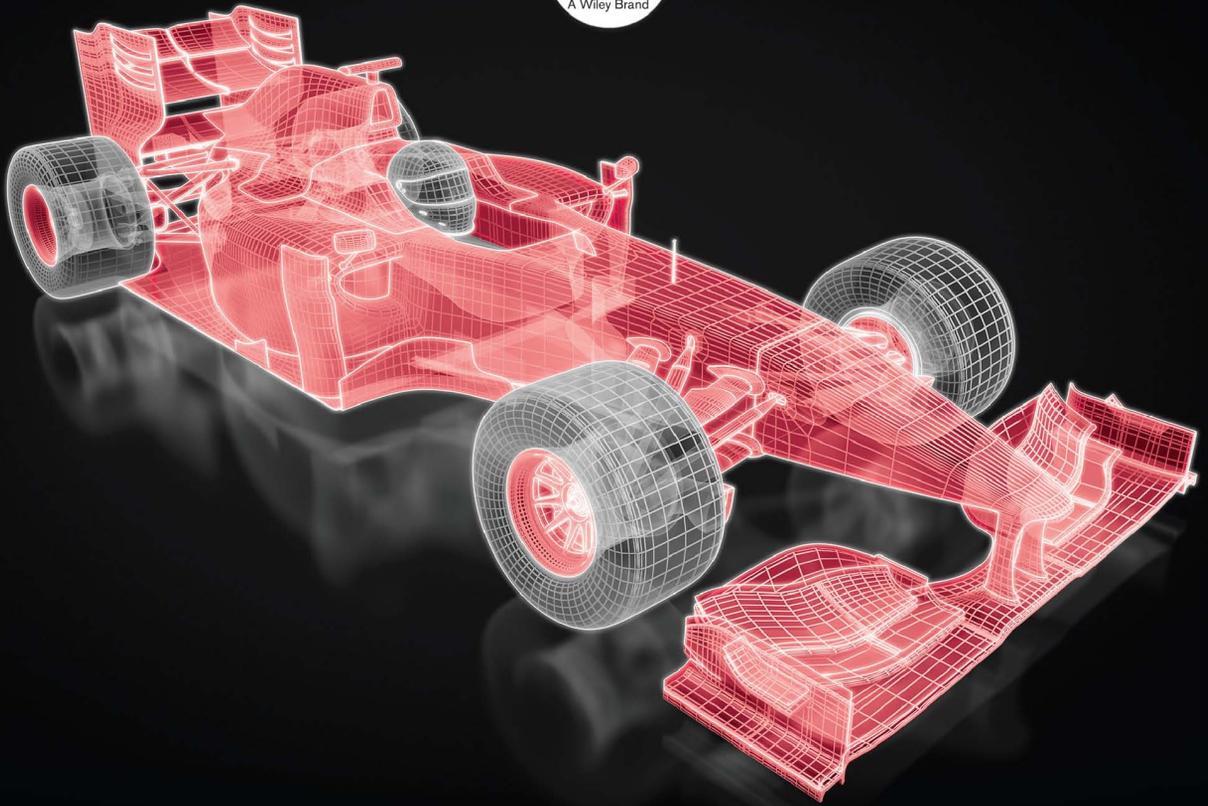


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# JavaScript<sup>®</sup> and jQuery<sup>®</sup>

## for Data Analysis and Visualization

Jon Raasch, Graham Murray, Vadim Ogievetsky, Joseph Lowery



# **JavaScript<sup>®</sup> and jQuery<sup>®</sup> for Data Analysis and Visualization**



# JavaScript® and jQuery® for Data Analysis and Visualization

Jon J. Raasch  
Graham Murray  
Vadim Ogievetsky  
Joseph Lowery



# JavaScript® and jQuery® for Data Analysis and Visualization

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*To Ally and Kaiya. You brighten all my days.*

—GRAHAM MURRAY

*For Annie*

—VADIM OGIEVETSKY

*To Whic, Granger, Charisma, Surley, Two-Gun, FEM,  
and especially Rafe. See you soon, guys.*

