



# The Use of Data Visualization in Government



# The Use of Data Visualization in Government

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# Foreword

On behalf of the IBM Center for The Business of Government, we are pleased to present this report, *The Use of Data Visualization in Government*, by Genie Stowers, Professor of Public Administration, School of Public Affairs and Civic Engagement, San Francisco State University.

The concept of visualization recalls a pivotal scene in the movie *A Beautiful Mind* which showed the protagonist, mathematician John Nash, looking at an expansive table of numbers. Slowly, certain numbers seemed to glow, suggesting that Nash was perceiving a pattern among them, though no other researcher had been able to draw any meaning from the table.

For most people, however, a table of numbers is not intrinsically meaningful. Think of the most prosaic example: a spreadsheet. Since their early days, spreadsheet applications have offered tools that allow users to create graphics of all sorts from their tables, the better for people to understand exactly what the data are showing. Pie charts, bar graphs, and three-dimensional line charts are the barest tip of the visualization iceberg that has developed in the wake of the big data explosion. In fact, some designers use icebergs for data visualization (and others use explosions to visualize big data).

The best visualizations help viewers understand not only the data, but also their implications. This report contains numerous examples of visualizations that include geographical and health data, or population and time data, or financial data represented in both absolute and relative terms—and each communicates more than simply the data that underpin it.

In addition to these many examples of visualizations, the report discusses the history of this technique, and describes tools that can be used to create visualizations from many different kinds of data sets. Government managers can use these tools—including Many Eyes, Tableau, and HighCharts—to create their own visualizations from their agency's data.



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The report presents case studies on how visualization techniques are now being used by two local governments, one state government, and three federal government agencies. Each case study discusses the audience for visualization. Understanding audience is important, as government organizations provide useful visualizations to different audiences, including the media, political oversight organizations, constituents, and internal program teams. To assist in effectively communicating to these audiences, the report details attributes of meaningful visualizations: relevance, meaning, beauty, ease of use, legibility, truthfulness, accuracy, and consistency among them.

The report concludes with steps that government managers can take to create and deploy powerful visualizations. Among them are to use the visuals to tell a story, to connect with an audience in a way that helps to frame the data and allows viewers to create meaning.

This report is one in a series of publications from the IBM Center that relate to best practices for leveraging data and analytics to improve government. We hope that as data consumers become more savvy in their ability to decode visualizations and to understand the data that undergird them, government managers will be able to create more powerful visualizations that can help citizens better understand their world.



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# Introduction

The purpose of this report is to help public sector managers understand one of the more important areas of data analysis today—data visualization. Data visualizations are more sophisticated, fuller graphic designs than the traditional spreadsheet charts, usually with more than two variables and, typically, incorporating interactive features. Data are here to stay, growing exponentially, and data analysis is taking off, pushed forward as a result of the convergence of:

- New technologies
- Open data and big data movements
- The drive to more effectively engage citizens
- The creation and distribution of more and more data

It is now “cool” to be a data scientist, working on data and helping decision-makers and the public understand data.

One important part of this fast-emerging movement centers on data visualization, using maps or charts to help users understand and interpret data since, as Edward R. Tufte, a modern guru in this field puts it, “Graphics *reveal* data.”<sup>1</sup> Figure 1 is the Periodic Table of Visualization Methods by Lengler and Eppler, illustrating the many different ways in which data, information, and concepts can be visualized.

At the U.S. Department of State Tech@State conference on data visualization in 2011, Dr. Kerri-Ann Jones, assistant secretary of state for oceans and international environmental and scientific affairs, stated,

From the perspective of a scientist, it is important to be able to present data and findings to public audiences and to our peers. Pictures and charts are, of course, a big help in this. Data visualization is something more.

Data visualization is being used effectively in so many arenas already. It is being used in disaster response and coordination—strengthening the ability of communities to respond. It is helping information become more transparent and accessible to society in general. It is allowing donors to see how their money is being used in projects ranging from disaster relief to climate change. Data visualization shows progress being made, bumps along the road and pledges being fulfilled.<sup>2</sup>

This report provides:

- An introduction to data visualization in government

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1. Tufte, Edward R. 2001. *The Visual Display of Quantitative Information* (2nd edition) Cheshire, Connecticut: Graphics Press; 15.  
2. DIPNote. 2011. Tech@State Convenes Data Visualization Conference. Available at <http://blogs.state.gov/2011/10/article/techstate-convenes-data-visualization-conference>.



Figure 1: Periodic Table of Visualization Methods

# A PERIODIC TABLE OF VISUALIZATION METHODS

☼☼☼ <b>C</b> continuum	☼☼☼ <b>Data Visualization</b> Visual representations of quantitative data in schematic form (either with or without axes)																		☼☼☼ <b>Strategy Visualization</b> The systematic use of complementary visual representations in the analysis, development, formulation, communication, and implementation of strategies in organizations.																		☼☼☼ <b>G</b> graphic facilitation						
☼☼☼ <b>Tb</b> table	☼☼☼ <b>Ca</b> cartesian coordinates	☼☼☼ <b>Information Visualization</b> The use of interactive visual representations of data to amplify cognition. This means that the data is transformed into an image, it is mapped to screen space. The image can be changed by users as they proceed working with it.																		☼☼☼ <b>Metaphor Visualization</b> Visual Metaphors position information graphically to organize and structure information. They also convey an insight about the represented information through the key characteristics of the metaphor that is employed.																		☼☼☼ <b>Me</b> meeting trace	☼☼☼ <b>Mm</b> metro map	☼☼☼ <b>Tm</b> temple	☼☼☼ <b>St</b> story template	☼☼☼ <b>Tr</b> tree	☼☼☼ <b>Ct</b> cartoon
☼☼☼ <b>Pi</b> pie chart	☼☼☼ <b>L</b> line chart	☼☼☼ <b>Concept Visualization</b> Methods to elaborate (mostly) qualitative concepts, ideas, plans, and analyses.																		☼☼☼ <b>Compound Visualization</b> The complementary use of different graphic representation formats in one single schema or frame.																		☼☼☼ <b>Co</b> communication diagram	☼☼☼ <b>Fp</b> flight plan	☼☼☼ <b>Cs</b> concept skeleton	☼☼☼ <b>Br</b> bridge	☼☼☼ <b>Fu</b> funnel	☼☼☼ <b>Ri</b> rich picture
☼☼☼ <b>B</b> bar chart	☼☼☼ <b>Ac</b> area chart	☼☼☼ <b>R</b> radar chart cobweb	☼☼☼ <b>Pa</b> parallel coordinates	☼☼☼ <b>Hy</b> hyperbolic tree	☼☼☼ <b>Cy</b> cycle diagram	☼☼☼ <b>T</b> timeline	☼☼☼ <b>Ve</b> vean diagram	☼☼☼ <b>Mi</b> mindmap	☼☼☼ <b>Sq</b> square of oppositions	☼☼☼ <b>Cc</b> concentric circles	☼☼☼ <b>Ar</b> argument slide	☼☼☼ <b>Sw</b> swim lane diagram	☼☼☼ <b>Gc</b> gantt chart	☼☼☼ <b>Pm</b> perspectives diagram	☼☼☼ <b>D</b> dilemma diagram	☼☼☼ <b>Pr</b> parameter ruler	☼☼☼ <b>Kn</b> knowledge map																										
☼☼☼ <b>Hi</b> histogram	☼☼☼ <b>Sc</b> scatterplot	☼☼☼ <b>Sa</b> sankey diagram	☼☼☼ <b>In</b> information lense	☼☼☼ <b>E</b> entity relationship diagram	☼☼☼ <b>Pt</b> petri net	☼☼☼ <b>Fl</b> flow chart	☼☼☼ <b>Cl</b> clustering	☼☼☼ <b>Lc</b> layer chart	☼☼☼ <b>Py</b> minto pyramid technique	☼☼☼ <b>Ce</b> cause-effect chains	☼☼☼ <b>Tl</b> toulmin map	☼☼☼ <b>Dt</b> decision tree	☼☼☼ <b>Cp</b> cpm critical path method	☼☼☼ <b>Cf</b> concept fan	☼☼☼ <b>Co</b> concept map	☼☼☼ <b>Ic</b> iceberg	☼☼☼ <b>Lm</b> learning map																										
☼☼☼ <b>Tk</b> tukey box plot	☼☼☼ <b>Sp</b> spectrogram	☼☼☼ <b>Da</b> data map	☼☼☼ <b>Tp</b> treemap	☼☼☼ <b>Cn</b> cone tree	☼☼☼ <b>Sy</b> system dyn./simulation	☼☼☼ <b>Df</b> data flow diagram	☼☼☼ <b>Se</b> semantic network	☼☼☼ <b>So</b> soft system modeling	☼☼☼ <b>Sn</b> synergy map	☼☼☼ <b>Fo</b> force field diagram	☼☼☼ <b>Ib</b> ibm argumentation map	☼☼☼ <b>Pr</b> process event chains	☼☼☼ <b>Pe</b> pert chart	☼☼☼ <b>Ev</b> evocative knowledge map	☼☼☼ <b>V</b> vee diagram	☼☼☼ <b>Hh</b> heaven's hell chart	☼☼☼ <b>I</b> informal																										

☼☼☼  
**Cy**  
Process Visualization

☼☼☼  
**Hy**  
Structure Visualization

☼☼☼  
**Overview Detail**

☼☼☼  
**Detail AND Overview**

< >  
**Divergent thinking**

> <  
**Convergent thinking**

Note: Depending on your location and connection speed it can take some time to load a pop-up picture.  
© Ralph Lengler & Martin J. Eppler, www.visual-literacy.org

version 1.5

☼☼☼ <b>Su</b> supply demand curve	☼☼☼ <b>Pc</b> performance charting	☼☼☼ <b>St</b> strategy map	☼☼☼ <b>Oc</b> organisation chart	☼☼☼ <b>Ho</b> house of quality	☼☼☼ <b>Fd</b> feedback diagram	☼☼☼ <b>Ft</b> failure tree	☼☼☼ <b>Mq</b> magic quadrant	☼☼☼ <b>Ld</b> life-cycle diagram	☼☼☼ <b>Po</b> porter's five forces	☼☼☼ <b>S</b> s-cycle	☼☼☼ <b>Sm</b> stakeholder map	☼☼☼ <b>Is</b> ishikawa diagram	☼☼☼ <b>Tc</b> technology roadmap
☼☼☼ <b>Ed</b> edgeworth box	☼☼☼ <b>Pf</b> portfolio diagram	☼☼☼ <b>Sg</b> strategic game board	☼☼☼ <b>Mz</b> mintzberg's organigraph	☼☼☼ <b>Z</b> zwicky's morphological box	☼☼☼ <b>Ad</b> affinity diagram	☼☼☼ <b>De</b> decision discovery diagram	☼☼☼ <b>Bm</b> bkg matrix	☼☼☼ <b>Stc</b> strategy canvas	☼☼☼ <b>Vc</b> value chain	☼☼☼ <b>Hy</b> hype-cycle	☼☼☼ <b>Sr</b> stakeholder rating map	☼☼☼ <b>Ta</b> taps	☼☼☼ <b>Sd</b> spray diagram

Source: Lengler, Ralph and Martin J. Eppler. A Quick Visualization Primer for Data.gov. Available at [www.visual-literacy.org/periodic\\_table/periodic\\_table.html#Bottom of Form](http://www.visual-literacy.org/periodic_table/periodic_table.html#Bottom%20of%20Form)

- The tools being used to produce data visualization
- Case studies of how data visualization is being effectively created and used at the federal, state, and local levels

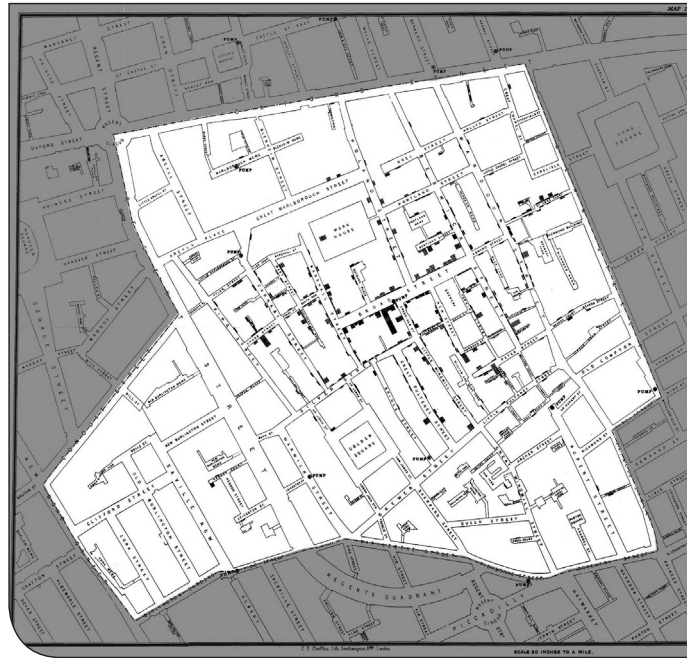
Government agencies at any level can now take advantage of these emerging tools and opportunities.

## The Beginnings

Effective data visualization, or graphic display, has been used to help understand patterns since the 1750s. One early use of maps, complete with data, was John Snow's map of cholera cases in London. Snow is considered a pioneer in the public health and epidemiology fields. With a map showing where the 500 people who died over 10 days actually lived, Snow was able to show that the cholera outbreak was caused by contaminated water from one particular pump (Figure 2). This visualization is believed by some to be one of the most influential of all time.<sup>3</sup> The blocks on the map represent cholera cases; note the number on the center of the map, which was the location of the contaminated water pump.

3. Bachand, Jen. 2012. What are the top five visualizations of all time? Tableau Software Blog, available at [www.tableausoftware.com/about/blog/2012/11/top-5-visualizations-all-time-19810](http://www.tableausoftware.com/about/blog/2012/11/top-5-visualizations-all-time-19810)



**Figure 2: John Snow Cholera Map, 1854**

**Source:** Kelley, Peter. 2012. Documents that Changed the World Podcasts: John Snow's Cholera Map, 1854. Available at: [www.washington.edu/news/2012/08/28/documents-that-changed-the-world-john-snows-cholera-map-1854](http://www.washington.edu/news/2012/08/28/documents-that-changed-the-world-john-snows-cholera-map-1854).

## Data Visualization Today

Today, use of data visualization is growing rapidly. The use of data in everything from performance measurement to forecasting to database reports has been emphasized by governments for some time. What is new in analytics is the emphasis on more sophisticated data analysis and data modeling, searching for patterns in data, and use of data warehouses and data mining by government managers looking for ways to answer increasingly difficult and more complicated kinds of questions. (For definitions of these terms, see box, *Key Terms*.)

Even with these more sophisticated means of analysis, government managers still have the challenge of explaining issues and results to decision-makers and the public; that is where data visualization comes in. Numbers and patterns can be more readily grasped in graphic visualization, particularly when interactive. Data visualization can help citizens understand data and data analysis more readily through graphic presentations. It is a tool to connect data with citizens and foster citizen engagement.

