Visualizing Density of Healthcare Workers Across Time and Countries

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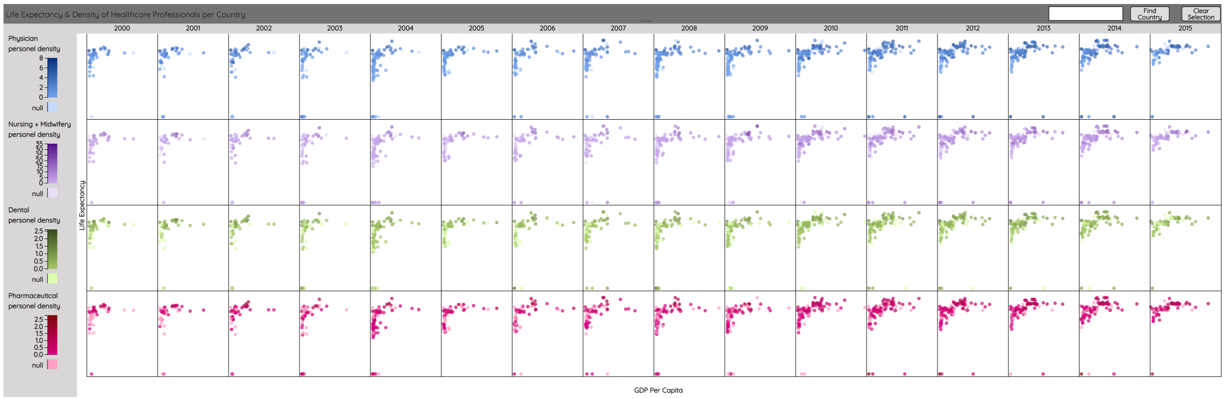

Figure 1: Overview of our visualization that shows the amount of healthcare workers per capita across time and countries. It consists of 4 rows of scatterplots each representing a different role of healthcare professionals; physicians, nurses and midwives, dentistry personnel, and pharmaceutical personnel. In the scatterplots, each mark (a circle) represents a specific country. Each row has a scatterplot for every year present in our data set — from 2000 to 2015. The y-axis encodes life expectancy and the x-axis encodes GDP per capita. Density is represented using colours, and the scale for each row is shown to the left of the scatterplots.

Abstract

We present a visualization that makes use of a novel highlighting and animation technique. The primary motivation behind the design of this visualization was to enable people to look at data about healthcare services, and specifically to increase their knowledge about the impact of the amount of healthcare workers per capita. We use animation in the process of showing changes within an individual country over the course of several years, as well as to facilitate comparisons between multiple countries at once, by letting people keep track of selected countries. We discuss the motivation behind our use of animation, our choice to include a search bar, and potential areas for improvement and revision.

1 Introduction

The World Health Organization estimates that the world will be short 12.9 million healthcare workers worldwide by the year 2035 [5]. This statistic may sound concerning, but how severe of an impact does the number of health professionals have on a population? In our visualization we use three different variables; density of healthcare professionals, life expectancy, and GDP per capita. Density of healthcare professionals refers to the number of professionals per 1000 people, life expectancy indicates the number of years that a person can expect to live and is based on an estimate of the average age that people in a population-based group will be when they die [4], and GDP is an indicator of country economy. Both life expectancy and GDP per capita are often used when considering measures of the health of a population [4]. Therefore, the combination of life expectancy and GDP per capita might be a valuable indicator of the impact that the number of health care workers has on the wellness of a country.

We present a visualization of the amount of healthcare workers per capita across time and countries (see Figure 1). Our visualization offers temporal and persistent selections, which are highlighted using color and animation. Selections can be done by mouse and through a search interface. By visualizing this data, we might allow people to better understand the relationship between life expectancy and density, and possibly to grasp the severity of the impact of a lack of health care workers.

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2 Our Visualization

We aimed to enable people to explore the relationship between life expectancy and healthcare worker density, which guided the design of the visualization. A key objective of our work was to provide people with the ability to compare density levels of a single country throughout multiple years and across all density types. We also wanted people to be able to compare values between two different countries. These goals were the motivation for our use of interaction in our visualization.

Our visualization consists of 4 rows of scatterplots each representing a different role of healthcare professionals. Each mark (a circle) represents a specific country. Each row has a scatterplot for every year present in our data set – from 2000 to 2015. Life expectancy is shown on the y-axis of each scatterplot. The x-axis encodes GDP per capita. Density is represented using colours, and the scale for each row is shown to the left of the scatterplots. A search bar in the right-hand corner, along with a *find country* button and a *clear selection* button allows people to search for a country and clear any previously selected countries.

