# Information Visualization, is this new?

Data, data everywhere. As a UX practitioner, there will come a time when you will be assigned to a project that will require you to represent data in a way that is easy to understand for your target audience—whether it is a fitness app, a sales dashboard, a medical application, or even a powerpoint slide that will be used to persuade and convey an interesting trend or fact. Nowadays, we use computer applications to present numbers and figures and representation. However, it is not hard to even imagine early man drawing with a stick in the sand communicating information such as a where to find food in a given direction or drawings of animals or land features she had seen and how they compare in shape or size or some other measure.

While how we display and consume information through technology today is vastly different, the history of information visualization starts roughly 32,000 years before the internet. Humans have been writing on cave walls since 30,000 BC to represent and communicate data and information about their environment to their contemporaries as well as future generations. These paintings could be called the first visualizations.

In 2014, it was discovered that the Pettakere cave on the island of Sulawesi in Indonesia contained drawings of animals that date beyond 35,000 years old!

A babirusa or 'deer-pig' and a hand stencil. Hunter-gatherers preyed on the strange and unique land mammals that evolved in isolation on Sulawesi. Photograph: Kinez Riza

Another early form of information visualization that we have all heard of was used in Egypt around 3000 BC. Of course, I'm talking about hieroglyphics, which they used to tell stories of life, work, and religion.

As humans got interested in the heavens, they began to create tables of the positions of the stars and planets, yet another early contributor to visualization.

By 200BC in Egypt, surveyors used coordinates to layout out their towns and also chart objects in the sky with something similar to latitude and longitude.

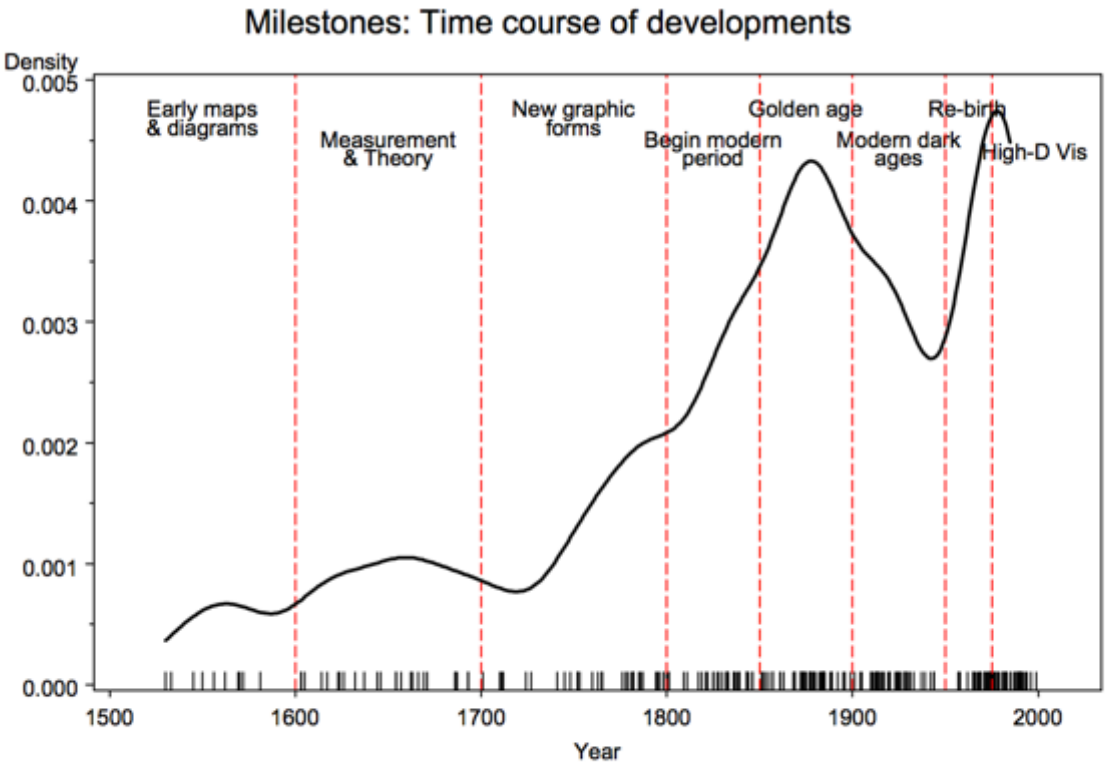



Figure 1: The time distribution of events considered milestones in the history of data visualization, shown by a rug plot and density estimate.

