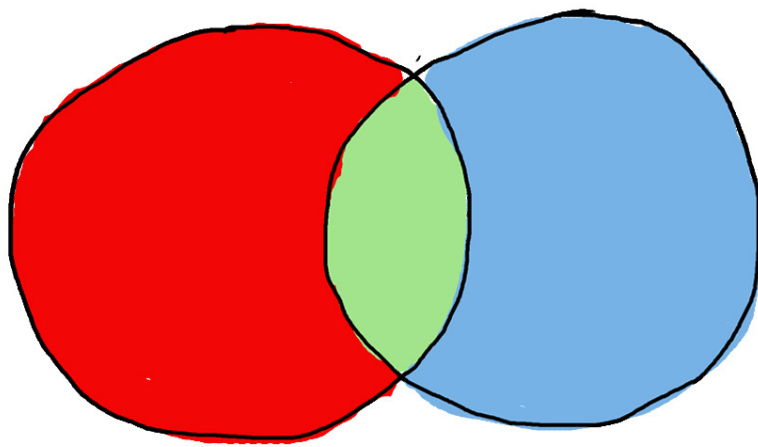


VENN DIAGRAM OF VENN DIAGRAM UNDERSTANDING.



-  PEOPLE WHO GET VENN DIAGRAMS.
-  PEOPLE WHO KINDA GET VENN DIAGRAMS.
-  PEOPLE WHO HAVE NO CLUE WHAT THIS CARTOON IS ABOUT.

Seddon . .

A Guide to Reading Charts

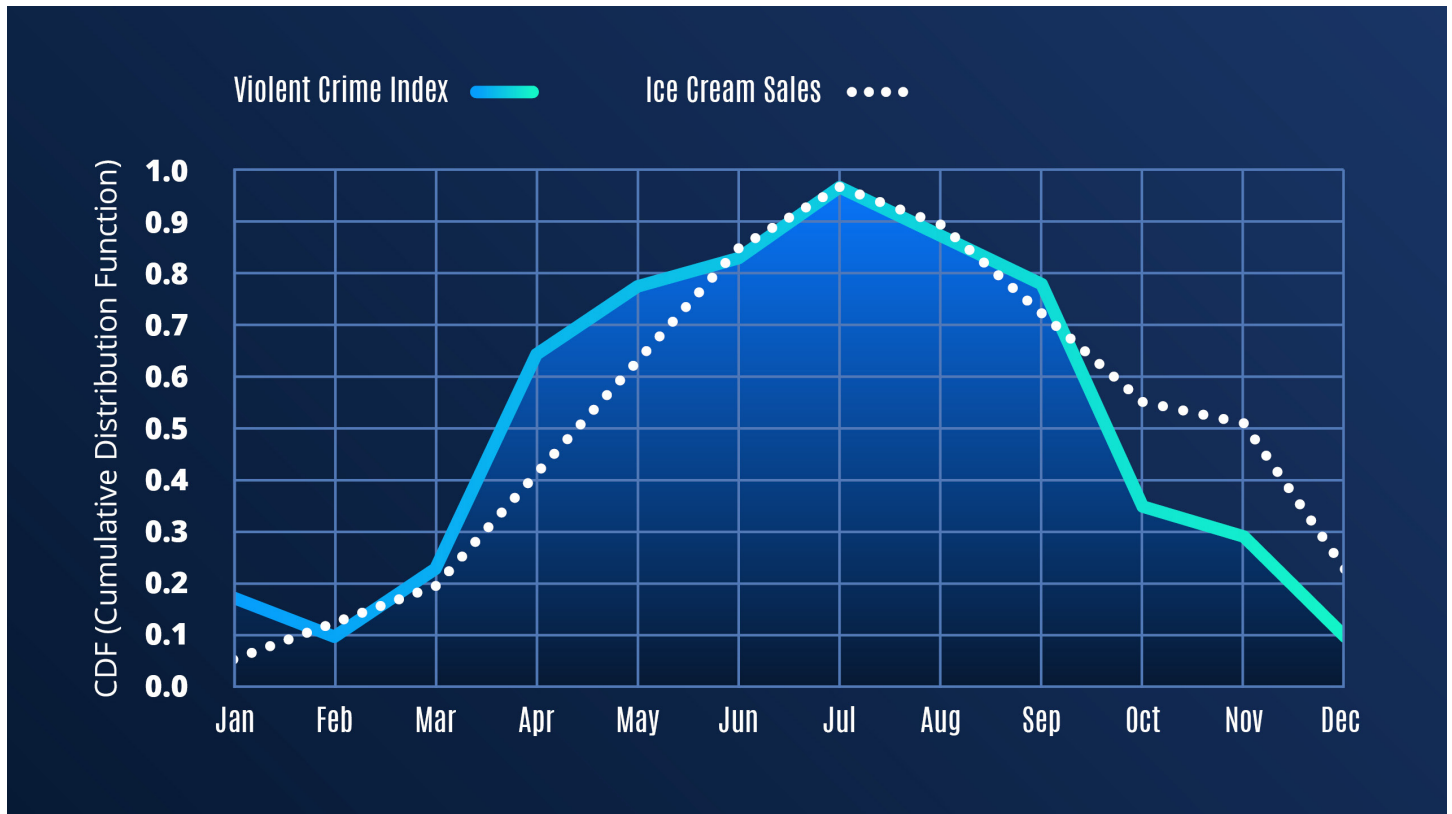
By Marissa Major

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.

