Design of Plots for Likert and Other Rating Scales

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Abstract

Rating scales, such as Likert scales, are very common in marketing research, customer satisfaction studies, psychometrics, opinion surveys, population studies, and numerous other fields. We recommend diverging stacked bar charts as the primary graphical display technique for Likert and related scales. We discuss the perceptual and programming issues in constructing the graphs. Many examples of plots of Likert and related scales are given. The code for diverging stacked bar charts is available in the HH package in R. The graphical presentation of Likert scale data in R can be used from the command line, from the Rcmdr menu, and from an Excel Workbook using the RExcel interface.

Key Words: diverging stacked bar charts, graphics, population pyramids, Likert scales, HH package in R, psychometrics

1. Likert Scale Data

A rating scale is a form of psychometric scale commonly used in questionnaires. Likert scales consist of choices per question from the sequence:

> Strongly Disagree, Disagree, No Opinion, Agree, Strongly Agree

Our primary data example is from an *Amstat News* article [Luo and Keyes(2005)] reporting on survey responses to a question on job satisfaction. A total of 565 respondents replied to the survey. Each person answered one of five levels of agreement or disagreement with the question "Is your job professionally challenging?"

Table 1: The respondents have been divided into five employment categories. The rows (employment categories) are displayed in the original order: alphabetical plus other. Columns are displayed sequentially, with disagreement to the left and agreement to the right.

Is your job professionally challenging?				
Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
Employment Sector				
Academic (nonstudent)	0	5	8	78	162
Business and industry	0	11	5	88	72
Federal, state, an local government	2	3	5	34	27
Private consultant/self-employed	0	0	2	15	11
Other (including retired, students, not employed, etc.)	2	2	5	15	10

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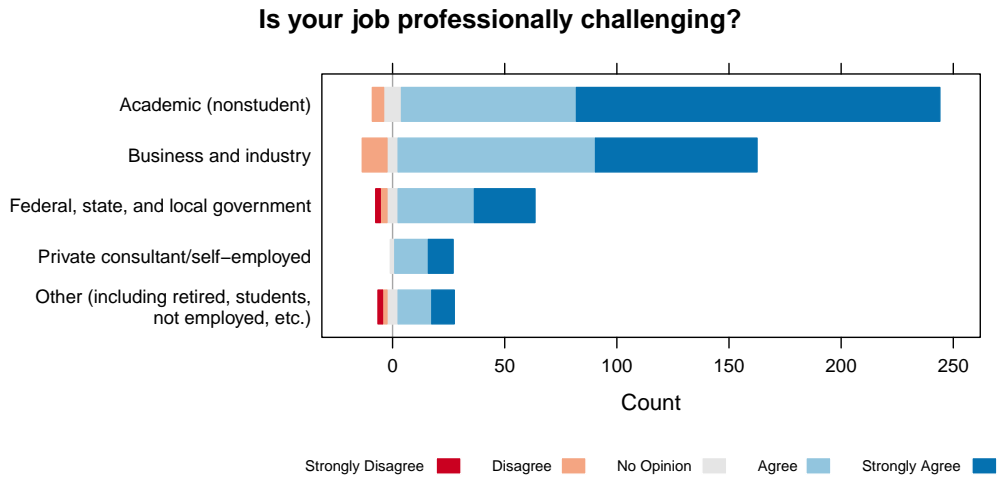## 2. Counts

Is your job professionally challenging?

Figure 1: This plot is a direct translation of the counts in Table 1 to graphical form. Blue is agree, red is disagree, gray is no opinion. The strongest message in this presentation is that the sample has a very large percentage of academics.

