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Data Storytelling
Using visualization to share the human impact of numbers

"The universe is made of stories, not atoms."—Muriel Rukeyser (1913–1980)

Storytelling is a cornerstone of the human experience. The universe may be full of atoms, but it's through stories that we truly construct our world. From Greek mythology to the Bible to television series like *Cosmos*, stories have been shaping our experience on Earth for as long as we've lived on it.

A key purpose of storytelling is not just understanding the world but changing it. After all, why would we study the world if we didn't want to know how we can—and should—influence it?

Though many elements of stories have remained the same throughout history, we have developed better tools and mediums for telling them, such as printed books, movies, and comics. This has changed storytelling styles—and perhaps most importantly, the impact of those stories—over the millennia.

But can stories be told with data, as well as with images and words? That's what this paper's about.

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The Tales We Tell

## A little drama makes a big impact

Which do you prefer: raw, unbiased data, or an intriguing tale? It may seem unfair, but—when it comes to understanding the world, at least—your brain has an unequivocal preference for stories.

Consider the number 131,824. That's how many 4.0-plus-magnitude earthquakes we've detected since 1973. This dashboard shows their distribution around the world.

Merriam-Webster defines an earthquake as "a shaking or trembling of the earth that is volcanic or tectonic in origin." But it's hard to think about earthquakes without imagining the ground shaking beneath your own feet. By relating to the concept, you can understand it better.

On Friday, March 11, 2011, a 9.0-magnitude earthquake struck off the coast of Tōhoku, Japan, resulting in a catastrophic tsunami. As The New York Times reported, "On Friday, at 2:46 p.m. Tokyo time, the quake struck. First came the roar and rumble of the temblor, shaking skyscrapers, toppling furniture and buckling highways. Then waves as high as 30 feet rushed onto shore, whisking away cars and carrying blazing buildings toward factories, fields and highways."

Stories take advantage of human cognition. They build connections and context around facts in order to make them more memorable.
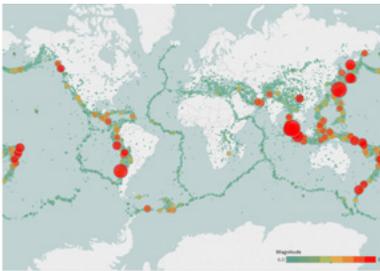
▶ *See this story come together here.*

Magnitude **9.0** near the east coast of Honshu, Japan

Magnitude
6.0 — 8.0
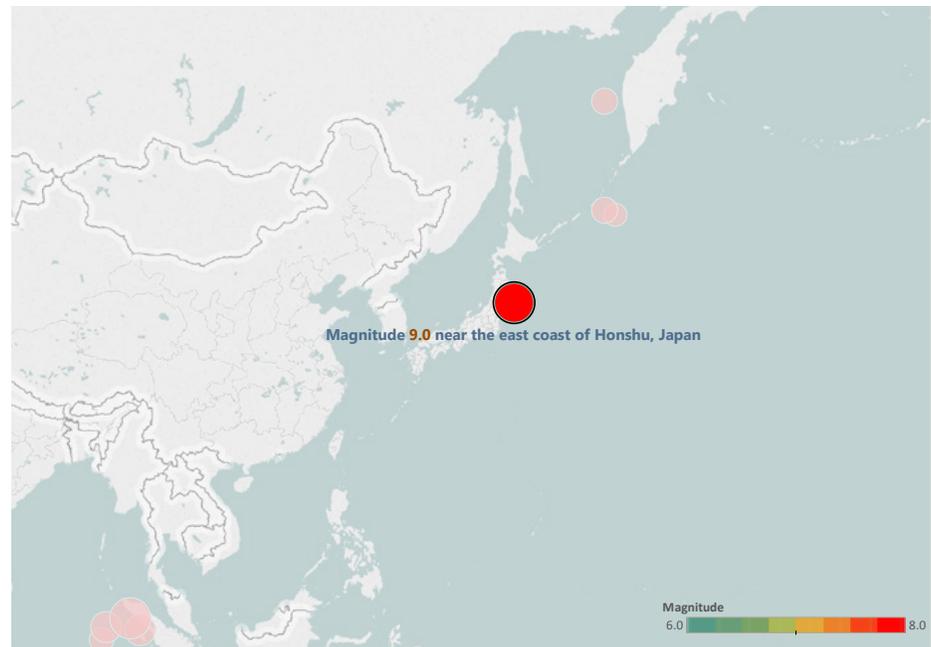
While facts and data form the backbone of this story—2:46 p.m., 30 feet high—it's the flow of the story that ties them all together. Stories also add embellishments that make data more memorable. Words like "roar" and "shaking" add drama to the facts, making them easier to relate to.