700L

Lies and ice cream

People put a lot of trust in numbers. Yet numbers can lie. Well, more accurately, people can use numbers to lie. They can use charts to tell stories that support their point of view. For an example of this, look at the chart below.



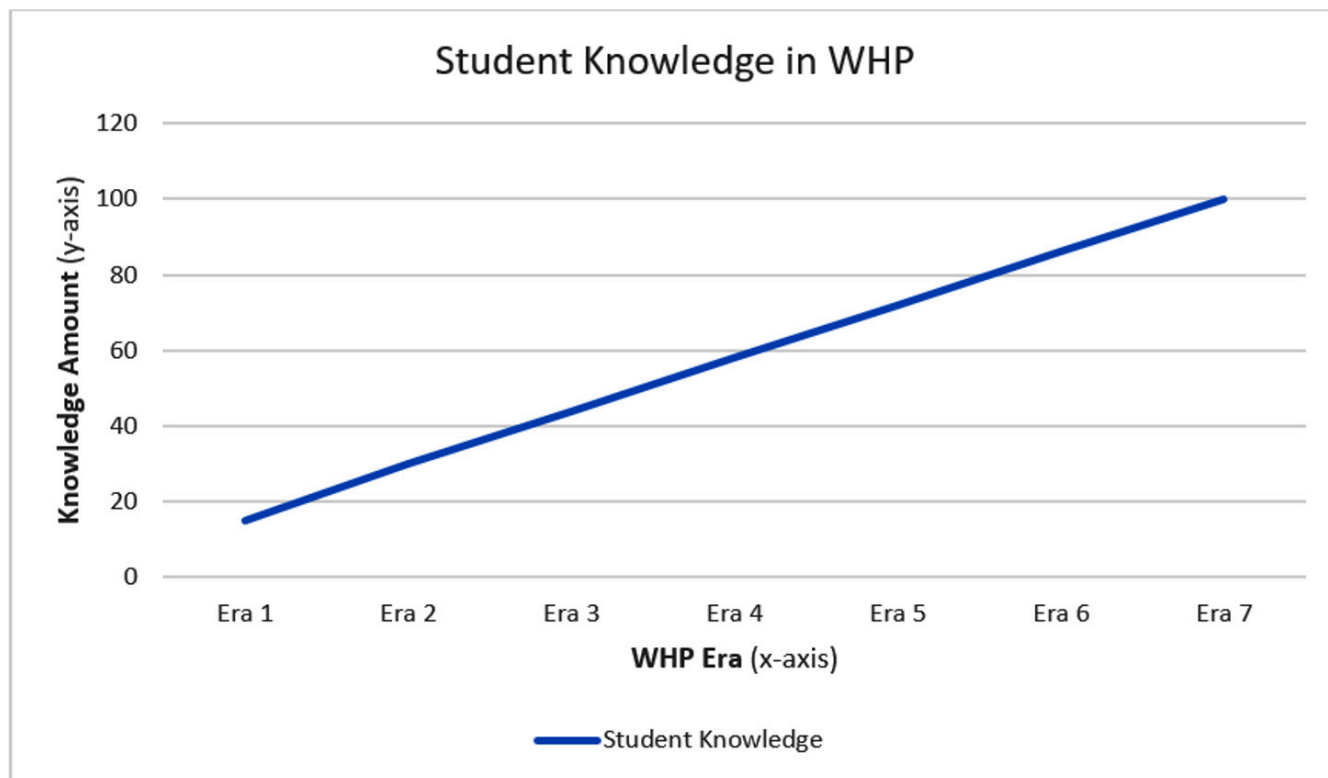
Correlation does not equal causation: violent crime index vs ice cream sales. By WHP, CC BY-NC 4.0.

This chart shows a connection between eating ice cream and violent crime. In fact, it makes it seem like eating more ice cream leads to more violent crime! But the chart leaves out something important: weather. When it's warm and sunny outside, people eat more ice cream. When the nights get warmer, people stay out later and commit more crimes.

A lot of charts are misleading in this way. That is why it is important to learn how to read charts and determine if they are showing information accurately. This article will explain how.

The basics

Let's start with a simple question. What is a chart? A chart is a way to show data visually. Data is another word for information that is collected. Data can be statistics. It can also facts. Charts use data to illustrate two things. The first is change over time. The second is how two or more "things," or variables, are related to each other.



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 move through the course. How do you start reading a chart like this one? First, read the title and captions. They may give you clues about the chart. Next, identify what the chart is measuring. You can do this by looking at the x-axis and y-axis. Both are labeled in the chart above.

