Glyphs and Mosaic: Interactive Visualizations of Likert Scale Questionnaires

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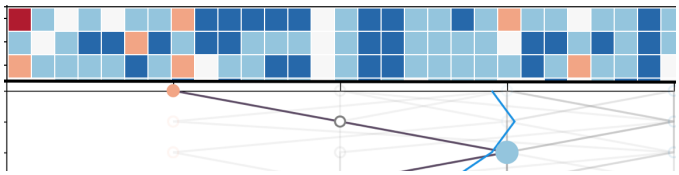

Figure 1: Mosaic/Glyph Likert scale view available at https://raphael-diana.github.io/glyph-mosaic_likert-scale/

Abstract

Being able to identify trends and connections within the answers of a Likert scale questionnaire could bring useful information to its creator. The aim of this project is to provide tools to help experts of a domain to go beyond statistical analysis while examining the results of their Likert scale questionnaire and to be able to explore the data in a more precise way. In order to do so, we researched the possibility of visually analyse this type of data and then we experimented whith a glyph-style view and a mosaic view on a data set containing results of the Cattell's 16 Personnality Factor Test found on http://personality-testing.info/_rawdata/.

1 Introduction

The aim of this project was to create visualisations for Likert scale questionnaire results.

A Likert scale is a scale used in questionnaire where the respondent is invited to answer to the question by expressing a level of agreement or disagreement with a statement (cf Figure 2). They are mostly used in psychometric questionnaire (e.g.: personality tests) and satisfaction survey.

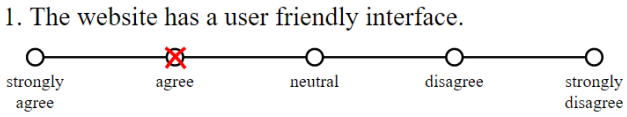

Figure 2: Likert scale example from **Wikipedia**

Likert scale mainly contains four or five items, depending on if a neutral answer is available. Those items are generally named as the ones on Figure 2 but other variants can also be found.

Visualizations depicting Likert scale questionnaires exists but for the most part they only show global trends and does not express the correlation between answers nor does represent the individual answers of the respondent.

Those visualizations can be sufficient if the user only want to answer a simple question like *"Are my customers generally pleased with the way I conduct my business ?"* where a simple statistical analysis on the questionnaire results can answer but if the creator of the survey need more details, he is rapidly out of tools.

We thought it would be interesting to try to design new types of Likert scale questionnaire results visualizations where a more detailed analysis would be possible. We wanted to make it possible for experts of a domain to be able to analyse visually the results of a questionnaire to detect answer trends (e.g.: "People that answered "strongly disagree" to question 1 globally answered "disagree" on question 15, maybe there is a link between those two questions") and see if they are correlated with respondents characteristics (e.g.: age, gender).

In order to do so we made some research on the previous work that has been done on Likert scale visualizations.

We then used the JavaScript library *D3.js* to create two different visualizations. One was designed to help the expert to detect common or uncommon answer patterns by navigating through *glyphs* and the other was designed to help the expert understand if and how the meta data collected during the tests are correlated with the answers given.

2 Related Work

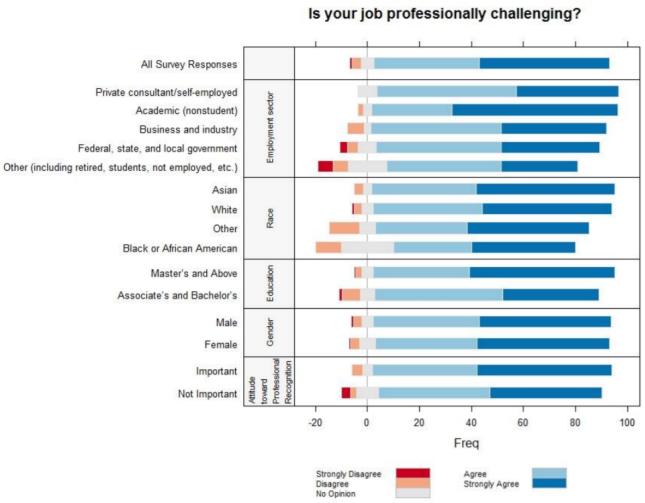

Figure 3: Stacked bar diverging graph used as example in the paper *Plotting Likert and Other Rating Scales* [2]

In a 2011 paper named *Plotting Likert and Other Rating Scales* [2], Naomi Robbins and Richard Heiberger discuss several

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types of visualization that are commonly used to represent likert scale results such as tables, pie charts, waffle chart, ribbon chart, radar chart and different types of bar charts : classics, diverging stacked and grouped.

