Healthcare resources in Switzerland

Process book by
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Physical and human resources in the healthcare system in Switzerland

Milestone 3

Contents

I. Problem Statement and Motivation

In the middle of a worldwide pandemic, we wish we could take a step back from the stressful "new covid cases" and "number of death" by which we are constantly bombarded in the media at the moment. Interested in a more "neutral" way at a more "local" scale, I chose to explore the number of physical and human resources in the healthcare system in Switzerland. I use datasets from earlier this year as well as older data, enabling an analysis both before and during the crisis.

On top of the demographic analysis, I was willing to ask social justice questions such as "who is the more impacted during the pandemic ?". However, one must be careful when extracting answers from data like *number of doctors per inhabitants* or *amount of money made by each canton*. Indeed, the data collection wasn't necessarily meant to illustrate any repartition of privileges in the country at the first place. Seeking for this kind of answers may lead to over-interpretation. Hence, the interactive data visualizations that I developed in this project aim to illustrate some of the disparities by showing the numbers *as they are,* while asking open questions and providing an interactive tool for anyone to draw their own conclusions.

II. Datasets Exploration

I started with an exploratory analysis on three datasets from the Federal Office of Statistics, dated before 2020:

1. *Cas d'hospitalisations selon l'âge et le sexe (2001-2018)*
2. *Hôpitaux: lits et hospitalisations par type d'activité et canton (1998-2018)*
3. *Professions de la santé selon le sexe: diplômes délivrés depuis 1980 (1980-2005)*

This exploration allowed me to discover what type of informations were publicly available and gave me a better idea of the different numbers and scales that I could later use in the project. Amongst the three datasets though, I only kept the last one in the final design, as it was providing some valuable insight on the gender gap in the healthcare sector.

From the very beginning, I knew that I wanted to use a 2D map of Switzerland as core visualization. For a comparison between cantons, I needed to find another dataset providing demographic informations. I found one from 2020 by - again - the Federal Office of Statistics, containing regional indicators including the health sector:

4. *Regional comparisons of regional indicators (2020)*

While moving forward with my idea, I was hoping to look at the numbers of resources during the pandemic as well. It actually turned out to be quite difficult to obtain open datasets on the subject. After writing to two researchers from the *CHUV*, one researcher from *Health Geography and Policy Group* at *ETH* and to the *Swiss Society of Intensive Care Medicine (SSMI)*, I wasn't able to obtain any current numbers for the intensive beds per cantons or the number of healthcare practitioners recruited since the start of the pandemic.

A few weeks ago though, I found an update from *Health Geography and Policy Group* at *ETH* and discovered their online platform made to monitor beds occupancy in Swiss hospitals. As the numbers are written in the html page, I copied them in my own csv file. In parallel, I asked for the most recent numbers from the *Swiss Society of Intensive Care Medicine* and I used both datasets to complete my project:

5. *Near-real time monitoring of intensive care occupancy, IES system (13 may 2020)*
6. *Liste zertifizierte (anerkannte) Intensivstationen (23 March 2020)*

III. From brainstorming to final design

The final webpage contains four interactive visualizations: a map, a bar chart, a bubble chart and a bipartite graph. After some iterations, I decided to name the different sections with a main theme and a question that should be answered by each design [Table 1].

Visualization	Questions (Title)	Theme (Menu)
Map	General	General
Bar Chart	What is the difference between the number of certified ICU beds at the beginning of the soft lockdown and the recent numbers listed by the Swiss Armed Force ?	ICU
Bubble Chart	Does the number of resources grow with the number of inhabitants and canton's wealth ?	Wealth
Bipartite Graph	What is the gender repartition in healthcare practitioners ?	Gender

Table 1: The four visualizations are ordered so that the final web page tells a story. Each section starts with a thematic question that should be answered by each design. Each theme is summed up in the menu at the top of the webpage.

The Map

The 2D map of Switzerland is the first design of the webpage, where one could select the different cantons interactively and display regional informations. As I was about to explore human and physical resources in healthcare, I decided to display the numbers of beds and doctors per inhabitants for each canton. I opted for flat design icons that would be fixed in a dom element above the map. As one would select a canton on the map, the numbers related to this geographic area would change below the icons [Figure 1].

Figure 1: The interactive map is implemented with *TopoJson* and *d3.js (left)*. As one select a canton on the map (right), the numbers below the icons will change accordingly.

The initial design of the map was a choropleth showing the density of each canton. As of today, this remains the default option, but there is now the possibility to change the semantic of the choropleth by clicking on the buttons below the map (this feature has replaced the optional zoom feature from milestone 2). One can choose to display a choropleth for the numbers of beds per inhabitants or for the numbers of doctors per inhabitants. As the color spectrum is the same for the three options (light to dark grey), the map morphs to different results when clicking on the buttons. It shows that the canton which has the darker density doesn't necessarily correspond to the canton with the darker number of beds. In other words, the canton with the larger population doesn't necessarily has the larger amount of beds per inhabitants.

