

Interactive Multi-view Visualization on Powerlifting Performance

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1. Problem analysis/Introduction

Powerlifting is a strength sport referring to lifting the barbell in predefined ways to achieve maximal weight. It consists of 3 components: squat, bench press, and deadlift. Over decades, it has become increasingly popular on a global scale. Although powerlifting may seem like a pure strength sport, knowledge, programming and analysis play a more important role than many people think. In this report, we identify two main aspects related to the growth of powerlifters, design and implement a set of visualizations with interaction based on the competition dataset maintained by Open Powerlifting [Ope].

Firstly, to facilitate the process of making a training program, individual lifters and coaches need to understand how good the lifter is among the lifter population. Besides, the visualization needs to provide information about lifters, for instance, name, age, sex, best performance on each of the 3 lifts, etc. Furthermore, tracing the competition records of a specific lifter is also beneficial for deriving the lifter profile for further reference. Secondly, although powerlifting is an individual sport, the community is in fact vital for the growth of lifters. Therefore, we propose to visualize which part(s) of the world provides welcoming communities for reference of serious powerlifters, to help decide where is a good place to live long-term or even start a career. We, therefore, raised two **domain questions**:

1. How to inspect and trace lifters' performances and compare them with that of the population?
2. Which areas are the best places to live to maximize personal development?

The dataset(**What**) we applied to the visualization consists of two major parts. For the first domain question, the data is in the form of a table with items and attributes which are mainly categorical and quantitative. For the second domain question, we utilize geometry data with items and positions as datatypes.

Based on the 2 questions above, the abstracted tasks(**Why**) can be summarized as follows:

1. Discovering and exploring the distribution;

2. Identifying trends;
3. Comparing features and similarities;
4. Presenting features.

2. Proposed and justified solution

To accomplish all these tasks, we had several candidates for visualizing the powerlifting data, including bar charts, and line charts to display lifter information or track their performance. However, considering the need for user interaction, and the fact that a smaller number of views with a sufficient level of complexity is beneficial to lowering cognitive loads, we designed and implemented(**How**) the following three components, namely an interactive scatterplot and a boxplot for the first question, and a world map for the second. Figure 1 shows the sketch of our design.

• Interactive Scatterplot

The interactive scatterplot consists of two views, one for displaying best performances of lifters, and one for all the competition records of the population.

We consider the kilograms lifted as the indicator to identify how good the lifter is. Since there are 3 lifts in a general powerlifting competition, we provided a selector to choose 2 lifts out of 3 for display. To differentiate lifters of different sex(as generic powerlifting competitions do), we applied different color codes to the data points. Considering that data points are numerous, zooming in and out to inspect the details is necessary. To this end, we incorporated the brushing feature to inspect the selected area(zoom in) and double-click to switch back to the original view.

To display the information on lifters, we applied a hovering effect on each data point, displaying name, sex of each lifter, and numbers on the squat, bench press, and deadlift for best performance.

To focus on a specific lifter, inspect competition records of the lifter, and compare the performances with the population, we implemented a name selector. Data points of lifters will be highlighted if they match with the text entered in the selector field.

Considering the performance of the visualization, we decided to limit the data inside the Netherlands.

- **Boxplot**

To aid lifters in comparing their performance against other lifters and get a general idea of the capabilities of other powerlifters, we created a set of filterable boxplots. The filterable boxplots consists of 5 views that display the distribution of personal records of lifters around the world in bench press, squat, deadlift, total weight, and Wilks [FAC20].

Users can decide the type of competitions they want to check by using the provided selectors for expected divisions within generic powerlifting competitions such as weight class, sex, and equipment.

To compare their performance with the rest of the population within their chosen parameters, users can also enter their personal records in the fields adjacent to the plot of each category.

The advantage of a boxplot is that it summarizes almost a million data points in each category (squat, bench, deadlift, total weight, and Wilks) into an easily readable format. The option of plotting the user's personal records onto the boxplot also lets the user get a general idea of their standing among other powerlifters.

- **World Map**

To aid lifters in comparing different countries that would be welcoming and beneficial to live in as a powerlifter we created a choropleth world map. A choropleth map uses different colors or patterns to represent the data values for each country. For example, a country with a higher number of powerlifters will be displayed with a darker color, while a country with a lower number of powerlifters will be displayed with a lighter colour. This helps users easily see which countries have higher or lower values for the data being displayed. Lifters can pick between a few different categories to compare the countries in, namely the Number of lifters from that country and the Average/Max Squat, Bench, and Deadlift from lifters in that country.