3. Row Percents
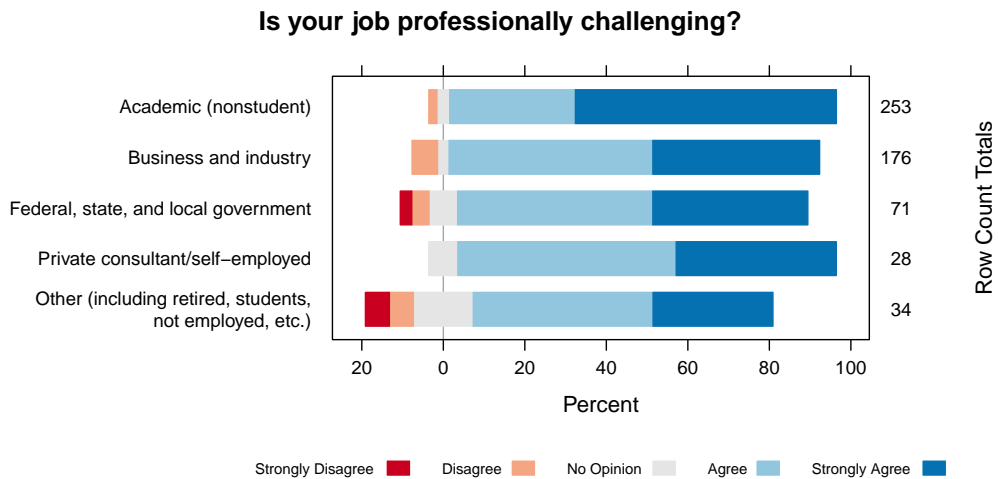
Is your job professionally challenging?

Figure 2: In this variant of the plot, we display the row percents. We don't want to lose the uneven selection of respondents from the employment sectors so we display the counts as the right axis labels. Now we see that "Academic (nonstudent)" stands out as the largest percentage of dark blue on the graph. Now it is easy to see that a large majority of the people in all employment categories have a positive answer to the survey question.

4. Row Percents, Sorted by Total "Percent Agree"

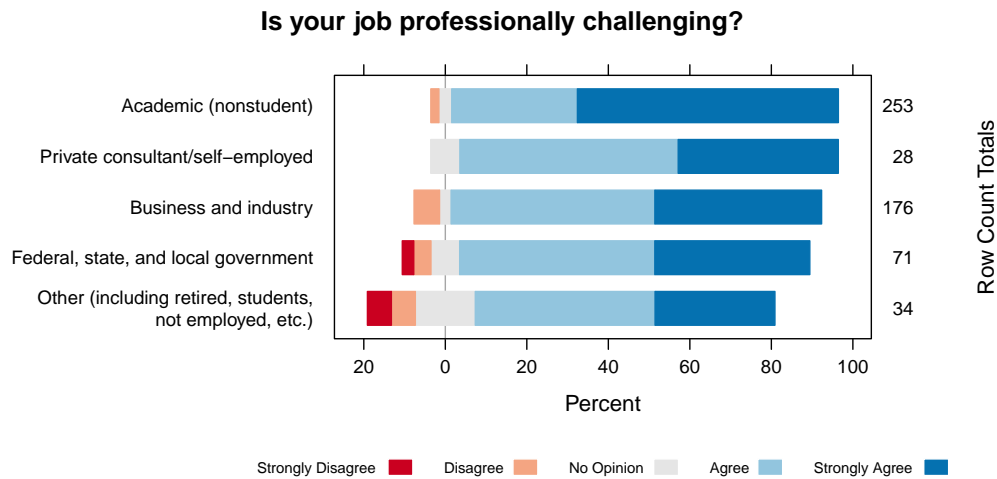**Is your job professionally challenging?**

Figure 3: We can still do better. In our third presentation of the same table, we sort the rows of the table by the total percent agree (dark blue + light blue + $\frac{1}{2}$ gray). Data-dependent ordering is usually more meaningful than alphabetical ordering for unordered categories.