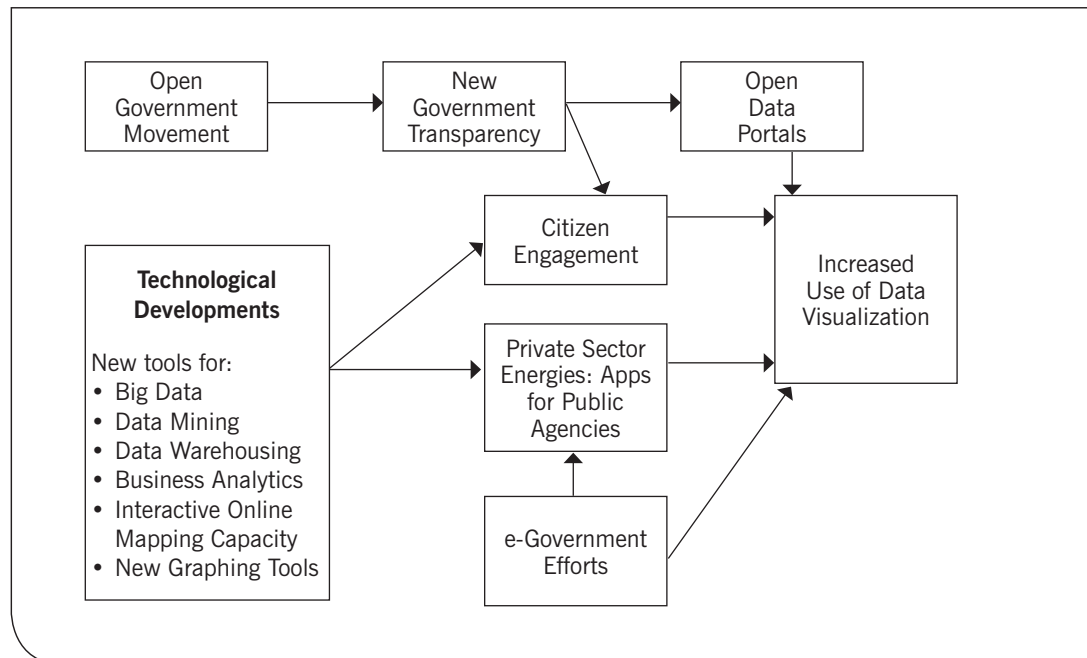
This is the beginning of a new, increased use movement; more sophisticated data visualization will replace charts that were put together quickly with low visual expectations. The movement is the result of numerous converging trends—the open data and transparency movements, growing citizen engagement with data, new tools for data mining and analysis that use ever larger data sets, advances in web graphic technology and interactive online mapping and graphing, and new awareness of the need for a more proactive citizen engagement (Figure 3). These drivers, particularly the advances in technologies and interactive capacity of the web, have allowed the rapid diffusion of these innovations across sectors and fields in a matter of months.

Data visualization is spreading rapidly today, certainly in the private sector in combination with business analytics. The open government movement has created significant momentum

## Key Terms

- **Big data.** The very large volumes of data being generated on or by the Internet and other means today, such as that generated by social media or even utility payment data by a public utility over time. Big data can refer either to its sheer volume, so large that traditional databases and analytical techniques are not capable of effectively analyzing it. Or it can refer to conducting the analysis on the entire population of data rather than on the random sample used in routine statistical analysis.
- **Business analytics.** The group of tools and techniques used to analyze business data to make decisions.
- **Data mining.** The use of statistical or database software to discover patterns in data (often in big data).
- **Data visualizations.** Today's more sophisticated charts or graphics, which use newly available software and often the web as a platform. They are more interactive, often contain additional variables and are easier to understand and interpret for everyday citizens. Data visualizations is often abbreviated as data vizes.
- **Data warehousing.** Using different databases across an entire organization; the scale is different and tools are available so that managers can use the data to make decisions.
- **Interactive online mapping.** The number of online maps has grown exponentially; geographic information systems and other kinds of interactive maps are now more available than ever, also due to improved software and the extension of the web as an interactive tool.
- **Open data.** Data from government or private-sector firms available to anyone to use to analyze, develop new applications, or create new products. Providing open data is one strategy for creating more transparency in government.

**Figure 3: Emergence of Increased Use of Data Visualization**



at all levels of government to make data available for analysis and visualization so that citizens and decision-makers can better understand the patterns data can reveal. Private-sector groups are also using the data to create new mobile apps for their customers.

Data scientists have consequently become highly visible. They can mine, manage, and analyze the data and create visualization so that others can understand it. New groups are organizing online to train data scientists and promote their working in collaboration to achieve even more.

Data scientists and would-be data scientists are now entering competitions to see who can generate the best analysis and visualization of a given set of data. Kaggle is one organization that hosts competitions and is a leading platform for predictive modeling competitions. Kaggle describes itself as the world's largest community of data scientists. Companies, governments and researchers present data sets and problems and the world's best data scientists compete to produce the best solutions. Its slogan is "treating data science like a sport."

The public sector is also sponsoring competitions. From [Challenge.gov](#), the federal government competition site: "On Challenge.gov, the public and government can solve problems together." On this site, challenges can involve creating a video or a visualization or reporting small business success stories; the competitions are broader than just data analysis and visualization.

Finally, a new field in journalism has been created, that of data journalism. Previously called CAR for computer-assisted reporting, it places journalists in the forefront of interactive data visualization development as a way to help readers understand complicated policy.

Figure 4 presents an example of this new type of journalism. In these bubble charts, Shan Carter has four different visualizations of President Obama's 2013 budget proposal. Each bubble is a federal agency; the size of the bubble indicates the size of the budget proposed for that agency. A color scale from red to green indicates the size of percentage increase or decrease from the 2012 budget. View 1 shows all spending; the bubbles group together, roughly by color. View 2 shows types of spending; mandatory spending bubbles move to the left and discretionary to the right (as in Figure 4). View 3 indicates the relative size of year-to-year changes and View 4 is department totals; each bubble moves, along with its fellow bureaus, to its place in a ranked order of agencies by size of budget. Finally, the user can move the cursor over a bubble and agency name and budget proposal details on that agency emerge. A central goal of data visualization—to provide more information about a given phenomenon in one chart in an understandable manner—is clearly achieved here.

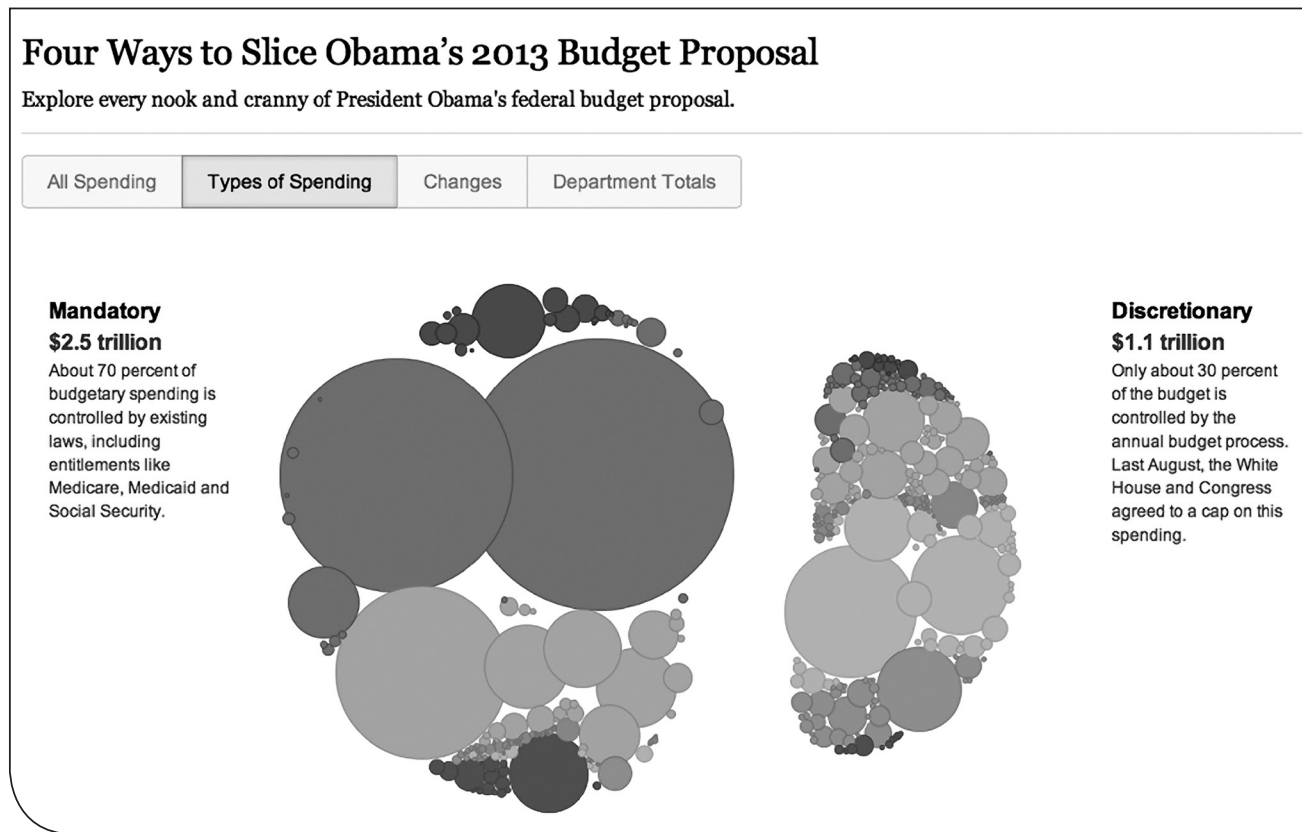
## Types of Data Visualization

There are several kinds of data visualization, beginning with the most static kind available in most spreadsheet software. In this case, static means that users cannot manipulate the data to see for themselves what different patterns exist in the data.

**Table 1: Types of Data Visualization Available Today**

Data Viewable/ Manipulable	One or Two Variables	More than Two Variables
<b>No:</b> Static	<b>Old School Charting</b> <ul style="list-style-type: none"> <li>Basic Paper Charts—Excel, etc</li> <li>Basic Paper Graphs</li> </ul>	<b>Old School Plus</b> <ul style="list-style-type: none"> <li>Infographics</li> <li>Static Dashboards</li> </ul>
<b>Yes:</b> Interactive	<b>Limited Interaction</b> <ul style="list-style-type: none"> <li>Online Charts</li> <li>Online Maps</li> </ul>	<b>Highly Interactive and Citizen-Friendly</b> <ul style="list-style-type: none"> <li>Interactive Dashboards</li> <li>Interactive Online Charts and Maps</li> </ul>

Figure 4: Example of Data Journalism: *New York Times*, Four Ways to Slice Obama's 2013 Budget Proposal



**Source:** Carter, Shan. 2012. Four Ways to Slice Obama's 2013 Budget Proposal. *New York Times*. Available at [http://www.nytimes.com/interactive/2012/02/13/us/politics/2013-budget-proposal-graphic.html?\\_r=0](http://www.nytimes.com/interactive/2012/02/13/us/politics/2013-budget-proposal-graphic.html?_r=0)

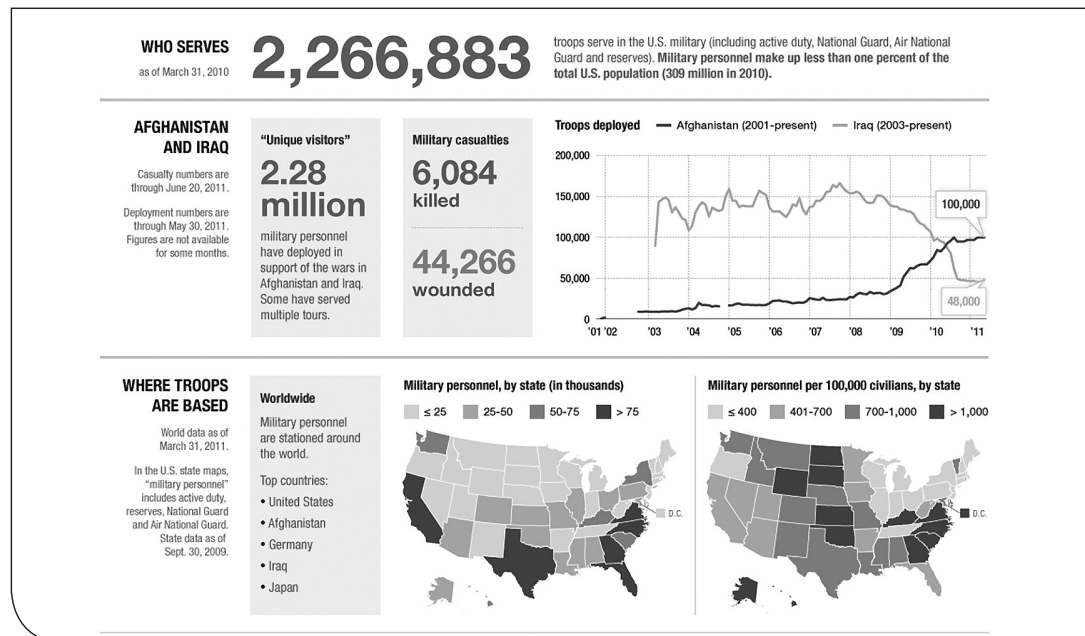
Figure 5 is an example of the first type of data visualization, typically called an infographic (categorized as Old School Plus in Table 1). Infographics typically consist of a series of charts and image-intensive statistics on a particular topic. While they can be useful, they are not interactive and are not what many governments are trying to move toward today.

The infographic in Figure 5 was created by NPR and is only one of a long series of charts illustrating various data about the military in 2011.

Figure 6 is a map with one type of interactive data from the U.S. Census Bureau's Data Visualization Gallery, a rich source of data visualizations alternated on a weekly basis. This particular visualization (Limited Interaction in the typology) is a map overlaid with interactive data on median household income. By moving the slider below the map, the user can select the level of median household income and so isolate islands of high income around the country. The image in Figure 6 shows islands of income in green that are greater than the median U.S. value, \$51,914 (or, \$52,000); in other words, the green islands illustrate those counties with median household incomes higher than the national median.

