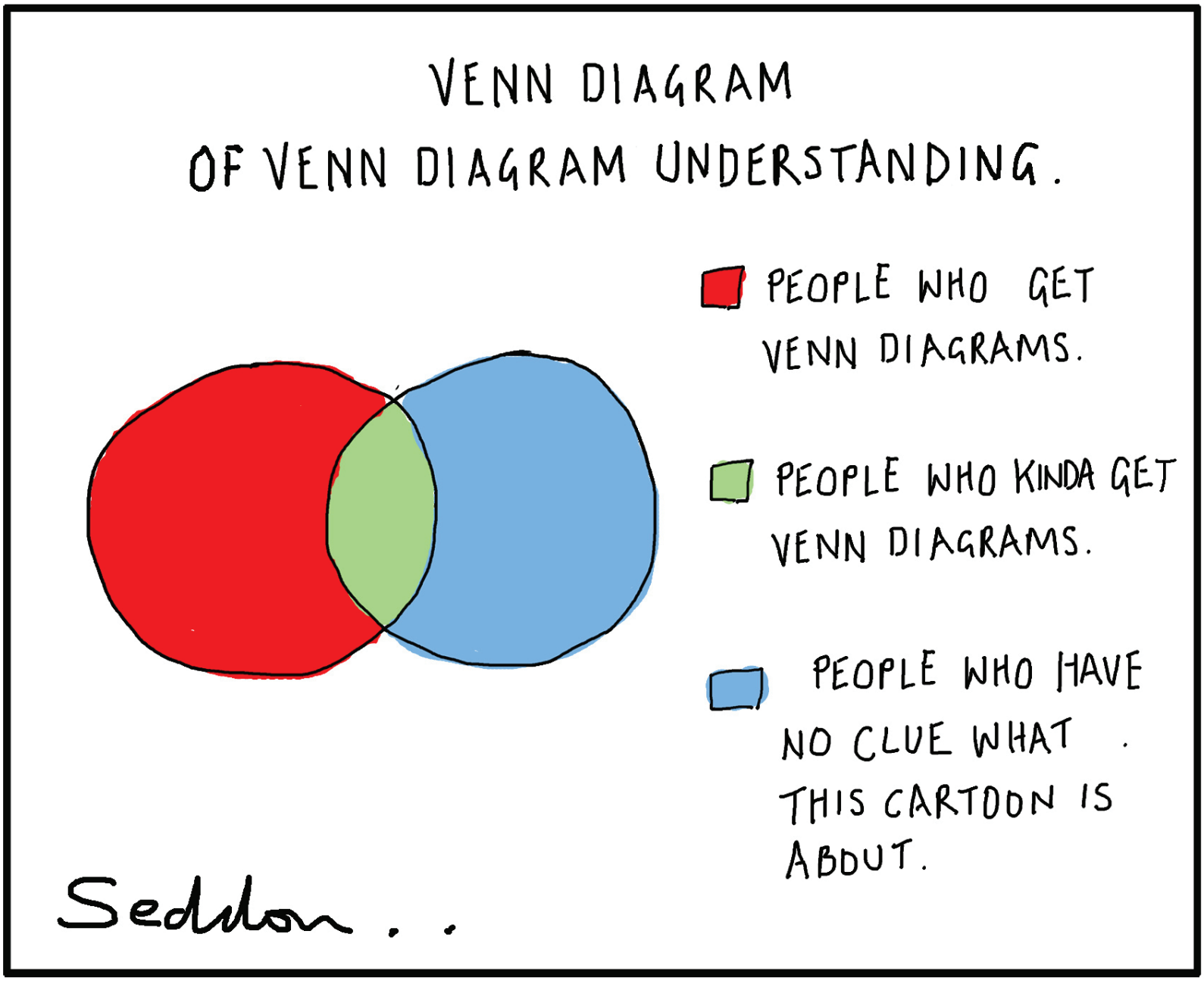


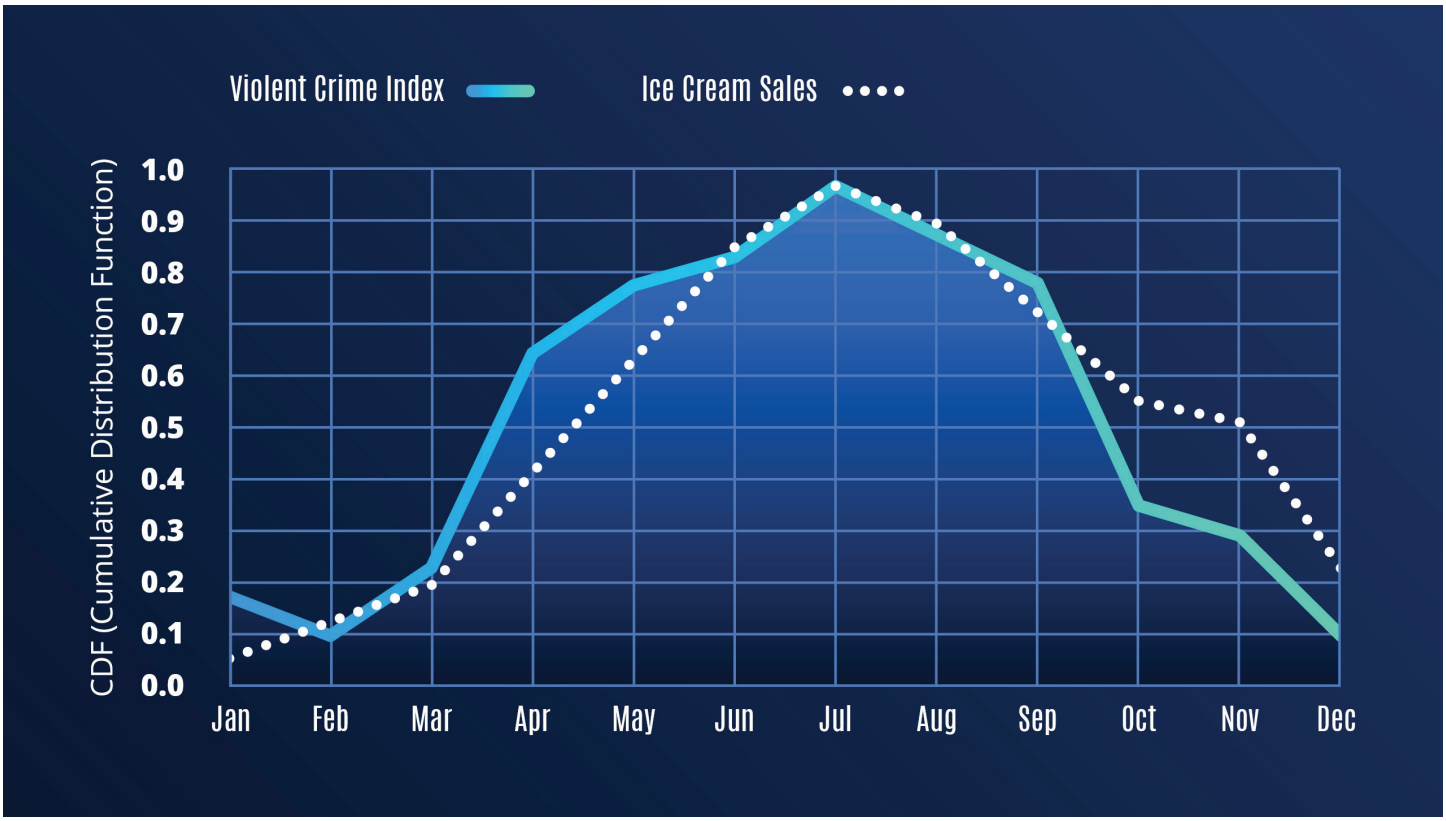

# A Guide to Reading Charts

*By Marissa Major*

Learning to read and evaluate charts is an important skill. This guide will be a useful reference as you encounter different charts in this course.

## Lies and ice cream

There's an old saying in the English language: "There are three kinds of lies: lies, damned lies, and statistics." People have a lot of trust in numbers, but numbers lie. Or, rather, people use numbers to lie. They use charts to tell stories that support their point of view. For example, look at the chart below.

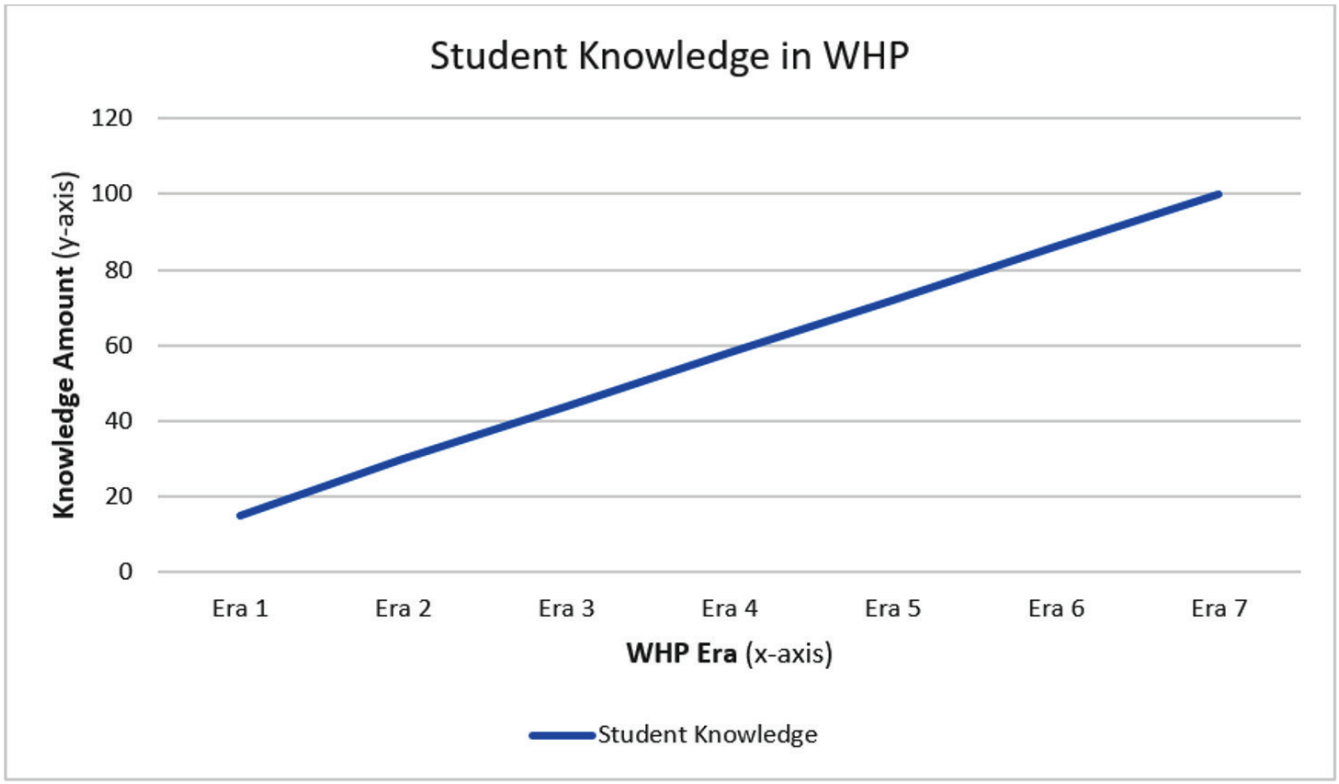



*Correlation does not equal causation: violent crime index vs ice cream sales. By WHP, CC BY-NC 4.0.*

This chart makes it seem like eating ice cream causes violent crime. But whoever made this chart left out something important: weather. When it's sunny and hot, people eat more ice cream. When the nights get warmer, people stay out later and commit more crimes. You'll see a lot of charts in your life, and a lot of them are going to be misleading, like this one. It's important to learn the difference between the good use of information, and the use of information to support a faulty assertion. You don't want to give up ice cream, do you? This article will guide you through the tools you'll need to start reading and evaluating charts.

