

6.1: Check your confidence in your mean

We've talked about getting a sample of data. We know we can find the mean, we know we can find the standard deviation. We know we can look at the data in a histogram. These are all useful things to do for us to learn something about the properties of our data.

You might be thinking of the mean and standard deviation as very different things that we would not put together. The mean is about central tendency (where most of the data is), and the standard deviation is about variance (where most of the data isn't). Yes, they are different things, but we can use them together to create useful new things.

What if I told you my sample mean was 50, and I told you nothing else about my sample. Would you be confident that most of the numbers were near 50? Would you wonder if there was a lot of variability in the sample, and many of the numbers were very different from 50. You should wonder all of those things. The mean alone, just by itself, doesn't tell you anything about well the mean represents all of the numbers in the sample.

It could be a representative number, when the standard deviation is very small, and all the numbers are close to 50. It could be a non-representative number, when the standard deviation is large, and many of the numbers are not near 50. You need to know the standard deviation in order to be confident in how well the mean represents the data.

How can we put the mean and the standard deviation together, to give us a new number that tells us about confidence in the mean?

We can do this using a ratio:

$$\frac{\text{mean}}{\text{standard deviation}}$$

Think about what happens here. We are dividing a number by a number. Look at what happens:

$$\frac{\text{number}}{\text{same number}} = 1$$

$$\frac{\text{number}}{\text{smaller number}} = \text{big number}$$

compared to:

$$\frac{\text{number}}{\text{bigger number}} = \text{smaller number}$$

Imagine we have a mean of 50, and a truly small standard deviation of 1. What do we get with our formula?

$$\frac{50}{1} = 50$$

Imagine we have a mean of 50, and a big standard deviation of 100. What do we get with our formula?

$$\frac{50}{100} = 0.5$$

Notice, when we have a mean paired with a small standard deviation, our formula gives us a big number, like 50. When we have a mean paired with a large standard deviation, our formula gives us a small number, like 0.5. These numbers can tell us something about confidence in our mean, in a general way. We can be 50 confident in our mean in the first case, and only 0.5 (not at a lot) confident in the second case.

What did we do here? We created a descriptive statistic by dividing the mean by the standard deviation. And, we have a sense of how to interpret this number, when it's big we're more confident that the mean represents all of the numbers, when it's small we are less confident. This is a useful kind of number, a ratio between what we think about our sample (the mean), and the variability in our sample (the standard deviation). Get used to this idea. Almost everything that follows in this textbook is based on this kind of ratio. We will see that our ratio turns into different kinds of "statistics", and the ratios will look like this in general:

$$\text{name of statistic} = \frac{\text{measure of what we know}}{\text{measure of what we don't know}}$$

or, to say it using different words:

$$\text{name of statistic} = \frac{\text{measure of effect}}{\text{measure of error}}$$

In fact, this is the general formula for the t-test. Big surprise!

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