**Claudius Ptolemy** (born c. 100CE — died c. 170CE) was a mathematician, astronomer, and geographer of Alexandria who projected the round earth into latitude and longitude around the first century and also created this chart of a geocentric universe below, which held as the standard view until the 14$^{th}$ century.


Ptolemaic diagram of a geocentric system, from the star atlas *Harmonia Macrocosmica* by the ...
*Photos.com/Thinkstock*

As for a very early representation of quantitative information, sources point to a 10th century multiple time-series graph of the position of seven sky features over space and time (Figure 2). It is referenced in 1936 by Funkhouser , an American mathematician, historian and professor in his publication "A note on tenth century graph" and Edward Tufte recreated it in his 1983 book, The Visual Display of Quantitative Information (p. 28).

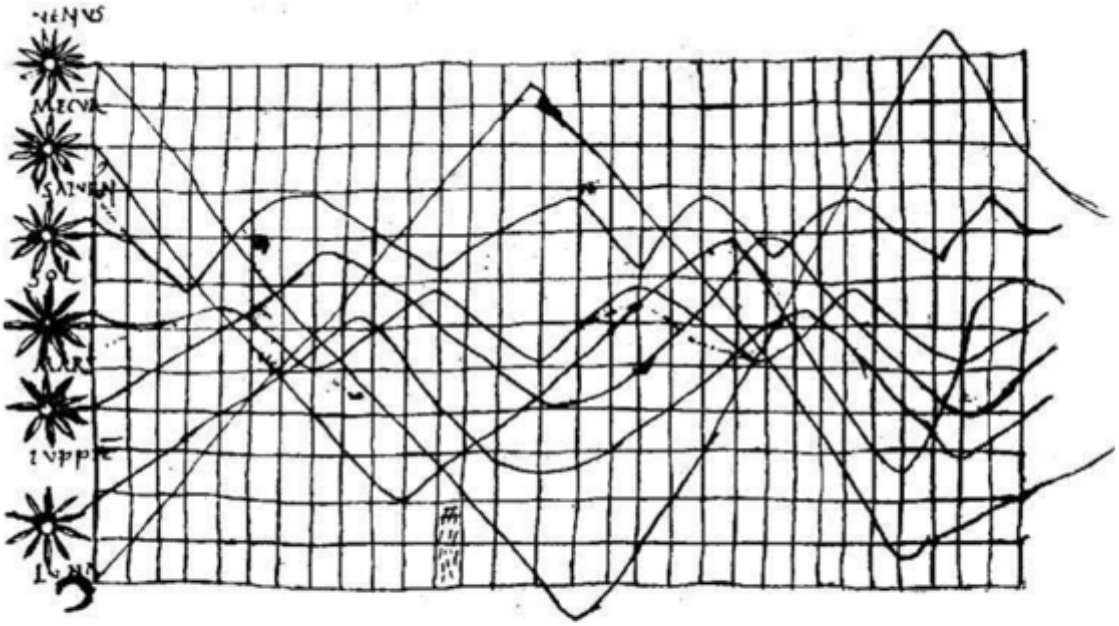
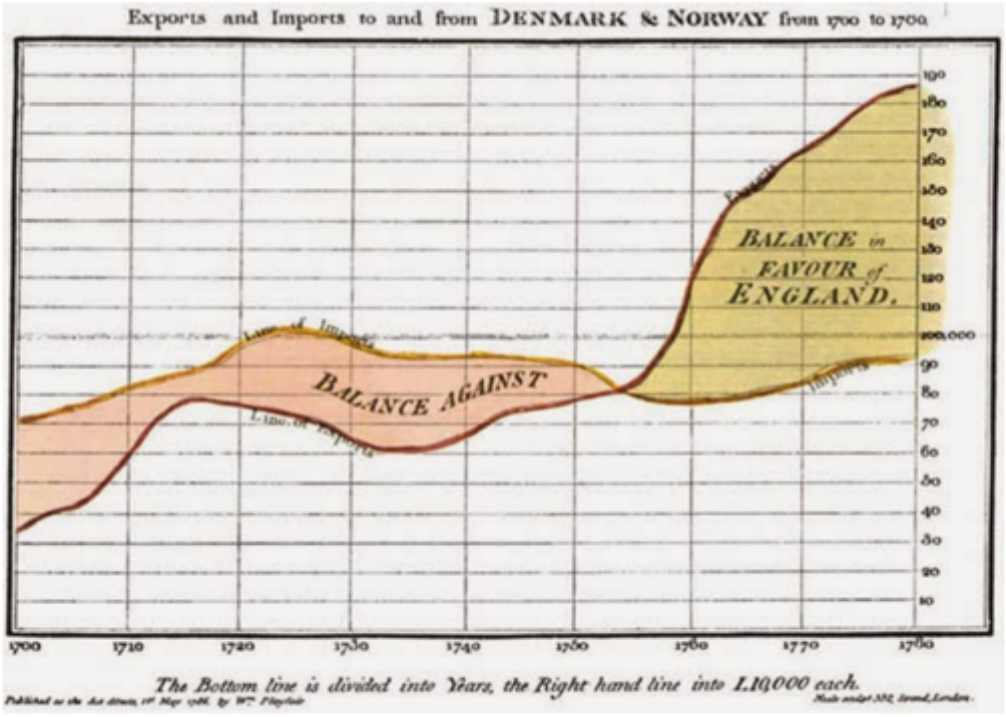