—JOSEPH LOWERY

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—JON J. RAASCH

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—GRAHAM MURRAY

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—JOSEPH LOWERY



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# INTRODUCTION

**WHEN IT COMES TO THE WEB**, you may have heard the expression “Content is king.” Coined by Bill Gates in the 1990s, this oft-repeated mantra stresses the importance of information above all else. Think about it: The average user doesn’t visit your site to admire a beautiful design or cool animation—she goes there for content. In that sense, everything we do as web professionals—whether it’s design, development, or marketing—has a single goal: conveying information to the user.

And what better source of information is there than raw data? That said, raw data by itself is nothing more than static noise. Data visualization allows us to bridge that gap, turning raw data into meaningful content.

At this point, you’ve probably gathered that data visualization is a lot more than flashy widgets to impress your boss. Although this book does cover some impressive tools—such as the comprehensive D3 library—the focus at all points is on the information. At a minimum, data visualization conveys this information to the user. But you’re going to go deeper than that. That’s because data visualization is capable of so much more; in addition to conveying information, data visualization analyzes information to provide meaningful insights.

Good data visualization doesn’t just aggregate data into more digestible chunks. Good data visualization leads users to powerful conclusions. It shows rather than tells, and in our experience there is no better way to get your point across. There’s just no substitute for leading users to a conclusion they can then draw for themselves.

## WHAT’S IN THIS BOOK

*JavaScript and jQuery for Data Analysis and Visualization* starts off in Part I with a broad discussion of data visualization. It discusses the current state of data visualization and its general goals, and then it covers some of the basic tenets of analysis. Part I closes with an overview of some of the technical foundation that you need to understand the rest of the book, such as the basics of HTML5 canvas and SVG.

Part II takes you into the realm of data analysis and acquisition. It discusses techniques for pulling data from a server and even covers how to combine stored data with form data from the user. Next, it covers data validation as well as techniques for displaying tabular data. Part II wraps up with a discussion of client-side analysis tools, providing a robust statistical analysis toolkit that’s based in JavaScript.

Part III explores actual data visualization tools, and in all likelihood it’s going to be your favorite part of this book. You’ll start off by running through basic charting solutions such as Google Charts. From that point, the book gets into more complex charting options—covering how to build custom solutions with Raphaël as well as how to use the D3 library. Finally, you learn all about more specific data-visualization applications, such as geographic and stock data.

Last but not least, Part IV consolidates everything you learned in Parts I through III with a couple of real-world examples. You first see how to build an interconnected dashboard that renders U.S. Census data using Google Charts and then you see how to use D3 in production to create reusable visualizations.

## WHO THIS BOOK IS FOR

This book is geared toward web developers with a basic understanding of front-end development. Although you don't need to have advanced skills in this realm, you should have at least a beginner's level of knowledge of JavaScript and jQuery. Beyond that, we make no assumptions of your skill level. We cover data visualization tools from the ground up, as well as some of their underlying technologies. Whenever possible, we point you to external resources to further support your knowledge in these areas. That way, we can cover the basics quickly and move on to the more and impressive parts of data visualization.

By the end of the book, you'll have advanced knowledge of a variety of data visualization tools and techniques. This book will provide you with a comprehensive toolkit to handle all your visualization needs.

## CONVENTIONS

To help you get the most from the text and keep track of what's happening, a number of conventions are used throughout the book.

**WARNING** *Warnings hold important, not-to-be-forgotten information that is directly relevant to the surrounding text.*

**NOTE** *Notes indicate notes, tips, hints, tricks, or and asides to the current discussion.*

As for styles in the text:

We *highlight* new terms and important words when we introduce them.

We show filenames, URLs, and code within the text like so: `persistence.properties`.

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We use a monofont type with no highlighting for most code examples.

We use bold to emphasize code that's particularly important in the present context or to show changes from a previous code snippet.

