CCT111 Analytical Visualization Part 3: Reflection Essay
Sagar Suri

Table of Contents

A) Visualization vs. Data Queries

Visualization and data queries are two tools for the analysis and viewing of data. Visualization allows one to explicitly identify trends and patterns in the data which might not be obvious in data queries. Data queries allows one to request information from a data set. Queries are often used to return information like *minimums, maximums* and *averages*, but can provide more complex results based on expertise and program. However, the information is presented in numbers and text. In contrast, visualization allows users to summarize data in a succinct yet still informative way by using graphs, charts and tables.

During part 1 of this assignment, a program was created to select data about measles immunization rates from a *csv* file provided by the World Health Organization (WHO). The queries in this program are ideal for accessing data (per year) such as: a) number of records; b) the minimum and maximum immunization rates, and c) averages. However, these statistics alone are not very useful. Data visualization helps us choose more specific things to analyze and spot trends to extract more meaningful information.

To illustrate this point, see Figure 1 below.
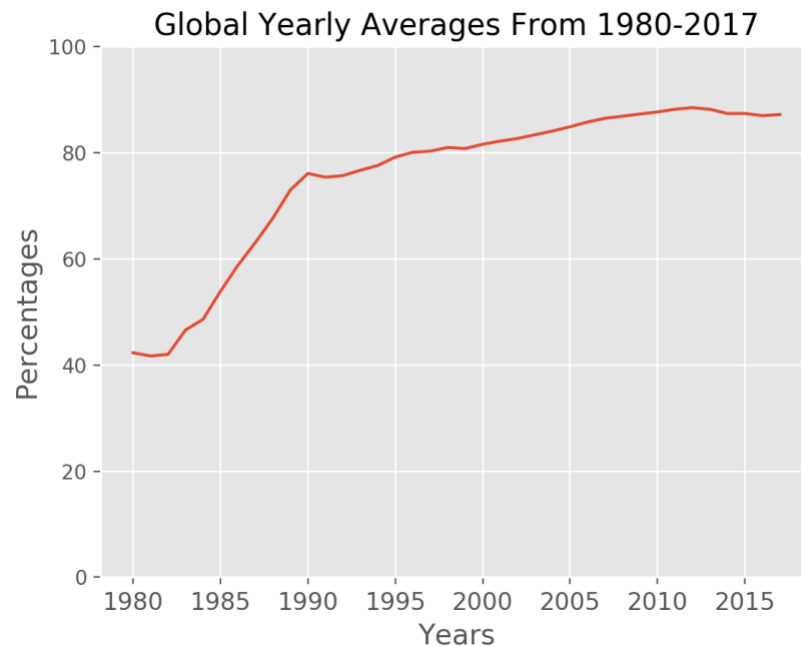
Compared to reading data from the queries in part 1, this visualization makes it a lot easier to interpret the data. In the program, the query returns numbers for each year but it is hard to spot any trends without spending an exorbitant amount of time working with the numbers, this can also be overwhelming due to the sheer amount of numbers. In the graph, an increasing trend can easily be spotted.

Another thing which is hard to determine from data queries alone is the rate of change across a certain period. In the graph, it is represented visually in the form of the slope of the line. The fastest immunization rate increase occurred from 1982 to 1989, from a global immunization percentage of about 40% to just under 80%. From there on, while the increasing trend was present, the growth rate was decreased. From 2010 onwards, it can be seen that immunization rate is actually decreasing/unchanging. They key point here is that all of this can be seen from just from a glance.

The visualization also makes it easier to identify outliers or concerning data. For example, there is one point in the graph (1990) where immunization rates decreased temporarily before increasing again.

From the above trends/outliers, further questions can be asked:

1) What caused the rate of increase to decrease after 1989?

2) What caused the dip in the graph during 1990s?

3) Was the slowing growth rate and the dip related to the false claim that MMR (Measles, Mumps & Rubella) Vaccine caused autism during the early 1990s?

Immediately it can be seen that the granularity of the data provided by the visualizations is far greater than the data queries. Further exploring the first two mentioned questions can potentially offer a good deal of insight however, coming to these same questions without visualization would be a far less intuitive experience. The last question also only came about as result of the visualization, if one was solely looking at the data queries, this connection would be unlikely to come about. Although the last question is speculation and cannot be visualized, it is still helpful in explaining why the data trends in a certain way, and in creating more in-depth questions about the data.

