

# Responsive Data Visualisation

Keith Andrews<sup>1</sup> and Aleš Smrdel<sup>2</sup>

<sup>1</sup>Institute of Interactive Systems and Data Science (ISDS), Graz University of Technology, Austria

<sup>2</sup>Faculty of Computer and Information Science, University of Ljubljana, Slovenia

## Abstract

*In responsive web design, web pages are assembled from flexible components which adapt to the characteristics of the display device. For web pages to be truly responsive, any charts or visualisations embedded within them must themselves be responsive. This paper looks at the principles of responsive web design as applied to web-based information visualisations. Approaches are presented through which four commonly used visualisations (line chart, bar chart, parallel coordinates, and scatterplot) can be made responsive.*

Categories and Subject Descriptors (according to ACM CCS): H.5.2 [Information Interfaces and Presentation]: User Interfaces—Graphical user interfaces (GUI) H.3.5 [Information Storage and Retrieval]: Online Information Services—Web-based Services

## 1. Introduction

Responsive web design is a powerful new approach to designing web sites. Rather than designing and maintaining separate web sites for different types of device, a single design under a single URL adapts (responds) to the characteristics of the end user's device. In order to implement responsive web pages in a meaningful way, the various chunks of content such as blocks of text, tables, images, videos, ads, etc. must be able to adapt both to the available screen space and other device capabilities such as touch interaction, motion events, ambient light, and so forth. Charts, graphics, and visualisations are important content components, which need to be inherently responsive in order to support the responsive web design paradigm.

## 2. Responsive Visualisations

*Scalable* visualisations freely scale to fit the available screen space, but their basic appearance remains the same. Scaling can be implemented in many ways, both with or without skewing, for example by using relative units (rems or ems) rather than pixels. *Responsive* visualisations, on the other hand, go further:

- *Responsive Layout*: the visualisation changes its appearance or form at specific breakpoints (for example, a bar chart switching from vertical to horizontal bars at smaller viewport widths), as well as freely scaling between breakpoints.
- *Responsive Display Density*: The visualisation takes account of the display density, for example by sampling (important) data points for lower resolution displays.
- *Responsive Interaction*: the visualisation provides selective support for touch (tap, swipe, pinch zoom), keyboard, mouse, motion events, etc.

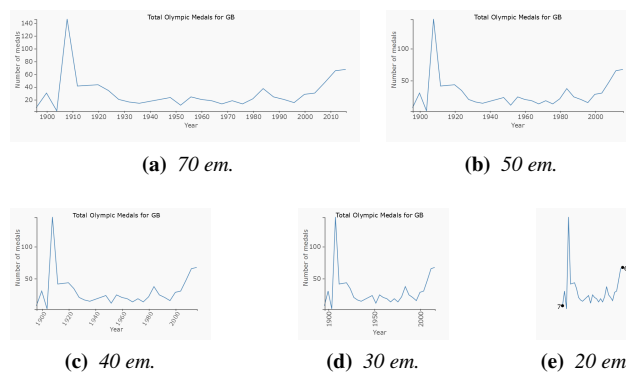


Figure 1: A responsive line chart.

In essence, a responsive visualisation contains logic within itself so that it can adapt to specific display constraints and opportunities. Web-based visualisations can be made responsive using either JavaScript or the ability to embed CSS3 media queries inside SVG.

### 2.1. Responsive Line Chart

A line chart can adapt to its display width in a number of ways. Tick marks and labels on the *x* axis can be thinned out. Tick labels can be rotated or abbreviated if less space is available. At the narrowest widths, the axes can be removed entirely, producing a sparkline. Figure 1 shows the same line chart at widths of 70, 50, 40, 30, and 20 ems. If very many data points are available for the line chart, the

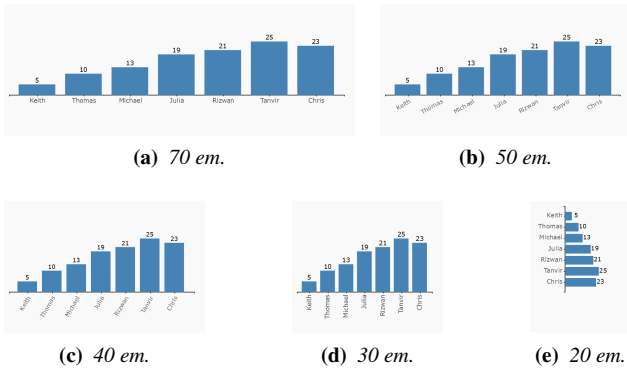


Figure 2: A responsive bar chart.