Among all those visualizations, the authors recommend to use the diverging stacked bar charts because they offer an overall insight of the data. Those charts are composed of stacked bar chart that represent the percentage of the different possible answers for the question asked. Every bar are centred on a mark representing neutrality. Every answer above this line is positive and every answer beneath this line is negative. If there is a neutral option on the likert-scale, the part of the bar representing it is split in half around the line. Each bar represent a category of respondent.

As we can see in Figure 3, it is easy to compare the answers given by different categories of respondents.

When looking on the Internet for Likert scale visualizations, one can find that those diverging stacked bar graphs are actually very popular.

However, even if this type of graph can quickly provide an global comprehension of the questionnaire results, the data are aggregated and the number of questions represented is very limited. It is impossible to have a more detailed analysis to identify trends and links within the answers.

A different approach was presented by A. Kachkaev, J. Wood and J. Dykes, the authors of the paper *Glyphs for Exploring Crowd-sourced Subjective Survey Classification* [1].

They decided to use *glyphs* to represent the answer of a respondent in a Likert scale questionnaire. A glyph is simply a "drawing" of the answers given by a person to a questionnaire. It is made by placing the answers value of a respondent on a graph with the questions in ordinate and the possible answers in abscissa and by connecting the dots.

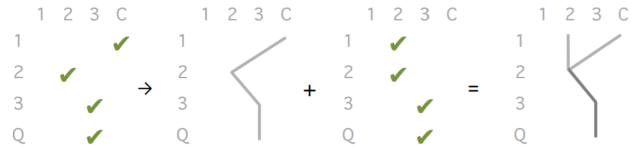

Figure 4: Example of Glyph found in the paper *Glyphs for Exploring Crowd-sourced Subjective Survey Classification* [1]

As we can see in the Figure [**?**] it is possible to stack the glyphs of different individual in the same picture. This stacked representation allow the user to see at the same time all of the answers given by an individual and by the group, to detect commons answers profiles and disagreement among respondents. A more detailed analysis is now possible.

The idea of glyph really interested us and we decided to construct one of our visualization around it.

3 Project Description

In our project we wanted to provide tools to help the user to go beyond statistical analysis and to extract interesting data from the results of his questionnaire by detecting answers patterns. For example, we wanted to be able to detect the insincerity of a respondent or see if respondents pertaining to the same categories tend to respond alike.

In order to do so, we conceived two visualizations with the JavaScript library D3, one using the glyphs presented in the previous section and one mosaic of answer values using meta data available in the data set.

3.1 Glyphs

In [Glyphs for Exploring Crowd-sourced Subjective Survey Classification] [1] the author discuss the possibility of using visual exploration when the trends are unknown at the beginning of the data analysis. The main goal of our glyph-view was to give a tool to data analysts to discover pattern in the questionnaire by selecting individual answers.

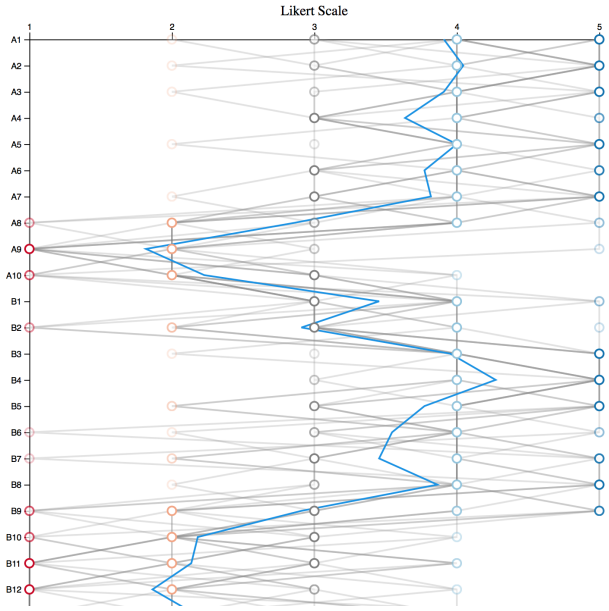

Figure 5: Glyph view

To construct the visualisation we laid our data on a grid with the Likert scale in abscissa and the question index in ordinate. For each person we traced a line crossing all his answers. This is called a *"Glyph"*. The lines are transparent and when drawn on top of each other their common parts are naturally darker and visually identifiable. The answers are represented by hollow circles. Those are coloured accordingly to a diverging colour scale correlated to the Likert scale.