## The basics

You're going to encounter a lot of different charts and data in this course, and some of it will be really complex. Let's start simple: What's a chart? A chart is a way to show data visually. Data refers to pieces of information collected together, often statistics or facts. Charts use data to illustrate two things: change over time and how two or more "things" are related to each other. We call these "things" variables. That might be a little confusing. Let's look at an example:

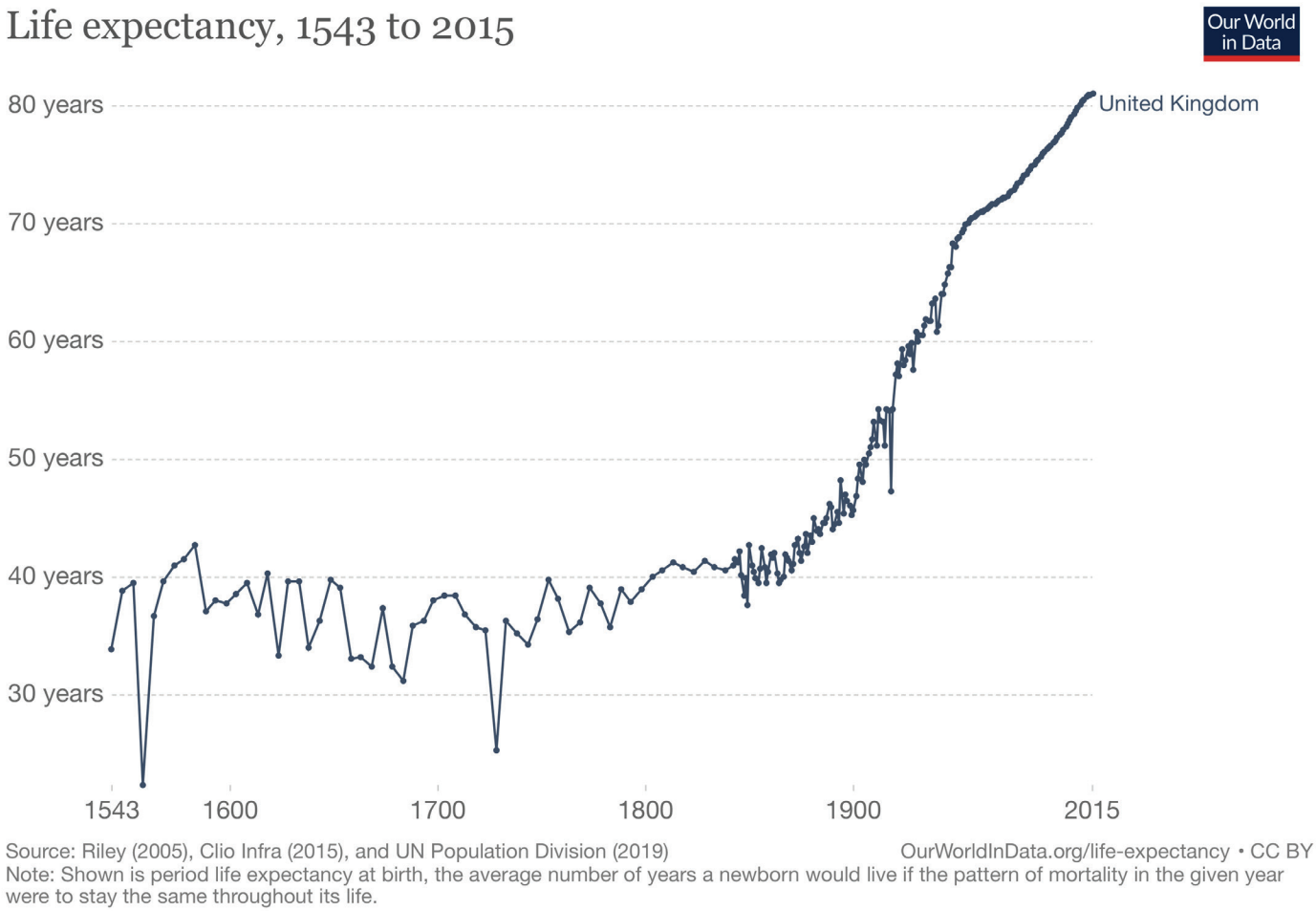



*Student knowledge in WHP. By WHP, CC BY-NC 4.0.*

This is a line graph. It shows how student knowledge changes as WHP students progress through the seven eras or units of the course. How do you start reading a chart, like this one? First, look for a title and any captions that might provide clues. Second, identify what the chart is measuring by looking at the x-axis and y-axis (labeled in this chart). In this chart, the blue line represents the relationship between time (x-axis) and student knowledge (y-axis). The relationship between these two things is measured by a blue line. So what argument is this chart making? It's arguing that as students move through the course, they gain more knowledge. Do you agree? Do you trust this chart? Where do you think the data came from? (Hint: we totally made it up.)

## Variables and scale

The most important part of reading a chart is identifying the variables. Variables are the information in the chart that can change, depending on where you're looking. Take a look at the line graph below.




*Life expectancy, 1543 to 2015. Explore an interactive version of this chart here: https://ourworldindata.org/grapher/life-expectancy?country=~GBR*