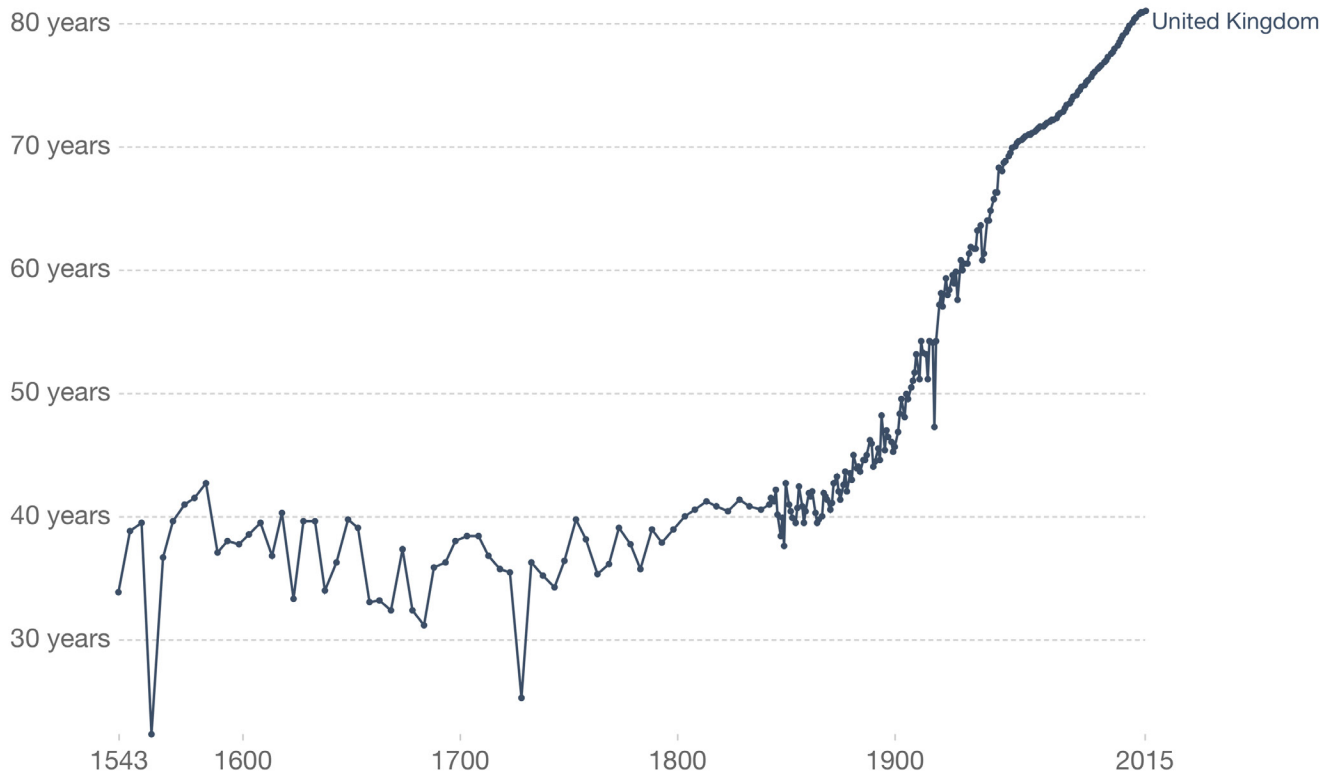
In this chart, the blue line stands for the relationship between time (x-axis) and student knowledge (y-axis). The relationship between these two things is measured by a blue line. This chart is saying that as students move through the course, they gain more knowledge. Do you trust this chart? Where 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 change, depending on where you are looking. Let's look at the line graph on the next page. It's titled "Life Expectancy, 1543 to 2015." Life expectancy is the average length of time a person can expect to live.

Life expectancy, 1543 to 2015

Our World
in Data



Source: Riley (2005), Clio Infra (2015), and UN Population Division (2019)

OurWorldInData.org/life-expectancy • CC BY

Note: Shown is period life expectancy at birth, the average number of years a newborn would live if the pattern of mortality in the given year were to stay the same throughout its life.

Life expectancy, 1543 to 2015. Explore an interactive version of this chart here:

<https://ourworldindata.org/grapher/life-expectancy?country=~GBR>

In this chart, there are three variables. The first is life expectancy (on the y-axis). The second is years (on the x-axis). The third country (the line labeled “United Kingdom”). If you move from left to right in the chart, the year increases. If you move from bottom to top, the life expectancy increases. The jagged line shows the relationship between life expectancy and dates. This line stands for changes in life expectancy in the United Kingdom. It tracks these changes over 500 years. The online version of this chart is interactive. If you click on the link above, you can add more countries and regions.

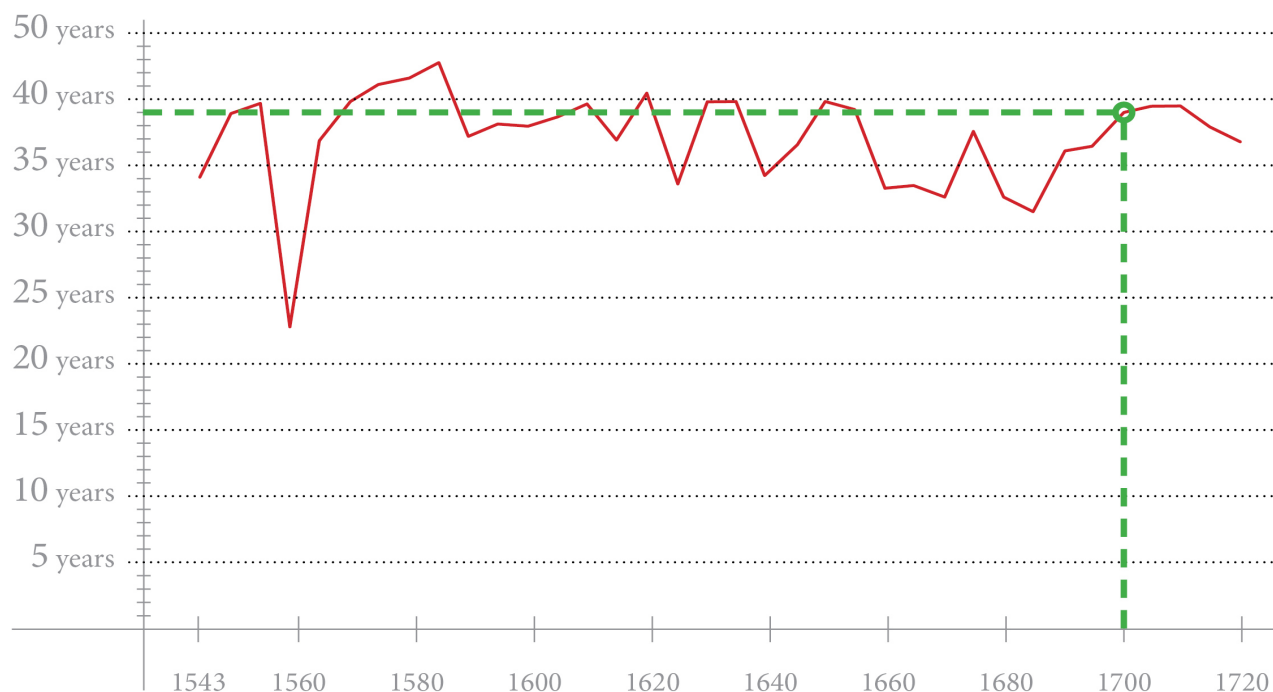
We talk about *scale* a lot in WHP. Scale is also important for charts. In charts, scale means the range of numbers on either axis. The dates in the chart above are provided in years ranging from 1543 to 2015. Changing the scale of a chart can change its meaning. If you click the link above, you can change the scale of this chart by sliding the range of the blue line. How does changing scale change the chart? Try switching to a 25-year period from 1703 to 1728. How does it look now?