Data tells you what's happening. Stories tell you why it matters.

Why We Tell Stories

The importance of understanding events from beginning to end

What, exactly, makes a story? While we've been telling them since the beginning of history, we didn't look at their structure until about 335 BC. That's when Aristotle claimed that all stories have a beginning, middle, and end.

While this might seem like common sense, it was a pretty big leap at the time. If you follow an event from start to finish, you begin to understand why it unfolded that way.

The flow of a story helps us spot causal connections. Getting to the root cause of an issue can be tricky, but our brains are hardwired to find connections between events. If you turn them into a well-structured story, it can be easier to spot an underlying cause—and then to share your understanding of that cause.

For instance, teacher turnover has been a problem in Austin, Texas for a decade. Austin's turnover rate has been higher than the national average for all but one of the past ten years, and by 2013 it had reached 22.3 percent.
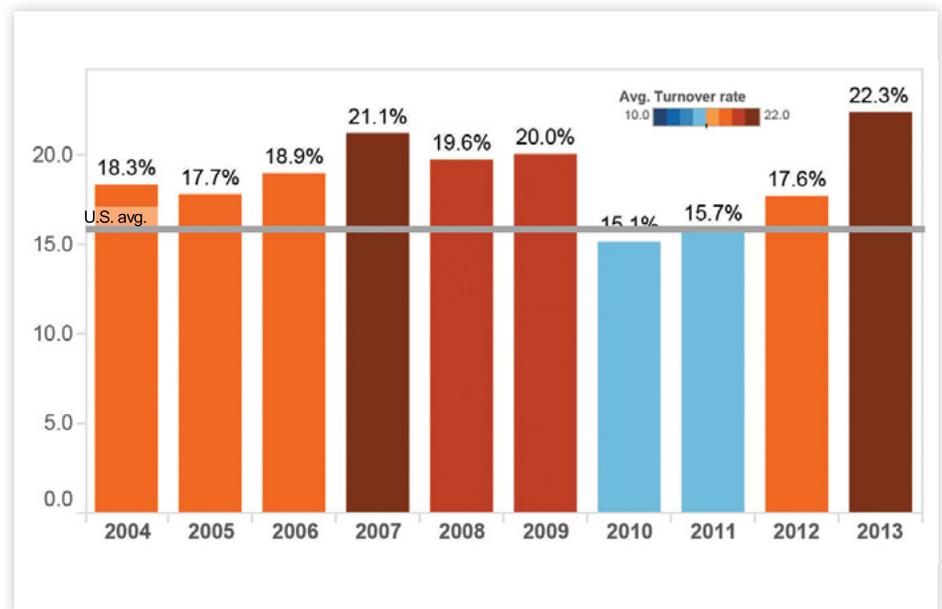
In August of that year, a former teacher from J.E. Pearce Middle School in East Austin—an area with one of the highest poverty rates in the city—published his long-untold story on Salon.com.

"In 2002, the year I started teaching at Pearce," he explains, "many of the faculty had been hand-selected to revive the struggling school." When he entered Pearce, he was determined to "do whatever it took to help these kids overcome classism and racism and escape poverty."