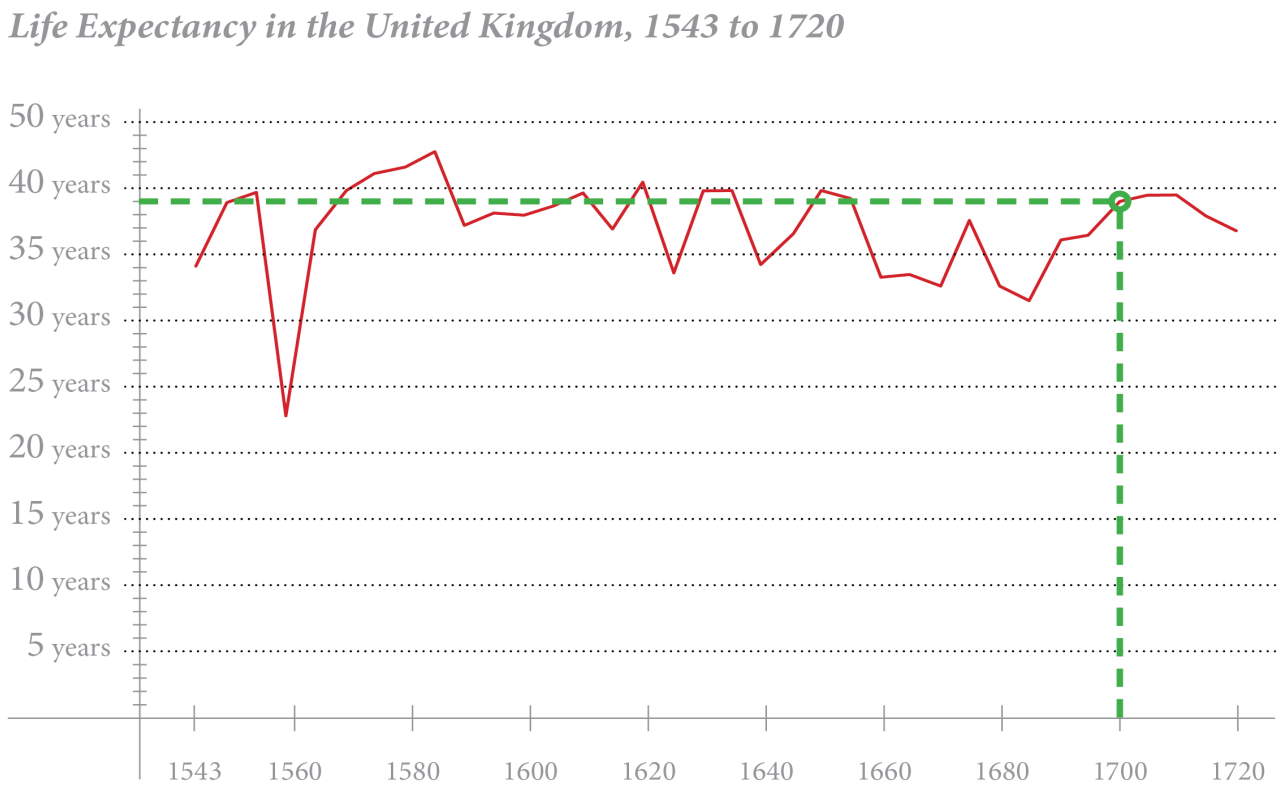
In this chart, titled "Life Expectancy, 1543 to 2015," there are three variables: life expectancy (y-axis), years (x-axis), and country (the line labeled "United Kingdom"). If you move from left to right in the chart, the year increases, and if you move from bottom to top, the life expectancy increases. The jagged line shows the relationship between life expectancy and dates. More specifically, this line represents changes in life expectancy in the United Kingdom over 500 years. If you view this chart online, you'll see that it's is an interactive chart. So, if you click on the link above, you can add more countries and regions as variables on this chart.

We talk about scale a lot in WHP. Scale is also an important part of charts. In charts, *scale* just means the range of numbers on either axis. For example, the dates in this chart are provided in years ranging from 1543 to 2015. Changing the scale of a chart can transform its meaning. If you click the link above, you can change the scale of this chart by sliding the range of the blue line left or right. How does this chart look different if you switch scales to a 25-year period from 1703 to 1728?

You're going to read a lot of different charts in this course, but you should always begin by identifying titles, variables, and scale. Once you have those identified, you can start to dig into the details.

## Points on the graph

The line in the graph above shows how life expectancy changed in the United Kingdom, but how do I find what life expectancy was in a specific year? Easy! Just look at the illustration below.




*Detial from the Life expectancy, 1543 to 2015 chart. By WHP, CC BY-NC 4.0.*

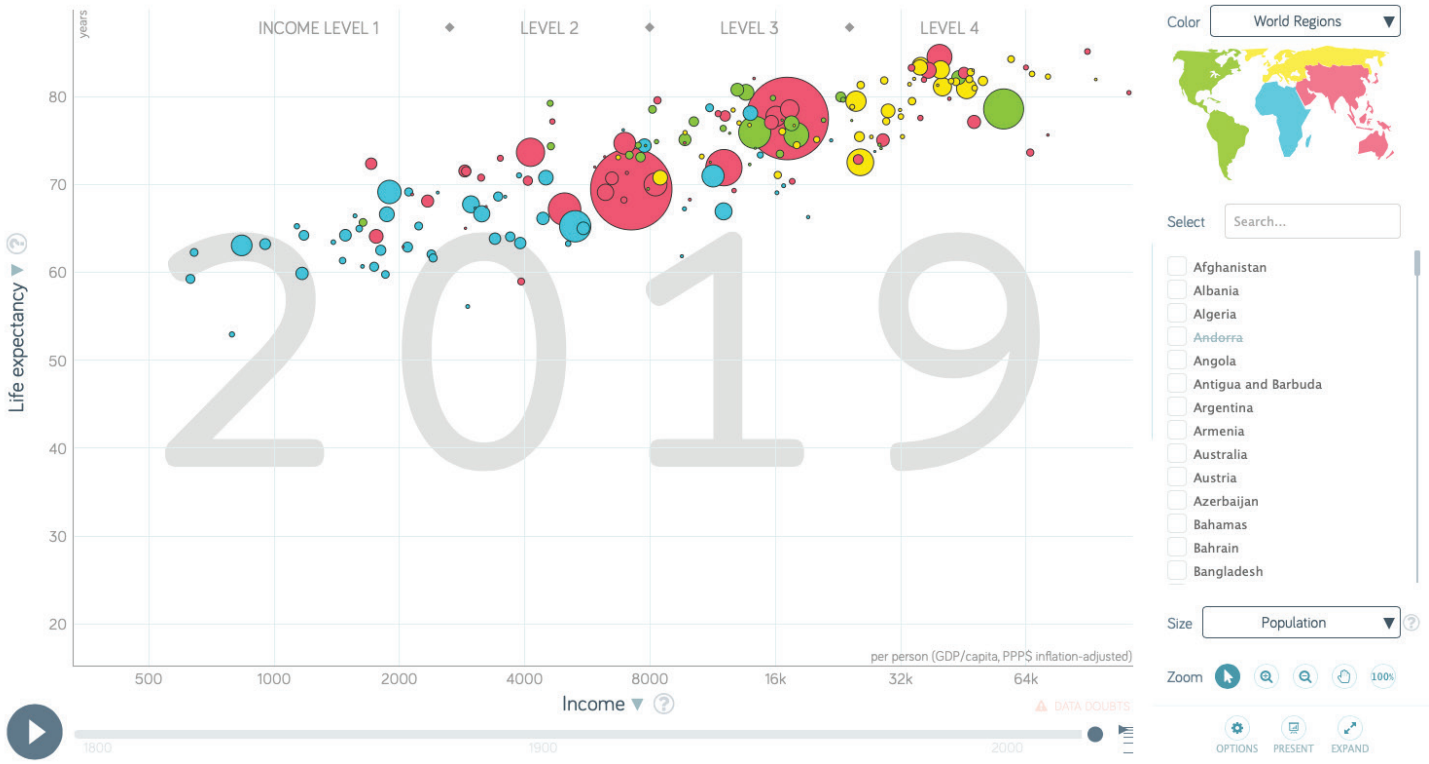
If I'm interested in the year 1700, I just find that value on the x-axis and follow it straight up (green dotted line) until I hit the line representing the United Kingdom. Looking at that point, I see how high up on the y-axis it lands. In this case it lands at 39 years. So, in the year 1700, the life expectancy in the United Kingdom was 39 years. (Yikes!)