Figure 2: Planetary movements shown as cyclic inclinations over time, by an unknown astronomer, appearing in a $10^{th}$ century appendix to commentaries by A. T. Macrobius on Cicero's *In Somnium Scripionus*. Source: Funkhouser (1936, p. 261).

# Who were some of the important players in shaping the field?

## Playfair

The slightly more modern history of infographics might very well have started with **William Playfair**, an early innovator in Statistical Graphics. In 1786, he published *The Commercial and Political Atlas*, which displayed many bar charts, line graphs and histograms representing the economy in England. He followed this up with the first area chart and first pie chart in 1801 (below).




Playfair's trade-balance time-series chart, from *The Commercial and Political Atlas and Statistical Breviary*, 1786

He is generally considered the founder of graphical methods of statistics. It is said his invention of the bar chart was inspired by the earlier work of **Joseph Priestley** in 1765 where he used bars to represent an individual's life juxtaposed to the life spans of multiple persons represented by the other bars. Playfair argued that charts better represented data than tables. Playfair was an extraordinary person who is credited with inventing four types of diagrams: line graph, bar chart, pie chart, and circle graph.

He truly changed the way the world looked at data. Unfortunately, he was not appreciated in his time and it took about 100 years for his universal language that has come to aid science and commerce to be fully accepted.

