Public Transport vs. Medical Care

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1. Business Problem

If the pandemic has taught us anything it is that a functioning public health system is key in overcoming the pandemic. Germany has always prided itself with an expansive and – crucially – free health insurance. However, there is not only a gap between words and deeds but even more so between East and West Germany. We know that vaccinating as many people as possible as fast as people is paramount. Still, what if the doctor is not easily available? Many people and especially those from financially challenging backgrounds heavily rely on public transportation. I want to examine the distance from public transport to a possible vaccination facility and whether there is a significant difference within the cities as well as between the East and the West. Additionally, this could give an indication as whether there is a shortage in medical professionals since people would have to walk from many different areas to the same professional or whether the public transport system is not nearly developed enough since many people would have to walk long distances in general.

2. Data

Since my approach is rather straightforward, I do not rely on extensive data sources. I will only use the Foursquare API to acquire the coordinates from all public transport stations and medical facilities within a certain area. How will I use the data to solve the problem? First of all, I will extract, transform and load the respective datasets. Secondly, plotting the data within the folium-map based on real coordinates is important to get an impression of the distribution and whether it makes sense to analyze for possible clustering. However, the coordinates have to be translated into radians for mathematical calculations in order to calculate distances based on the Haversine Formula. Afterwards, results for each city will be concatenated into one data frame for statistical analysis.

3. Methodology

As has been stressed earlier, the main challenge was calculating distances from a 3D sphere in a 2D coordinate system. Using simple optimization approaches would lead to unrealistic results since the earth's surface is spherical, thus 3D approaches would provide solutions that are mathematically correct but physically impossible. For this reason, I used the popular Haversine formula that is in this case largely drawn from Wikipedia:

$$d = approximate\ distance\ between\ to\ points\ on\ a\ sphere$$

$$r\ = radius\ of\ th\ earth$$

$$\theta = central\ angle$$

$$\lambda_1, \lambda_2 = Longitude\ of\ point\ 1\ and\ 2$$

$$\varphi_1, \varphi_2 = Latitude\ of\ point\ 1\ and\ 2$$

$$versin(\theta) = 1 - \cos(\theta)$$

$$haversin(\Theta) = \frac{1 - \cos(\theta)}{2}$$

$$\theta = \frac{d}{r}$$

$$d = 2 * r * archav(hav(\Theta))$$

4. Results

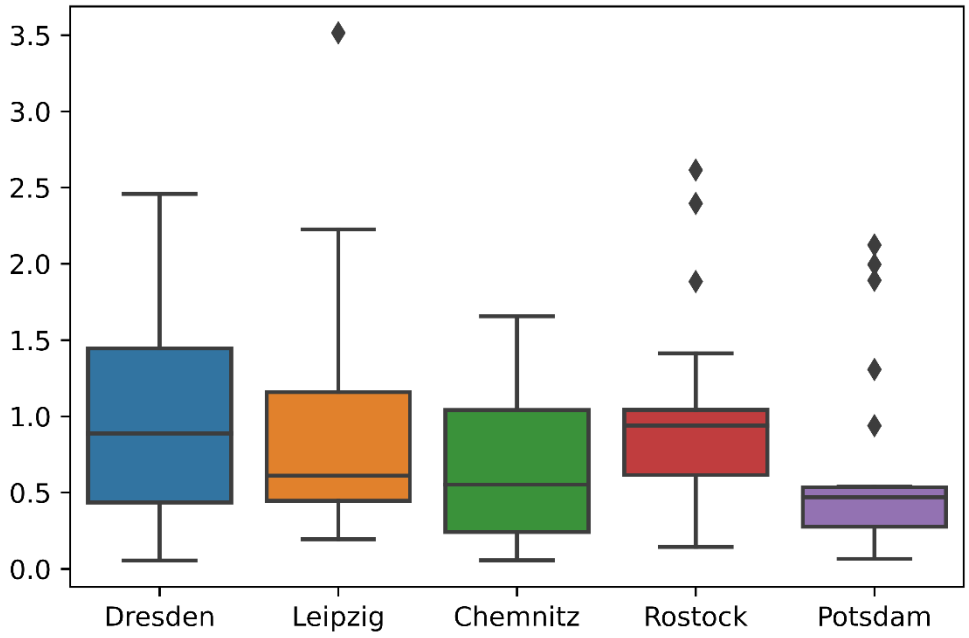

Figure 1 East Germany

As shown in the figure 1, Dresden appears to have the largest spread amongst minimum distances and the second highest median value after Rostock. However, what stands out the most is that Potsdam seems to have the best values, e.g., lowest overall minimum distance and smallest spread. Still, it has unlike Dresden or Leipzig also a lot of outliers. This is quite revealing in several ways. It means that people would have to walk at least 500 to 1000 meters on average as well as potentially up to several kilometers. Facing such a long distance might give raise to serious considerations if people already suffer from bad physical conditions.