5. Plots with Multiple Panels

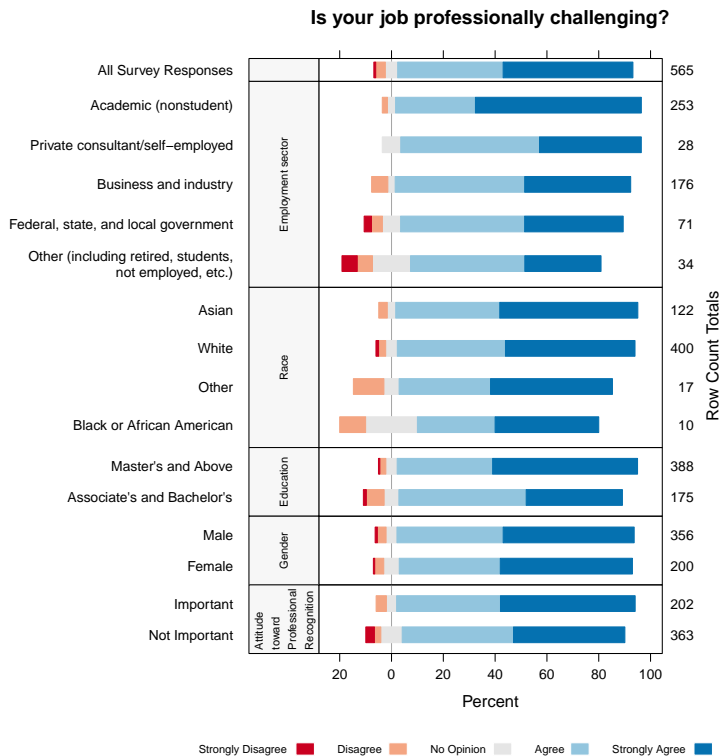**Is your job professionally challenging?**

Figure 4: The full survey report displayed the responses for the same respondents partitioned into several series of groups based on characteristics in addition to employment. The partitions have different numbers of groups. In order to retain the same vertical spacing between parallel bars, the vertical space allocated for the panels must differ. Within each panel the bars have been sorted by the total percent of positive responses.

Table 2: Features of `plot.likert` diverging stacked bar chart.

1. centered at 0, with reference line at 0

2. symmetric intensity of colors in each direction

3. sort by right-hand side (optional)

4. parallel one-dimensional bars for each question

5. reference line placed behind bars so that the neutral group is not artificially split

6. the default color palette is accessible to those with color vision deficiencies

7. user control of color palette

8. counts or percents can be plotted

9. bar heights can be specified

10. multiple panels can be coordinated

11. vertical bars are optionally available

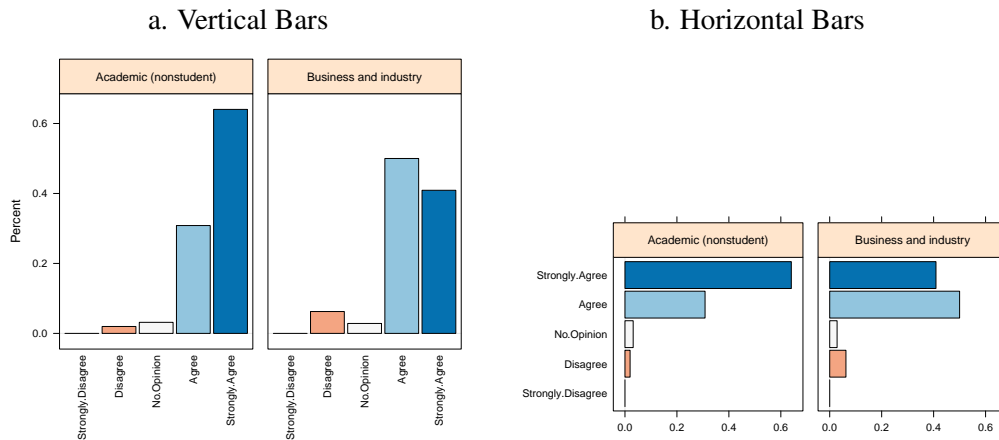## 6. Less Good Displays for Likert-Style data — Grouped Bar Charts

a. Vertical Bars

b. Horizontal Bars

Figure 5: The grouped bar chart facilitates comparisons of the various levels of agreement within an employment sector. It doesn't emphasize the comparison of employment sectors. Vertical bars have difficult to read x-tick labels. Horizontal bars permit a single set of y-tick labels on the left.