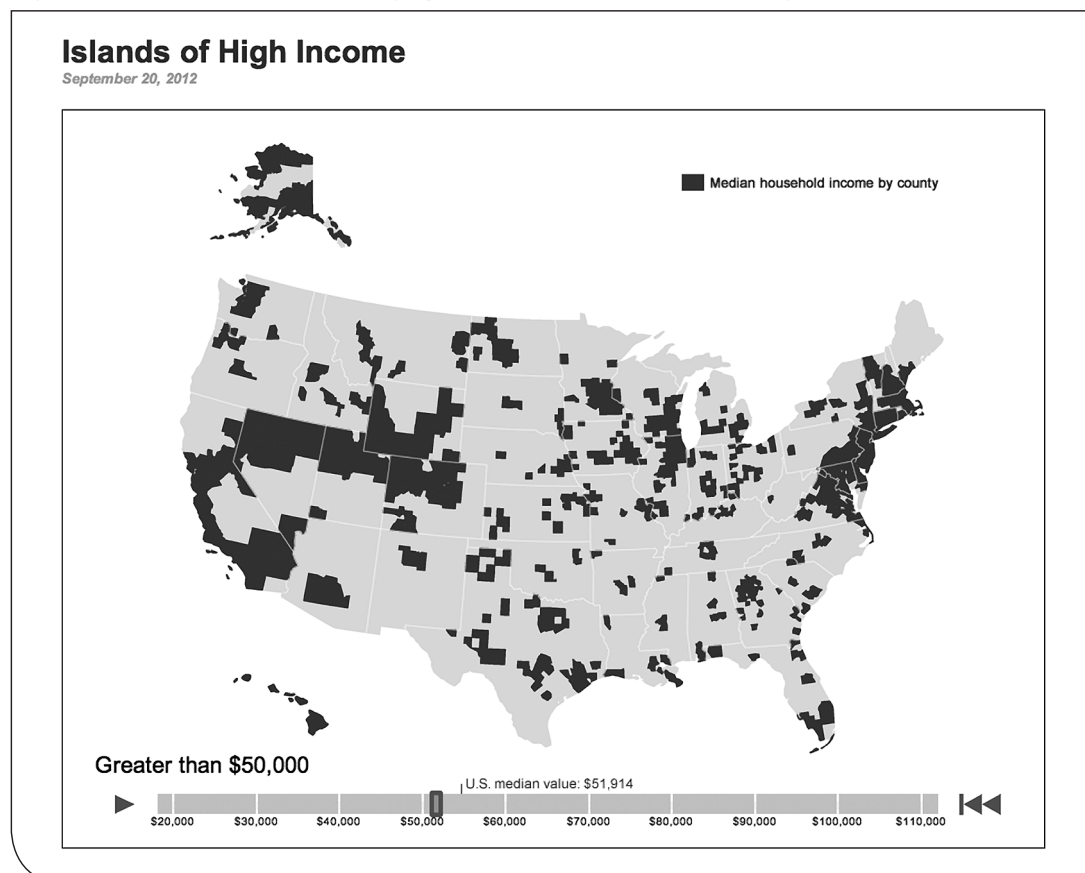
Figure 7 is the federal government's IT (information technology) Dashboard, an interactive data visualization with more than one interactive variable (Highly Interactive and Citizen-Friendly in the typology). With one of several different charts, the user can manipulate the year, the particular variable being charted, whether or not the variables are being transformed using a logarithmic transformation, and the agency. The circles are colored according to the

Figure 5: Old School Plus Infographic: By The Numbers: Today's Military (July 3, 2011)



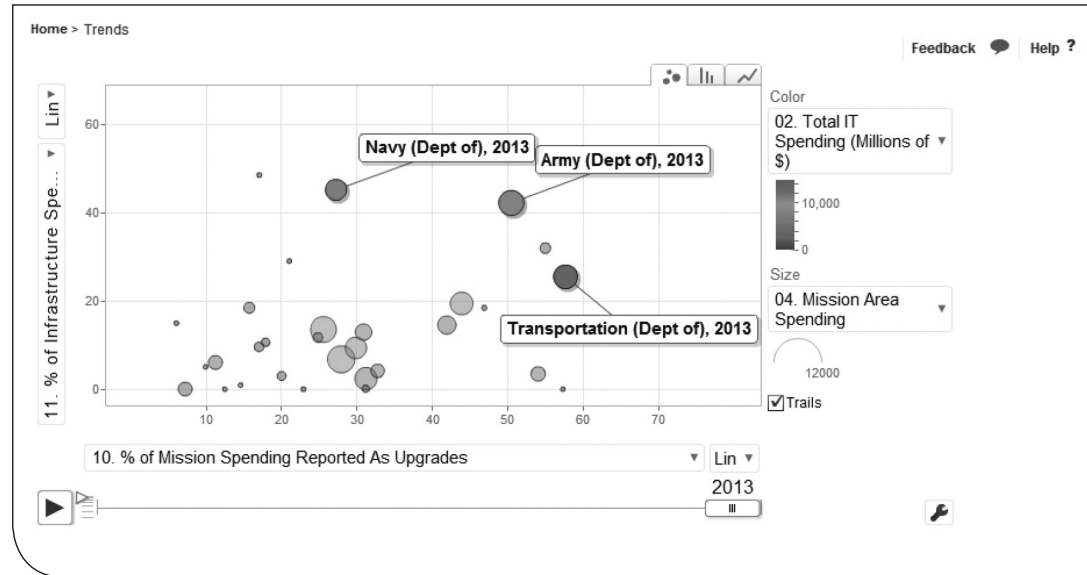
Source: National Public Radio. 2011. Those Who Serve. [www.npr.org/2011/07/03/137536111/by-the-numbers-todays-military](http://www.npr.org/2011/07/03/137536111/by-the-numbers-todays-military)

Figure 6: Limited Interaction Infographic: U.S. Census Islands of High Income



Source: U.S. Census Bureau. 2012. [www.census.gov/dataviz/visualizations/019/](http://www.census.gov/dataviz/visualizations/019/)

**Figure 7: Highly Interactive and Citizen Friendly Data Visualization—Federal Government IT Dashboard (ITDashboard.gov)**



**Source:** IT Dashboard. 2012. Available at [www.itdashboard.gov/trends?motiontype=2](http://www.itdashboard.gov/trends?motiontype=2)

amount of total IT spending (in this case) and their size also provides another piece of information (the amount of mission area spending, in this case). Once the variables have been charted, the user can click on a circle and the identity of the data point emerges (see the Navy, Army, and Department of Transportation). In this way, the user can explore and drill down into the data to determine any underlying patterns.

## What Makes a Good Data Visualization

Recently, government trainers on visualization suggested the following characteristics as critical to an effective visualization:

- **Interesting**
  - Relevant
  - Meaningful
  - Beautiful
- **Functional**
  - Ease of Use
  - Load Time
  - Legibility
- **Integrity**
  - Accuracy
  - Truthfulness
  - Consistency<sup>4</sup>

4. Allage, Ali; Wayne Kei, Audrey Buehring, and Earlene Dowell. 2012. Data Visualization and Infographics in Government. Available at [www.howto.gov/sites/default/files/data-visualization-infographics-government.pdf](http://www.howto.gov/sites/default/files/data-visualization-infographics-government.pdf).

Edward Tufte, one of the most prominent graphics and data experts, adds more detail while prescribing that “graphical displays should:

- Show the data
- Induce the viewer to think about the substance rather than about methodology, graphic design, the technology or graphic production, or something else
- Avoid distorting what the data have to say
- Present many numbers in a small space
- Make large data sets coherent
- Encourage the eye to compare different pieces of data
- Reveal the data at several levels of detail, from a broad overview to the fine structure
- Serve a reasonably clear purpose: description, exploration, tabulation, or decoration
- Be closely integrated with the statistical and verbal descriptions of a data set”<sup>5</sup>

The box, *Data Visualization Resources*, presents some resources to investigate to view data visualizations both inside and outside of the public sector. Readers can learn more by viewing the wide variety of data visualizations available in these resources.

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5. Tufte, Edward R. 2001. *The Visual Display of Quantitative Information* (2nd edition) Cheshire, Connecticut: Graphics Press: p. 15.



## Data Visualization Resources

- **Chartsnthings** is a personal blog run by a staffer from the *New York Times* graphics department. Available at [chartsnthings.tumblr.com](http://chartsnthings.tumblr.com).
- A highly useful resource for the public sector is **Dataviz: Improving Data Visualization for the Public Sector**, from the United Kingdom's Oxford Consultants for Social Inclusion and Communities and Local Government. Available at [www.improving-visualisation.org](http://www.improving-visualisation.org).
- **Datavisualization** is a news resource for data visualizations at [datavisualization.ch](http://datavisualization.ch).
- **Eager Eyes** at [eagereyes.org](http://eagereyes.org) is a blog by Robert Kosara, a researcher and analyst at Tableau Software; the site contains excellent information and honest evaluations of techniques and a useful feature showing acceptance rates for papers and presentations at visualization conferences.
- **Webdesignerdepot**. Fifty great examples of data visualization can be found at [www.webdesignerdepot.com/2009/06/50-great-examples-of-data-visualization](http://www.webdesignerdepot.com/2009/06/50-great-examples-of-data-visualization).
- **Freegovinfo.info** is a quick visualization primer for data.gov that provides a list of resources for public sector visualizations. Available at [freegovinfo.info/node/2610](http://freegovinfo.info/node/2610).
- **FlowingData** is the website by Nathan Yau, author of one of the best books on visualization, *Visualize This: The FlowingData Guide to Design, Visualization, and Statistics*. Available at [flowingdata.com](http://flowingdata.com).
- **HowTo.gov's Data Visualization and Infographics in Government** is an excellent resource, providing a one-hour webinar by public sector employees on how they created visualizations as well as PowerPoint slides from their presentations. Available at [www.howto.gov/training/classes/data-visualization-and-infographics](http://www.howto.gov/training/classes/data-visualization-and-infographics).
- **Information is Beautiful**, run by a self-described data journalist. Funded by sales of data visualizations in the form of posters, images, and books with examples separated into categories (health, people, thought, science), this site is clearly more focused upon visualization as art rather than data analysis. However, it still contains excellent examples of data visualization at work. Available at [www.informationisbeautiful.net](http://www.informationisbeautiful.net).
- **Information Aesthetics** is a weblog that collects projects considered important or original; the focus is on design at [infoethetics.com](http://infoethetics.com).
- **Information design** is a resource for design professionals with a focus on information design at [www.informationdesign.org](http://www.informationdesign.org).
- **Kaggle.com** is a competition site for data analysis and visualizations at [www.kaggle.com](http://www.kaggle.com).
- **Visualcomplexity.com** focuses on resources on the visualization of networks. Available at [visualcomplexity.com](http://visualcomplexity.com).
- **Visualizing.org** presents itself as a "community of creative people making sense of complex issues through data and design, hosting competitions, sites for posting data sets and featuring visualizations." Users can create accounts and join the community to share resources and space. Available at [www.visualizing.org](http://www.visualizing.org).

# Creating Data Visualizations

## Reasons for Doing Data Visualization

There are a wide variety of reasons to do a data visualization. The accompanying box lists some of them—telling a story, analyzing the data graphically in order to better understand its patterns, comparing and contrasting different features of the data, and making connections more visual and thus better understood.

## How to Create Data Visualizations

The overall process of creating a data visualization is described by Ali Allage in the webinar and slide presentations available at [HowTo.gov](#) (Figure 8). Everything begins with the data. The data need to be explored and thoroughly analyzed with whatever tools are most effective (SPSS, SAS, Stata, Systat are all statistical software packages commonly used by analysts but there are many others available on the Internet today, including R, which also is known for its effective graphics).

Having drawn conclusions from data analysis, the analyst must consider the audience for the analysis and develop a strategy for communicating to them the patterns found in the data. The most important part of this process is that the visualization tells a story about those patterns—the story aimed at the target audience. After the story is settled, the design of the visualization is begun. Only then are the actual chart and graphics designed and published.

### Reasons for Doing Data Visualization

#### To Tell a Story

- To constituencies
- To funders
- To government officials
- To the media
- To other organizations
- To the general public

#### To Analyze Data

- Discover hidden patterns
- Find trends in changing systems

#### To Make a Plan

- Analyze relationships of power
- Illustrate social networks
- Find out where an issue has the most impact
- Project future trends

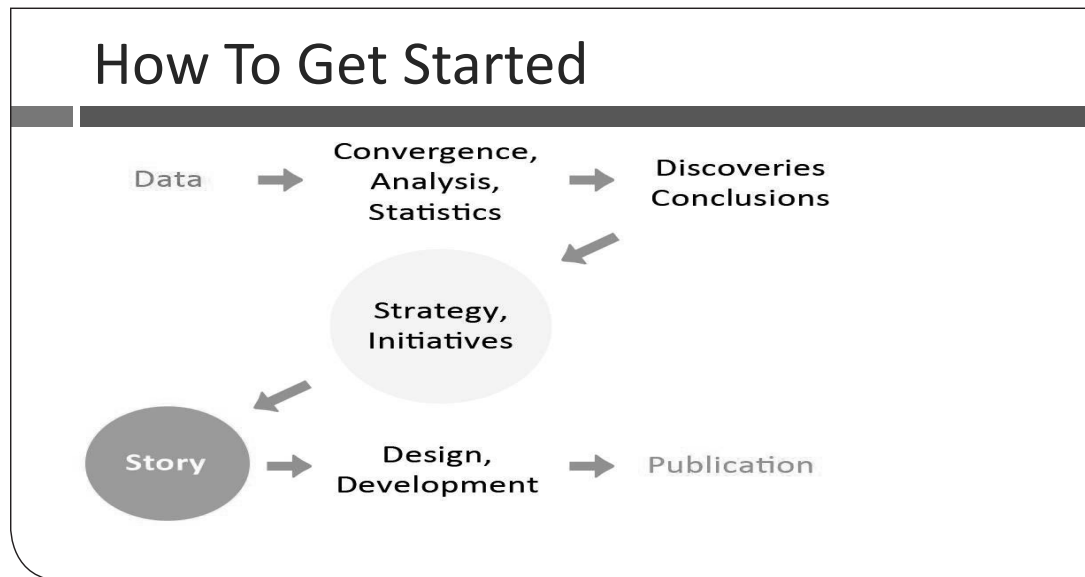
#### To Make Information Visible

- Show influence and causality
- Illustrate the consequences of specific choices
- Compare and contrast

#### To Simplify and Clarify

- Illustrate analysis of an abstract idea
- Show the flow of a process or changing system
- Make your conclusions visible and easy to navigate
- Show structure and order in apparently chaotic data

**Source:** Emerson, John. 2008. *Visualizing Information for Advocacy: An Introduction to Information Design*. Tactical Technology Collective. [backspace.com/infodesign.pdf](https://backspace.com/infodesign.pdf)

**Figure 8: How to Get Started on Creating Data Visualizations**

**Source:** Allage, Ali, Wayne Kei, Audrey Buehring, and Earlene Dowell. 2012. *Data Visualization and Infographics in Government* (Slides). [www.howto.gov/sites/default/files/data-visualization-infographics-government.pdf](http://www.howto.gov/sites/default/files/data-visualization-infographics-government.pdf)

## Features Used in Interactive Data Visualizations

The most basic features of the chart or graph are the graph type itself (bar, line, pie, etc). But creating interactive visualizations allows the user to move beyond these types and incorporate other features. Some of the most common features are:

- **Size** of data point can be set to vary with the value of a variable.
- **Color** of a data point may also be used to vary with the category of a variable.
- **Type or shape** of data point may be used to indicate a category of variable.
- **Labels** of the data point and the underlying data itself may be used as options that pop up when the user selects a particular data point.
- **Drop-down menus or checklists** can have options selected to allow the user to select one variable after another (for instance, year).
- **Filters** allow particular subsets of a data set to be selected for viewing.
- **Sliders** can allow the user to select a continuous variable (year) so that the progression of a variable over time is illustrated.

## Tools

There are now a wide variety of tools with which to construct data visualizations, extending from the simple spreadsheet (Excel, Google Docs Sheets), to the more comprehensive and newer tools being developed for today's online charting and mapping environment (Tableau, HighCharts, Many Eyes), to those which require some basic programming (Google Charts, R). (For a description of these tools, see box, *Tools for Data Visualization*.) A number of these are free, or have free versions that match up with more robust versions. Some run on browsers and so are platform-independent and some run on the user's computer.