When looking at a chart, you should always begin by identifying titles, variables, and scale. Then you can start to look closer.

Points on the graph

The line in the graph above shows how life expectancy changed in the United Kingdom. Say you want to know the life expectancy for a certain year. How do you find it? Easy!

Life Expectancy in the United Kingdom, 1543 to 1720



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

If I'm interested in the year 1700, I find that value on the x-axis. Then I follow it straight up along the green dotted line. I stop when I hit the line that stands for the United Kingdom. Next, I see where on the y-axis this point lands. Here, it lands at 39 years. So, in the year 1700, the life expectancy in the United Kingdom was 39 years.

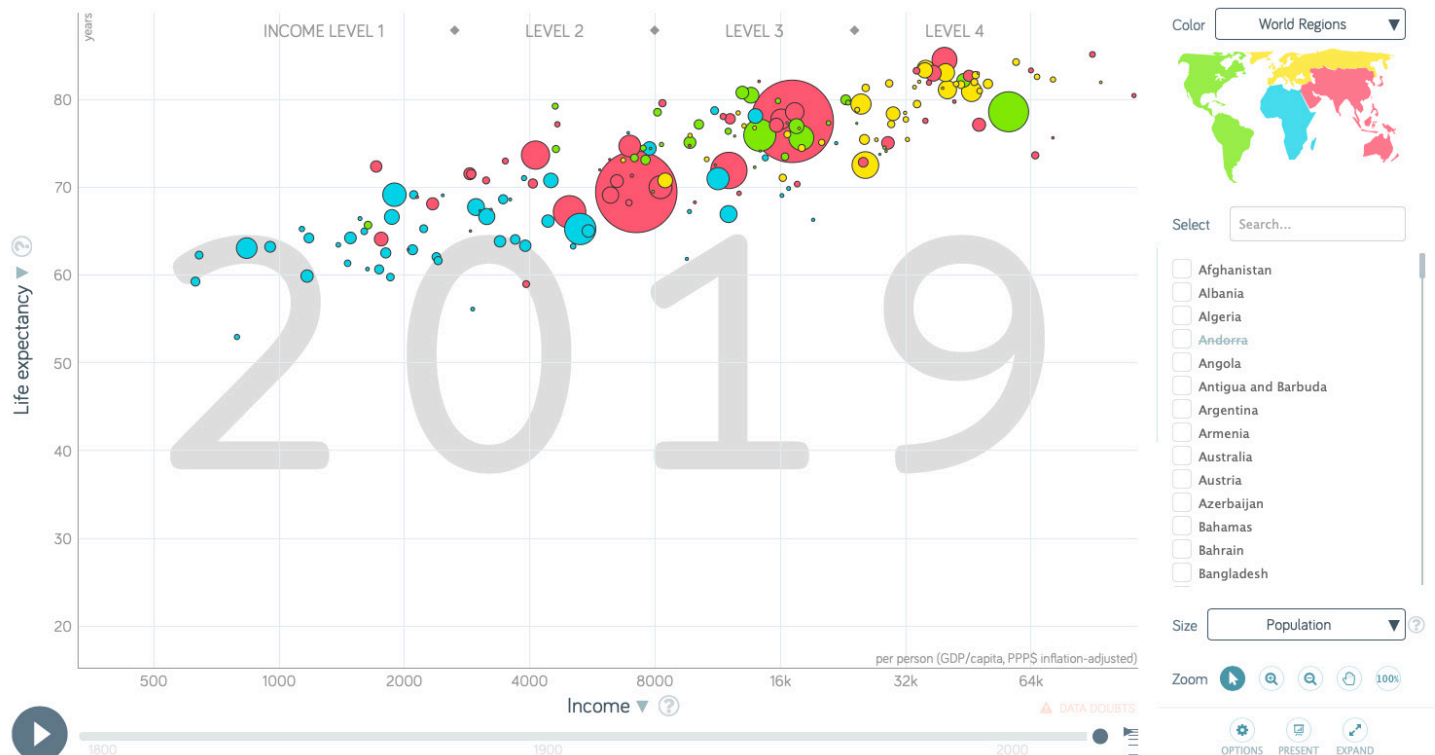
Evaluating charts and data

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. You may notice that there are fewer points in the first few hundred years. What was happening in those years? Was that steep drop around 1550 because of a war or famine? Or was the data collected only from certain regions? We don't know. We're missing parts of the story.