7. Less Good Displays for Likert-Style data — Heatmaps

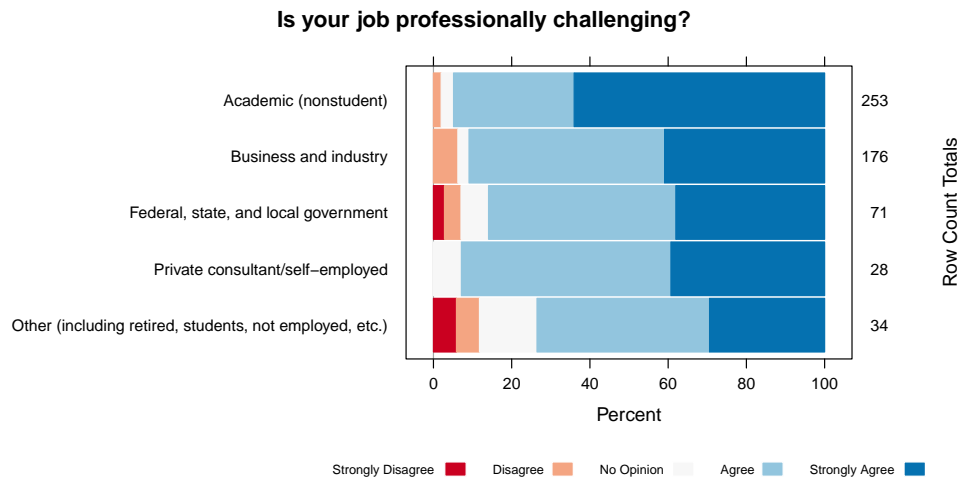**Is your job professionally challenging?**

Figure 6: This heatmap is a divided barchart. It can be drawn as if it were a stacked barchart with the reference line at the left edge. We don't think it works well for Likert-type data because aligning at the left edge hides the fundamental comparison of "Percent Agree" with "Percent Disagree".

8. One or more subpopulations with multiple questions

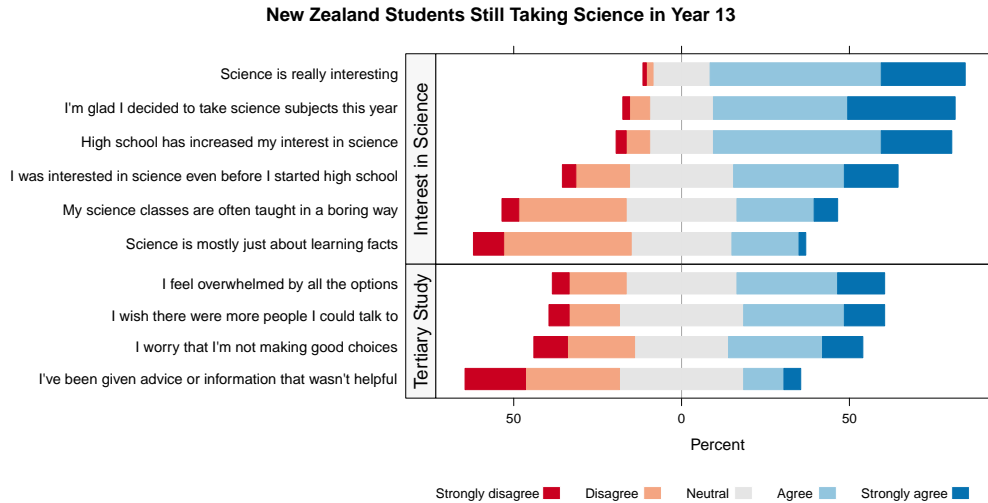**New Zealand Students Still Taking Science in Year 13**

Figure 7: This plot shows responses to a survey on science education sponsored by the New Zealand Ministry of Research Science and Technology [New Zealand Ministry of Research Science and Technology(2006)]. Two sets of questions, six in the first set and four in the second set, have been asked of all respondents. Each set is presented in its own panel.