Criteria for assessing these tools include:

- **Cost.** Their cost—many are free.
- **Learning curve.** A varying learning curve is required for learning these tools; some are quite simple while others require some practice before users are able to create visualizations with the tool.
- **Interactivity.** Some tools can be used to create visualizations that allow users to manipulate variables and so drill down into the data more effectively; others create infographics that are not interactive.
- **Published on the web or not.** Some tools can have interactive versions easily posted to the web, typically on the company's own servers.
- **Platform.** The platform on which the tool runs—some run within browsers and so are platform-independent and can be used on PCs or Macs; others must be downloaded and are available for specific platforms.
- **Must upload own data and make it public or not.** Most tools allow users to upload their own data in order to publish on the web; some then require it to be made public, however.
- **Training available.** Some tools have very extensive training available for users, including video tutorials and user learning communities.

Appendix I will provide examples of how data visualizations can be created using two tools listed above, Many Eyes and Tableau. These illustrations will provide an idea of the ease with which these graphics can be developed.

## Tools for Data Visualization

### General Tools

**Spreadsheets.** The most basic charting tool is the spreadsheet; numerous examples are available (Microsoft Excel, Google Docs Sheets, etc.) These can be manipulated if the user also has the data and can be cut and pasted into other documents or converted into images for use on the web.

**Chart Chooser.** Now at Juice Labs, this tool allows users in Excel or PowerPoint to select the most appropriate kind of chart for their data. Available at [labs.juiceanalytics.com/chartchooser/index.html](http://labs.juiceanalytics.com/chartchooser/index.html).

**Datawrapper.** Datawrapper is an open source tool developed by ABZV to create embeddable charts for the web, mainly for the use of journalists. To create more customization for charts, services are available for a fee; users may also install a version of the server for themselves. Without charge, data can be copied and pasted online (or a CSV file uploaded) then a chart type selected, some options selected, and titles added. By registering on the site, users are then enabled to embed the chart on their own site.

**Google Chart Tools API.** Used to make charts out of data located on a user's own server, not on Google servers. Relies on some coding but extensive examples of coding for numerous kinds of charts are available for use. New features are also available.

**Google Fusion Tables.** Google Fusion Tables ([www.google.com/drive/start/apps.html#fusiontables](http://www.google.com/drive/start/apps.html#fusiontables)) is a relatively new Google tool that was created specifically to allow collaborations, share, and visualize data; it is a self-contained application designed to work with data stored on its own servers. It is found under Google Drive and is still listed as experimental. The app is also available for the Google Chrome browser. Users can combine tables of data, upload their own data, embed visualizations in Google Sites, and even open and view data in Google Earth. While uploaded data sets are moved to Google servers, they are not made public.

**HighCharts.** HighCharts provides interactive JavaScript codes for interactive charts with numerous chart options and chart types. For personal or non-profit projects, the download is free; government agencies can purchase relatively inexpensive licenses. Available at [www.highcharts.com](http://www.highcharts.com).

**ICharts.** A dedicated data visualization tool with pricing plans that vary with the types of data that can be used as well as the types of features available. See [www.icharts.net](http://www.icharts.net).

**JavaScript InfoVix Toolkit.** This free code library provides wonderful-looking demos with their accompanying code so that users may learn about using the system. Users would have to be comfortable with some level of Javascript programming, as they are expected to change the existing code to create their own visualizations. Available at [philogb.github.com/jit](https://philogb.github.com/jit).

**Many Eyes.** Many Eyes is a browser-based, experimental IBM tool. It enables the user to create and post many kinds of charts and a few map opportunities. It is also easy to use. Once data or visualizations are posted to Many Eyes, however, they are public. See [www-958.ibm.com/software/data/cognos/manyeyes](http://www-958.ibm.com/software/data/cognos/manyeyes).

**Tableau Public.** Tableau Public is free data visualization software that is easy to use to make sophisticated and powerful interactive charts or maps with a limited variety of data types; these can then be posted online on Tableau's servers. The Public version matches up with other versions available for a fee that allow users to use additional data types and to host their own servers. Tableau also allows an easy way to create interactive dashboards.<sup>6</sup>

**Timeline.** A widget that helps the user to create timelines. Originally created as part of an Andrew Mellon Foundation project, it is now maintained by the open source community. Available at [www.simile-widgets.org/timeline](http://www.simile-widgets.org/timeline).

**R.** R is an open-source statistical programming language that produces excellent, publication-quality graphics. There are numerous versions and add-ons available by searching online, since anyone can take R and make their own changes. It is also surprisingly easy to learn. See [www.r-project.org/](http://www.r-project.org/) for the R Project site which provides a wide variety of information about R.

**Socrata.** Socrata is a vendor tool that is its own platform, including dataset management, charting and mapping tools. It is notable at this time for its use by the group of big cities referred to as the G7 which are collaborating together on open data and using Socrata to host their Open Data portals.

**Visualize Free.** A browser-based tool much like Many Eyes where users can bring their data and upload it on their site or use some of their data and then with their tool, create an interactive visualization. Available at [visualizefree.com/index.jsp](http://visualizefree.com/index.jsp)

**Visual.ly** is both a tool and a site for designers and analysts and companies to find one another and work together on infographic projects. See [visual.ly](http://visual.ly).

### Specialized Tools

Three other tools, BetterWorld Flux, City Forward, and Gapminder World, are available on sites that come with specific kinds of data, urban and global, respectively. The visualizations created here automatically on the provided data are designed to educate users about the issues in specific policy areas.

**BetterWorld Flux.** BetterWorld Flux was created for the World Bank Open Data Apps for Development Competition; users cannot upload their own data but data about national development are provided for them to explore. Available at [www.betterworldflux.com](http://www.betterworldflux.com).

**City Forward.** Created by IBM, City Forward is a collection of data sets for each of over 100 cities (and some countries) around the world; the data are from the U.S. Census or other sources. Users choose a city, choose the data indicator they want to view, and then click a button to create the visualization. Users can also add features like titles and descriptions and can now upload their own data. Visualizations created by others are also available. See [cityforward.org](http://cityforward.org).

**Gapminder World.** Gapminder World is a nonprofit developed to promote sustainable global development and the achievement of the United Nations Millennium Development Goals. It uses the tool formerly known as Trendalyzer to allow a user to manipulate data supporting those goals and available on the site in graphs that are already created. After manipulations, graphs created can be shared as long as Gapminder is cited. Over 500 global indicators are available on the site; this data can be downloaded in Excel format, viewed, or used to create visualizations. See [www.gapminder.org](http://www.gapminder.org).

6. Three resources helpful in developing this list were Creative Blog's 2013 article, 20 Best Tools for Data Visualization, available at [www.creativebloq.com/design-tools/data-visualization-712402](http://www.creativebloq.com/design-tools/data-visualization-712402); the Dataviz: Improving Data Visualization for the Public Sector site at [www.improving-visualisation.org/](http://www.improving-visualisation.org/); and Sharon Machlis' 2011 article on data visualization, 22 Free Tools for Data Visualization and Analysis, in ComputerWorld, available at [www.computerworld.com/s/article/9215504/22\\_free\\_tools\\_for\\_data\\_visualization\\_and\\_analysis?taxonomyId=18&pageNumber=1](http://www.computerworld.com/s/article/9215504/22_free_tools_for_data_visualization_and_analysis?taxonomyId=18&pageNumber=1).

# Case Studies

The case studies highlight government organizations' experiences with data visualization. The cases, all organizations experienced with data visualization, were selected to represent different levels of government on experience with data. All used different software and all have different reasons for using data visualization.

## Chicago, Illinois

The real push for open government in the city of Chicago began when Mayor Rahm Emanuel was first elected and directed the city's Chief Information Officer Brett Goldstein to support open government. From there, citizen data visualization was a natural consequence. The city, already in a partnership with New York, Boston, Philadelphia and three other big cities in a collaboration known as the G7, centered on analytics. The city was further spurred by the National Day of Civic Hacking (this year on June 1 and 2, 2013). Other partnerships soon developed from that event, such as the gatherings every Tuesday evening between the city's Data Science Division and community statisticians, developers, programmers, and activists.

Tom Shenk, director of the Data Science Division, believes Chicago is the first, if not the only, city with its own chief data officer (Shenk). The data science division is a new area under the Department of Innovation and Technology (headed by the chief information officer). The division conducts advanced analytic studies and high level studies plus summary reports on their data. The funds for these efforts come from the Information Technology budget, and the city staff in that area posts new data sets. One dedicated full-time employee is used and other staff members periodically contribute. A press person participates when something significant is released. There is no advertising for the site, although numerous articles have been written about the site and its contents.<sup>7</sup>

The first two projects that emerged from these efforts were How's Business Chicago and Second City Zoning. How's Business Chicago ([howsbusinesschicago.org](http://howsbusinesschicago.org)) (Figure 9) is a set of dashboard charts based on open economic and business data for Chicago.

How's Business Chicago was soon followed by Second City Zoning ([secondcityzoning.org](http://secondcityzoning.org)) (Figure 10), an open application and interactive map that allows users to:

- Find out how a building was zoned
- Explore city-wide patterns
- See differences in zoning by playing a game.

The developers took inspiration from the simulation game Sim City 2000, including some of the music from the game as well as the color scheme. Both of these projects were volunteer efforts.

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7. Interview with Tom Shenk, chief data officer for the city of Chicago. January 24, 2013.

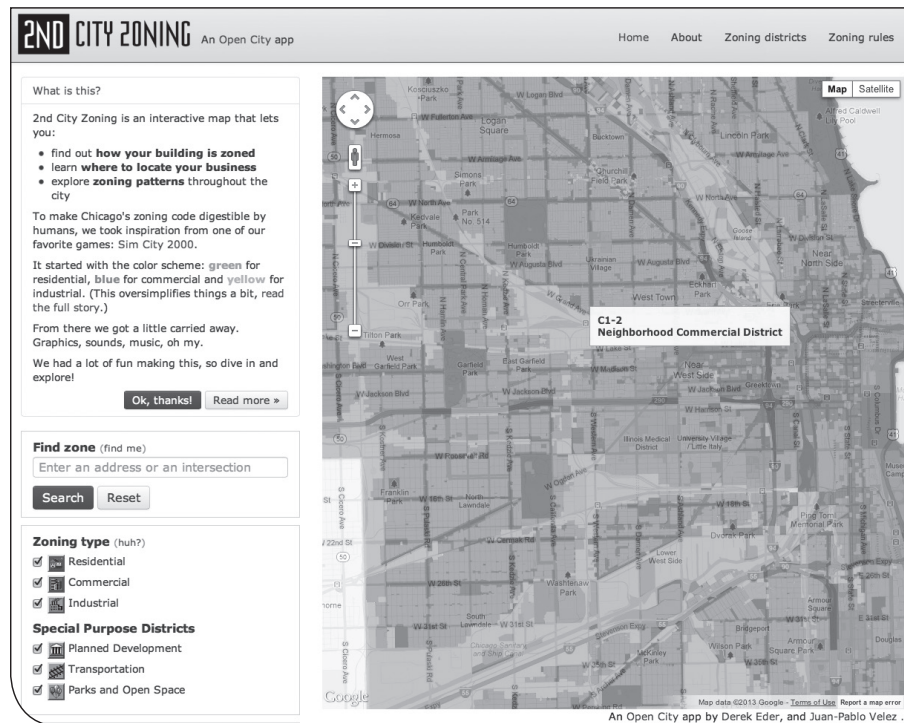


Figure 9: How's Business Chicago: Open, Interactive Data Visualization



Source: [howsbusinesschicago.org/](http://howsbusinesschicago.org/)

Figure 10: Second City Zoning



Source: [secondcityzoning.org](http://secondcityzoning.org)

The city's Data Science Division also hosts the City of Chicago Data Portal (<https://data.cityofchicago.org>). This portal contains over 200 data sets, although 907 separate data sets and files are listed. Using the vendor Socrata's Open Data solution, users can manipulate the data themselves by clicking on Filter, Chart, or Tabular to see the data in various formats.



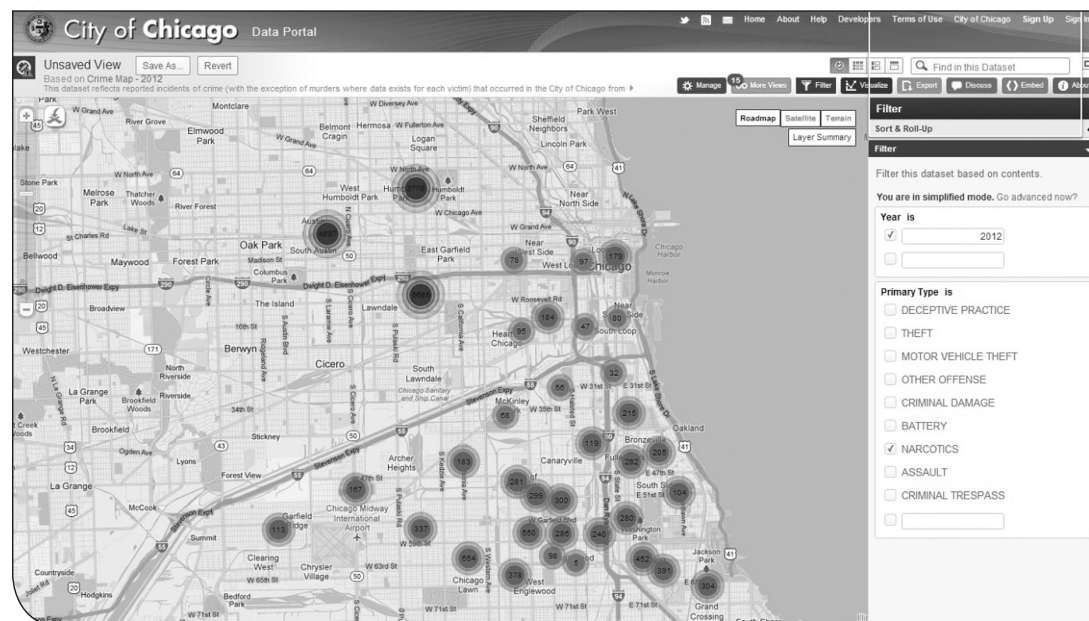
Other options available in the Socrata portal are Manage (some control of format), More Views, Filter, Visualize (to create charts and maps), Export (the data), Discuss (an option allowing discussion of the findings), and Embed (allowing the data set to be embedded in other websites). Video guides are available to aid users in using the site. All kinds of data are available in this data set, from applicants for an alderman's seat to locations of all kinds of services to shapefiles (used to create maps). Data on the site are organized into 16 different substantive categories, including administration and finance, education, facilities and geographic boundaries, public safety, and transportation. According to Director Schenk, the crime data, charts, and maps are the most popular features on the site.

There are seven types of files available in their portal:

- Data sets
- External data sets
- Files and documents
- Filtered views
- Charts
- Maps
- Calendars

Figure 11 presents an example of a user-created chart made from another type of popular data, crime data. This is a map with user-selected options for the year and the types of crime. The color and size of the data point represents the amount of that type of crime in that particular district.

**Figure 11: Crime in City of Chicago (Narcotics, 2012)**



Source: [data.cityofchicago.org/Public-Safety/Crimes-Map/dfnk-7re6](http://data.cityofchicago.org/Public-Safety/Crimes-Map/dfnk-7re6)

Chicago's big-city experience with data visualization is extensive, particularly due to its partnership with other large cities. However, even small organizations or jurisdictions may create useful data visualizations with the wide range of tools available today.