We give the possibility to data-analysts of filtering their data to examine different emerging patterns. To do so they can select glyph points, then the glyphs containing the answer corresponding to the node are highlighted. We also provide some metrics about each answer. When hovering on a node, the number of glyphs crossing the node or the number of selected glyphs if there is some is display along with an anonymous identifier for each glyph.

In addition to the glyphs we also draw the mean glyph (displayed in blue) to show global trend or bias. For example a shift to one or the other end of the scale can easily be spotted. In this visualization we discard uncompleted surveys because they will not result in a continuous glyph.

3.2 Mosaic

This visualization is a mosaic. Each square represent an answer given by a respondent to a question and the colour of the square represent the answer's value. A legend is displayed to allow the user to know which colour represent which value. The questions are in ordinate and the respondent are in abscissa. The question names are displayed on their axis.

As we can see on Figure 7 the low answer's values are represented by red colours and the high values are represented with blue colours. In the data sets we used, the lowest values are associated with disagreement and the highest values are associated with agreement so

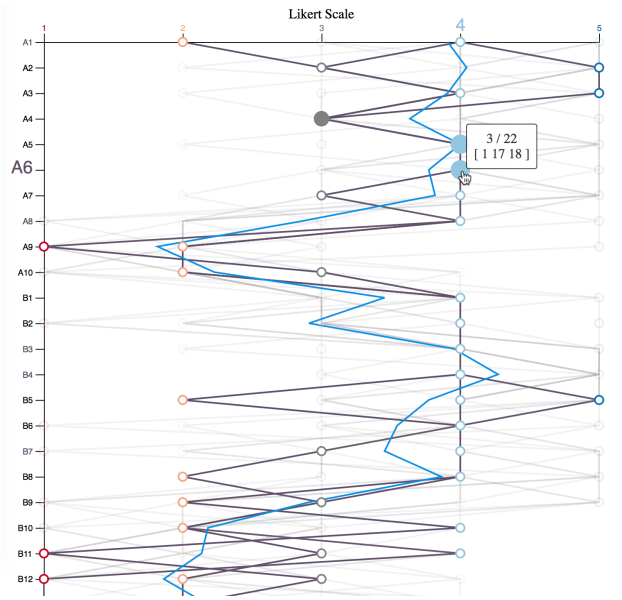

Figure 6: Glyph node selection

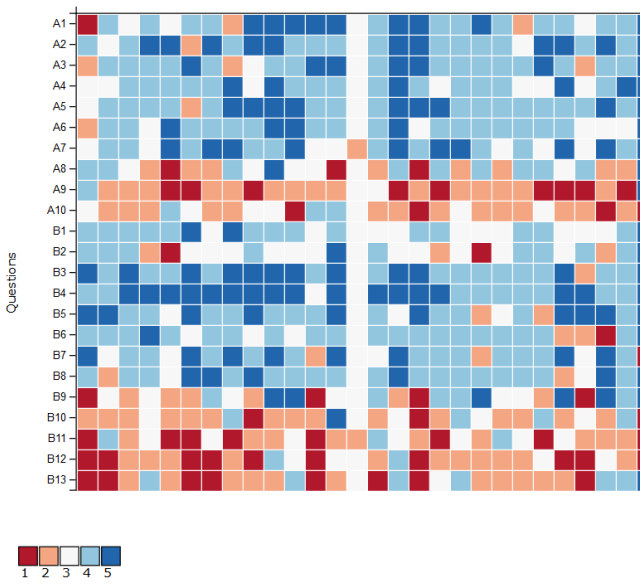

Figure 7: Squares

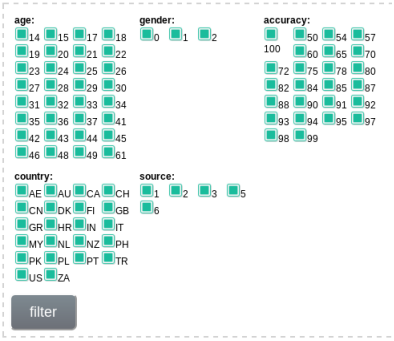

Figure 8: Filtre

we wanted to use colour commonly used to represent those concepts, red and blue. Beyond the natural signification of the colours, it makes the visualization easier to read than if we used a simple gradient of one colour.