## Evaluating charts and data

Often, what's missing from the data is just as important as what's included. The graph above consists of points connected by a line. The points represent the years when data was collected, and there are fewer points in the first couple centuries. What was happening in those years where no data was collected? Was that steep drop around 1550 because of a war or famine? Or was the data collected only from certain regions, where people tended to die younger? Without answers to these questions, we're missing parts of the story. Very few societies kept detailed records before the nineteenth century, so when you see charts that go back hundreds or thousands of years, you should always ask yourself where that data came from. Even when looking at very recent data, it's important to ask this question.

## Bubble charts

Let's examine two other types of charts that you'll encounter in the course: bubble charts and maps. The bubble chart below also displays data on life expectancy, but it uses bubbles instead of lines. This enables the chart to include more variables.



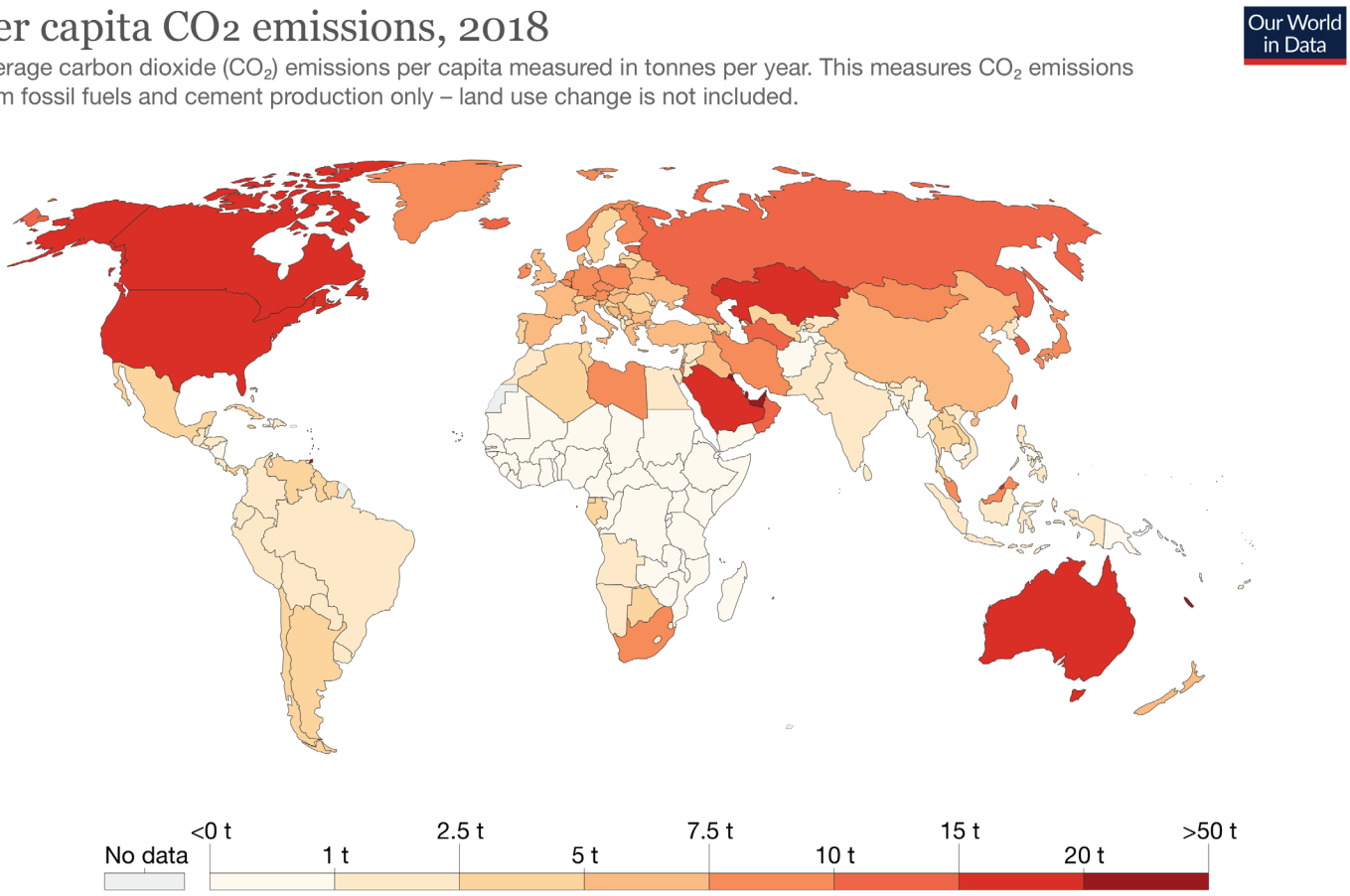

*Bubble chart. Explore an interactive version of this chart here: https://www.gapminder.org/tools/#$chart-type=bubbles. By Gapminder, CC BY 4.0*

Each bubble represents a country. The bigger the bubble, the larger the country's population. In this image, the chart is paused in the year 2019, but there's a "play" button at the bottom that allows you to move through the years from 1800 to 2019. So, if you're looking at the chart online, when you press play, the chart changes each year as the bubbles bounce up and down and slowly move toward the upper right corner as life expectancy and national incomes increase. Click the link above and experiment with this interactive chart. In addition to changing the year, you can add or remove countries and regions. You can even change the variable that's represented by the size of the bubbles. Have some regions improved life expectancy more than others? Which countries have seen the biggest improvements in the last two centuries?

In total, this chart has six variables: life expectancy (y-axis), income (x-axis), country (bubbles), population (bubble size), year, and geographic region (bubble color).

## Map charts

Now, let's take a look at a kind of chart that doesn't really look like a chart at all: maps. Map charts are weird charts. They don't have axes. But the principles of reading them are the same: Begin by identifying titles, variables, and scale. In the chart below, we have three variables: CO2 emissions per capita (represented by color), country, and year. There's a play button and slider on the bottom that lets you adjust the year from 1800 to 2017.