Very few societies kept detailed records before the 1800s. When you see charts that go back hundreds or thousands of years, make sure to ask where that data came from. It helps to ask this question even when you are looking at very recent data.

Bubble charts

Let's examine two other types of charts: bubble charts and maps. The bubble chart below also displays data on life expectancy. It uses bubbles instead of lines. Bubble charts can include more variables than line charts.



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

In this chart each bubble stands for a country. A bigger bubble means a larger population. In this image, the chart is paused in the year 2019. There's a "play" button at the bottom that allows you to move through the years from 1800 to 2019. When you press play, the chart changes. The bubbles bounce and slowly move toward the upper right corner as life expectancy and national incomes increase. Click the link above and experiment. You can add or remove countries and regions. You can even change the variable that the bubbles stand for.

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

Map charts

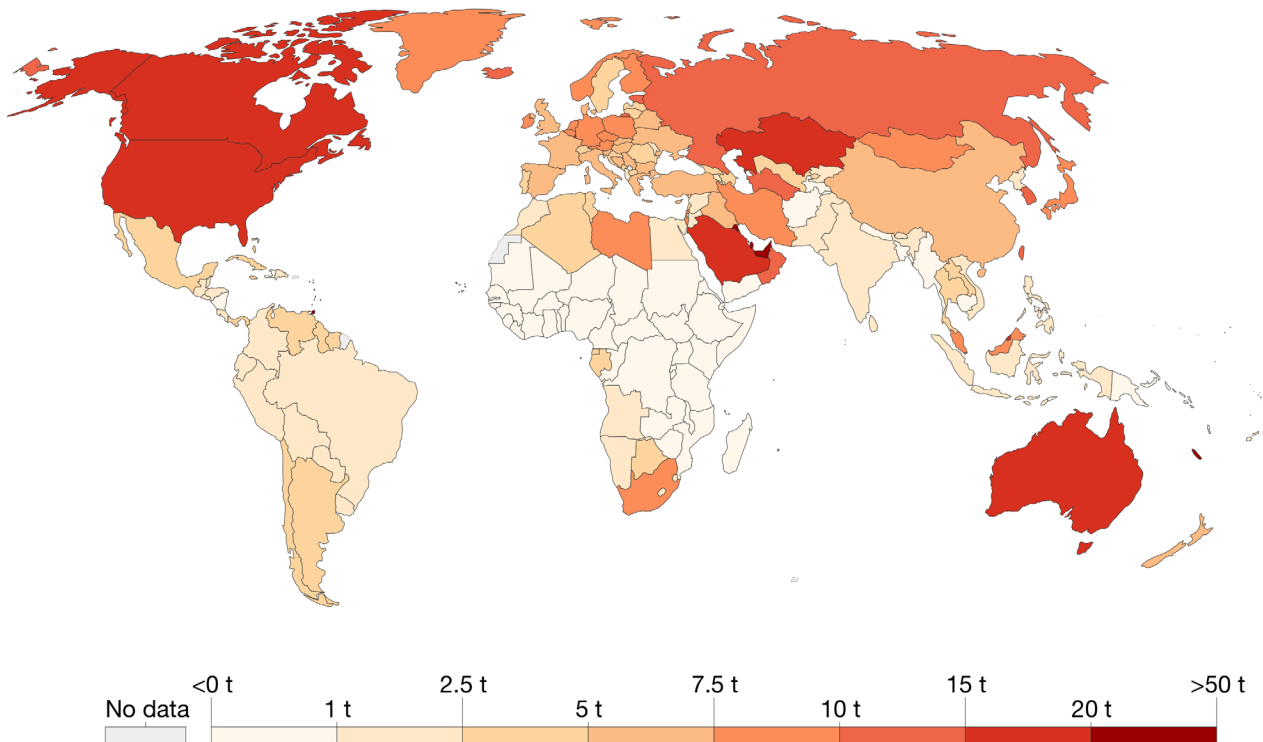
Now let's look at maps. Unlike other charts, maps don't have axes. However, the rules of reading maps are the same as for other kinds of charts. You should begin by identifying titles, variables, and scale.

In the chart below, we have three variables. The first is CO₂ emissions per capita, which is represented by color. (Per capita means per person.) The second is country, and the third is year. There's a play button and slider on the bottom for adjusting the year.

Per capita CO₂ emissions, 2018

Average carbon dioxide (CO₂) emissions per capita measured in tonnes per year. This measures CO₂ emissions from fossil fuels and cement production only – land use change is not included.