But within two years, he had quit. Why? Despite his qualifications and efforts, in the end he came to believe they were in vain. His experiences led him to conclude that poverty—and not teacher quality—was the root cause that really needed to be addressed.

As human beings, we're constantly receiving information about the world around us. The amount of sunlight hitting your eye, the level of ambient noise in your current location—these are all data points that tell you something about the current state of the world.

Since you receive each piece of data at a specific time, you automatically fill in the missing information between each moment. It's something our brains have evolved to do exceptionally well: We stitch data points together to turn them into a cohesive, step-by-step story and decide how to act. Sometimes, we do this too well. We identify patterns and causes that aren't really there.

This chart shows the teacher-turnover rate at Pearce Middle School over the past decade.
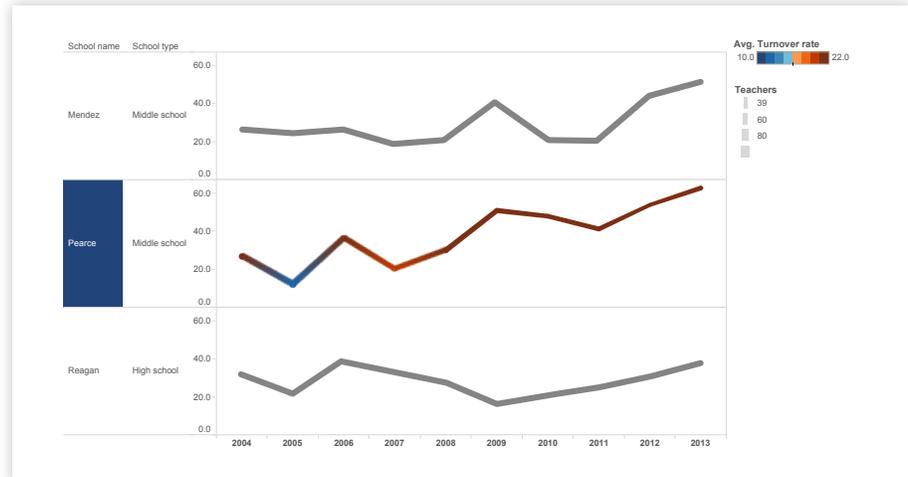
If the leaders of Austin's school system looked at this data in a meeting, each of them might walk away with a different story about what's causing this rate to increase. Each would write that story based on his or her individual experiences. With that story in mind, they would each walk away from the meeting with separate ideas about how to act next.

But what if the data told a complete story? What if it was told in a clear sequence, step-by-step from beginning to end? And what if everyone left that meeting believing in the same story—a story founded in data? Could the students in Austin's school system get to their own happy ending, and faster?

John Savage wanted to influence change by becoming a teacher. But now, he does that by telling stories. As a journalist, he shares information in a relevant, sequential way so that readers can see important connections between facts. But what if he used data visualizations to help tell those stories?

Data tells you what's happening, and stories tell you why. When you put them together, great change is possible.

Storytelling through the Ages
Evolving tools for influential tales

The Austin school district's story hasn't been resolved yet, but one thing is clear: There's nothing like a compelling plot to make people care. And since the days of Aristotle, we've delved deeper into the structure of stories—and learned it's not just about the beginning, middle, and end. A good story also has an arc.

A clear flow turns a collection of facts into a compelling narrative. It glues them together into a structure that makes sense. And the rising action of a story arc makes it more engaging and memorable.
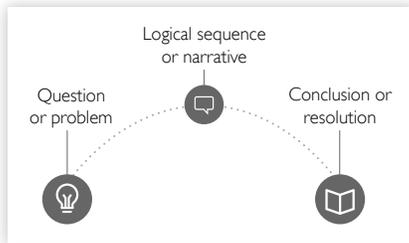
That's why we've been telling stories for so long. They are excellent tools for passing knowledge from one person to another. And they're exceptionally good at getting a point across.