3. Evaluation

- **Interactive Scatterplot**

The general view of the interactive scatterplot is shown in figure 2. Each data point is of the same size, low opacity, and encoded in different colors according to lifter sex. When hovering over the data point, the lifter name, sex, and performance on squat, bench press, and deadlift are shown in figure 3. When brushing an area on the left view (see figure 4), the two views will be zoomed in to a more detailed level (see figure 5). Double-clicking the left view to zoom out. After zooming into an appropriate level of detail, once entering a name in the name selector, lifter(s) and their competition records are highlighted in a different color, and the size of the data points is enlarged, as is shown in figure 6. If a lifter has multiple competition records, trend tracing can be performed (see figure 7).

- **Boxplot**

The general view of the boxplot is as shown in figure 8. Each category (Bench, Squat, Deadlift, Total and Wilks) has its own boxplot. When any filter is applied, the box-

plots are updated to show the distribution of lifts over the filtered data as shown in figure 9. When the user enters their own personal records in any of the categories, their position on the plot is represented by a circle that also gives details about their percentile as shown in figure 10. Once the entries for squats, deadlifts and bench are entered, the total personal record of the lifter is automatically updated. The user can also hover over their entry on the plot to check their percentile within the category. This gives the user a general idea of their standing among other powerlifters.

- **World Map**

In figure 11 you can see one of the views for the choropleth world map. Countries are colored based on their value for the selected category. These categories are amount of lifters, Average Squat/Bench/Deadlift, and Max Squat/Bench/Deadlift, and can be picked in a drop-down menu. In the bottom left, there is a legend where users can quickly see what colors roughly correspond to what amounts. To actually see the stat per country users can hover over a country where a tooltip then displays the country name and its value in the selected category (see figure 12).

4. Discussion/Conclusion

After evaluation, our implementation showed versatile and satisfying visual functionality, fulfilling the tasks defined in section 1. The bottleneck lies in the loading time due to the size of our data.

If we had more time, we would like also to implement the following features: Firstly, providing in-depth visualization for other features of lifters, for instance, their height, weight, body anatomy, etc. (depending on the research needs of the domain expert). In this way, the visualization will become more powerful for enthusiasts, coaches, trainers, sports analysts, and others. On the other hand, it requires extended data sources since many of the above-mentioned features are not present in the dataset we are using. Secondly, defining the goodness of lifters in a more objective scale, for instance, Wilks score, or using encoding related to lifters' weight class. Lastly, we intended to also include analysis regarding lifters' age to encourage older people to also participate in the sport but the workload is beyond the time given. However, it would have been another main component in our visualization if time permits.

References

- [FAC20] FERLAND P.-M., ALLARD M.-O., COMTOIS A. S.: Efficiency of the wilks and ipf formulas at comparing maximal strength regardless of bodyweight through analysis of the open powerlifting database. *International journal of exercise science* 13 (04 2020). 2
- [Ope] OpenPowerLifting. <https://www.openpowerlifting.org/>. Accessed: 2022-12-01. 1