Our World
in Data



Source: OWID based on CDIAC; Global Carbon Project; Gapminder & UN
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

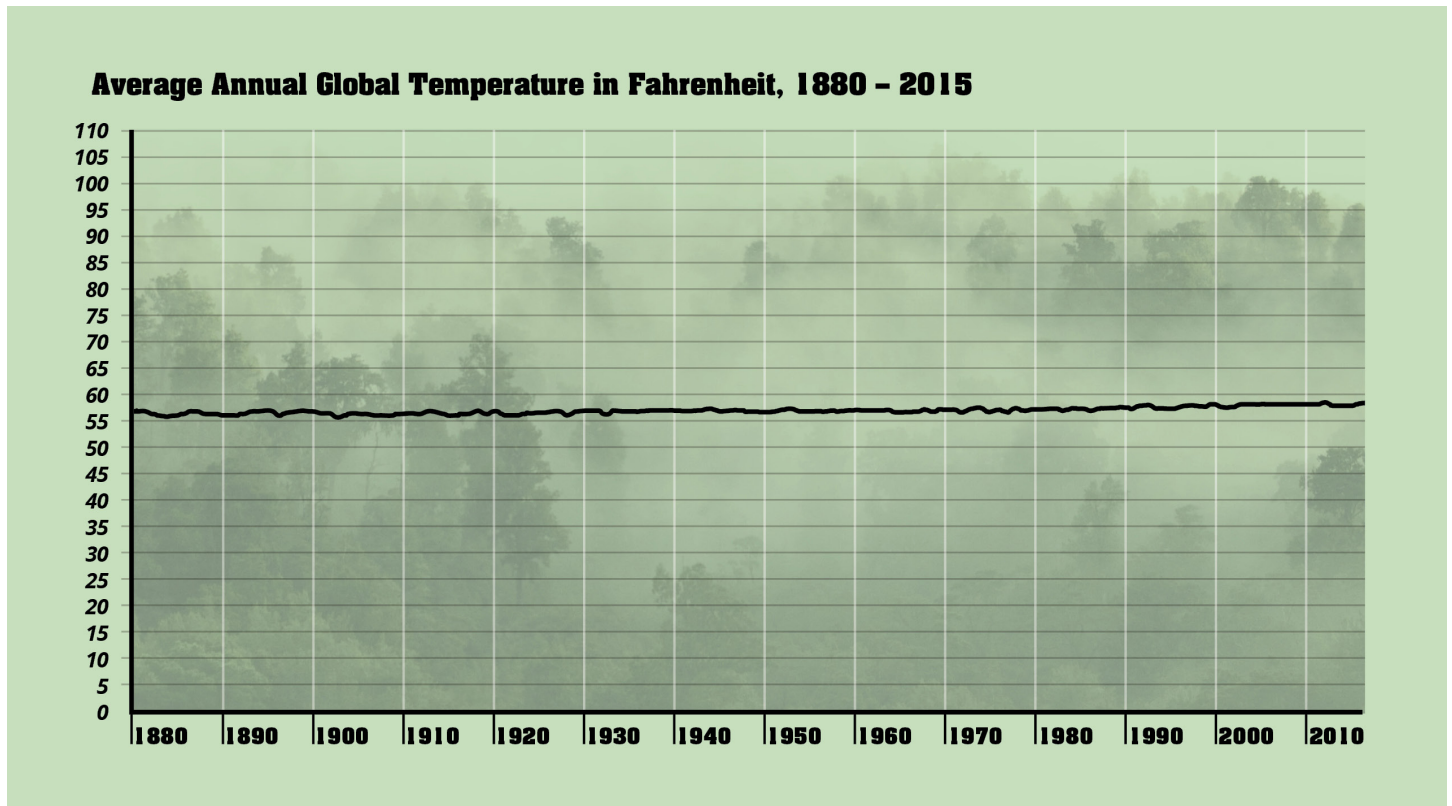
Per capita CO₂ emissions, 2018 Explore an interactive version of this chart here:
<https://ourworldindata.org/grapher/co-emissions-per-capita>. By Our World in Data, CC BY 4.0.

Click on the link above to explore this chart. What are some conclusions you can draw by watching the chart change? What parts of the world turn red? When do they turn red? 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. Changes are different from region to region. What part of the world produces the most emissions?

Lies and the lying charts that tell them

Charts can help you make sense of data. But they can also be misleading. Remember, we started with a chart that suggests that eating ice cream causes crime! In that example, it was a missing variable in the chart that caused the confusion. Now, you're going to see an example of how scale can also 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: 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. Climate change is when the climate of Earth changes in major ways over a long period of time.