9. Population Pyramids
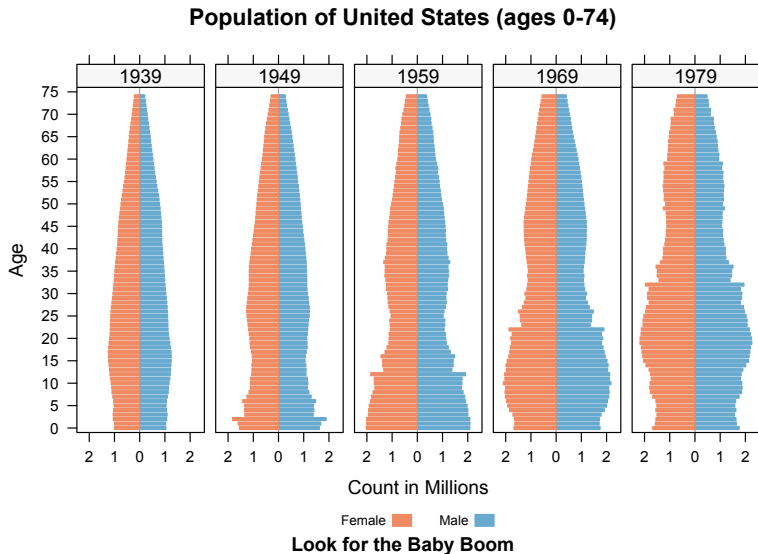
Population of United States (ages 0-74)

Figure 8: We display the population pyramid as a Likert-type scale with two levels, female and male, for each age range. We can see the bulge representing the baby boom start at the bottom of the population graph for 1949 and work its way up over time. The data is from [Sarkar and Andrews(2011)].

10. Economic Policy

Presidential candidate Newt Gingrich made the claim, "Really poor children in really poor neighborhoods have no habits of working and have nobody around them who works." This claim is easily refuted by looking at the data. We [Heiberger and Robbins(2011)] constructed Figure 9 based on US Census data as a revision of [Blow(2011)].
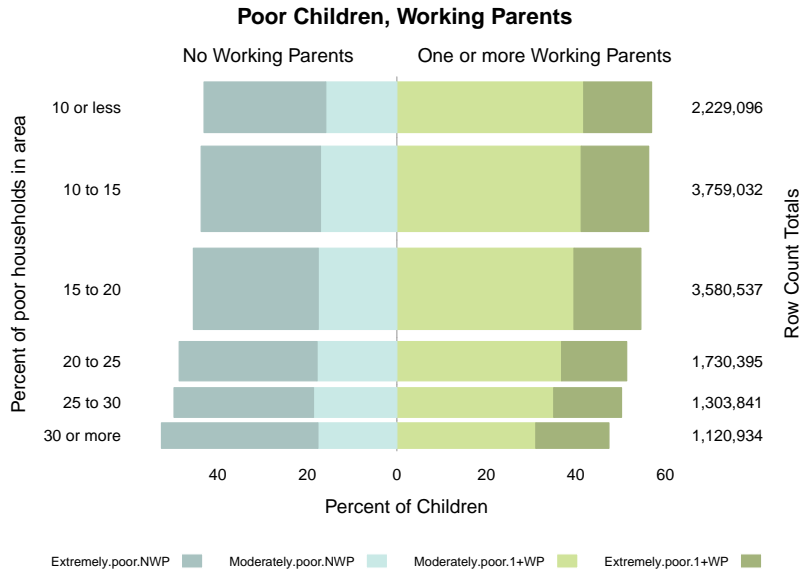