As a disclaimer, these questions will not actually be explored in depth. They will only be used as a medium to showcase the benefits of data visualization.

Moving on, perhaps we suspect that the concerns about Figure 1 are related to World Bank income levels. To investigate further, one potential option is checking the global yearly averages for each World Bank income level separately:
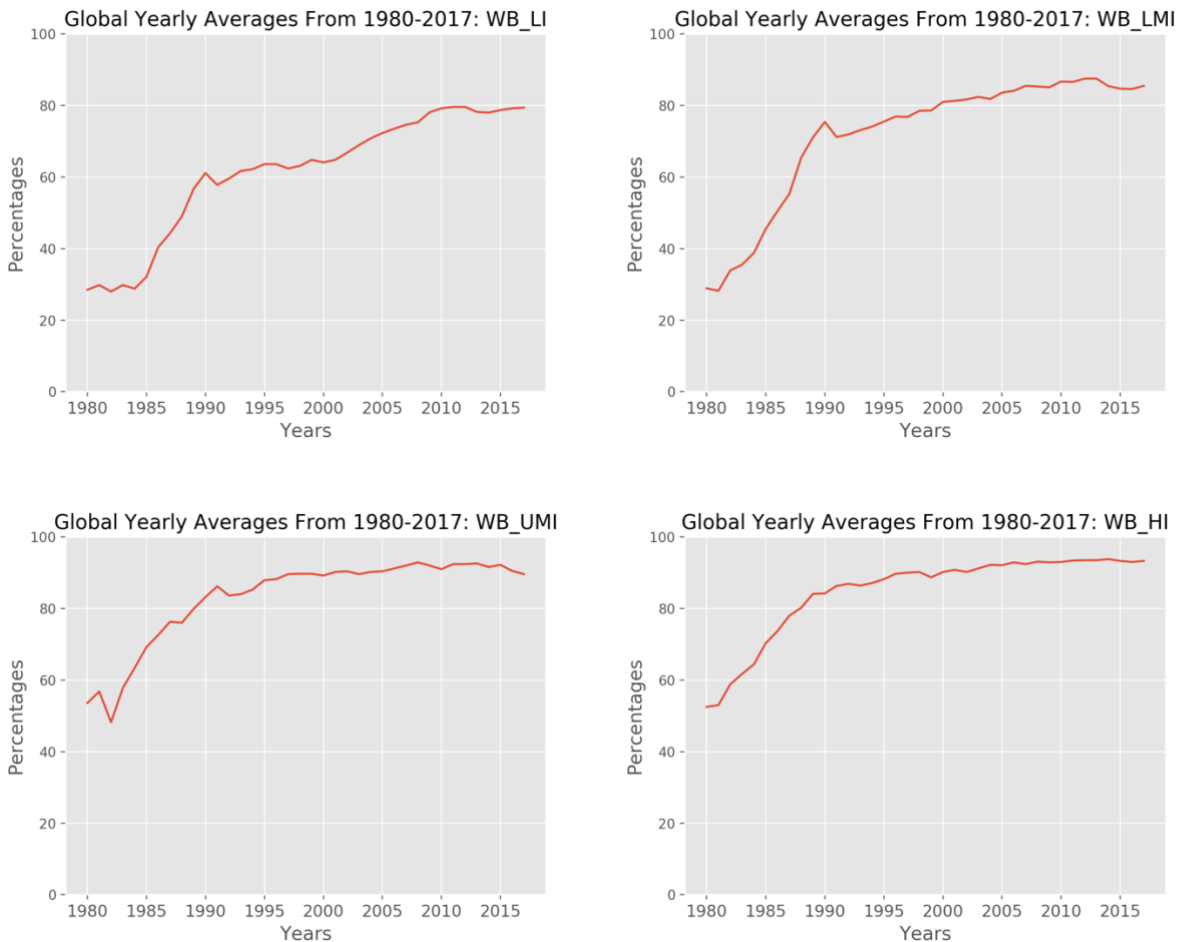
From these four graphs, more information can be extracted regarding concerns from Figure 1:

- The decrease of rate of change around 1990 is not present in the High Income graph.

- The decrease of rate of change in 2013 is only present in the Lower Middle Income.

- It can be seen that the rate of increase slows down for all income levels gradually after 1990.