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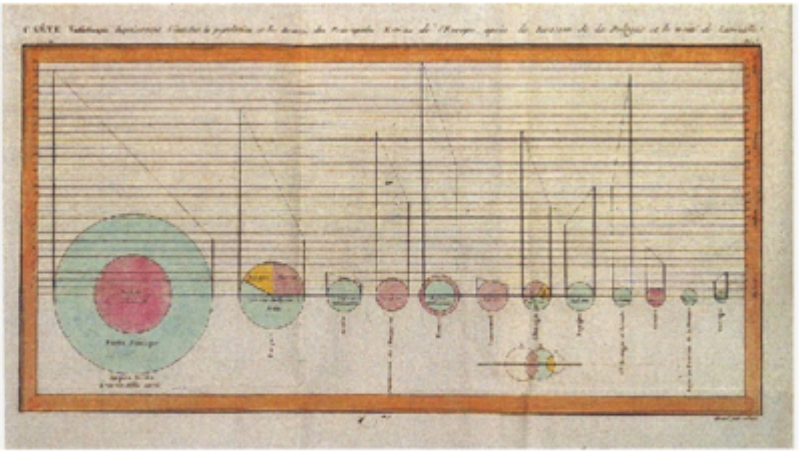

Playfair 's Pie Charts from *The Commercial and Political Atlas and Statistical Breviary*, 1786

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# Nightingale

Most don't realize that in 1857 the familiar **Florence Nightingale** influenced the course of history by persuading Queen Victoria to improve conditions of military hospitals through her use of information displays, most notable a combination of stacked bar and pie charts known as a coxcomb chart. It conveyed to the Queen how people were dying over the course of the Crimean War. It showed how many died of wounds versus those who died of preventable diseases. (shown below)

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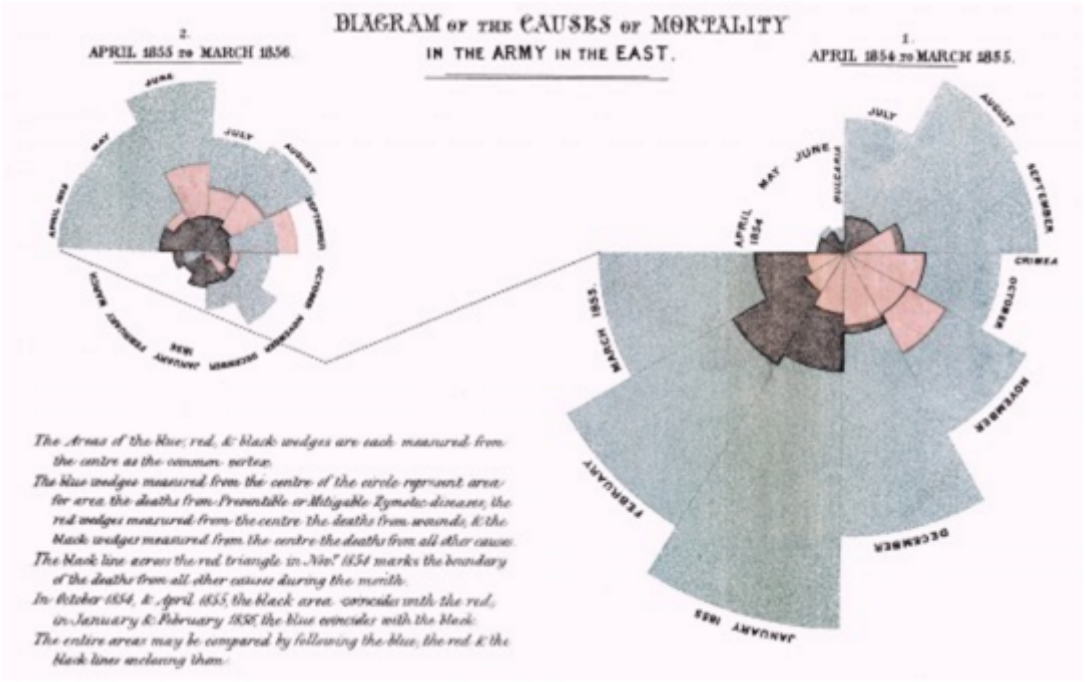


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# Brinton

In 1914, **William C. Brinton** published *Graphic Methods for Presenting* Facts, which some consider to be the first business book about data visualization.