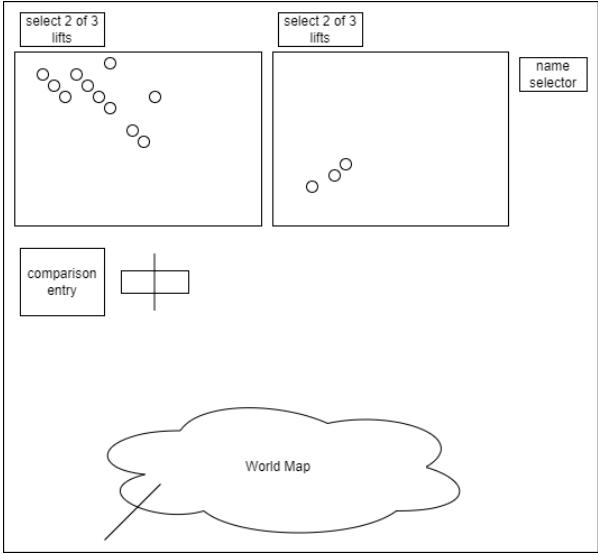


Figure 1: Visualization Sketch

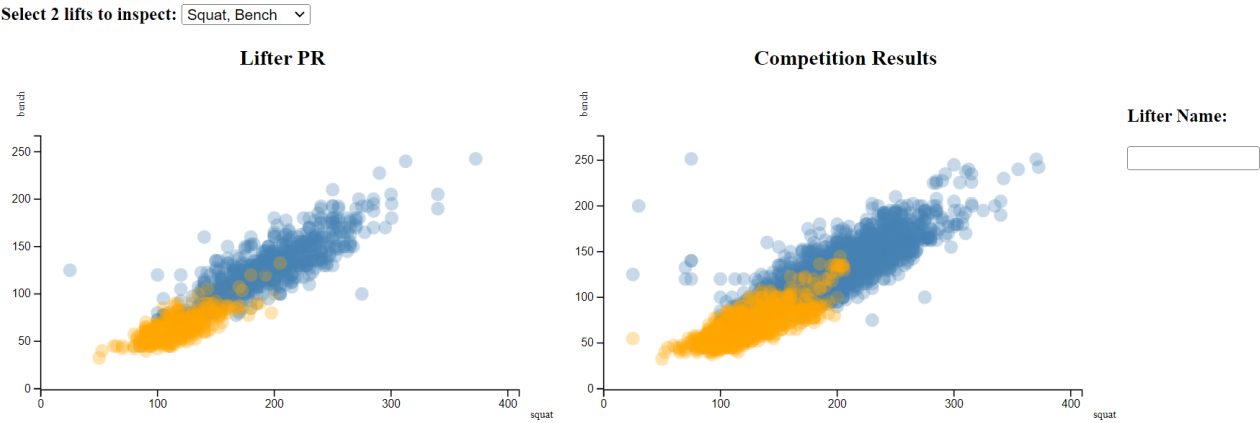


Figure 2: Scatterplot Overview

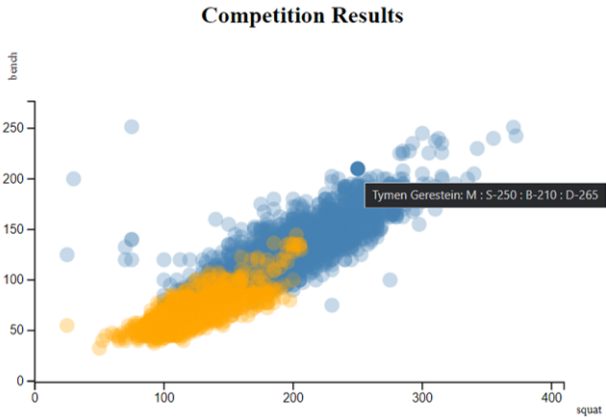
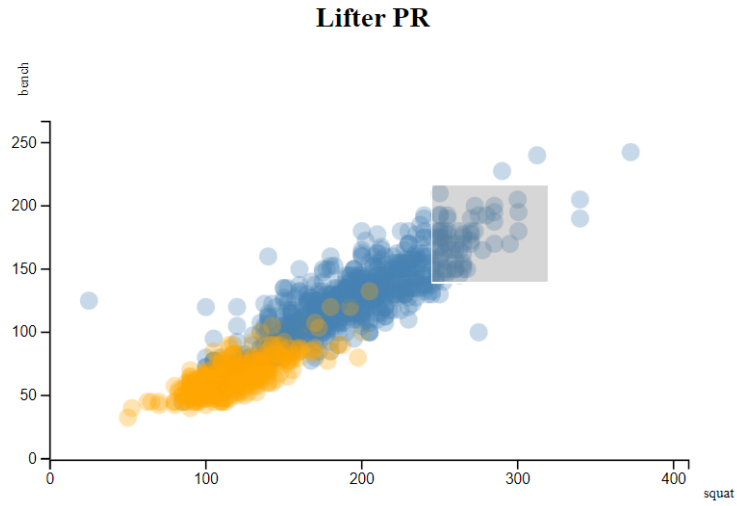