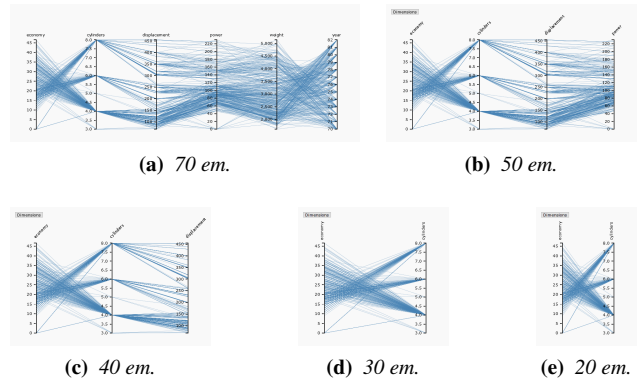


Figure 3: A responsive parallel coordinates visualisation.

data itself can be downsampled to an appropriate density (taking care to preserve important landmark data points).

### 2.2. Responsive Bar Chart

Bar charts (assuming vertical bars) can be made freely scalable by scaling the width of the individual bars between a maximum and minimum value. Bar charts can be made responsive in a similar way to line charts. Labels on the x axis can be rotated or abbreviated. At the narrowest widths, the bar chart can be flipped (rotated) 90°, so that vertical bars become horizontal bars, utilising vertical space to accommodate however many bars are present. Figure 2 shows a bar chart at widths of 70, 50, 40, 30, and 20 ems.

### 2.3. Responsive Parallel Coordinates

A parallel coordinates visualisation is usually displayed with the data dimensions spaced as vertical parallel lines. Fluid scaling can be achieved by smoothly decreasing the separation between the dimensions and possibly rotating the dimension labels. However, at very narrow widths, it might be preferable to selectively display only some of the available dimensions. This is shown in Figures 3 and 4. As soon as one or more dimensions are not displayed, a button “Dimensions” is shown, so that the user can override the default choice of which dimensions to display and which to hide. An alternative approach would be to flip the parallel coordinates visualisation by 90° at narrow widths, so that it extends vertically rather than horizontally.

### 2.4. Responsive Scatterplot

Scatterplots are particularly difficult to make responsive because of issues of occlusion of data points when display space is limited. Filtering and zooming (pinch zooming on touch devices) are essential. Additional methods of disambiguation, such as fisheye and Cartesian distortion and temporary displacement can also be extremely useful. Figure 5 shows a responsive scatterplot with a fisheye lens.

### 3. Related Work

Hinderman [Hin15] describes how to make visualisations scalable. Körner [Kör16] also covers some of the issues in making visualisa-

tions responsive. Le Bek [Le 14] discusses aspects of responsive line charts including point sampling to reduce data density. Examples of responsive bar charts include Nagle [Nag14] and ORF [ORF13]. Responsive scatterplots are discussed by Florit [Flo13], Kissane [Kis13], and Meeks [Mee14]. Touch interactions for visualisations are described by Diakopoulos [Dia13].

### 4. Acknowledgements

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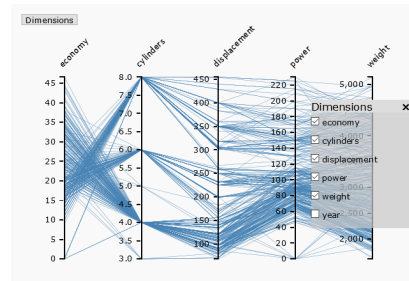


Figure 4: Responsive parallel coordinates with dimensions chooser.

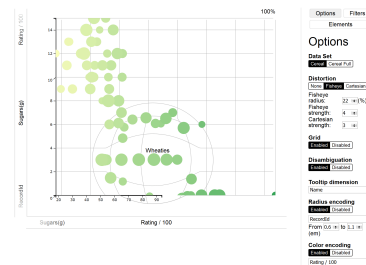


Figure 5: Responsive scatterplot with fisheye lens.

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