To build upon our last question, the speculation that individuals stopped vaccinating due to the fear that MMR Vaccine was linked to autism, this presents an interesting case as the rate of increase

for immunization slows down past the early 1990s. There were claims that the MMR vaccine was linked to autism in the early 1990s, this claim was largely noticed by the public in the late 1990s, and the graph seems to show a dip in immunization levels at the same times. However, the dip in immunization percentages differs slightly between the different income levels. It is likely that individuals in lower income brackets were more likely to believe these claims whereas individuals in the higher income group were likely to be better educated and possibly looked into the false claim further and learnt quickly that the data used for the paper that claimed the link was fudged.

The above scenarios illustrate that visualization can allow for easier analysis and forming of further questions. While the above was just an example, further insight could be found by:

1) Graphing rates of measles immunization in developing countries vs. developed countries.
2) Graphing rates of measles immunization in European countries vs. North American countries.
3) Graphing specific countries that had measles outbreaks and recovered.

B) Ethical Issue

According to the World Health Organization, measles vaccinations have reduced measles related deaths by 73% between 2000 and 2018 (WHO, 2019a). Despite this large reduction, measles is still a prevalent outbreak in many countries today, with more measles outbreaks in even Canada and the USA. According to WHO, measles transmission stops when a large percent of the population in immune to measles, this is known as *herd immunity* when 93-95% of the population is immune. This protects those that are not immune, because the chain of infection is disrupted, which stops or slows the spread of measles (Funk, 2017).

Looking at the data in Figure 1, it can be seen that the global average for immunity rate in 2017 was 87%. While this is relatively high average, the immunity threshold for measles is still not being hit by many countries. As seen in Figure 3, only 49.5% of countries actually hit the immunity threshold for measles in 2017. This implies that over half of all countries are still at risk for measles outbreaks.

Figure 3: 2017 Percentage of Countries Under/Over the Immunity Threshold
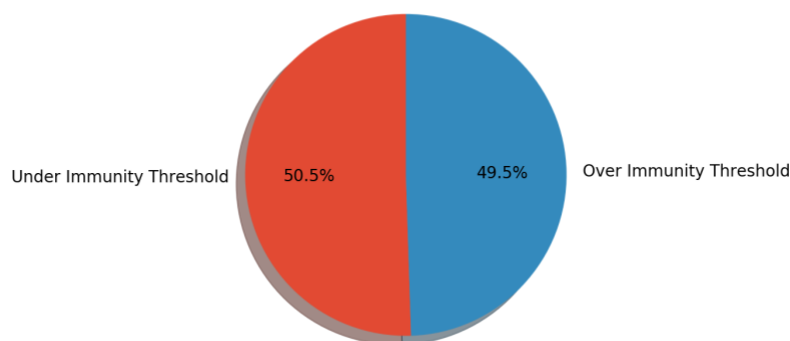
According to recent reports, even as of 2019, many countries are still well below this threshold and that is why there has been a global resurgence of measles in 2019 (WHO, 2019b).

WHO reports that stagnant or inadequate immunization rates are the root cause of all recent measles outbreaks. The data in Figure 1 also supports this. Great progress was made in increasing the immunization rates over the past few decades but as Figure 1 shows more recently, the rate of increase has stagnated. In Figure 2, it can be seen that the averages for Upper Middle and High Income countries have stagnated close to the threshold but for Lower Middle and Low Income countries, the averages are closer to 80%.

In the earlier years, many individuals were dying due to measles, thus, getting the vaccination seemed obvious. As more people got vaccinated the prevalence of measles decreased, thus individuals may feel that there is no need for vaccination, the principle of *herd immunity* is not one that is known to everyone.

In a recent report, UNICEF reported that reported measles cases in 2019 have surged 300% from 2018, and the organization says anti-vaxxers are the one to blame (Pesce, 2019). The anti-vaxxer movement is spreading misinformation about the safety of the vaccination. These groups use the 1998 *Lancet MMR autism fraud* as ammunition for their cause (Flaherty, 2011). In a 1998 a fraudulent research paper in the *Lancet* medical journal, claimed to link the MMR vaccine to autism spectrum disorder. The paper was later retracted and the author was stripped of his qualifications, yet individuals still believe the link exists (Dyer, 2010). Large amounts of research clearly contradicts this claim, but the idea is so firmly placed in individuals' mind that they refuse to believe any contradictory evidence (Hussain, Ali & Hussain, 2018). This has led to a large number of people not believing that vaccines are safe, and distrusting science as a whole.