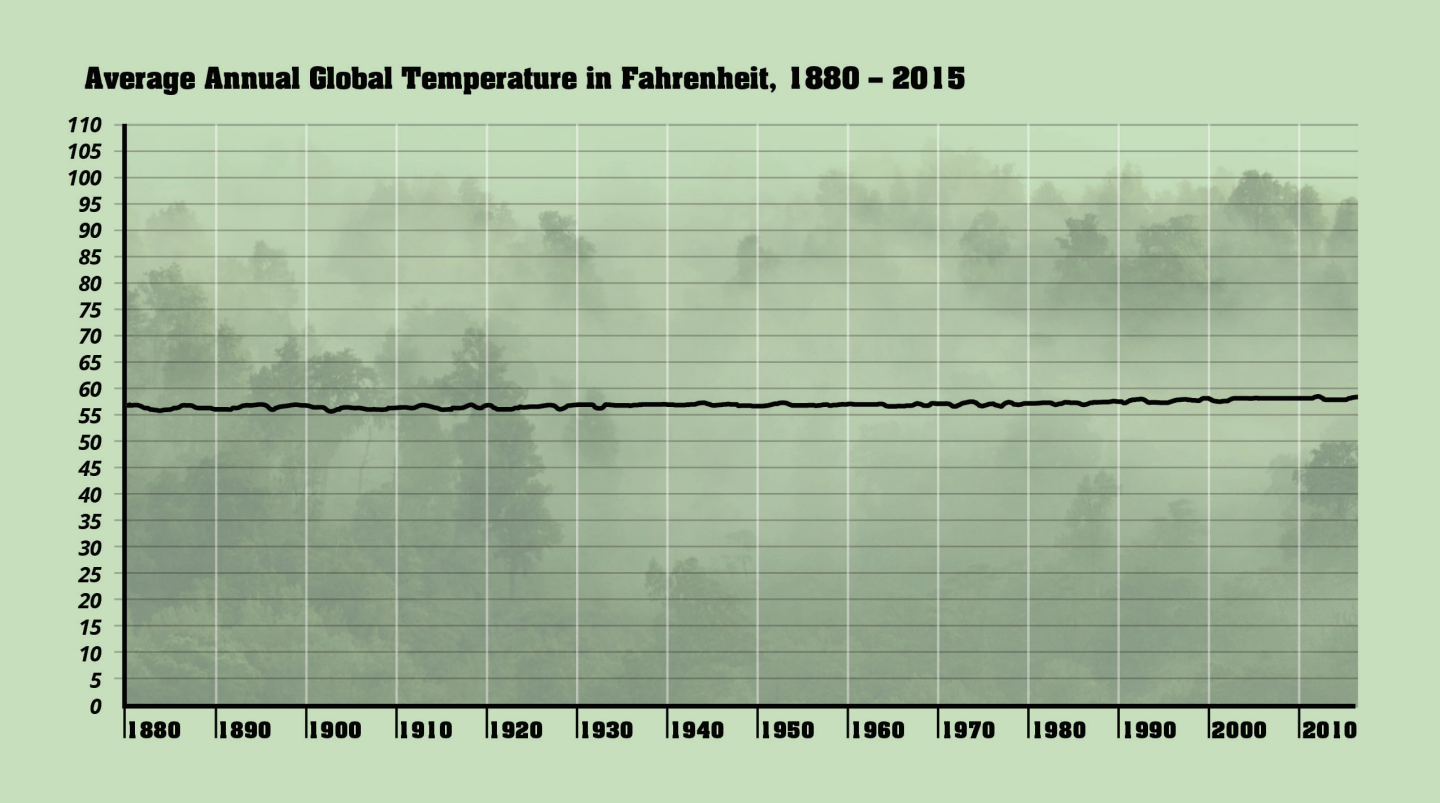



*Per capita CO2 emissions, 2018 Explore an interactive version of this chart here: https://ourworldindata.org/grapher/co-emissions-per-capita. By Our World in Data, CC BY 4.0.*

Click on the link above to explore this chart. What are some conclusions you can draw by watching the chart change from 1800 to 2017? What parts of the world turn red and when do they do so? You can click on individual countries to display the data as a line graph for that country. The main takeaway from this map is that global CO2 emissions have risen since 1800, but those changes differ depending on region. What part of the world produces the most emissions?

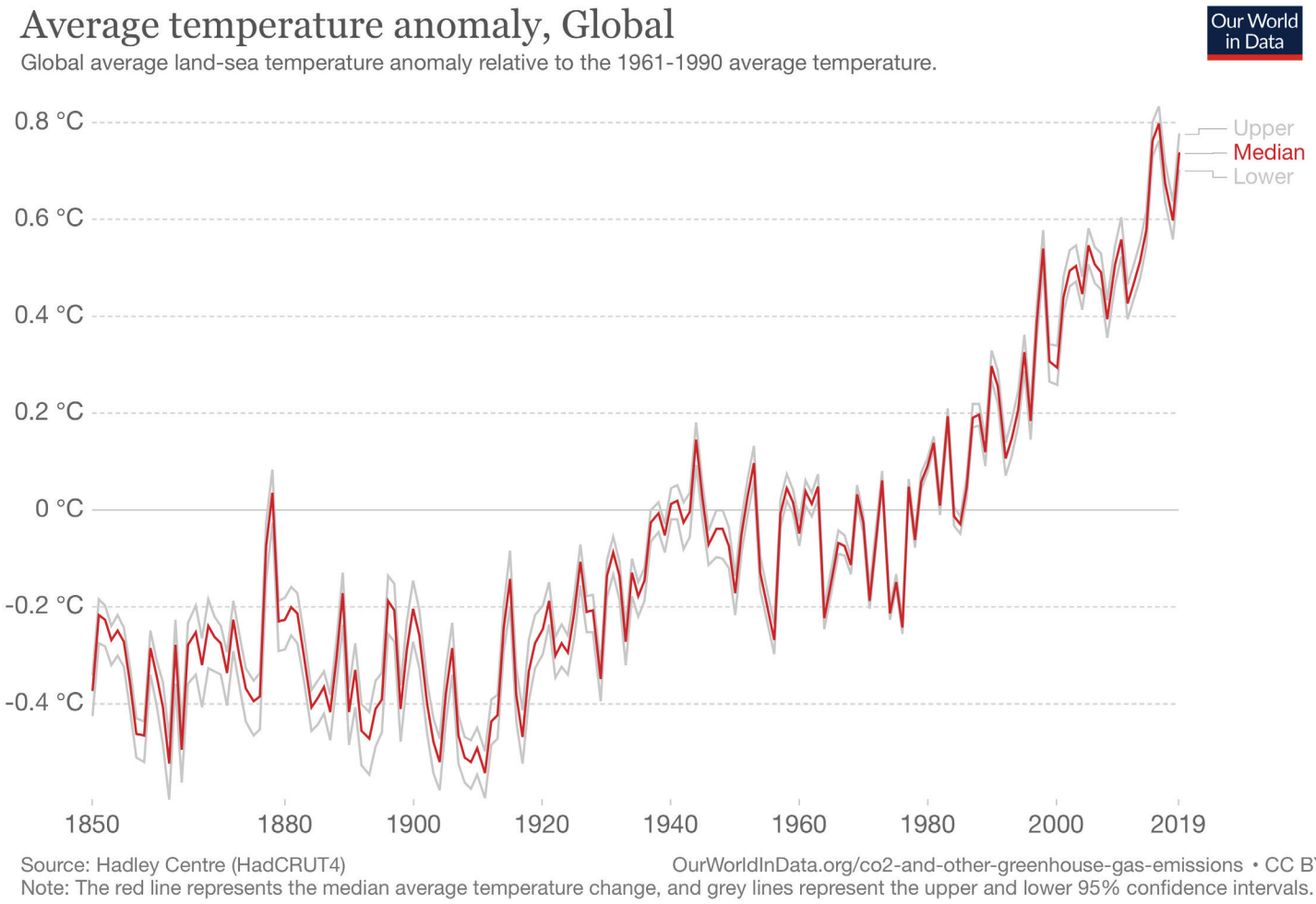
## Lies and the lying charts that tell them