Countries that are non-existent in the data set are not shown in the visualization. Countries for which we do not have data for life expectancy are shown with the appropriate colour but are positioned at the bottom of the y-axis. Similarly, countries for which we have no GDP data, are positioned left-most in the scatterplot. Countries for which there is no information about health professional density are shown in the lightest colour of the shade range of the given scale, which is indicated in the color legend, in a position determined by their life expectancy and GDP values. In some cases, countries will be shown in the visualization on some years and then they disappear on others.

2.1 Interaction

There are several ways to interact with the data. When a mouse cursor hovers over a circle, the circle animates as if it is stretching to become larger. Additionally, the circle changes from full to stroked, and continued hovering shows a tooltip with more details. Moving the mouse away, the circle returns to its original state. Clicking on the circle causes a more persistent selection – the circle is highlighted when moving the mouse away (see Figure 2). Similarly, finding a country from the search bar causes a persistent selection. Selections can be removed by clicking on a specific country circle, or alternatively, from the search bar. To enable people to select and analyze one or more countries, we include a search function. The search bar enables people to type a country name into the search field causing the respective country to be highlighted in each scatterplot. We used the same animation on the search function as with the mouse over to similarly draw people's attention to the various points.

3 Discussion

We use animations to highlight key points across the entire screen and the relationship between these points. Bartram et al. [1] conducted a study to determine a set of guidelines for use in motion-assisted search in dense visual displays. Their research found that the use of a circular expansion animation, similar to our use of animation, resulted in the lowest error rate in their search task. They also concluded that small, brief graphical motions are sufficient to draw user attention towards specific objects in a crowded display. Hong et al. [2] conducted a study on the effects of flashing on information search performance, analyzing whether such animations attract people's attention online. They found that flashing does attract people's attention and enables them to locate target items more quickly on crowded screens. Our use of animation is similar to flashing as the quick transformation from one state to another closely resembles the rapid change present in flashes. While the animation may draw attention to the highlighted points in other sections of the visualization, whether they help to indicate the relationships between the points is debatable. Robertson et al. [3] found that when evaluating static and animated depictions of trends, animation is the least effective form for analysis when compared to various static depictions. Their research may suggest that while animation is beneficial to draw user's attention to points of interest, it may not be beneficial in indicating trends over time. This suggests that there might be better design options for showing trends.

Interacting with our visualization has revealed several relationships within the data. As expected, the visualization suggests a positive correlation between life expectancy and GDP. However, there do not appear to be a clear relationship between the number of health care providers and life expectancy. However, there is a general trend of growth throughout the years displayed in our visualization among all three factors; GDP, life expectancy and healthcare professional density, across all countries included in our data set.

4 Future Work

There are multiple elements in our visualization that may benefit from revision, and some elements that might be added to increase user understanding of the data.

First, to help people see trends, we think it would be worth exploring trend lines between data points in each row of the visualization. Currently, it may be difficult for people to perceive slight differences between two countries with similar life expectancies. It is possible to mouse over individual points and compare exact values from the

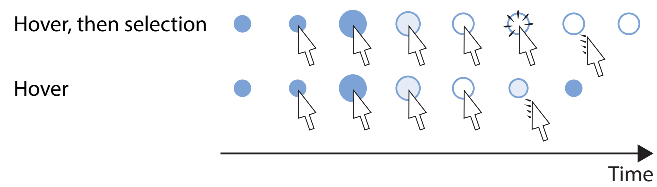

Figure 2: Data marks are animated on selection (top) and hover (bottom).

tooltip. However, a trend line would make this process much easier and eliminate the need to mouse over each individual point. When a user selects a data mark a line could be drawn across each row, connecting the marks present in each year. This could greatly improve peoples' ability to view and understand changes over time as even small differences between years could be easily detected. The addition of trend lines could also make it easier to compare changes over time between two or more countries.

Second, we would like to explore how NULL values are represented in our dataset. Currently the visualization puts emphasis on missing data by showing them in a separate part of each scatterplot, but we think that there might be other interesting possibilities.

Finally, the scatterplots in our visualization suffer from overplotting. We think it would be valuable to eliminate or reduce this. Currently there is no mechanism in our visualization to prevent data marks from being drawn on top of one another. This means that many marks often overlap. As a possible solution we could allow people to interactively adjust the size of data marks based on their areas of interest. This allows another layer of interactivity while eliminating the problems that arise from overplotting. We also consider making each data mark transparent so that all points are visible regardless of overdrawing.

5 Conclusion

We presented a visualization that provides people with the ability to interact with data on healthcare worker density and life expectancy, allowing them to analyze trends and patterns within the data. The visualization shows the amount of healthcare workers per capita across time and countries. Our visualization offers temporal and persistent selections, which are highlighted using color and animation. While some aspects of our visualization would benefit from adjustments, other elements provide interesting ways for people to interact with the data. While our use of animation to draw attention to various data points and trends requires further research, we think it points to interesting design possibilities.

References

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