## Redwood City, California

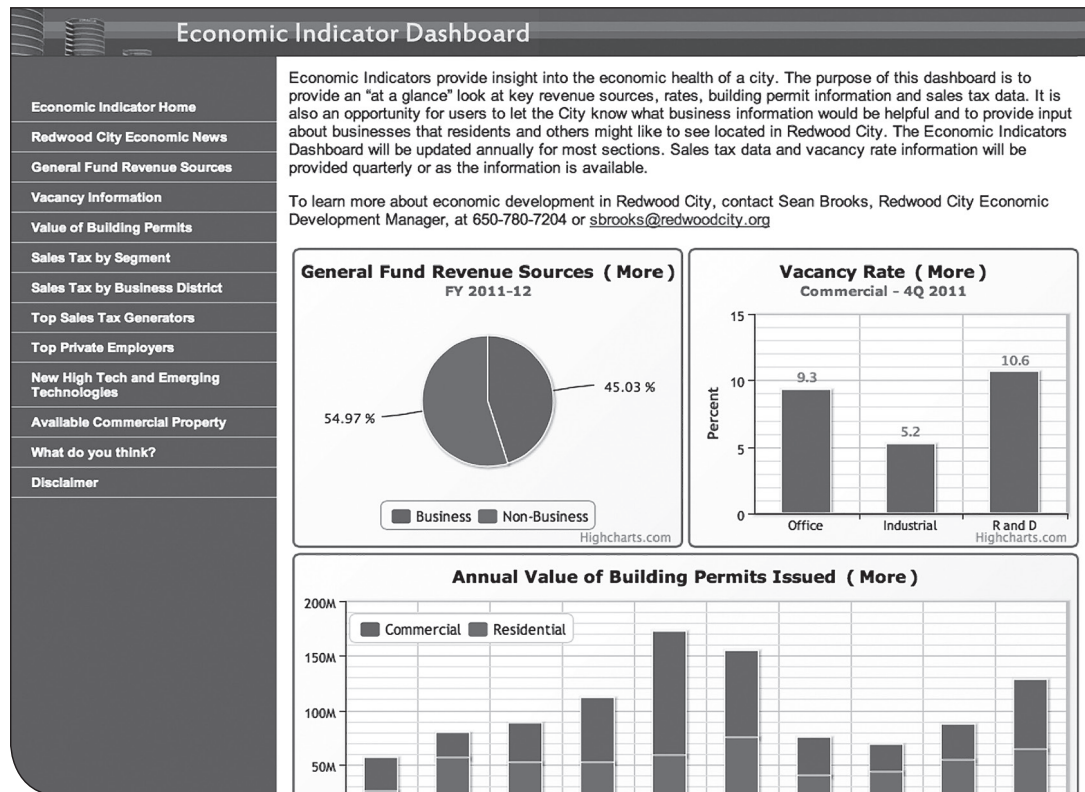
On another scale, the much smaller town of Redwood City, California (a suburb of 76,815<sup>8</sup> in the San Francisco Bay area) is also making a name for itself with its data visualization. Redwood City posts interactive budget, economic, and business data in a dashboard in order to be more transparent, help local business, and attract additional economic activity ([www.redwoodcity.org/business/dash/index.html](http://www.redwoodcity.org/business/dash/index.html)).

“This dashboard is so straightforward and user-friendly, yet it provides a great deal of valuable information that businesses will find indispensable,” said Bob Bell, city manager. “We worked with Vice Mayor Gee ... to create this easy-to-use tool, and I think residents will be interested in seeing where the city’s revenues come from—which in turn are used to provide the city services they use.”<sup>9</sup>

The dashboard (Figure 12) provides graphic data visualizations and data tables for:

- General fund revenue sources
- Non-residential revenues
- Commercial vacancy rates by sector
- Annual value of building permits issued
- Sales tax by economic segment

**Figure 12: Redwood City Economic Development Dashboard**



Source: [www.redwoodcity.org/business/dash/index.html](http://www.redwoodcity.org/business/dash/index.html)

8. Association of Bay Area Governments. 2012. Bay Area Census. Available at <http://www.bayareacensus.ca.gov/cities/RedwoodCity.htm>.

9. *Government Technology*. 2012. Redwood City Gets Graphic with Economic Data. Posted September 7, 2012. Available at [www.govtech.com/budget-finance/Redwood-City-Gets-Graphic-with-Economic-Data.html](http://www.govtech.com/budget-finance/Redwood-City-Gets-Graphic-with-Economic-Data.html)

Also included in the dashboard is a citizen response area (What do you think?) that asks two questions:

- Is there a business or service that you think would add value to the City's business mix?
- After looking at this Economic Indicators Dashboard, is there anything else that you think should be added? If so, please describe.

All of the work for this dashboard and its data visualizations was done in house between the economic development program within the Department of Community Development and the information technology program within the finance department. They used all internal resources from the economic development and IT programs for the project.

Sean Brooks, the current economic development manager, and Joe Marvin, the city's webmaster, estimate that it took 20 hours of Marvin's time, plus meetings to coordinate and plan, and the time required to gather the data; the total estimated time to complete the project was approximately 100 hours. More planning time was spent than actual time doing the project, in their case. Staff determined what needed to be posted and will maintain the data on a quarterly basis. However, members of the city council working on the economic subcommittee also worked and consulted on the project.<sup>10</sup>

The staff used [Highcharts.com](http://Highcharts.com), an inexpensive software investment, to implement the project. Rather than allowing the user to create charts from scratch, Highcharts is an open-source library of Javascripts; users may download scripts and alter them for their own circumstances. Users from nonprofits, personal projects, or school projects may download the scripts for free. Beyond that, a single website license is only \$80 for a non-developer website; for websites that are applications that charge fees, a developer license is required, for \$360. Highcharts states it works in all web browsers and numerous chart types and chart options are available; no programming skills are required. Beyond Highcharts for the charts themselves, the web editor Dreamweaver was the only other software needed to implement the project.

Once the dashboard was completed, the city issued a press release which resulted in some stories about their project, including one in *Government Technology* magazine; no other advertising, marketing, or community outreach was done for the project. Based upon just that much outreach, they received considerable initial feedback from other cities and businesses asking how they implemented the project. The project was highlighted as an important innovation for the city in the 2011–2012 *Annual Report* of Redwood City.<sup>11</sup>

From August 1, 2012 (date of implementation) to January 28, 2013, the dashboard site received 2,205 visits and 2,274 page views. Today, the dashboard overall is receiving 3,000 times the page views of the average Redwood City website page and the top dashboard pages are receiving 4.5 times the page views of the average page, indicating a relatively high level of success for the city in this project.

The city's future plans for the project are to continue to maintain the site while expanding to include new economic development projects and adding other features to make the site useful to the business community. Redwood City is continuing to learn what works best and which of the data visualizations they have already incorporated are easiest to understand.

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10. Interview with Sean Brooks, Redwood City economic development manager, and Joe Marvin, city webmaster, January 25, 2013.

11. Redwood City. Innovations Implemented this Fiscal Year. In *Redwood City Annual Report*, Fiscal Year 2011–2012, p 3.

## State of Texas

Work on incorporating transparency into the Office of the Texas Comptroller of Public Accounts website began the week after the current comptroller, Susan Combs, was elected in 2007. Serving as both the state treasurer and chief financial officer, she believed strongly in the need for citizens to see and understand the finances of their governments. She immediately posted information about state expenses and then encouraged the state's 24 largest agencies to let her do the same with their information. She followed this by developing a virtual check register to allow citizens to more easily understand, at a glance, the kinds of expenditures made by the state.

From there, it has been a clear road to moving steadily toward more and more open government and to some significant data visualization. In Comptroller Comb's office, visualization is a natural tool to help citizens understand their government.

As Jeremiah Akin and Michael Castellon, two comptroller's office staff tasked with making these tools available to the public, made clear at the 2011 SXSW Interactive Festival (South by Southwest, a popular technology conference held in Austin every year):

The expectation of transparency is creating demand for government agencies to develop new ways to communicate complex data and trends to the public in easy-to-access and easy-to-understand formats.

Some agencies are turning to Google Maps and KML data to visualize raw information online and on mobile devices. Delivering data in more easily understandable formats not only boosts trust and confidence between government agencies and their publics, but also streamlines workloads among Data, Web, Editorial, and Customer Service teams.<sup>12</sup>

There are now tens of data sets available as well as many visualizations; these are mostly focused on government expenditures, revenues, and performance, such as where sales and property taxes go and how much debt governments have. There are sections tracking the Texas economy, including a complete dashboard of economic indicators, along with a map indicating where ARRA stimulus funds went around the state (Figure 13). As the key indicates, the color of the blocks (counties) indicates the level of stimulus funding going to that county. The map is interactive for users, as they can select a county from the drop-down menu and see that county's detailed stimulus funding by category in data table and pie chart.

One unique map (Figure 14) allows users to drill down into school spending compared to school performance; this also allows comparisons of similar schools and districts.

According to Beth Holloway, manager of the web and editorial section of the Data Services Division,<sup>13</sup> their transparency and open government pages receive up to 9,000 page views per month. The most popular are maps indicating where the state's money goes.

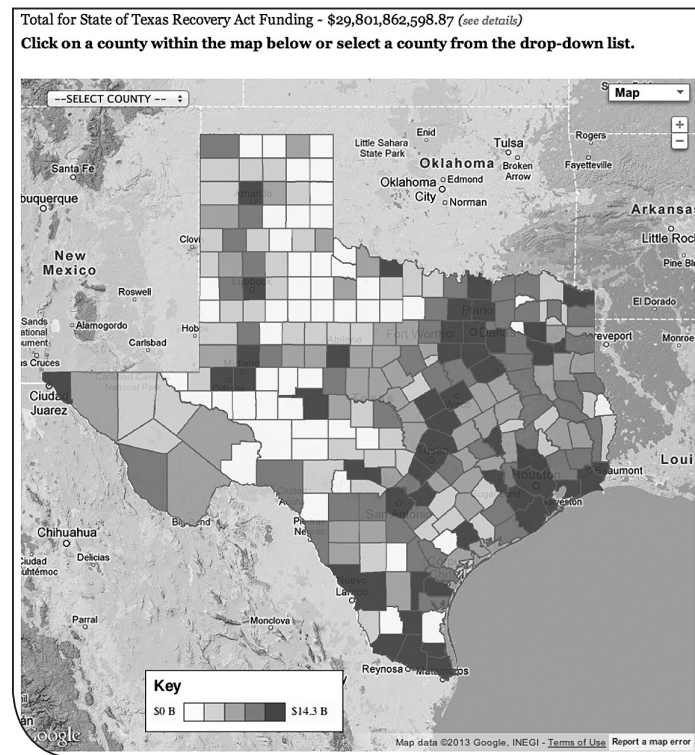
There is no special allocation or budget for data visualization or even open government efforts; the comptroller sees it as part of her legislative duty to report on the state of the Texas economy; transparency is part of the culture of the services she provides as chief financial officer of Texas. The work is done within the Data Services Division by a web team, data analysts,

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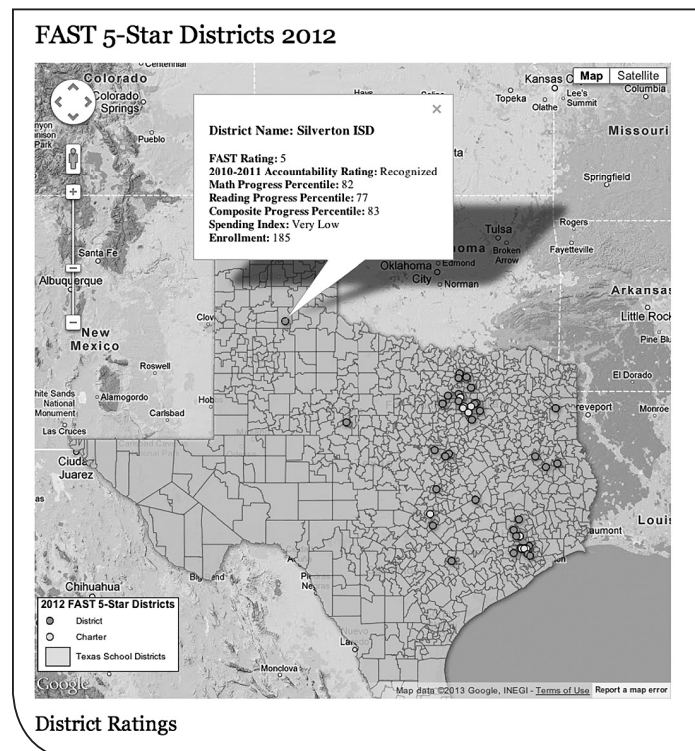
12. Howard, Alex. 2011. Making Open Government Data Visualizations That Matter. Gov20.govFresh. Available at [gov20.govfresh.com/making-open-government-data-visualizations-that-matter/](http://gov20.govfresh.com/making-open-government-data-visualizations-that-matter/), March 13, 2011.

13. Interview with Beth Holloway, manager, web and editorial section, Data Services Division, Texas Comptroller of Public Accounts. February 25, 2013.



**Figure 13: Texas ARRA Stimulus Funds Map**

Source: Texas Office of the Comptroller, Texas Transparency,  
[www.window.state.tx.us/recovery/transparency/map/index.php](http://www.window.state.tx.us/recovery/transparency/map/index.php)

**Figure 14: Texas School Achievement Results Combined with Spending Information**

Source: Financial Allocation Study for Texas (FAST), 2012. [fastexas.org/results/districtMap.php](http://fastexas.org/results/districtMap.php)

graphic designers, and some editors. The actual tool is delivered online by the IT division. Ms. Holloway estimates that perhaps 10 percent of the division's work is involved in providing these online maps, visualizations, and data sets.

All of these maps and other data visualizations have been built in-house in the comptroller's office using a variety of tools, including Google Fusion Maps, ArcGIS and ArcGIS Online, business analytics tools, and some custom programming. Currently, the office is searching for new tools to use as they expand their usage of data visualization, including developing more dashboards.

Outreach to advertise these services has not really been necessary since the Open Government site with the data visualization and interactive maps is on the comptroller's primary portal and that portal is where Texans come to pay their state taxes. However, they do take advantage of this traffic by setting up opt-in e-mail subscription registrations so that citizens can sign up to get notified when something new has been posted.

In the future, Texas will be working more on dashboards and additional data visualization, and with local governments to help them promote their own data by posting it and doing visualization. The comptroller's office will also be adding more pension information, given that it is such a critical issue today; and will be incorporating considerably more mapping technology. Texas is also making open data and data visualization available on mobile devices like smartphones and tablets.

Texas is convinced that this is the way of the future—it is not enough to put data out there and make it available, it is also important to make it useful. This leads to better government and ultimately, to real savings.

## U.S. Department of State

Many federal agencies are currently working to create excellent data visualization. One of these is the U.S. Department of State, which has made innovative technology, open government, and transparency the centerpiece of many of its initiatives and is thus one of the federal innovators in data visualization. They began the data visualization efforts discussed in 2012 as part of the Department's Open Government Plan. Prior to that, the State Department had already begun moving ahead in the area of information technology.

