, the metal parts example. In this scenario, 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. The current process is stable, but the process is off target: the mean thickness is 41.328.

You use problem-solving tools, data, and statistical methods to identify critical input variables and develop an understanding of cause and effect. Based on these efforts, your team has identified process improvements.

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 a random sample of 20 parts.

The sample mean is 40.345, which is a little higher than the target. However, you know that individual samples will vary. From this one sample of 20 parts, what can you determine about the process mean?

Is the process still off target? If it is, your team would have more work to do. Or, is there evidence that the changes might be effective in bringing the process to target, even though the sample mean is a little high?

Using the skills you developed in the estimation lesson, you could calculate a 95% confidence interval for Thickness, and ask whether the interval contains the target of 40. This would provide evidence to make the decision about whether the target of 40 has been achieved.

Let's look at this confidence interval. You can see that the 95% confidence interval for mean thickness, for these pilot data, includes 40. This tells you that the true mean might, in fact, be 40.

As you will see in the next lesson, hypothesis tests use computations that are related to those used for estimation. Although you can use interval estimates to draw conclusions about the parameter you're estimating, the hypothesis testing protocol provides a more formal framework for statistical decision-making.

The goal of hypothesis testing is to make a decision based on incomplete information (a sample). As a result, hypothesis testing addresses two potential issues: inconclusive results and erroneous decisions.

First, your results might not be conclusive. So, in hypothesis testing, you specify a default decision to be followed if the sample data are inconclusive.

Second, you might not make the correct decision. Hypothesis testing anticipates the consequences of an erroneous decision. This can occur simply due to sampling variation, or if you don't have enough data. Taken together, these two concerns underlie two important concepts in hypothesis testing: the null hypothesis and the p-value (or probability value).

Let's conduct a hypothesis test using these data to get a sneak peek of what you'll learn in the upcoming videos. Note that, for now, we omit many of the details and background information, and focus on the decision-making process. The purpose of this example is simply to provide some context.

In this scenario, the default decision, the null hypothesis, is that the mean thickness is 40. Hypothesis testing requires a second statement, an alternative hypothesis, that is accepted if you reject the null hypothesis. The alternative hypothesis is that the mean thickness is not 40.

To determine whether to reject or not reject the null hypothesis, you look at the p-value.

The p-value is a measure of the strength of the evidence against the null hypothesis. It measures the improbability of your sample results, if the null hypothesis is actually true.

A low p-value would lead you to reject the null hypothesis. A typical cutoff for rejection for the null hypothesis is a p-value of 0.05. That is, if you have a p-value less than 0.05, you would reject the null hypothesis in favor of the alternative hypothesis. For this example, a low p-value would lead you to conclude that the mean thickness is not on target.

The p-value for this test is 0.2426. With this p-value, you would not reject the null hypothesis. The sample data are consistent with the null hypothesis that the process mean is 40. This confirms what you would learn from the confidence interval: 40 is a reasonable value for the true mean thickness. From a practical perspective, you have evidence that the piloted changes, if implemented, might bring the process to target.

In upcoming videos, you learn more about the language of hypothesis testing, and how to use hypothesis tests to guide your decision making.

In the next lesson, you learn how to conduct common hypothesis tests for continuous data in JMP.

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