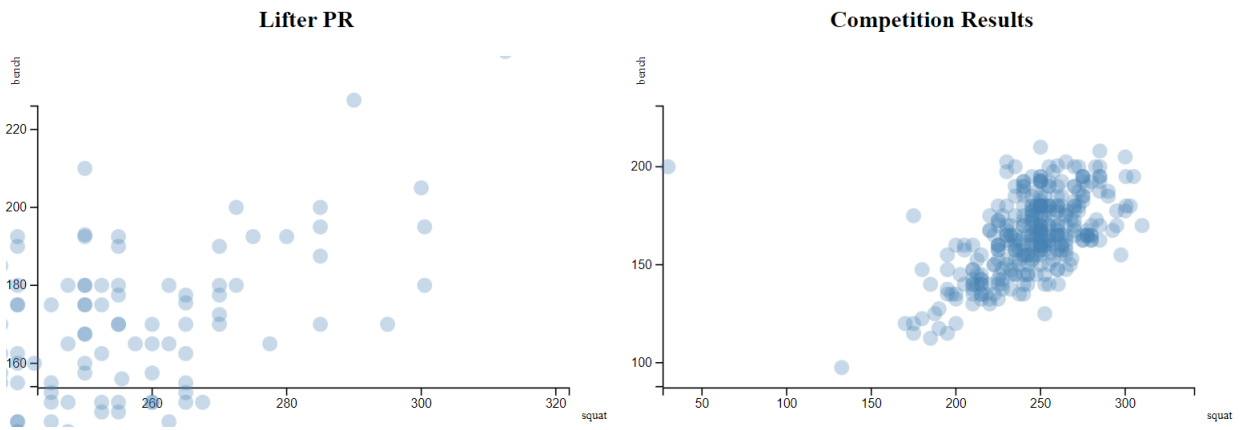
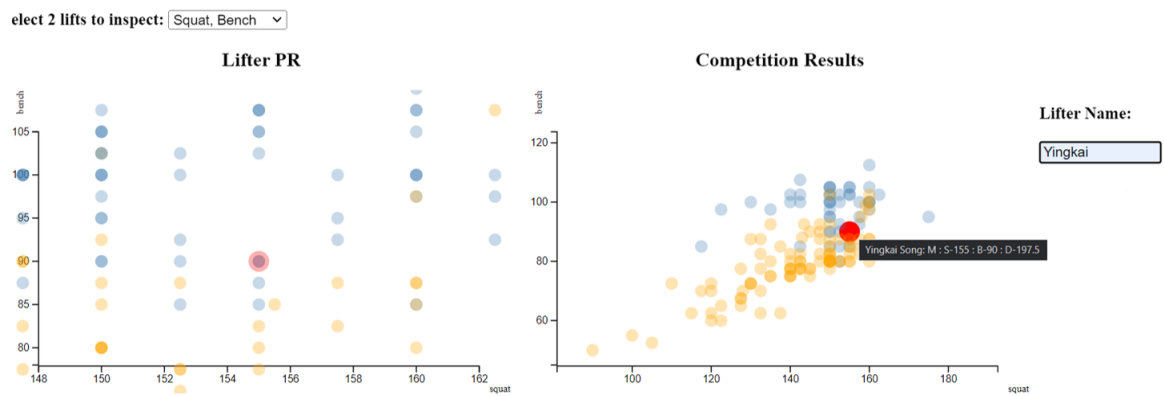


Figure 3: Lifter Information

Figure 4: *Brushing An Area*Figure 5: *A Higher Level Of Detail After Brushing*Figure 6: *Highlighted Data Points*