## COMPANION WEBSITE

To complement the content in this book, we've also created a companion website at [www.wrox.com/go/javascriptandjqueryanalysis](http://www.wrox.com/go/javascriptandjqueryanalysis). This website provides a variety of useful resources, such as downloads of all the code examples in the book. It's a useful place to turn if you get stuck at any point.

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# PART I

# The Beauty of Numbers Made Visible

---

- ▶ CHAPTER 1: The World of Data Visualization
- ▶ CHAPTER 2: Working with the Essentials of Analysis
- ▶ CHAPTER 3: Building a Visualization Foundation





# 1

## The World of Data Visualization

### WHAT'S IN THIS CHAPTER

---

- Overview of chart design options
- Comparison of different business applications for data visualization
- Rundown of technological advancements that have made data visualization what it is today

When thinking about data visualization, it's hard to resist the comparison to natural metamorphosis. Consider raw data as the caterpillar: functional, multi-faceted, able to get from here to there, but a little ungainly and really appreciated only by a select few. After data is transformed via visualization, it becomes the butterfly: sleek, agile, and highly recognizable to the point of inspiring and evoking an emotional response. The world of data visualization is an ecosystem unto itself, constantly spawning new nodes of details that—under the proper nourishing conditions—evolve into relatable depictions that consolidate concepts into an understandable, and hopefully compelling, form.

And where does the web professional fit in this metaphor? Why, they are the spinners and caretakers of the cocoon that transforms raw numbers into meaningful representation, of course. Putting the linguistic paraphrasing aside, web designers and developers are a vital component in visualizing data. Naturally, the current and evolving technological landscape has made this role possible—and increasingly efficient.

Overall, *JavaScript and jQuery for Data Analysis and Visualization* serves as a practical field guide to the robust world of data visualization, from the acquisition and nurturing of data to its transfiguration into the optimal visual format. This chapter is intended to provide an overview of the present environment, highlighting its capabilities and limitations and discussing how you, the web professional, are a key player in visualizing data.

## BRINGING NUMBERS TO LIFE

Appreciating numeric data can be a challenge. Data visualization with relational graphics and evocative imagery helps make raw data meaningful. But before you can transform the data into a meaningful representation, you have to get it first.

### Acquiring the Data

The data sphere is enormous and growing dramatically, if not exponentially, every day. Data is streaming in from everywhere—and when you consider that the Mars Rover, Curiosity, continually sends its data findings back to Earth, you understand that “everywhere” is no exaggeration.

With the tremendous amount of data already available, its acquisition is often just a matter of logistics. If the information is in a non-digital form—that is, written records—it will need to be transcribed into the proper format. Should the desired data be accessible digitally, it may need to be converted from its current structure to one compatible with the display or visualization application.

When your information is in the proper format, you next need to ensure it is exactly the data you need and nothing more. The wealth of data available today makes targeting your data selection, typically through a process known as *filtering*, pretty much a requirement in all situations. Even when organizations fine-tune their data input from the beginning, changes in the sample or desired output over time will force a filtering adjustment.

Why is it so important to restrict your data stream? One clear reason is processing efficiency. Working with an overload of unnecessary information increases application execution time—which corresponds directly to increased bandwidth and, thus, costs. Additionally, filtering makes raw data more meaningful. Focused information is easier to analyze and also more easily digested by end users.

### Visualizing the Data

In a sense, the most difficult aspect of data visualization is deciding exactly how the information should be depicted. The web designer must select the optimum representation that communicates the data in the clearest, most desired manner with the highest degree of impact. More importantly, the representation should be a discovery tool that leads the user to meaningful insights. Here’s an incomplete list of available formats:

- Area chart
- Bar chart
- Bubble chart
- Candlestick chart
- Column chart
- Donut chart
- Flow chart
- Funnel chart

- Gauge chart
- Geographic chart
- Heat map
- Hierarchical edge bundling
- Infographics
- Line chart
- Marimekko chart
- Network node map
- OLHC (Open-high-low-close) chart
- Org Chart
- Pareto chart
- Pie chart
- Polar chart
- Scatter chart
- Sparkline chart
- Timelines
- Tree Maps
- Word cloud

We've really just scratched the surface with ways data can be presented. Most of these formats can be shown in either 2D or 3D. You can include interactive elements and animation to add dimensions to the data. But be careful to balance these bells and whistles with meaningful data. No amount of eye candy is worth compromising the representation of information.