In 1854, Dr. John Snow was an epidemiologist in London, a city in the clutches of a cholera outbreak. Dr. Snow had a hunch about how cholera was being spread and how it could be stopped, but he needed a compelling way to tell this story to the people who were making the decisions. So he came up with a new way to tell a data story: he plotted each death on a map of the city.

Logical sequence or narrative

Question or problem

Conclusion or resolution

▶ *A story arc consists of rising action and conflict, presented logically and fluently to lead to a conclusion.*

When he showed his map to the city's leaders, they immediately understood what the problem was: an infected water pump in an area with no sewage system. Since most of the deaths occurred near that pump, they decided to replace its handle. Germ theory was developed less than a decade later.

The tools we use to share visual stories are only getting better with time. Just a few centuries have brought us from hand-drawn visualizations—like John Snow's map—to movies and computer graphics. Humans continue to build innovative ways to tell powerful stories. Tableau's Story Points feature is the next evolution of storytelling with data.

Story Points

Telling and discovering stories with the same tool

Story Points provide a framework for arranging data visualizations sequentially, so that you can tell stories with a beginning, middle and end—even with large and complex data sets. With Story Points, you can tell stories with data in the same tool you use to analyze data, and your presentation tool stays connected to your data.

Here's an example of how Story Points works:

More than 131,000 earthquakes have been detected worldwide since 1973. We've also seen many recent high-impact quakes, like the one that struck near Tōhoku, Japan in 2011. But is the number of quakes around the world actually increasing?


At the top of this visual, a series of annotations (shown above) guide viewers through their exploration. By clicking through these annotations—like pages in a book—a series of interactive visualizations appear.

This story begins at the global level, and then focuses in on some of the larger quakes we've recently seen. After surveying areas such as Japan, it turns to overall trends of earthquake detection.

Immediately, a trend pops out of the visual. More earthquakes are being detected than ever before, but most of the increase is actually coming from lower-magnitude quakes. It seems that earthquakes are not on the rise; rather, we've improved our methods for detecting them.

Of course, this does nothing to lessen the human impact of larger quakes. But when you're looking at a complex data set—whether in a research lab, a board room, or somewhere else—you need to be able to decide how you'll act upon it.
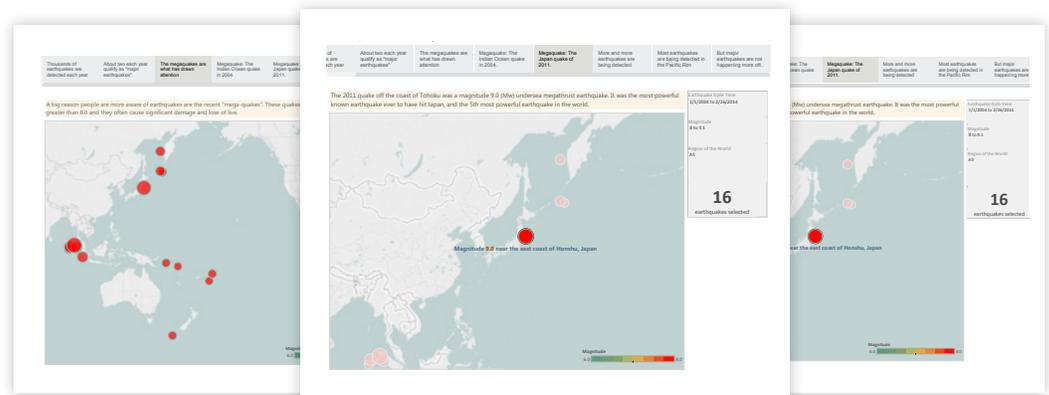
This story was built using visualizations connected directly to the data source. As earthquakes continue to be detected around the world, the visualizations in the story will update to include the new data.

Stories help you understand what's going on beneath the surface. From start to finish, they walk you through a series of events so that you can see what's causing them to happen.