The color mapping for the choropleth is given by the minimum and maximum values on the top right legend. To keep a coherent aesthetics within the page, I use the same design for all the legends, using small coloured rectangles in *d3.js*. The legends are interactive and one can click on them to display, in the case of the map for instance, either the numbers or the corresponding canton names.

The Bipartite Graph

As part of my initial idea was to take a feminist approach to show the gender gap in the field of care. I directly thought that a bipartite graph would be the perfect way to illustrate such disparity [Figure 2]. The primary variable corresponds to men or woman[1] and the secondary

[1] The gender was considered as a binary in this dataset

variable corresponds to the healthcare professions (caregivers, midwives, nurses, dentists and doctors).

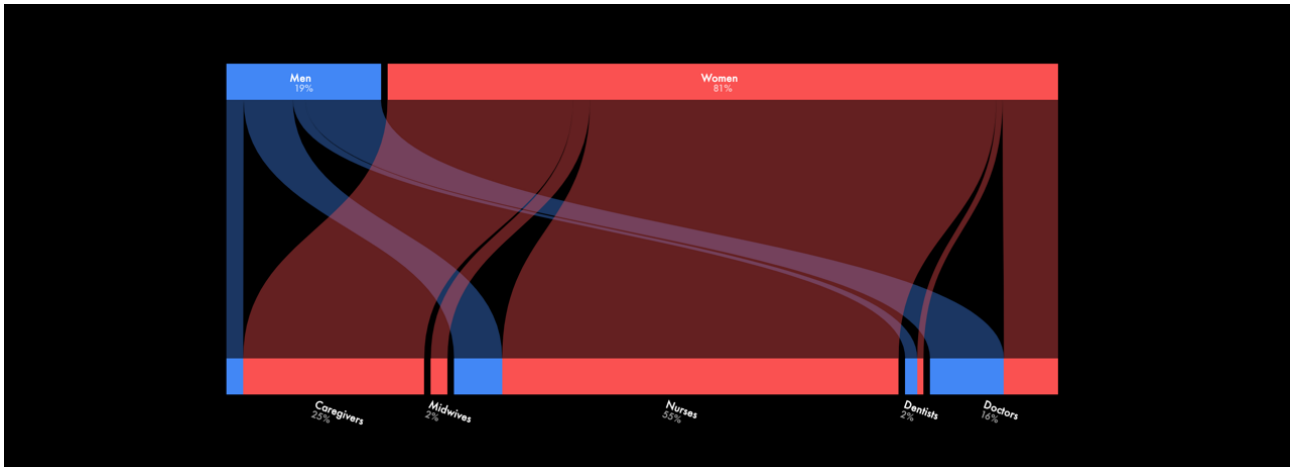

Figure 2: Bipartite graph: *What is the gender repartition in healthcare practitioners ?*

Between 1985 and 2005, 81% of women for only 19% of men obtained a diploma in healthcare. What is even more striking is the gender gap between high-paying jobs and less-paying jobs. Indeed, over ten years, 93% of woman studied to become caregivers, nurses and midwives, whereas only 38% received a diploma to become a dentist or a doctor. As salary equity is often used as an argument to show gender equality in an industry, the access to high-paying jobs should also be given for the sake of transparency; it still remains more difficult for women to access top-management postions and "prestigious" occupations. The following interactive dataviz entitles to show this disparity in healthcare.

The Bubble Chart

The interactive map and the bipartite graph were implemented by the second milestone. At this stage, I only had a draft idea for the bubble chart. I used jupyter notebook to investigate the possible correlations in the data. After testing the different variables in different orders and combinations, I selected the graph that shows the population in the x-axis with the growth domestic product per capita illustrated by the bubble radius [Figure 3].