One means of doing that is the Tech@State group, part of the secretary's 21st Century Statecraft Initiative, which is run by the Office of eDiplomacy in the State Department's Bureau of Information Resource Management. The stated goal of Tech@State is to "connect tech innovators with those interested in diplomacy and development to enable 21st century statecraft"<sup>14</sup> and a series of conferences is designed to accomplish this goal. Among the topics of these conferences have been technological innovations used in Haiti, mobile money, Civil Society 2.0, Serious Games, Open Source—and data visualization.

The Data Visualization conference was held in 2011. The keynote speaker was Edward Tufte, the graphics expert. Panelists looked at "ways visualization is being used to turn information into insight, and how visualization is being connected with mobile technology and new media to increase its overall impact."<sup>15</sup> Topics covered included how visualization is supporting the understanding of food security, foreign aid, and disaster response.

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14. U.S. Department of State. 2013. Tech@State. Available at [tech.state.gov](http://tech.state.gov).

15. Hayes, Tim. 2011. Tech@State Convenes Data Visualization Conference. In DipNote, the U.S. Department of State Official Blog. <http://blogs.state.gov/2011/10/article/techstate-convenes-data-visualization-conference>.

According to the Storify record by Ashoka + Changemakers, the major points made throughout the conference were:

- The whole point of data is to tell a story, and to do so effectively there must be credibility in content and creativity in presentation.
- Data visualization is about revealing the truth.
- The ultimate goal is not the visualization itself—it is to foster understanding.<sup>16</sup>

The scope of the department's efforts is made even more clear by examining the Virtual Student Foreign Service program; the "Virtual Student Foreign Service is part of a growing effort by the State Department to harness technology and a commitment to global service among young people to facilitate new forms of diplomatic engagement."<sup>17</sup> Among the duties of these e-interns (American students working virtually) are developing social media strategies and to "conduct research on the economic situation, prepare graphic representations of economic data, and prepare informational material for the U.S. Embassy website."<sup>18</sup> Being able to create data visualization is part of the job description for most, if not all, of these Virtual Student Foreign Service positions.

The State Department is also making data visualization part of its diplomacy effort; as stated in the Open Government Plan, it helps users understand what is happening in countries around the world and in situations around the world. The department has focused on two websites in particular—[HumanRights.gov](http://HumanRights.gov) and [ForeignAssistance.gov](http://ForeignAssistance.gov). According to the 2012 Open Government Plan, these two initiatives were innovative ways to bring information together about a wide variety of human rights efforts and foreign assistance.<sup>19</sup>

The plan for the HumanRights.gov site was to create a vertically and horizontally integrated site to be the main site for users to seek information about human rights. Within the Department of State, the Humanitarian Information Unit (HIU) has the mission of "providing U.S. Government officials and other aid organizations with geographic data and analysis to prepare for and respond to complex humanitarian emergencies worldwide."<sup>20</sup> Their products are found on HumanRights.gov, among those of other State Department offices. In addition to creating very sophisticated data visualization and infographics, HIU also uses geographic information systems (GIS) for maps. HIU maintains and distributes the Large Scale International Boundaries Data Set, maintains other data sets on important international trends such as the current Syrian crisis, and provides thematic coverage on issues like political and military conflicts, refugees, climate change, natural disaster, and food/water security. They map global trends in disaster response, human rights, and population; provide mapping of hazards, conflicts, and displacements; promote awareness; conduct policy analysis on issues of current interest, and do customized visualization.<sup>21</sup>

While data sets are available for download, the open government emphasis here is not on citizens taking that data and creating their own charts with tools provided on the site. Instead, the open government emphasis is on the creation of understandable policy analyses and graphics based on data.

16. Ashoka + Changemakers. 2011. Tech@State. [storify.com/changemakers/techstate](http://storify.com/changemakers/techstate)

17. U.S. Department of State. 2013. Virtual Student Foreign Service. [www.state.gov/vsfs](http://www.state.gov/vsfs).

18. Ibid.

19. U.S. Department of State. 2012. Open Government Plan. [www.state.gov/documents/organization/188085.pdf](http://www.state.gov/documents/organization/188085.pdf) April 9, 2012, p. 30.

20. Humanitarian Information Unit, U.S. Department of State. Mission. [hiu.state.gov/Pages/Home.aspx](http://hiu.state.gov/Pages/Home.aspx)

21. Humanitarian Information Unit, U.S. Department of State. HIU Overview. [hiu.state.gov/Products/Global\\_HIUOverviewPresentationBoard\\_2012Apr26\\_HIU.pdf](http://hiu.state.gov/Products/Global_HIUOverviewPresentationBoard_2012Apr26_HIU.pdf)



Figure 15 is an excellent example of a sophisticated infographic that simultaneously provides several pieces of information. While the infographic includes data tables to provide exact information, the eye is immediately drawn to the map itself and the arrows. The direction of the arrows provide critical information about refugee movements—where they are coming from and where they are going—while the size of the arrows indicates the number of the refugees going from one place to another. This makes the graphic especially informative, even to those not comfortable with numbers.

Another example of this sophisticated map-making and infographic capability is the map illustrating the displacement of Syrian citizens fleeing internal violence as refugees in 2012 and 2013 (Figure 16); this particular map illustrates the situation on January 10, 2013. More than infographic, it features notes providing particular pieces of data placed around the page.

The second site highlighted by the Open Government plan is ForeignAssistance.gov ([www.foreignassistance.gov/AgencyLanding.aspx](http://www.foreignassistance.gov/AgencyLanding.aspx)). The State Department website provides the background on the creation of the site:

The ForeignAssistance.gov site was created in response to the principles of the Paris Declaration on Aid Effectiveness and President Obama's Open Government Initiative. As part of the efforts to pursue greater transparency in government, the Administration has developed an Aid Transparency Agenda for Action, of which this Foreign Assistance Dashboard is an important part. The U.S. Government is committed to making information on foreign assistance programs more transparent, accessible, and compatible with international standards.

The ForeignAssistance.gov site is part of the National Action Plan of the multi-national Open Government Partnership. ForeignAssistance.gov is specifically highlighted in the plan as a means to increase the transparency of foreign assistance. The Aid Transparency Agenda for Action will enable us to pursue the following objectives: Make foreign aid more useful for development. Greater aid transparency accomplishes this objective by assisting recipient governments to better manage their aid flows and by empowering citizens to hold governments accountable for how assistance is used; Increase the efficacy of our foreign assistance. With a clearer understanding of what we are doing, where, and to what effect, the U.S. will be better positioned to maximize the impact of our resources and investments; and Increase international accountability. Greater access to information about assistance will help developing country governments and international civil society to hold donors accountable for the quantity and quality of aid flows".<sup>22</sup>

The ForeignAssistance.gov site is set up as a dashboard in progress, with data coming from an increasing number of federal agencies over time. Like other data visualizations presented in this report, the site is also set up for citizens to download and manipulate data themselves, generating their own tables.

The data on where foreign assistance funds are going are organized according to country receiving funds, by sector, by policy initiative, by agency, and by overseas contingency operations. Also included is a report query tool which allows citizens to create and download their own report.

22. U.S. Department of State. 2012. Open Government Plan. Available at [www.state.gov/documents/organization/188085.pdf](http://www.state.gov/documents/organization/188085.pdf) April 9, 2012, p. 34.

Figure 15: Sub-Saharan Africa: Major Refugee Presence

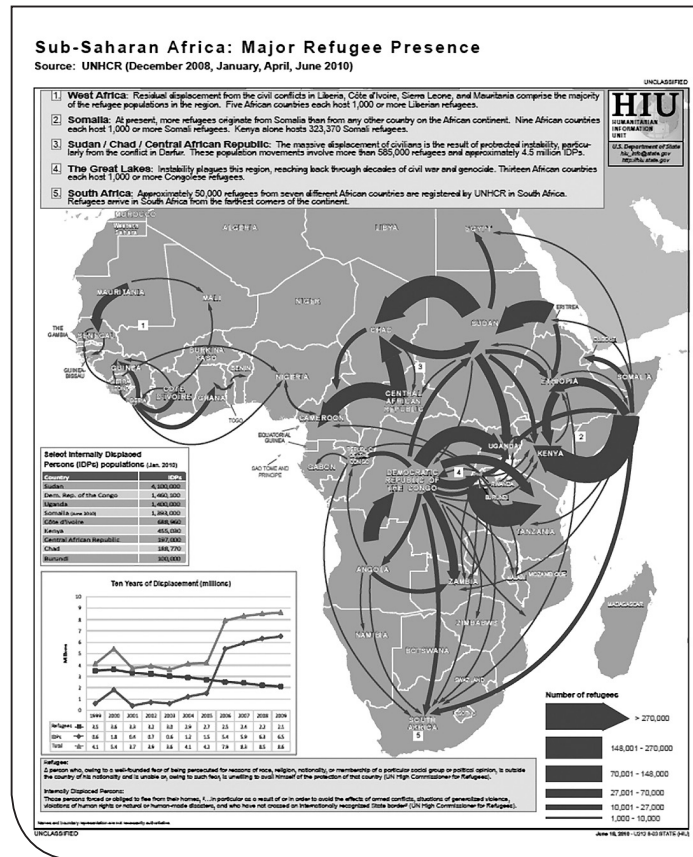
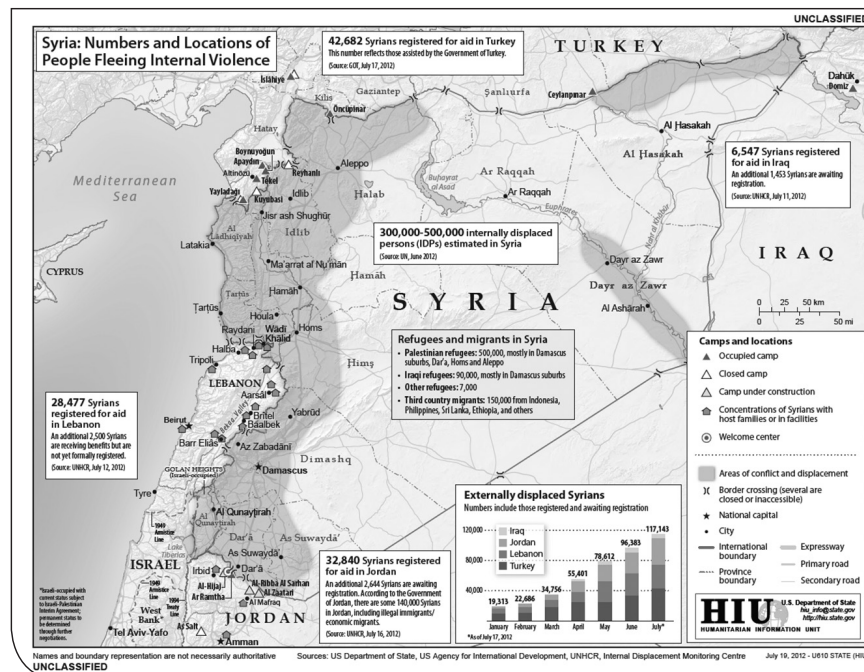
Source: [www.humanrights.gov/2010/06/22/african-refugee-map-3](http://www.humanrights.gov/2010/06/22/african-refugee-map-3)

Figure 16: Numbers and Locations of Syrians Fleeing Internal Violence

Source: [www.humanrights.gov/wp-content/uploads/2012/07/Syria\\_DisplacementRefugees\\_2012July19.pdf](http://www.humanrights.gov/wp-content/uploads/2012/07/Syria_DisplacementRefugees_2012July19.pdf)

Interactive maps and data visualizations are also available. Figure 17 provides an interactive map illustrating the amount of foreign assistance by country office, with the amount of funds indicated by color. Users can zoom in or zoom out and, by placing the cursor over a country, can receive details of each country's foreign assistance request for the current fiscal year. In addition, the data may be filtered (chosen) by fiscal year, from 2006 to 2013.

## U.S. Census Bureau

Another important contributor to data visualization in the public sector is the U.S. Census Bureau. The bureau has a data visualization gallery, updated weekly. Their early efforts focused on historical population data but the gallery will be expanding to include other kinds of data.

One compelling visualization is shown in Figure 18, The Top 20 Cities (Highest Ranking Cities, 1790 to 2010). An interactive map, its basis is the number of times each city has been in the top 20 cities in the country from 1790 until 2010; the size of each city name is a representation of how many times it has been in that top 20. Clicking on a city name will produce a timeline showing when the city was in the top 20 and its rank at the time, with an orange block indicating its highest ranking.

## U.S. Patent and Trademark Office

The U.S. Patent and Trademark Office (PTO) also has an impressive set of data visualizations in the form of data dashboards—including much data, but not interactive for the user. They include Patents, Trademarks, Office of External Affairs, and Patent Trial and Appeal Board dashboards. Figure 19 shows just one small part of the Patents Dashboard, illustrating performance measures for February 2013 and the bottom portion of a graph showing the numbers of patent applications received for the past year.

The box on page 33, *Further Reading on Data Visualization*, provides suggestions for further reading about data visualization for the interested reader.

FOREIGNASSISTANCE.gov

v1.1

search the data

WHAT'S COMING

WHERE IS THE MONEY GOING?