The data tells you what's happening, but the story guides you to an understanding of why. And once you understand that cause, you can decide how to act.
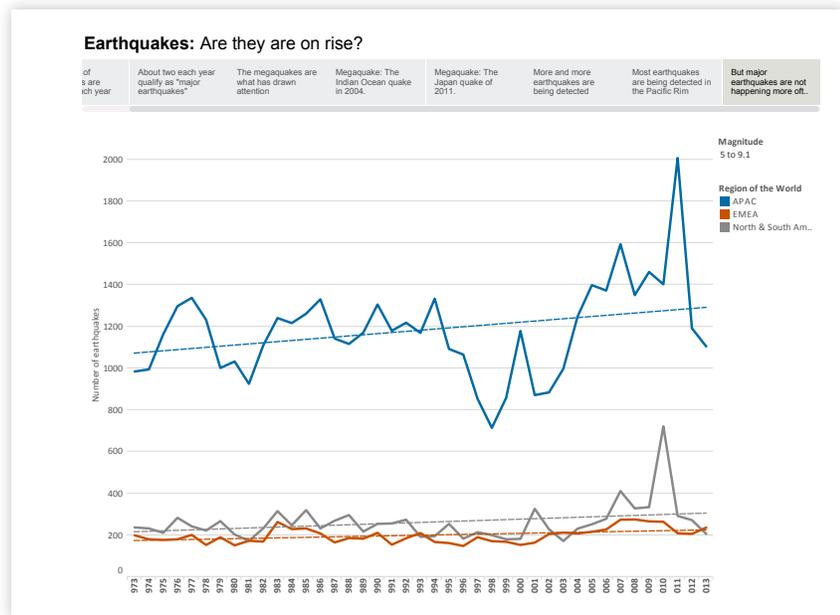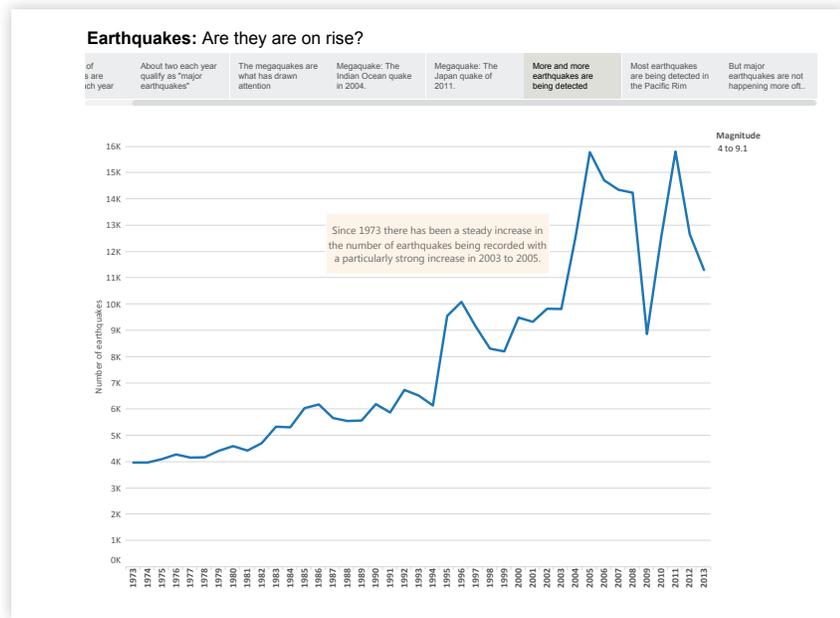
When to Tell a Story

Dashboards versus data stories

Data stories may be groundbreaking, but they're nothing new. John Snow's cholera map makes that clear. So why can't we just use dashboards to tell data stories?

We can.

Just as Dr. Snow adapted a versatile medium—paper, pen, and ink—to share a data story, so too can dashboards be shaped into compelling visual stories. However, they're already pretty darn good at what they're usually designed for.

Let's take a look.