**NOTE** *It's important to realize that a key factor in visualization is intent. Raw data on almost every subject can be interpreted in any number of ways. What message is intended to be communicated should be among the first decisions made when beginning the process of representing data visually.*

There are other primary options to consider as well. Do you expose the underlying data or not? If so, are the numbers always visible or are they visible only when some interaction occurs, such as when the viewer's mouse hovers over a data point? Is the initial visualization all there, or does the online version allow the user to drill down for more details? Is animation used to represent a dynamic change? Is there other interactivity available, such as horizontal scrolling along a timeline or zooming into it?

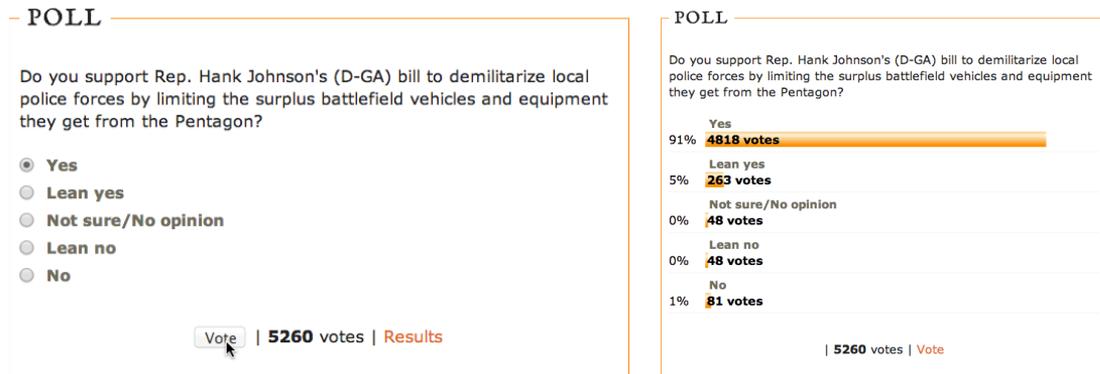
Then, of course, there is styling. With simple bar and pie charts, you'll not only need to decide which colors represent which elements, but also the size, color, style, and font to be applied for labels and legends, if any—yet another choice. Many such selections will be governed by other factors, such as the creating organization's branding or in-house standards; however, just as many will have no such foundation to work from, and the designer's vision will become paramount.

Moving beyond the basics of charting primitives, the visualization designer can choose to include graphics. Not only can background images frame a presentation—both literally and thematically—but symbols can be used as data points, like logos pinned in a map of third-quarter sales. An entire field of data visualization—infographics—is devoted to the combination of information and visual imagery.

The truth is that the web professional's current options for depicting data are a bounty of riches. Although the possibilities may appear to be overwhelming, it's up to the visualization designer to identify the optimum representation and bring it into reality.

## Simultaneous Acquisition and Visualization

The world of data visualization doesn't just consume existing data: New data is constantly being added to the stores, even in real time. Information can be collected directly through an HTML form on a website and incorporated into the representation programmatically. One of the most common examples of this is an online poll, such as the one shown in Figure 1-1. After a site visitor has chosen his or her desired response and clicked Vote, the current relative standing of all entries, including the one just entered, is displayed.



SOURCE: WWW.DAILYKOS.COM/STORY/2014/08/18/1322337/-CHEERS-AND-JEERS-MONDAY

FIGURE 1-1: Some polls allow the user to instantly see the current results.

Collecting live data has a number of challenges, but the recent advances made by the widespread acceptance of HTML5 have ameliorated many of them. When combined with a few key JavaScript