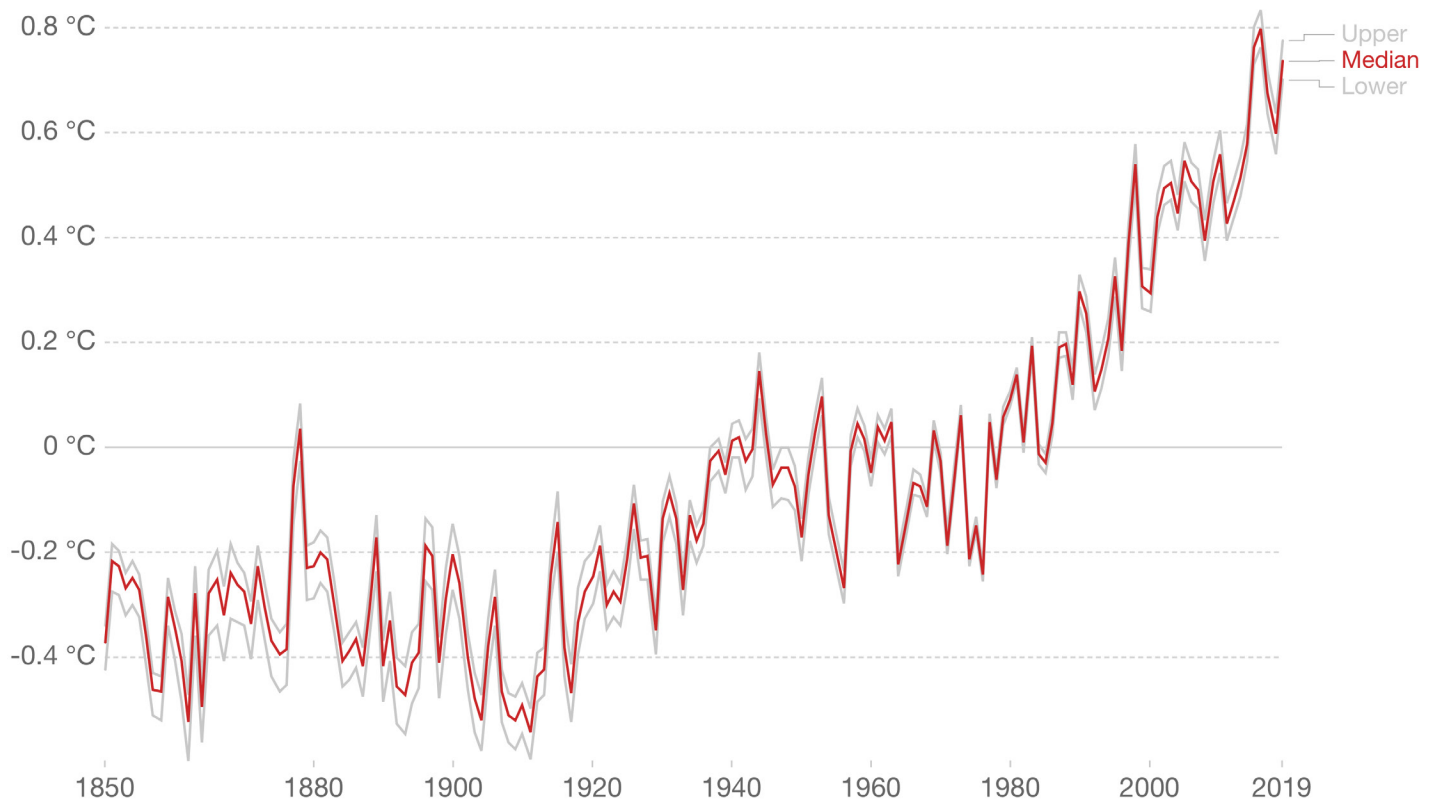
But look, now, at that scale on the y-axis. Those are some big numbers! Climate scientists claim that it takes an increase of only 1 degree on the global average to impact climate. Yet the temperature scale on the chart above is so large that we can't see a change of 1 degree.

The chart below displays almost the same information, but at a different scale.

Average temperature anomaly, Global

Global average land-sea temperature anomaly relative to the 1961-1990 average temperature.

Our World
in Data



Source: Hadley Centre (HadCRUT4)

OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY

Note: The red line represents the median average temperature change, and grey lines represent the upper and lower 95% confidence intervals.

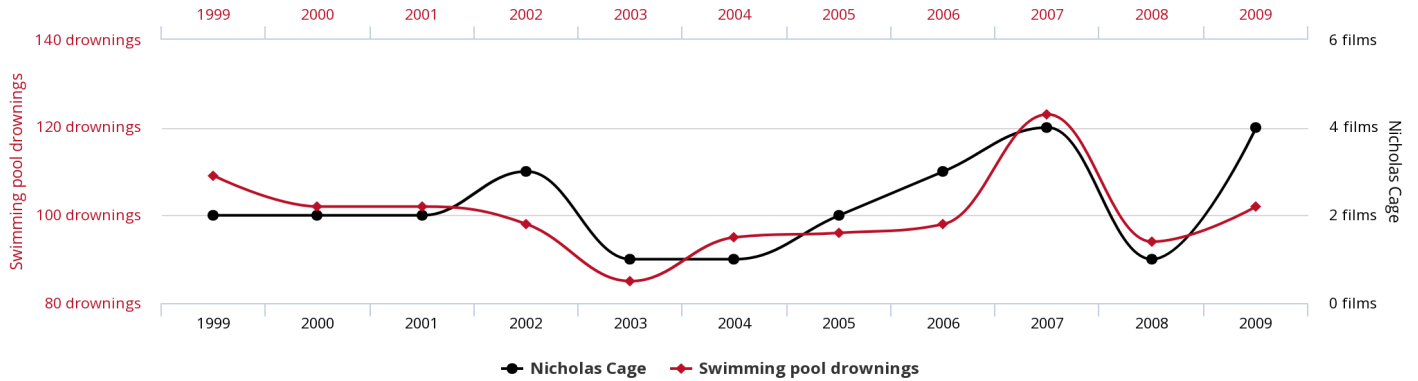
Average temperature anomaly, Global. Explore an interactive version of this chart here:
<https://ourworldindata.org/grapher/temperature-anomaly>. By Our World in Data, CC BY 4.0.

The only difference between these two charts is the scale. The second chart uses a scale that provides a more accurate picture.