When it comes to monitoring your data—keeping its daily pulse—an interactive dashboard is a great tool. And if you notice a change or problem in your data, you can use a dashboard to investigate the cause. But when you need to communicate your findings to others—when you need to convince them to take action—you need to show them why.

By putting data in a sequence, you can help viewers understand the context and make useful connections between each point. Francis uses a series of visualizations to guide readers through a thought process in a focused, user-friendly way.
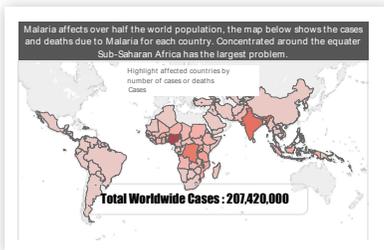
▶ *This* *visualization,* *by Matt Francis of the Wellcome Trust Sanger Institute, shows cases of malaria around the world. Once you see what's going on—that malaria is mainly striking Sub-Saharan Africa—chances are you want to know why. And then you want to tell that story.*

Dashboards tell you what's happening, but stories explain why.

Storytelling to the People

How to be a game-changer with data

What if you're not the one making decisions with data? In 1854, John Snow believed that water was spreading cholera in London, but needed to convince the city's leaders too.

Likewise, the former teacher John Savage—who recently wrote about Texas' struggling schools—has a major hunch about what's causing their problems. Could he do what Dr. Snow did in 1854: follow his instincts, dive into the data, and tell a life-changing story with it?

Savage's story impacts teachers all over the east side of Austin, Texas. And if you look at regional data, it's clear that Austin's east side struggles more than its (wealthier) west.
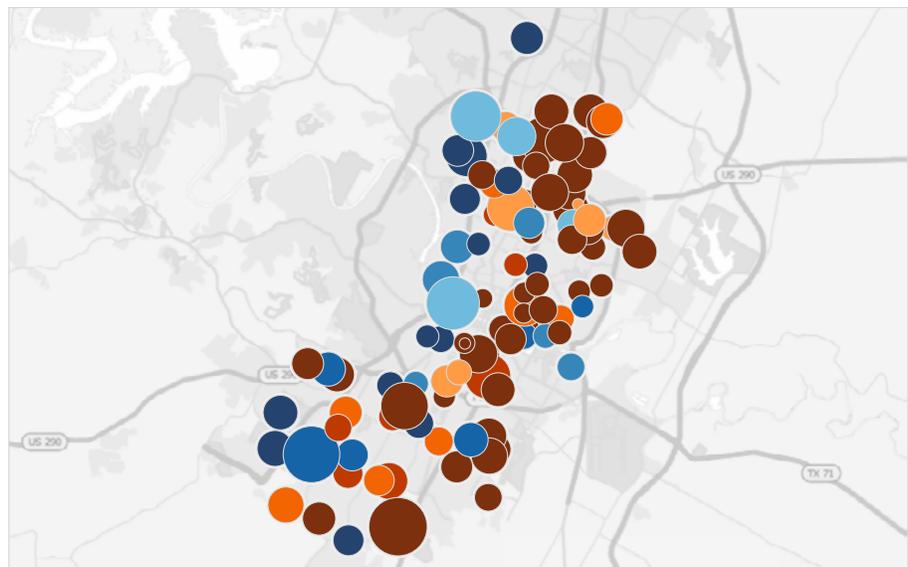
Savage also alludes to recovery efforts in Austin's schools. Did they work? About six years after he left Pearce, an article in the Austin American-Statesman reported on a new study that claimed teacher quality was higher in the west than in the east—and that at Reagan High School in Northeast Austin, "19 percent of teachers were giving lessons in subjects for which they were not certified." It went on to describe an incentive program aimed at improving teacher performance.