WHAT YOU SHOULD KNOW

FAQS

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DATA

Home / Where is the Money Going? / Country Office / Country Offices

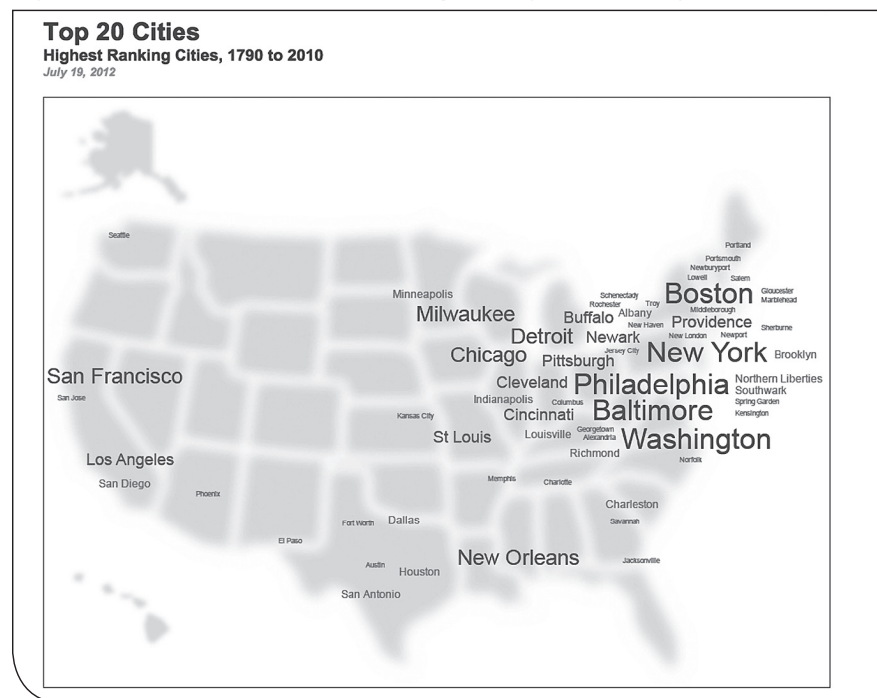
Foreign Assistance By Country Office

Filter Information by Fiscal Year: 2013

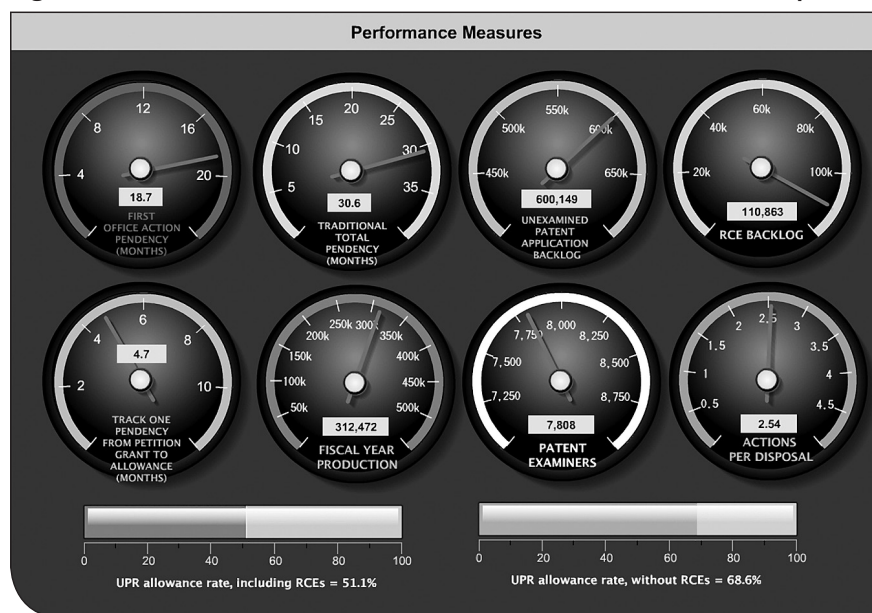
Legend:

- \$1B-\$4B
- \$250M-\$1B
- \$100M-\$250M
- \$50M-\$100M
- \$25M-\$50M
- \$10M-\$25M
- \$1M-\$10M
- <\$1M
- No funds

**Figure 18: U.S. Census Bureau Example—Highest Ranking Cities, 1790 to 2010**



32

**Figure 19: U.S. Patent and Trademark Office Data Dashboards Example**

Source: <http://www.uspto.gov/dashboards/patents/main.dashxml>

### Further Reading on Data Visualization

John Emerson's 2008 booklet, *Visualizing Information for Advocacy: An Introduction to Information Design*. Published by the Tactical Technology Collective, it is available online at [backspace.com/infodesign.pdf](http://backspace.com/infodesign.pdf).

Stephen Few's *Now You See It: Simple Visualization Techniques for Quantitative Analysis*. Burlingame, CA: Analytics Press.

Edward R. Tufte's books on data visualization, including the first, 2001. *The Visual Display of Quantitative Information* (2nd edition) Cheshire, Connecticut: Graphics Press.

Dona Wong, 2010. *The Wall Street Journal Guide to Information Graphics: The Dos and Don'ts of Presenting Data, Facts and Figures*. W.W. Norton and Company.

Nathan Yau's 2011. *Visualize This: The FlowingData Guide to Design, Visualization, and Statistics*. Hoboken, New Jersey.

# Recommendations

## How to Increase the Use of Visualization in Government Organizations

Data visualization is a creative and important way to express data's meaning. These six steps can increase the use of visualization in government.

### Step One: Begin and End with the Data

The first step is to answer the following questions:

- What story do you want to tell with the data?
- What are the patterns within the data?
- What conclusions can be drawn from the data?
- Determine the story within the data and then use the visualizations to tell that story.

### Step Two: Create a Storyboard to Map out the Points that You Want to Make with Your Visualization

### Step Three: Answer the Following Questions about Audiences and Goals

- Who is the audience?
- What level of knowledge and access to IT do they have?
- What level of understanding of data do they have?
- What do they want to know about your agency and its data?
- What do you want them to know about your agency and the issue you are trying to highlight?

The more sophisticated the audience, the more interactive the visualization that should be developed.

### Step Four: Analyze Your Resources

At this point, you should answer the following questions:

- Among your existing staff, who already has talent or experience in charts, data analysis, and graphics—or is willing to learn?
- How much time are you willing to devote to this project?
- Can you use interns and virtual interns as done in the Department of State?
- Can you collaborate with other agencies that might already be working with visualization and might be willing to share knowledge and resources?



**Step Five: Select the Software to be Used**

You should try out several of the available tools before making a final choice of software. Based upon the resource analysis, choose from among the wide variety of tools available today. You should not have to use one of the more sophisticated tools to produce a professional result.

As part of your resource analysis, you should have determined whether there funds are available to purchase software or whether you will be using free software.

**Step Six: Start on Visualization**

- Be creative in your production as well as in the visualization itself.
- Remember, tell a story: Data + Analysis + Design = Better Understanding of Data for users.
- Experiment with a few visualizations to get accustomed to the process—decide which options you'd like to use and which ones should be in your final visualizations.
- Check out the resources listed in this report—many are quite sophisticated but many also can be used with little training and resources. Go through the websites and review examples highlighted to see the process followed by others.
- Don't think the first efforts have to be perfect—start out simple and then over time add more and more elements to your graphics.
- Seek feedback from citizens using your site and from staff members. What is working and what is not? Be flexible in making changes.
- Make sure to incorporate disclaimers for the data just as agencies now do for their websites. Appendix II has sample disclaimers for Chicago, Texas, and Redwood City, California.
- Finally, this field is changing fast—for updates, bookmark relevant sites in this report and check them for developments. Follow the blogs to learn about new features and trends in the field and try them out.

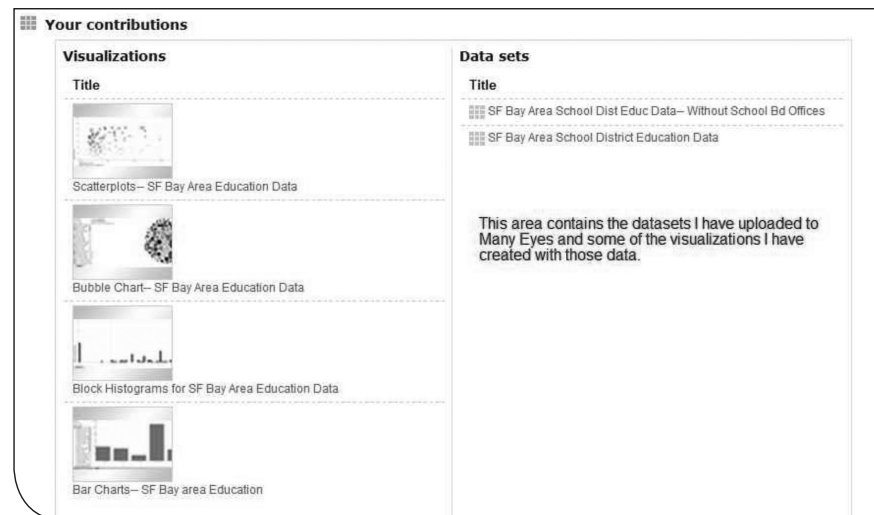


# Appendix I: Tool Examples

## Many Eyes

Many Eyes, IBM's free visualization tool, allows users to upload their own data or work with data from other users. In this example, the author has created and uploaded a data set of San Francisco Bay Area school districts with demographic, fiscal, and student achievement data. Uploading a data set from Excel is just a matter of copying and pasting into the Many Eyes website through a browser. This user's contributions to the site can be seen in Figure A.1.

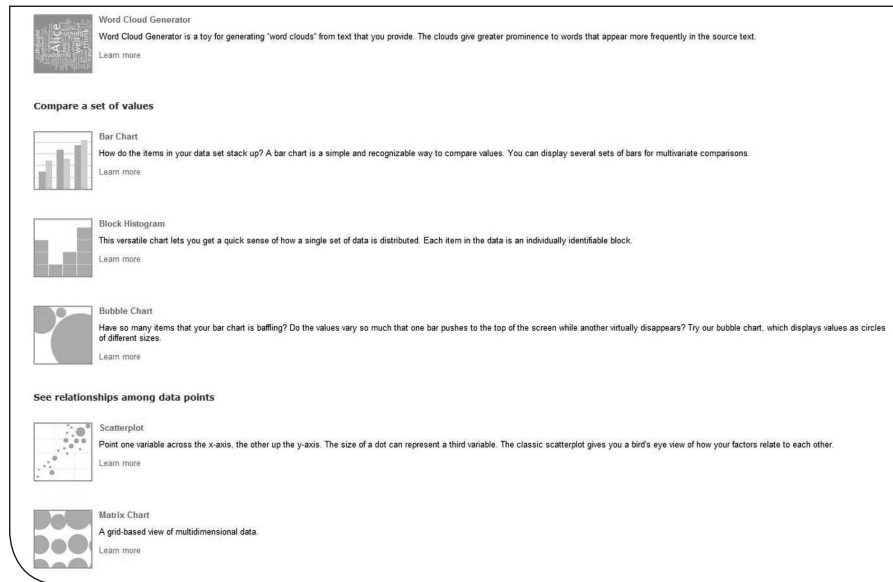
**Figure A.1: Example of One User's Contributions Area Including Data Sets and Completed Visualizations**



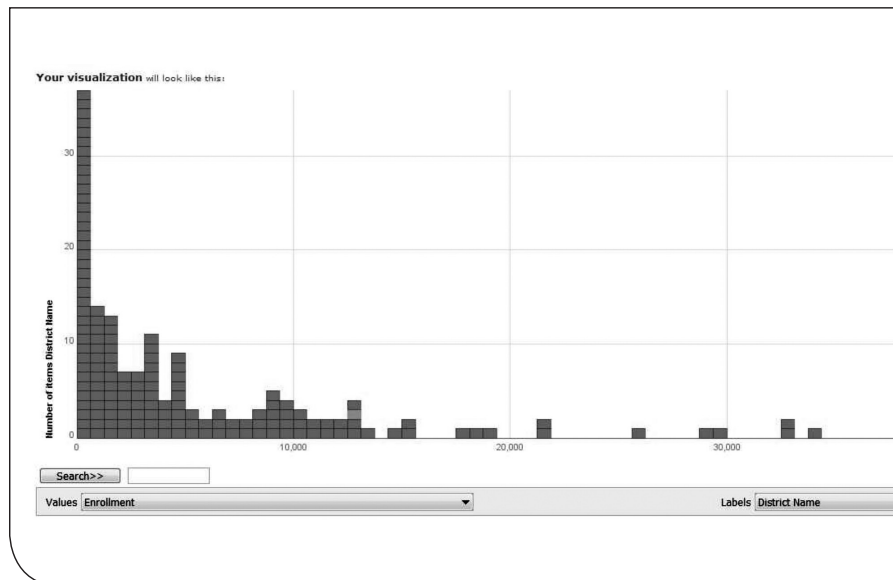
**Source:** [www-958.ibm.com/software/data/cognos/manyeyes](http://www-958.ibm.com/software/data/cognos/manyeyes)

After the user selects the data set and chooses to go on to Visualizations, they may select a graph type from categories of Analyze A Text (including Word Cloud Generator), Compare A Set of Values (Bar Chart, Block Histogram, Bubble Chart), See Relationships Among Data Points (Scatterplot, Matrix Chart, Network Diagram), See Parts of A Whole (Pie Chart, Tree Map), or See The World (do a map with supported countries or U.S. counties) (Figure A.2).

After selecting Block Histogram, the user can now select whichever variables they would like to display, using the Variable selector (select from drop-down menu); labels and variable level can also be chosen using the drop-down menu to the right. Note: the image is abbreviated and outliers are cut off so that labels may appear large enough (Figure A.3). Each block represents one data point; placing the cursor over one block allows the user to see its label and data content. The overall graph is a histogram of school districts by enrollment.

**Figure A.2: Examples of Select Graph Types**

Source: [www-958.ibm.com/software/data/cognos/manyeyes](http://www-958.ibm.com/software/data/cognos/manyeyes)

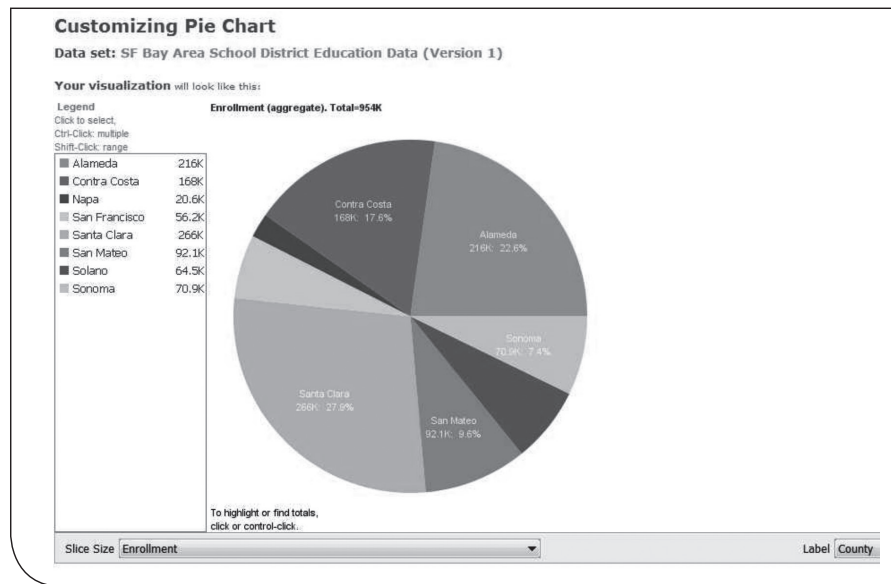
**Figure A.3: Many Eyes Example: Enrollment by School District**

Source: [www-958.ibm.com/software/data/cognos/manyeyes](http://www-958.ibm.com/software/data/cognos/manyeyes)

The user may easily change the variable illustrated by selecting other variables from the drop-down menu.

Another chart may be easily created by going back to the data and selecting Visualizations. This time, we will select See Parts of a Whole and then Pie Chart (Figure A.4).

Once again, variables may be changed easily to quickly examine other patterns in the data; data labels are automatically added as is the data table. Other options are available, as well.