For instance, a recent survey of more than 140 000 people in more than 140 countries found that only around 50% of Ukraine's residents trust that vaccinations work. There were 54 000 confirmed cases of measles in Ukraine in 2018, this was followed by Serbia who had 5076 cases

(UNICEF & Papowitz, 2019). This is also evident in the data provided where there are sharp decreases in the immunization rates between the years of 2007 and 2019 (Figure 4). The maximum rate of immunization is 99% while the minimum rate of immunization is 42% in 2016.

Figure 4: Ukraine's Immunization Rates Over Time
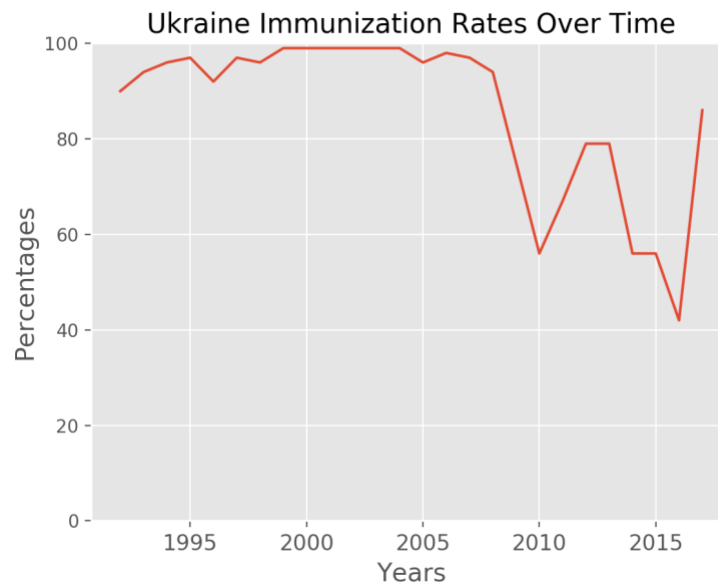
Anti-vaxxers claim that it is their right to choose if they should or should not vaccinate their child, and that they have the right to share their beliefs with the community (O'Hagan, 2019). However by choosing not to vaccinate they not only put their own child at risk but millions of other people as well. There are some individuals who cannot receive the vaccination due to health reason, for example, young infants, individuals with autoimmune disorders, and the elderly. This is evident in the recent rise of measles outbreaks worldwide (WHO, 2019a).

References

Dyer, Clare (2 February 2010). "Lancet retracts Wakefield's MMR paper". BMJ. 340: c696. doi:10.1136/bmj.c696

Flaherty, Dennis K. (October 2011). "The vaccine-autism connection: a public health crisis caused by unethical medical practices and fraudulent science". The Annals of Pharmacotherapy. 45 (10): 1302–1304.

Funk, S. (2017). Critical immunity thresholds for measles elimination. Critical immunity thresholds for measles elimination. World Health Organization / London School of Hygiene & Tropical Medicine. Retrieved from https://www.who.int/immunization/sage/meetings/2017/october/2._target_immunity_levels_FUNK.pdf

Hussain, A., Ali, S., Ahmed, M., & Hussain, S. (2018). The Anti-vaccination Movement: A Regression in Modern Medicine. Cureus. doi: 10.7759/cureus.2919

O'Hagan, E. M. (2019, February 15). Measles is on the rise. But telling anti-vaxxers they're stupid won't fix it | Ellie Mae O'Hagan. Retrieved December 7, 2019, from https://www.theguardian.com/commentisfree/2019/feb/15/measles-anti-vaxxers-communication.

Pesce, N. L. (2019, April 25). UNICEF blames anti-vaxxers for the 300% spike in global measles outbreaks. Retrieved December 7, 2019, from https://www.marketwatch.com/story/unicef-blames-anti-vaxxers-for-the-300-spike-in-global-measles-outbreaks-2019-04-25.

UNICEF, & Papowitz, H. (2019, February 7). Measles in Europe: Infection rates highest in a decade, says UN health agency | UN News. Retrieved December 7, 2019, from https://news.un.org/en/story/2019/02/1032171.

World Health Organization. (2019a, May 9). Measles. Retrieved from https://www.who.int/news-room/fact-sheets/detail/measles.

World Health Organization. (2019b, December 6). Measles: fighting a global resurgence. Retrieved from https://www.who.int/news-room/feature-stories/detail/measles-fighting-a-global-resurgence.