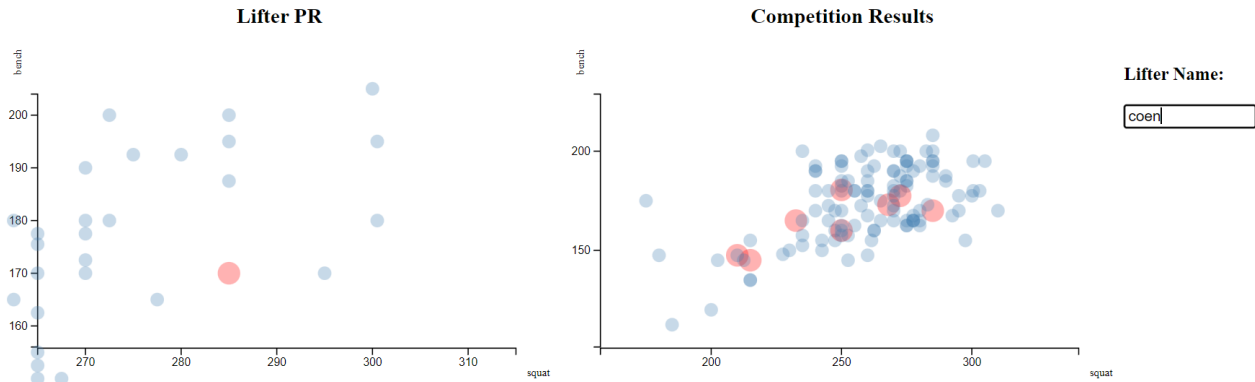


Figure 7: Performance Trend Tracing

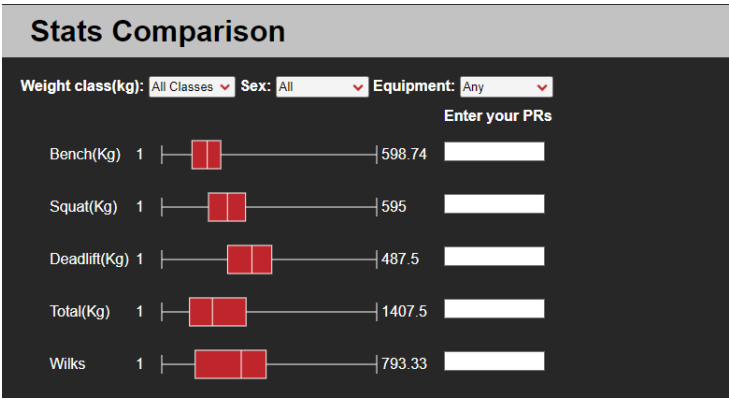


Figure 8: Boxplot General View



Figure 9: Boxplot Filtered View

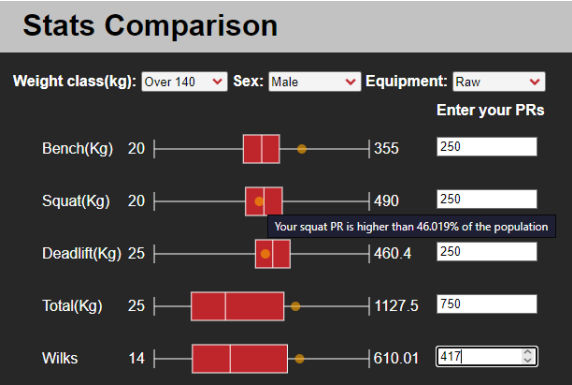


Figure 10: Boxplot View With User Entries

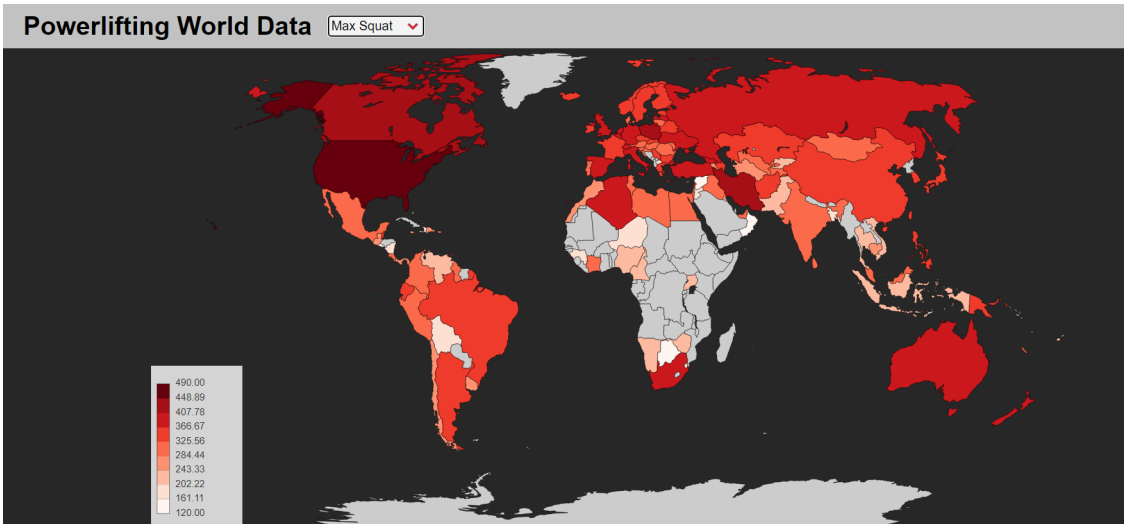


Figure 11: General World Map Showing max squat per country.

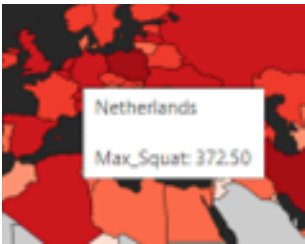


Figure 12: Tooltip for world map