**Figure A.4: Many Eyes Example: Pie Chart of Student Enrollment by County**

Source: [www-958.ibm.com/software/data/cognos/manyeyes](http://www-958.ibm.com/software/data/cognos/manyeyes)

## Tableau Public

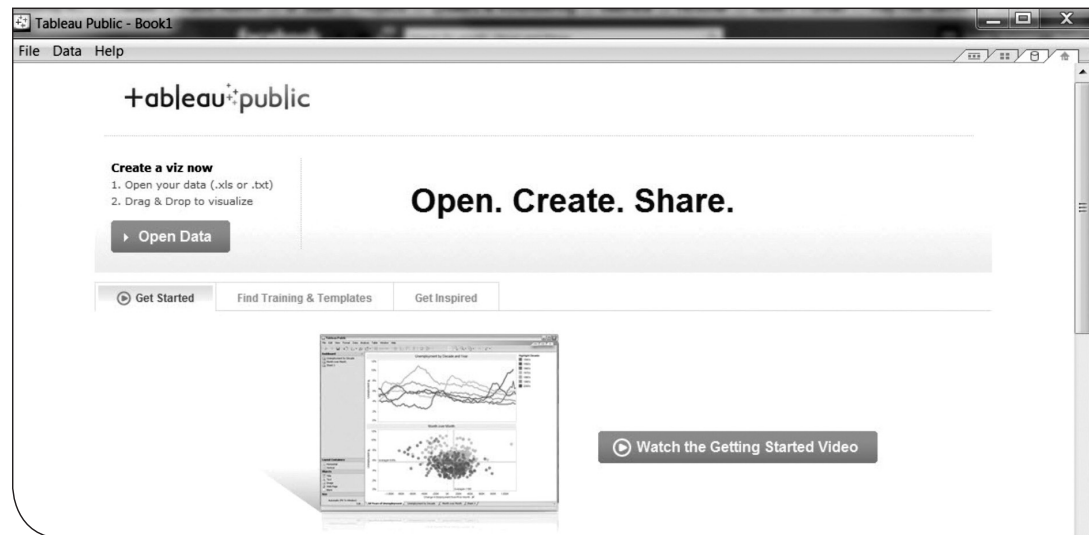
Tableau Public will be illustrated next to create some examples of data visualizations using different software approaches. The difference between Tableau Professional and Tableau Public is that Tableau Public is free and allows fewer data types (although Excel .xls, .txt, and Access files are allowed). Tableau does not work through a browser; it has to be downloaded and installed on a user's computer. It is not currently platform-independent, although a Mac version will be available in the summer of 2013. Unlike Many Eyes, the data are not made public when the user desires to post the visualization online, but are stored on the Tableau site.

Figure A.5 illustrates the opening screen of Tableau Public, where users may open their data sets. Note the tabs below that indicate the kind of help available—a Get Started video on one tab, Find Training and Templates on another tab, and Get Inspired (by examples) on the third; Tableau has excellent help available in the form of videos, examples, and quick responses to answers via e-mail.

Tableau guesses the structure of the data, assumes the labels are at the top of each column and the cases are in rows, and then prepares the data, separating the variables into either Measures (variables) or Dimensions (labels) (Figure A.6). Under the Show Me menu to the right are possible graph types; those suggested for the available data are shown highlighted, not grayed out.

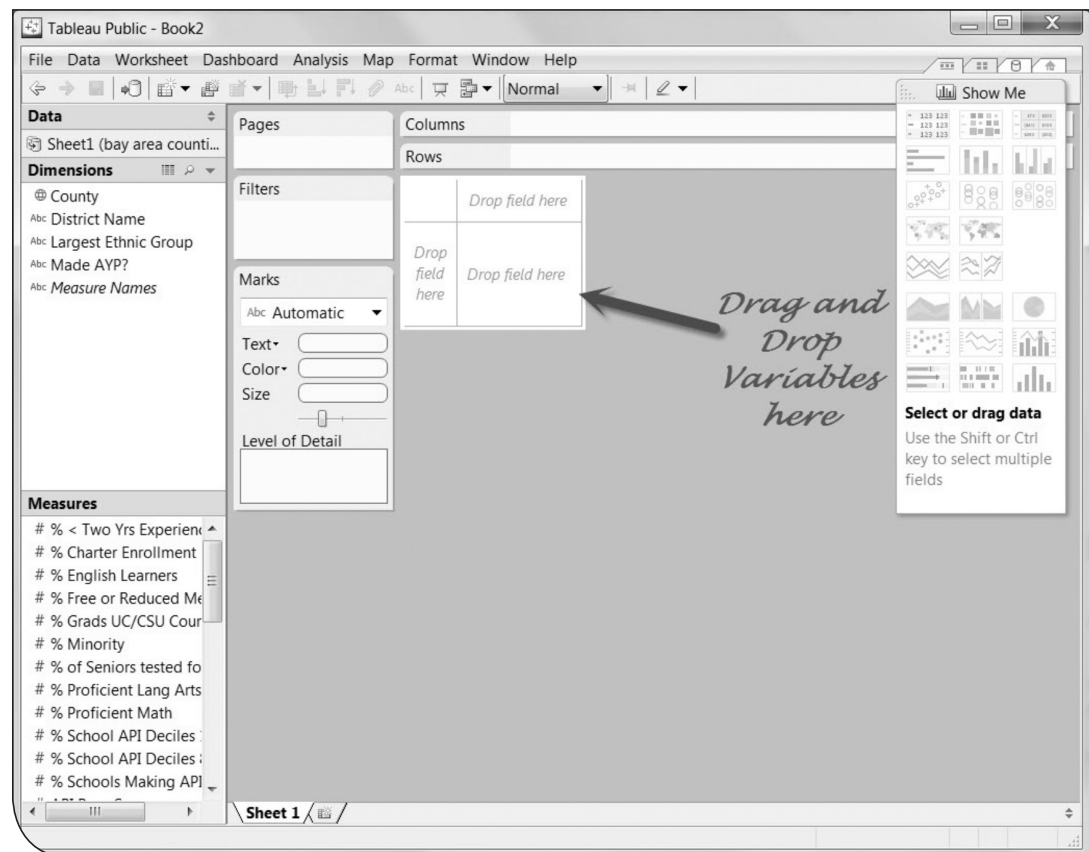
To create a visualization, the user simply drags and drops variable names into the center area, (Drop Field Here).

Figure A.5: Example of Tableau Public Opening Screen—Opening Data Set



Source: Created by author

Figure A.6: Example of Tableau Work Area

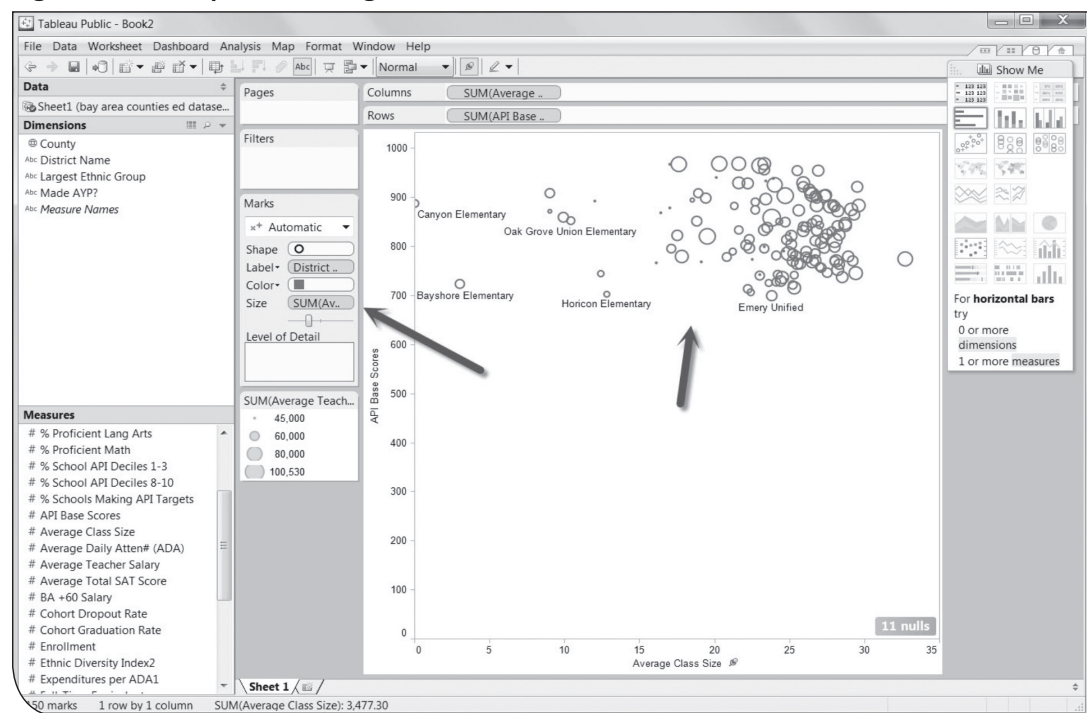


Source: Created by author

In this example (Figure A.7), Average Class Size was dropped into the Column Field and API (Academic Performance Index, the California student achievement measure) was dropped into the Rows field. In addition, the Dimension District Name was dropped into the Label area of the Marks tab and Average Teacher Salary was dropped into the Size area of the Marks tab. This allows the size of the data points to vary according to teacher salary and provide a chart illustrating the patterns from three different variables.

The labels from outlier data points are visible immediately but the user can see the labels and data from other data points by placing their cursor on top of the point. Many other options are also available from this powerful software. Creating a basic chart is very easy; learning the other options involves a slight learning curve and it is worth the time to view the videos before creating something more sophisticated (such as a chart with menu sliders or drop-down menus).

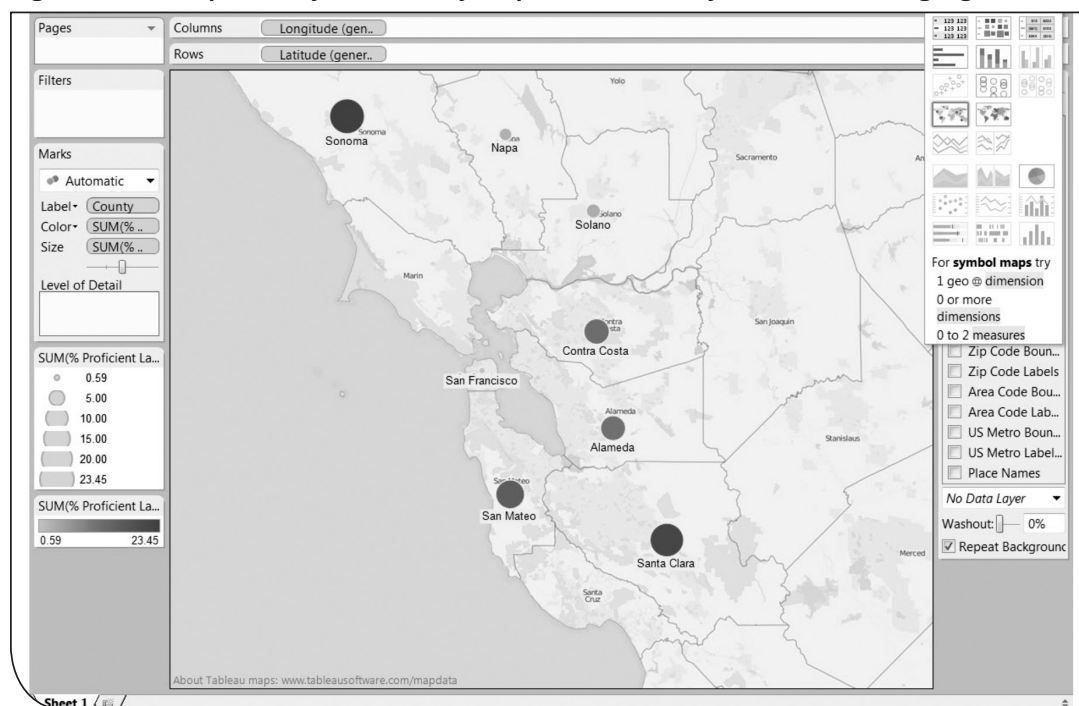
**Figure A.7: Example of Creating a Chart in Tableau Public**



**Source:** Created by author

Using the same data, a map can be easily and quickly created by moving the Latitude and Longitude variables automatically created (since County is one of the variables) into the Columns and Rows fields (Figure A.8). This time, % Proficient in Math is moved into the Color field and categories of the percent of students who are proficient in math are generated, with each category being given a color. Various color schemes may be selected for effect. The variable % Proficient in Language Arts is moved into the Size field; the size of each data circle reflects the percent of students who were tested as proficient in language arts. The categories for each size of data circle may also be edited.

Tableau Public comes with data overlays of U.S. Census data already available at the state and county levels, making it tremendously easy to do map graphics.

**Figure A.8: Example of Bay Area County Map with Proficiency in Math and Language Arts**

**Source:** Created by author

Any of the built maps or charts, complete with labels and titles, may be moved onto the web using the Tableau servers. In addition, a series of maps or charts may be easily dragged and dropped into a dashboard format and then also posted to the web.



# Appendix II: Disclaimers for Chicago, Redwood City, and Texas

## Data Disclaimer at the City of Chicago Open Data Portal

Source: [www.cityofchicago.org/city/en/narr/foia/data\\_disclaimer.html](http://www.cityofchicago.org/city/en/narr/foia/data_disclaimer.html)

### Data Terms of Use DISCLAIMER OF LIABILITY

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Users of this website should [report any errors or problems](#) that they encounter while using this website or accessing the data provided herein.

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**Source:** [www.redwoodcity.org/business/dash/disclaimer.html](http://www.redwoodcity.org/business/dash/disclaimer.html)

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## State of Texas Methodology and Disclaimer

Source: [www.window.state.tx.us/recovery/transparency/map/index.php](http://www.window.state.tx.us/recovery/transparency/map/index.php)

### What data is being used:

The information is compiled from data received directly from Texas state agencies and public institutions of higher education and data posted on the federal [Recovery.gov](http://Recovery.gov) Web site. The map also includes additional Recovery Act programs, such as Medicaid and Unemployment Benefits, which are not subject to Recovery Act reporting requirements.

The county breakdown does not include payments made to individuals and tax provisions pursuant to the Recovery Act. For state entities which received a direct award of Recovery Act funding (known as prime recipients), and subsequently allocated a portion of the funding to other entities (known as sub-recipients), the unallocated award amount is included for the prime recipient *within* its respective county.

### How we display location of funding:

Direct recipients of Recovery Act funding (known as prime recipients) must indicate a Place of Performance (POP) when reporting to the federal government. Direct recipients may allocate a portion of funding to other entities (known as sub-recipients) and must also identify the POP. The county breakdown is based on the POP, when available. Any direct recipient that has unallocated funding to date will be reflected in the county in which the state entity is headquartered. In the event that it is not possible to determine a single place that is receiving funding, the county in which the state entity is headquartered will reflect the Recovery Act funding. For example, unemployment benefits are paid to individuals across the state. The Recovery Act funding for this program will be reflected in Travis County and not allocated to any other county.

### Timing of the data:

Section 1512 of the Recovery Act mandates quarterly reporting for certain Recovery Act programs. The data displayed on this map reflects **Preliminary** data through the Section 1512 December 2012 quarter end and December 2012 data for federal programs not subject to the Section 1512 reporting. This map will be updated as new quarterly data becomes available.

**Note:** Geographic boundaries are approximations and not to be used for navigation or any use other than charting the data.

## About the Author

**Dr. Genie Stowers** is Professor of Public Administration at San Francisco State University. Her current research interests are online service delivery by cities and data visualization and mining in the public sector.

She has published in *Public Productivity and Management Review*, *Government Information Quarterly*, *Public Budgeting and Finance*, and *Journal of Public Affairs Education*, among others and was among the first in public administration to conduct research on e-government activities. She is completing work on a book about urban service delivery via digital government in the San Francisco Bay Area.

Dr. Stowers teaches budgeting, statistics, and information management (data, information, and knowledge management) in the SF State MPA program, and government, budgeting and financial management in the University's interdisciplinary Ed.D in Educational Leadership.

Dr. Stowers has also been a Visiting Scholar at the Institute for Governmental Studies at the University of California, Berkeley. She was also a Professor in the Department of Political Science and Public Affairs at the University of Alabama at Birmingham, where she directed the Women's Studies Program. Dr. Stowers received her undergraduate degree from the University of Florida and her Ph.D. from Florida State University.



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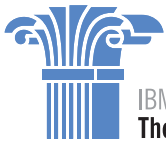
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