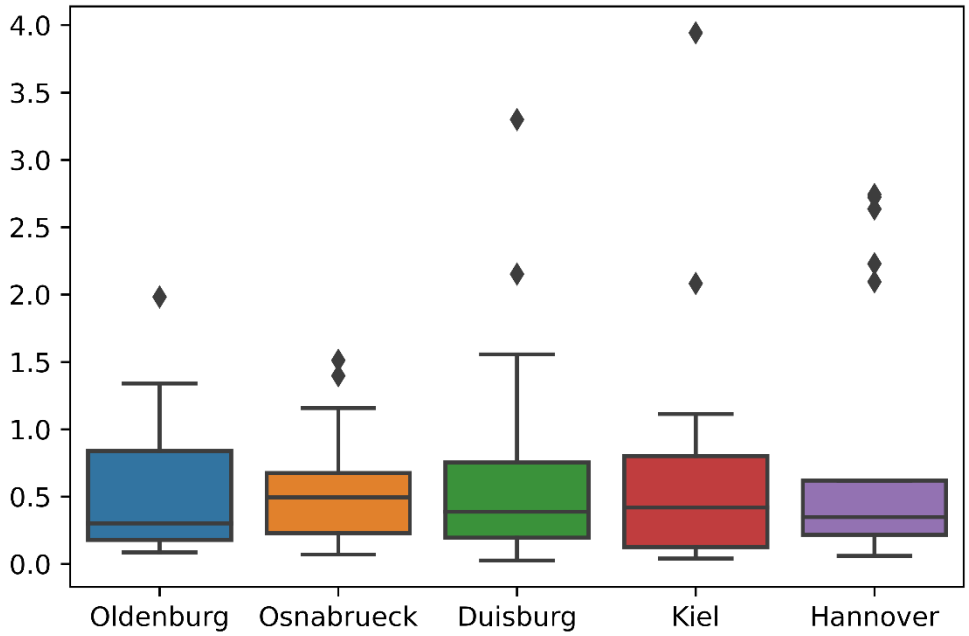

Figure 2 West Germany

The most striking difference compared to the previous figure is that all cities have overall low values none is above 1km minimum distance in the 75% quartile. The values are more evenly distributed but the cities do have more outliers as well. In this table, it would appear that people in West Germany would have to walk less than 500 m on average and only up to 1500 m worst case scenario. Given the low spread as well as low maximum values could lower the risk of people missing out on appointments due to poor connection.

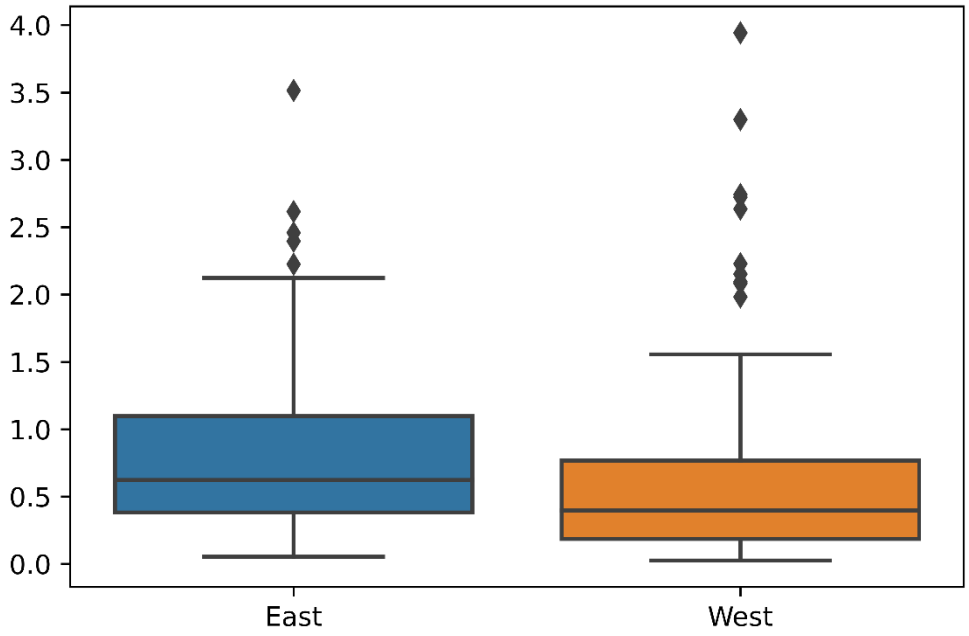

Figure 3 Germany

This figure summarizes previous graphs. It exemplifies clearly that the average minimum distance is lower in West Germany and the spread is also smaller. This indicates that people can commute more efficiently and smoothly in West Germany.

5. Discussion

This project proved an important opportunity to advance the understanding of public transport and medical care across Germany. It has become very clear that people in East Germany must travel longer distance to reach a medical professional. This could potentially hinder fighting the virus as every additional meter to travel lowers the motivation to take the journey in the first place. Still, the idea of a shortage in the East compared to the could not be strengthened. Either, because there is no shortage at all or there is a shortage in both parts of Germany. However, it is important to bear in my that this thesis does not engage in analyzing the current outbreak. It was designed to utilize tools available in Python to plot venues that might be of interest. Overall, the findings in this paper support the idea that public transport in East Germany is – on average - less well developed than public transport in West Germany.

6. Sources

1. Foursquare.com
2. https://medium.com/@danalindquist/finding-the-distance-between-two-lists-of-geographic-coordinates-9ace7e43bb2f
3. https://en.wikipedia.org/wiki/Haversine_formula