Figure 9: Bars have variable heights, proportional to the number of children in the areas they represent. Each bar shows by its color split the proportions of extremely and moderately poor children by the number of working parents.
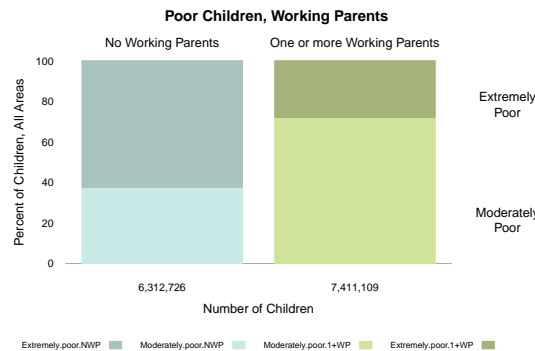

Figure 10: Summarized information from Figure 9. Bars have variables widths, proportional to the count of children they represent. Each bar shows by its color split the proportion of extremely poor children by the number of working parents. Here the two principal messages are: (a) Most poor children have working parents, and (b) children with working parents have a smaller percent of extreme poverty than children without working parents.

11. One-directional Scales

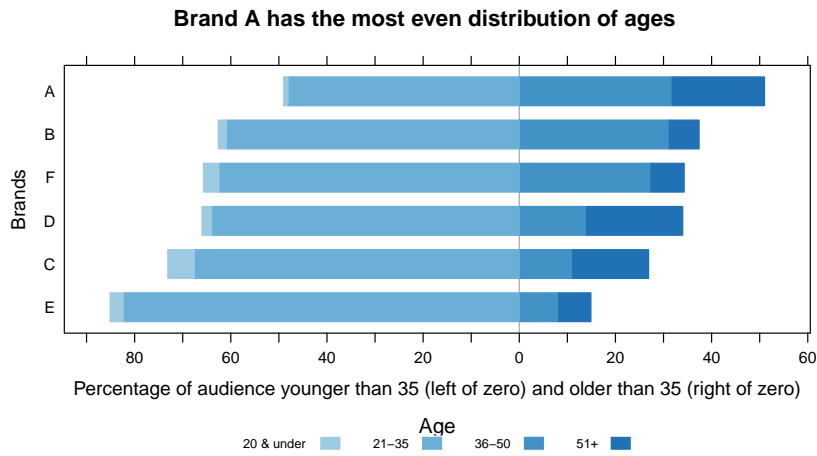**Brand A has the most even distribution of ages**

Figure 11: This data is from a recent study designed to compare the percentage of the target audience younger than 35 to the percentage older than 35. Therefore the common baseline for the bars is set to age 35. The brands are ordered by the percent of the audience older than 35. Since age is always positive and increases in a single direction, we use colors from a sequential palette for the age groups.

12. Conclusions

Diverging stacked bar charts provide an effective way to communicate summaries of data collected with Likert and other rating scales. We illustrate examples, using both single-panel and multiple-panel plots, for data from several fields. These charts are also useful for a number of applications in addition to rating scales, for example, age scales and population pyramids.

We showed and discussed two less-good displays of Likert-scale data. We have illustrations of several other less-good displays in our [Robbins and Heiberger(2011)].

Diverging stacked bar charts can be created in a number of software environments. The HH package [Heiberger(2011)] for R [R Development Core Team(2011)] includes a `likert` function to enable plotting of diverging stacked bar charts. It uses S3 methods to be responsive to the structure of the data. The `likert` function is built on the `barchart` function in the lattice [Sarkar(2012)] package.

We also provide a dashboard [Robbins(2011)] in Tableau [Tableau Software(2011)] using Gantt charts.

Diverging stacked bar charts are a useful addition to your graphical toolbox no matter what software you use.

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