But Savage believes it's poverty that needs to be addressed, not teacher performance. And the turnover rate at Reagan only went up after that article was published.
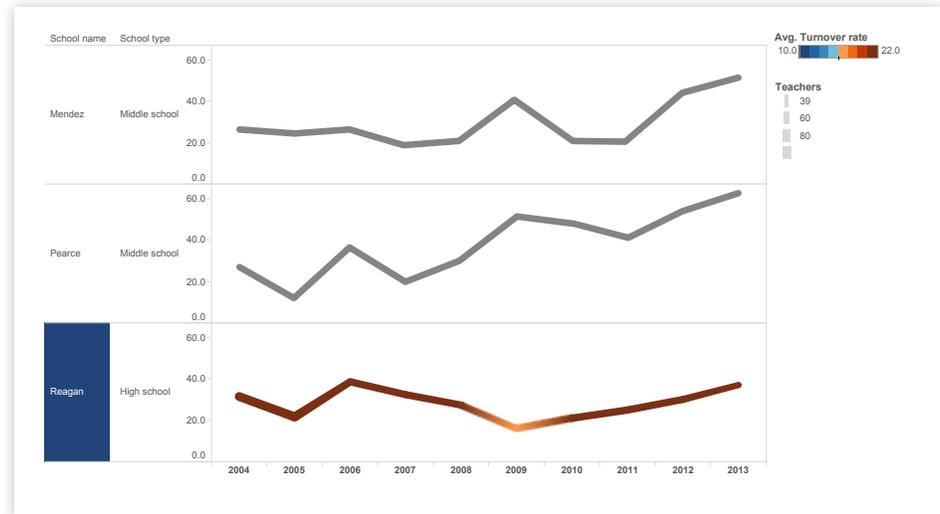
About three years later, the Statesman reported that millions of dollars spent on teacher incentives had done little to fix the problem. State data would show teacher turnover to be higher than ever before.

By telling this whole story—from the emotional impact it's had on real people to the data that points to the true cause—a single person could change the game for teachers and students across Austin.

From improving public education to preventing disease and better understanding natural disasters, data stories have unlimited potential. What would happen if there was an explosion of authorship around the world? Imagine the impact of billions of people telling their stories with numbers.

Stories have always been for everyone. Since ancient times, we've been using stories to conserve and pass on information. With game-changing inventions like the printing press, widespread access to information has become a reality. We're also seeing an explosion of authorship around the world today.

With a data story, hundreds of millions of rows can be distilled into a single narrative. By following that narrative, it's much easier to understand what's going on beneath the surface. The data can tell you what's happening, and a story can elucidate the cause.

Perhaps most importantly, though, stories motivate action. And in today's world of information overload, it's crucial to be able to make informed, actionable decisions with all of your data.

About the Authors

Jock Mackinlay

Jock Mackinlay is Tableau's Vice President of Visual Analysis. At Stanford University, he pioneered the automatic design of graphical presentations of relational information. He joined Xerox PARC in 1986, where he collaborated with the User Interface Research group to develop many novel applications of computer graphics for information access, coining the term "information visualization." Much of the fruits of this research can be seen in his book, "Readings in Information Visualization: Using Vision to Think." Jock has a PhD in computer science from Stanford University.

Robert Kosara

Robert Kosara is a researcher in Tableau's Visual Analysis group. Before he joined Tableau in 2012, he was a professor of computer science at UNC Charlotte. Robert has created visualization techniques like parallel sets and performed research into the perceptual and cognitive basics of visualization. Recently, his research has focused on how to communicate data using tools from visualization, and how storytelling can be adapted to incorporate data, interaction, and visualization.

Michelle Wallace

Michelle Wallace is a product marketer at Tableau Software, where she tells stories about how thought-leaders around the world are making an impact with data. She holds a BA in English from Western Washington University with a minor in astronomy. Prior to Tableau, Michelle was a magazine writer who covered local interests and histories around the United States.

About Tableau

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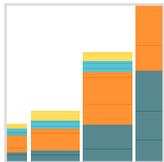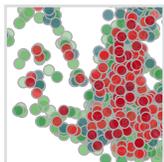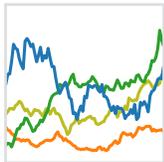
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