

# Data in the Cloud

The ability to move from one representation of data to another is one of the key characteristics of expert mathematicians and scientists. Cloud computing will offer more opportunities to create and display multiple representations of data, making this skill even more important in the future.

## Multiple Representations

We can represent data in a variety of forms—graphs, charts, tables of numbers, equations. Mathematicians, scientists, and engineers often look for patterns in data. Different representations of the same data sometimes make it easier to see a pattern. For example, the pattern in the table of numbers below is not immediately evident.

54	64	73	77	75	68	57	46	37	34	36	45	54
5	32	54	57	48	36	5	-35	-53	-57	-48	-25	5
63	55	48	50	52	55	59	66	72	73	73	70	63

Table 1.

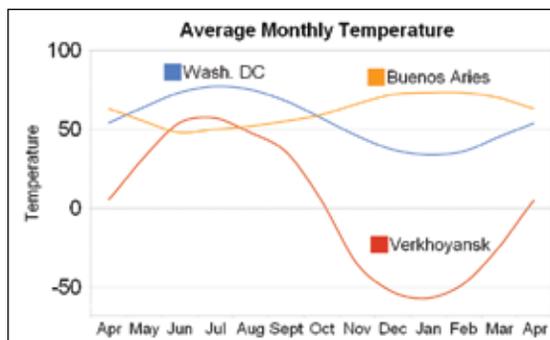


Figure 1: The relationships between the data in Table 1 become clear when displayed graphically.

However, if the table is displayed graphically, as in Figure 1, the relationships become clear. The three rows of numbers represent average

monthly temperatures for cities in the United States, South America, and Russia.

A quick inspection of the graph makes it evident that on average it is always colder in Verkhoyansk than in Washington (and much colder in the winter) and that the seasons in the southern hemisphere are reversed. These patterns would have been much more difficult to discern in a table of numbers alone.

Even young students can explore multiple representations of the same data with software such as The Graph Club (Tom Snyder Productions). This application allows students to view two linked representations of data simultaneously. As children drag icons to form a picture graph or enter numbers in a simple table, a corresponding bar graph or pie chart takes shape (see Figure 2).

Changing the size of a sector in the circle graph or the height of a bar in a bar chart changes the pictogram or vice versa. This allows students to see that the two representations are connected. This is useful preparation for a future in which linked multiple representations will be increasingly common on the Web.

## Cloud Computing

Cloud computing has created new opportunities to create and share multiple representations of data. The advent of the Internet led to widespread availability of data and software applications accessed through the Web that allow anyone to analyze data and display multiple representations.

Google Docs (<http://docs.google.com>) are a good example of cloud computing. The Google spreadsheet ImportHTML function can import data from a table on a webpage. This facilitates



Figure 2: Manipulating an icon in a picture graph changes the corresponding bar chart (or vice versa) in The Graph Club.

access to large data sets and ensures that the visualization can update as the data changes.

In Figure 3, the information in parentheses consists of three items:

1. The Web address (in quotation marks)
2. Specification of either a table or a list to be imported (in quotation marks)
3. The number of the table or list on the webpage

The temperature data in Table 1 is available in a table at [www.teacherlink.org/data/temperature](http://www.teacherlink.org/data/temperature). To access the average monthly temperatures for the three cities and import this data into a Google spreadsheet, enter the following into the first cell of the spreadsheet: `=ImportHTML("http://www.teacherlink.org/data/temperature","table",1)`.

This command asks the Google spreadsheet to import the first table on the page of the specified Web address.

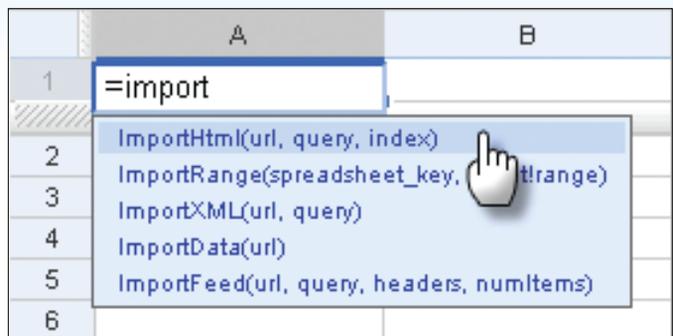


Figure 3: The Google spreadsheet ImportHTML command provides access to large data sets.

After the data is loaded into the spreadsheet, highlight the data. Then select the Insert option at the top of the spreadsheet and choose Chart from the dropdown list of choices that will appear. This will allow you to choose the type of chart that you wish to create, such as the line chart displayed in Figure 1.

Numerous sites on the Web display data in the form of lists and tables. An added benefit of connecting the data in a Google spreadsheet with a Web table is that the spreadsheet can automatically reflect any updates made to the table.

In addition to the ImportHTML command, you can use the related ImportFeed command to import data from RSS feeds. Much of the data on the Web is now available via RSS feeds, making this a particularly useful way to analyze and display data that changes over time.

### Sharing Data in the Cloud

Once users create a spreadsheet and visualizations, cloud computing makes it easy to share them with others. A share menu is available in the upper right-hand corner of the Google spreadsheet.

This makes it possible to invite others to jointly edit a spreadsheet or publish the spreadsheet and associated



Figure 4: This Google gauge shows the weighted average annual temperature in three cities.

charts on the Web with the click of a button. You can also link and embed the charts you create in a blog.

In addition to the Insert Charts function, you may also notice the Insert Gadgets option under the Insert menu. Google spreadsheet gadgets offer many other visualization options. For example, the app can display the data in the form of a gauge (see Figure 4). Google gauges make it evident at a glance that Verkhoyansk, with an average annual temperature of just 1 degree Fahrenheit, is much colder than Washington (56 degrees) or Buenos Aires (61 degrees).

As with Google spreadsheets and charts, Google gadgets can be published and shared on the Web. One particularly interesting option allows you to add these displays to a Google personalized homepage (iGoogle). The term *dashboard*, which refers to Web-based displays with information that changes over time and is collated from different sources, is derived from the gauges and displays that provide feedback and guidance in the cockpit of an aircraft. The ability to create displays with Google gadgets in a spreadsheet and organize them on a homepage now makes it possible to create a dashboard for personal use.

The larger concept of linked multiple representations—the idea that data can be displayed in different forms to make it easier to see an underlying pattern within the data—has important implications. The noted public health analyst Hans Rosling discovered the cause of a new paralytic disease in Mozambique at an early stage of his career through multiple representations and visualizations of medical data. He subsequently has devoted his career to the concept that public discussion and policy decisions should be informed by effective representations of data.

Cloud computing with Web applications and data can facilitate this process. Rosling has made analysis tools and global data available at [www.gapminder.com](http://www.gapminder.com), a site dedicated to this purpose. If students explore multiple representations of data by using these kinds of cloud-computing tools at an early age, they will develop the skills they need to participate in global discussions of the kind that Rosling envisions.



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