Let's conclude with some examples of how charts can be misleading. Remember, we started with a chart that seemed to argue that eating ice cream causes crime. But really, warmer weather is to blame for both. In that example, it was a missing variable (weather) that caused the confusion. In the charts below, you're going to see an example of how scale can change our understanding of charts.



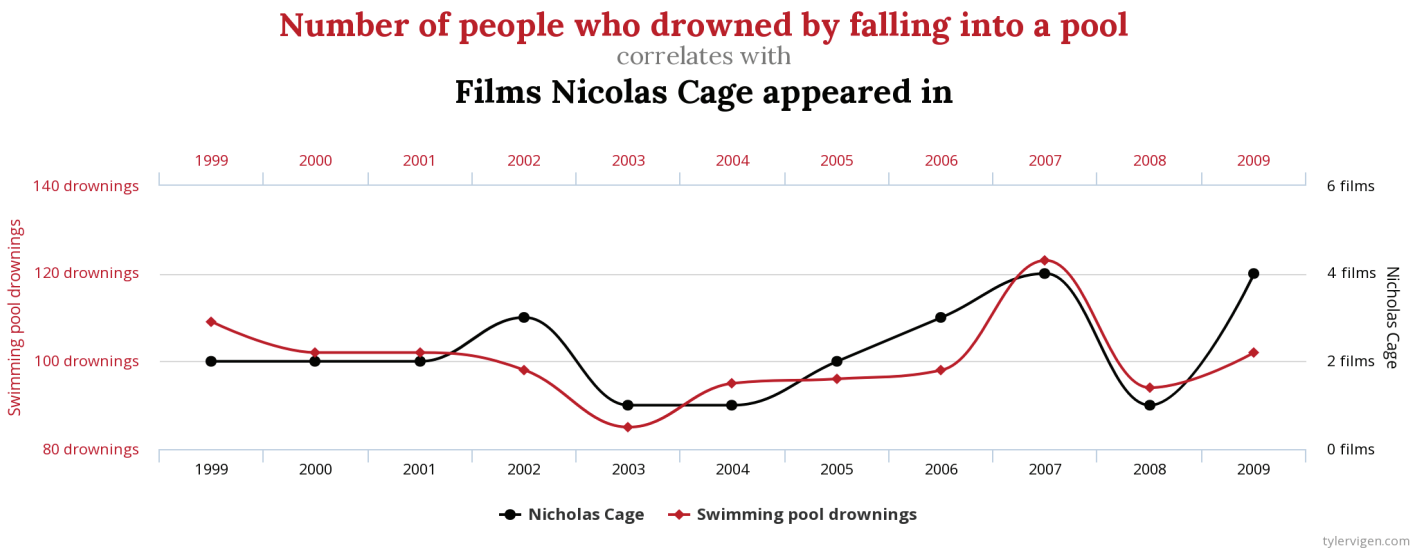

*Average annual global temperature in Fahrenheit, 1880-2015. By WHP, CC BY-NC 4.0.*

This chart is a line graph. It shows how the global average temperature has changed over time. There are two variables here: year and global temperature. Reading this chart might lead you to think that the average global temperature has stayed about the same for the last 150 years. It makes it look like climate change isn't happening. But look at that scale on the y-axis! Those are some big numbers. Yet, climate scientists claim that an increase of only 1 degree on the global average can have catastrophic impacts on weather, sea levels, and ecosystems. The temperature scale on the chart above is so large that we can't really see a change of 1 degree. Check out this chart below, which displays almost the same information at a different scale.




*Average temperature anomaly, Global. Explore an interactive version of this chart here: https://ourworldindata.org/grapher/temperature-anomaly. By Our World in Data, CC BY 4.0.*

The only real difference between these two charts is the scale used on the y-axis. However, the second chart uses a scale that is more appropriate to the situation and provides a more accurate picture of the danger posed by climate change. This is just one example of how charts can be used to mislead the viewer. Let's look at another.