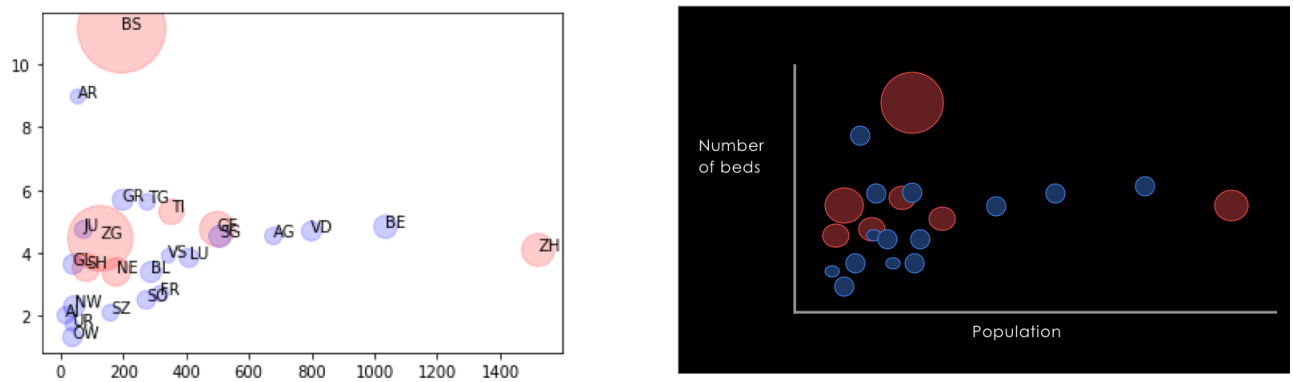

Figure 3: Exploration for the bubble chart: data analysis in python (left) and wire-framing for the final design in Sketch (right).

In the final design, I let the possibility to change what is plotted on the y-axis: one can click on the buttons below the graph to interactively change between the number of beds per inhabitants and the number of doctors per inhabitants. There is also the possibility to set the radius to uniform for better visibility [Figure 4].

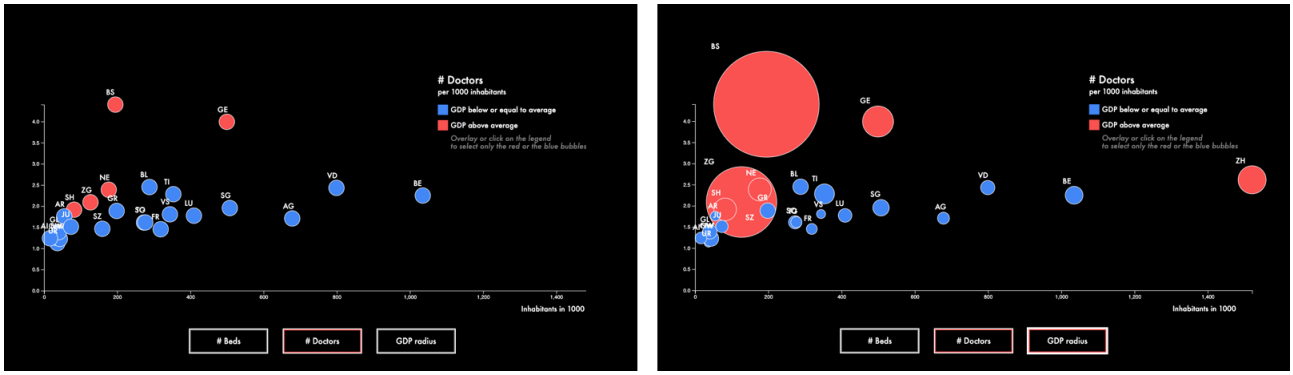

Figure 4: Bubble chart: *Does the number of resources grow with the number of inhabitants and canton's wealth ?*

One can imagine that the more inhabitants per canton, the more hospital beds and doctors. However, the correlation is not so clear. For instance, in the number of doctors, we observe a disparity between blue and red bubbles - where the reds represent the "rich" and the blues represent the cantons with a growth domestic product per capita (GDPpc) equal or below the average. In this case, the red slope is steeper than the blue one and can be interpreted as a more significative increase of resources per inhabitants for the rich cantons.

For both resources, Zürich and Basel-Stadt appears as outliers. Basel-Stadt, one of the business center of Switzerland with less than 200'000 inhabitants, has the biggest growth domestic product per capita and the more resources. As this could be seen as a "wealthy-logic" correlation, it is interesting to see that its numbers are far above the other red cantons's trend. Zürich on the other hand, with the biggest population in Switzerland, has a number of resources looking more similar to the blue trend despite its high growth domestic product per capita.