At first, all of the answers are displayed in the mosaic but the user can choose to hide some respondent by using the filter (cf Figure8). The filter is composed with several groups of check boxes that represent the different types of meta data available for this questionnaire results. Each available value for each meta data type appear as a check box. When clicking on the *Filter* button, every respondent who have a certain meta data value for a certain meta data type is removed from the mosaic if the check-box corresponding to this value and type is unchecked. If later the filter is re-applied when those the check boxes are checked, the previously discarded individuals reappear in the mosaic.

When the user's mouse go over one of the squares, a tool-tip is displayed. It contains the identifier of a user, the question corresponding to the answer and the user's values for the various meta-data available in the data set.

The aim of this visualization is to allow the user to see general trends in the answers such as "the answer given to question B13 are mostly associated with disagreement" and to examine the answer of specific individuals at the same time. It also allow him to check whether the answer trends vary between categories of respondent.

This visualization is supposed to be a tool to help experts of a domain explore the results of a questionnaire. We tried to make it adaptable to any data sets.

The data only need to match some requirements :

- The data need to be in a csv file
- Every line of the file should represent a respondent
- Every column header representing a question have to start with "q_"
- Every column header representing a meta data have to start start with "m_"
- The file can not contains missing values
- The values of the questions columns should only represent actual answers values (we should not find a 0 representing a missing value for example)

4 Discussion

The visualizations we designed allow us to analyse the data in a more precise way, we can easily detect, for example, the respondents that gave insincere answers because they often give the same answer to all questions. However those visualizations contains several flaws.

Firstly, the data have to satisfy many requirements in order to construct our visualizations. We can only work with complete questionnaire for example. We also used only data sets from http://personality-testing.info/_rawdata/ which are all structured the same. Furthermore the requirements on the data differs between our two visualizations and they could be easier to use if they both used the same file for the same data set.

The principal flaw of our visualizations is that they are not suited for displaying a huge number of questions and/or individuals at the same time. The visualizations become to big or bear too much information and become too complicated to analyse. And because we cannot display all of the respondents at the same time, the global analysis that was possible and easy with the diverging stacked bar graph presented previously is no longer an option. It could be

interesting to combine those two visualization to have a complete view of the data.

Moreover, our visualizations are designed to be used by experts of the data who are familiar with the questionnaire, however, in order to insure that our visualizations is actually effective for the tasks we wanted to accomplish, an actual experimentation need to be conducted with experts of several domains and different questionnaires.

Finally, the answers are coloured with a red-blue scale which is well suited for Likert scale but not for other ordinal scales.

We would have like to introduce same other features to our visualizations. For example the ability to discriminate an individual's answers using some criteria or the possibility to reorder the question. It also could have been interesting to use the meta data filter directly into the glyphs visualization in order to be able to see if answers trends differs from one category of respondents to another.

5 Conclusion

After we did some research on the previous work that have been done on Likert scale results visualization, we were able to create two visualizations designed to help experts in the analysis of their questionnaires results. Even if they contains some flaws, we were able to extract interesting information from the data and we can imagine that an expert could do even more with his knowledge of the domain associated with the questionnaire. The real challenge to improve our visualization is to maximise the inclusion of the meta-data associated with the questionnaire to enable the analysis of correlation between some respondent characteristic and their answer.

References

[1] A. Kachkaev, J. Wood, and J. Dykes. Glyphs for exploring crowd-sourced subjective survey classification. *Comput. Graph. Forum*, 33(3):311–320, June 2014.

[2] R. M. H. Naomi B. Robbins. Plotting likert and other rating scales. In *2011 JSM Proceedings, Miami Beach FL, July 30-August 4*, 2011.