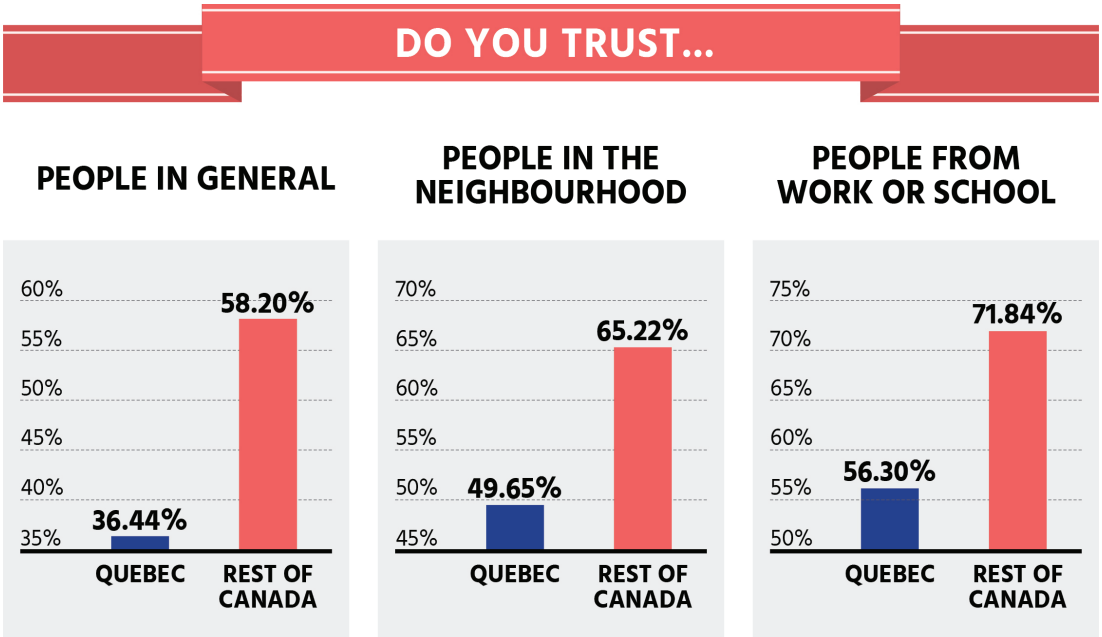



*Spurious correlations, by Tyler Vigen, CC BY 4.0 http://tylervigen.com/spurious-correlations*

In the chart above, the black line represents the number of films Nicholas Cage appears in each year while the red line represents the number of drownings in swimming pools each year. Notice that as one line goes up or down, so does the other (roughly). Two bogus conclusions can be drawn here: Either Nicholas Cage films cause people to drown in pools, or people drowning in pools cause Nicholas Cage to make more films. Either way, it seems that Nicholas Cage should stop acting! But, as much as you may agree with that statement, there is no actual proof here that one thing causes the other. It is probably a complete coincidence that they have fluctuated together over this 10-year span.

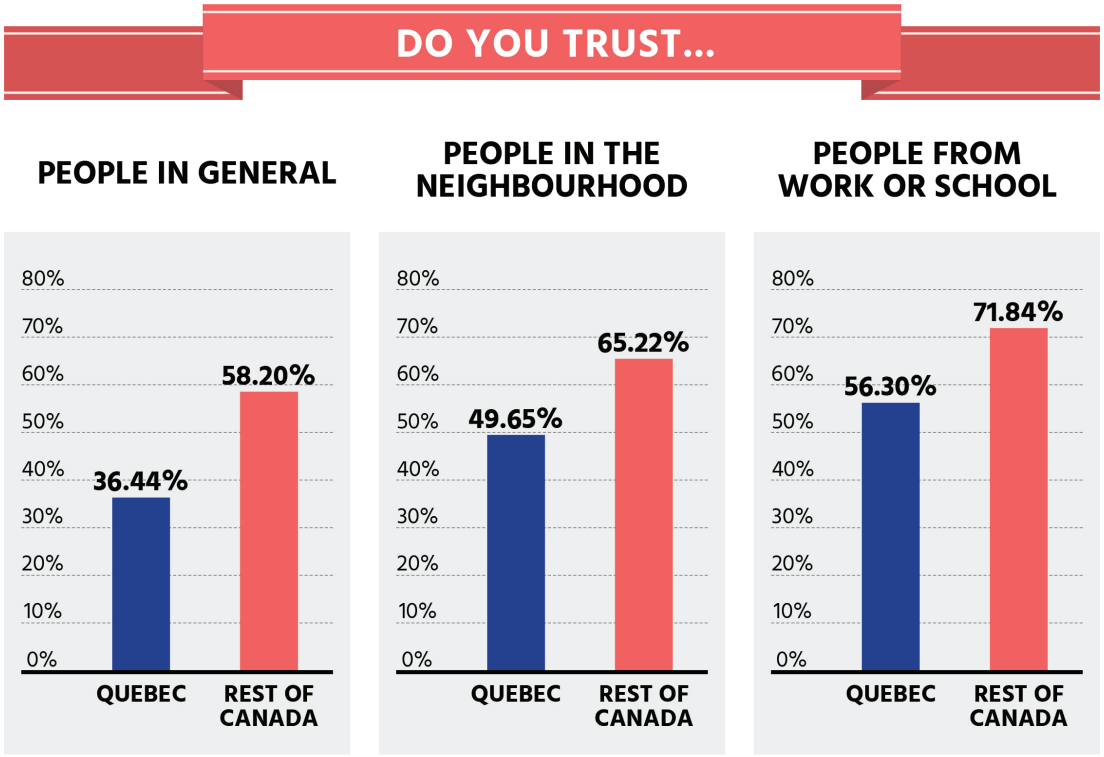
## Beware scales without zero

Let's look at a final example. The first graph below seems to suggest that people in the Canadian province of Quebec are much more suspicious than people from the rest of Canada.




*Do you trust... graphic adapted from an article in Maclean's. By WHP, CC BY-NC 4.0.*

But compare the chart above with the one below. They represent the same data. Yet in the first one, the disparity in trust between Quebec and the rest of Canada is much more pronounced.




*Do you trust... graphic adapted from an article in Maclean's. By WHP, CC BY-NC 4.0.*

The only difference between these two charts is their scale on the y-axis. The y-axis in the top chart starts between 35 and 50, while in the bottom chart it starts at 0. The top chart is misleading because it exaggerates the differences by not starting at 0. With charts misusing scale in this way, it's no surprise that Quebec is less trusting!

These are just a few examples of why learning to read and evaluate charts is important. They can be used or misused to support arguments on topics as serious as climate change or as trivial as ice cream consumption. As you move through the many different charts you'll encounter in this course, you should refer back to this article as a guide. The future of the planet and mint chocolate chip might depend on it!

## Marissa Major

Marissa Major holds a master's degree in pure mathematics from Portland State University and has taught all levels of undergraduate mathematics for the past five years. Her current goal, using writing, research, and curriculum development, is to promote mathematical thinking as a tool to gain more knowledge about the world and improve the lives of those in it.

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