# Significance

The concept of significance is introduced in your textbook in Chapter 1 in a couple of small paragraphs, but the concept is such a fundamental one that it deserves more detail now before we get too much farther. This worksheet will expand the idea without requiring more statistical knowledge than you'd have in Chapter 1.

If you were looking over your credit card bill, and you saw that the automatic payment for your phone bill was $70 more than it was last month or the month before, it would draw your attention. Your first thought might be, did I make and long-distance calls I knew I'd be charged for? Roaming charges? Did I go over my data? Maybe you could come up with an explanation for the extra charge, but if you couldn't, you'd know something was wrong, and you'd start looking into your phone usage to find an explanation.

There are numbers we *expect* to see in certain contexts, perhaps a range of numbers, but if we *actually* see a number outside that range then it's an indication that something is up. In statistics we formalize this idea with the concept of **significance**. We apply a test to decide whether data is significant or not: if it's too far away from typical values, we consider the data significant, and the data have something to tell us. If it's close to typical values, then the data aren't interesting enough to worry about.

### HOW FAR IS TOO FAR?

A phone bill that's $70 higher than normal is probably cause for alarm; a phone bill that's 7¢ higher might not be different enough to warrant investigation. Somewhere in-between there may be some amount of money where it changes from "that's a problem" to "that's not a problem". You may not know what that number is, and in different months you might make that decision differently even with the same discrepancy in your bill. In statistics, we do want to establish where that dividing line is (because mathematicians are like that) and we want to do it before we collect the data so we aren't influencing the results with our choices.

This can involve establishing **critical values** for the data we're measuring—one value above the average values and one below with space in between to allow for some variation in the data. (Here, that word *critical* comes from the same Greek root as the word *crisis*. You can think of it as the point on which we make a choice, where we decide whether there's a need to act on our information.)

For your fluctuating phone bill, maybe you decide that if your bill is less than $5 above the average, it's not worth looking at, but if it's more than $5 above, you check your phone's usage. Maybe that number would be higher. Maybe if there was any change at all, you'd look, because you know your bill shouldn't ever change. Your experience will tell you what the number, your personal critical value, should be.

## DISTINCTION WITHOUT A DIFFERENCE

In statistics significance means that a test shows that there's a difference between an observed value (say, from a study) and the typical value of a random variable. However, just because the data say there's a difference, that doesn't mean the difference is meaningful. A rival mobile phone company's advertising might refer to an independent study that says they have the cheapest rates in the city, and that might be true. On the other hand, if switching to that company would save you less than a dollar a month, it might not be worth it, no matter how rigorous the study was. The ads have **statistical significance**, but no **practical significance**. By reasonable statistical analysis, the rival company's rates are lower, but not so low that action is required on your part.

## EXERCISES

A. Let's say that the average height for a Canadian man is around 174 cm, or 5′8″, and the average height for a Canadian woman is around 161 cm, or 5′3″.
(Source: http://www.wecare4eyes.com/averageemployeeheights.htm)

Given these figures, establish critical values around them to define what you would mean by "extremely tall" and "extremely short" for a man and for a woman.

B. Above, you read about an ad with statistical significance, but no practical significance. Is it possible for a study to have practical significance but not statistical significance? Why or why not?

C. The concept of significance will be connected to the idea of probability once you've covered how to calculate probabilities. Do you think a significant result occurs with a high-probability event, or a low-probability event? Explain.

D. Use your critical values from Question A to decide whether these heights are extreme.

1) a man 249 cm / 8′2″ tall
2) a man 107 cm / 3′6″ tall
3) a man 168 cm / 5′6″ tall
4) a woman 183 cm / 6′0″ tall
5) a woman 132 cm / 4′4″ tall
6) a woman 174 cm / 5′8″ tall

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## SOLUTIONS

A: Answers will vary.

B: No. If the study has no practical significance, then the data from the study say there's no difference from expectations to speak of; any practical significance would only be an illusion.

C: Significant results are defined as low-probability events. Significant results were described in this worksheet as a contrast to typical results. If our phone bill is typically $60/month, then a bill of $62 or $67 is typical or likely to happen. A phone bill of $130 is unlikely to happen if $60 really is the average, which is why it's noteworthy.

D: Again, answers will vary, but most people would say that (1) and (2) are extreme values and (3) and (6) are not. The answers to (4) and (5) are somewhat ambiguous, which is why we use a formula to find critical values.