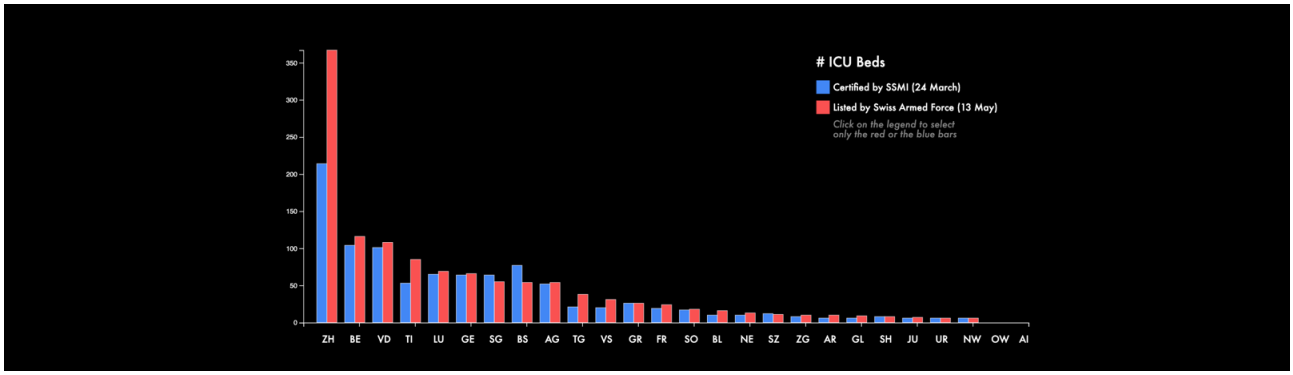

Figure 5: Bar chart: *What is the difference between the number of certified ICU beds at the beginning of the soft lockdown and the recent numbers listed by the Swiss Armed Force ?*

The Bar Chart

For the bar chart, a prior data analysis in python was made to find what would be the best way to visualize the numbers of ICU beds. I chose a descending bar chart with the two datasets shown side by side, as this is self-explanatory and can easily be understood [Figure 5].

IV. Technical Challenge

The code source is available on github.

Interaction	Reaction	Linked View
Overlay the map	- Change the icons numbers - Highlight the selected canton on the map while reducing the rest of the map's opacity - Display full canton name instead of ID	Bar chart and bubble chart
Click on the map	- Change the icons numbers - Highlight the selected canton on the map by changing its contour - Display full canton name instead of ID	Bar chart and bubble chart
Click on the map legend	- Alternate between min and max value and min and max canton name	/
Click on the map button	- Change the cholorpleth (three options: number of beds, number of doctors, population) - Change the legend title	/
Overlay a canton in bar chart	- Highlight the selected canton on the map while reducing the other bars's opacity	Map and bubble chart
Click on a canton in bar chart	- Highlight the selected canton on the map while reducing the other bars's opacity	Map and bubble chart
Click on the buttons bar chart	- Change the bar position and height if normalised or total option is selected - Change the y-axis	/
Overlay a bubble	- Highlight the selected canton while reducing the other bubbles's opacity - Display full canton name instead of ID - Display growth domestic product per capita	Map and bar chart
Click on a bubble	- Highlight the selected canton with bigger contour - Display full canton name instead of ID - Display growth domestic product per capita	Map and bar chart
Click on bubble chart legend	- Select only red or blue bubbles - Change font-size of selected legend	/
Click on bubble buttons for beds or doctors	- Change the bubble positions depending if beds or doctors option is selected - Change the y-axis to adapt to the new metric - Change the label positions	/
Click on bubble buttons for GDP radius	- Change the radius of the bubble to visualise the growth domestic product per capita - Change the label positions	/

Table 2: All the visualizations are interactive. Some of them use *linked views*, where an action on one view affects the others.

On three visualizations - the map, the bubble chart and the bar chart - the informations are sorted by canton. Therefore, I decided to use *linked views*, where an action on one view affects the others [Table 2]. For instance, if one selects a canton on the map, then it will select the same canton on the bubble chart and on the bar chart.

As part of the "nice to have features" from the second milestone, I wanted to make the webpage responsive for mobile. In the customised css file *(website/stylesheet/custom.css),* I added some specific css design when the screen is smaller than a desktop screen. For instance, the font size for the text will be smaller and the buttons and the svg canvases will reduce to fit to the smaller screen size so that one can interact with the page on their smartphone.

The empty svg element are predefined in the main html file *(website/dataviz.html)*. Each visualization is then implemented in a separate javascript class. The constructors take as parameters a data object and a string corresponding to the id of the svg element on which the specific visualization will be drawn. This allows to treat and process the data in the main javascript class *(website/javascript/main.js)* and give the same data to each object when we create them.

The main javascript class also contains the common interaction for the linked views, mainly for *mouseover* and *click* events. The update function for the icons is declared in the main class as well, since it is called when one selects a canton on the map. This holds also for the update of the bar chart when one normalizes the graph by density; when re-ordering the cantons, we unselect the current selection and call the common reset function for all visualizations.

Whereas drawing static design was a good starting point in *d3.js,* the main challenge was to make the visualizations interactive to engage the readers in the story. From the initial brainstorming to the final design, going through data analysis, sketches and wireframing, the final webpage now encourages the readers to use the interactive tools to navigate through the different questions and create their own answers.

Try it yourself
https://celinedupuis.ch/com480/dataviz.html