Number of people who drowned by falling into a pool

correlates with

Films Nicolas Cage appeared in



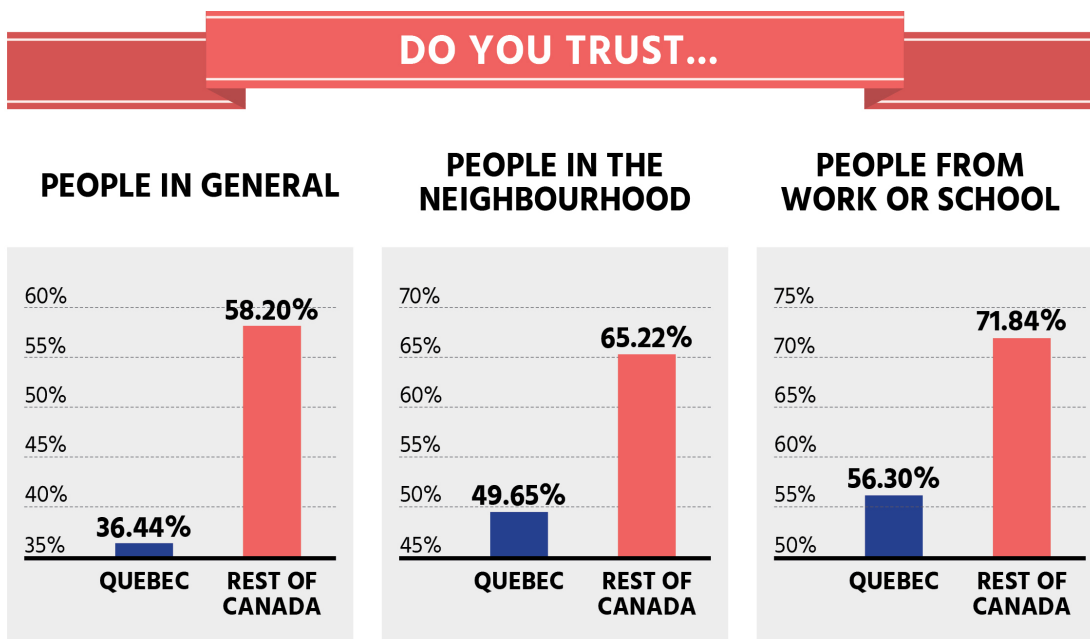
Spurious correlations, by Tyler Vigen, CC BY 4.0 <http://tylervigen.com/spurious-correlations>

tylervigen.com

Here is another example. In the chart above, the black line represents the number of films the actor Nicolas Cage appears in each year. The red line represents the number of drownings in swimming pools each year. As one line goes up or down, so does the other. Two silly conclusions can be drawn here. One: that Nicolas Cage films cause people to drown in pools. Two: that people drowning in pools cause Nicolas Cage to make more films. Neither one of these conclusions makes much sense! There is no actual proof here that one thing causes the other. It is probably a total coincidence.

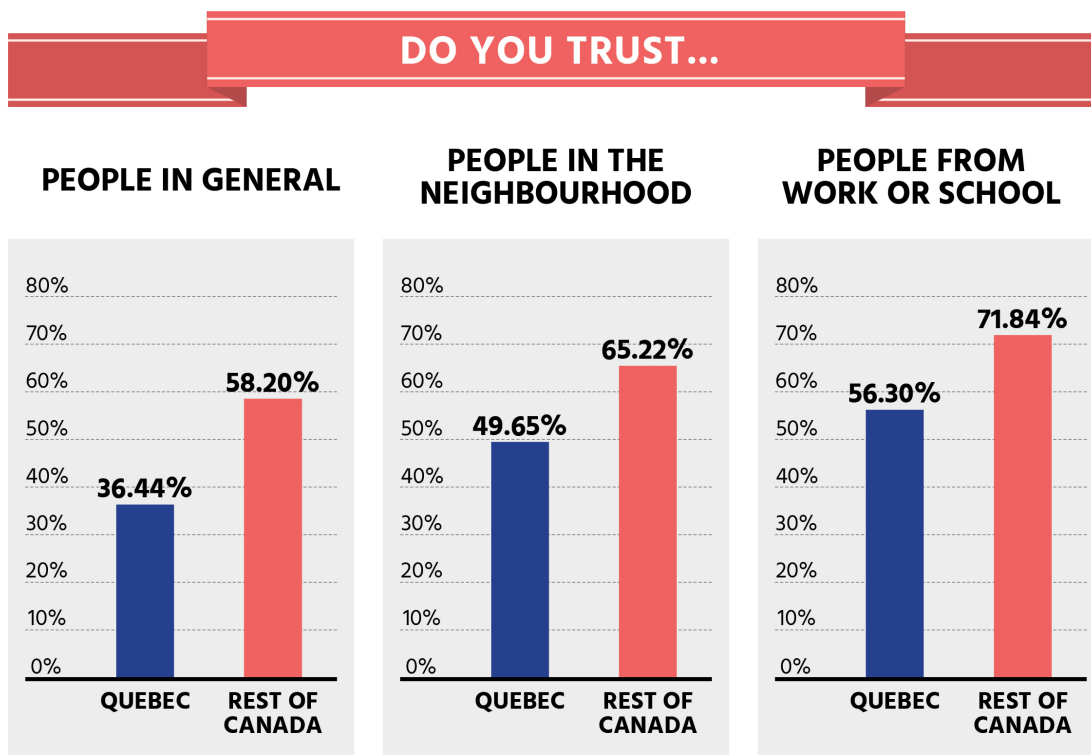
Beware scales without zero

Let's look at one more example. The first graph on the next page suggests that people in Quebec are much more suspicious than other Canadians.



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

Compare the chart above with the one below. They show the same data. Yet in the first one, the difference 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 the charts is their scale on the y-axis. The y-axis in the top chart starts between 35 and 50. In the bottom chart, it starts at 0. The top chart is misleading because it exaggerates the differences.

As you can see, learning to read and evaluate charts is important. Not all charts can be trusted. You will come across many charts in this course. When you do, look back at this article as a guide.

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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