He suggested ways to improve the charts that railroad companies were using and established some guidelines for presenting data through his example charts. He also instructed on which chart types to avoid as well

He was way ahead of his time for example by proposing the use of multiples, a series of simple graphs with the same axes, rather than piling lines on top of one another in a single graph. He provided early demonstrations of bump charts and slope graphs which many think today are much more recently conceived. Brinton was also one of the first to question the use of pie charts which currently are recommended to be avoided by today's experts.

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# Spear

Mary Eleanor Spear was a pioneer in charting during the mid 20th century. She was both a teacher at American University as well as a consultant for dozens of US agencies. As the author of Charting Statistics (1952) and Practical Charting Techniques (1969), Spear described solutions to problems she encountered

over her career of analyzing and presenting data. Also credited to her is the use of crosshatching patterns to distinguish variables in black and white charts.

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## Bertin

In 1967, **Jacques Bertin**, a mapmaker, published his famous book, *Semiologie graphique*, where he described a system that provided a theoretical foundation for information visualization. This system still provides the vocabulary for modern data visualization theory. He defines and discusses seven variables that we use to encode data: *position, size, shape, color, brightness, orientation* and *texture*.

Bertin also gave us these other two big ideas:

1. The Principle of Expressiveness: Say everything you want to say—no more, no less—and don't mislead.

2. Principle of Effectiveness: Use the best method available for showing your data. Moreover, choose the visual form that will most succinctly and most accurately convey the data's meaning.

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## Tukey

Later in the 1970s, **John Tukey**, a statistician and scientist created 3-D scatter plots back when they were still using mainframe computers! Also derived from this work, the concept of exploratory and confirmatory visualization became popular.

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## Mackinlay

In 1986 Jock Mackinlay focused his PhD thesis on automatically encoding data with software so that people could spend less time creating the visualizations and more time exploring and analyzing what surfaced in the visual representations. He also added motion as an eighth variable to Bertin's list. He had the vision to see how animation would become a powerful application for communicating data.

In 2003, Chris Stolte and Professor Pat Hanrahan extended Mackinlay's dissertation algebra to a formal specification language that combines query, analysis, and visualization into a single framework. They went on to found Tableau Software after Chris graduated. Jock joined Tableau Software in 2004.

In 2009, Jock received the Visualization Technical Achievement Award from the IEEE VGTC for "his seminal technical achievement on automatic presentation tools and new visual metaphors that helped to shape the field of information visualization".

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## Tufte

**Edward Tufte** is one of the most famous data visualization experts. He created a theory of information design in his 1983 seminal book called *The Visual Display of Quantitative Information*. Among other things, he is known for discussing Data to Ink ratio and coining term "chart junk". The data to ink ratio is the proportion of ink that is used to present actual data compared to the total amount of ink (pixels) used in the entire display. Chart junk refers to all visual elements in charts and graphs that are not necessary to comprehend the information represented on the graph, or that distract the viewer fro this information.

Tufte influenced a generation of designers with his minimalist approach. His books are ones that you often find on the bookshelves of visual designers. Besides being a statistician, artist, and professor at Yale, *Business Week* described him as the "Galileo of graphics."

## Cleveland and McGill

When we create data visualizations we use shape, color, and position to, in a sense, encode information. William Cleveland and Robert McGill set out to learn what people are able to decode most accurately and ranked them in the following list.

1. Position along a common scale, e.g. scatter plot
2. Position on identical but nonaligned scales, e.g. multiple scatter plots
3. Length, e.g. bar chart
4. Angle & Slope (tie), e.g. pie chart
5. Area, e.g. bubbles
6. Volume, density, and color saturation (tie), e.g. heatmap
7. Color hue, e.g. newsmap

Their most notable paper is "Graphical Perception: Theory, Experimentation, and Application to the Development of Graphical Methods" [pdf] from the September 1984 edition of the *Journal of the American Statistical Association*.

Cleveland also published a foundational text called *The Elements of Graphing Data* (1985).

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## Harrison

**Lane Harrison**, in 2014, created a ranking of chart-type effectiveness for showing correlation. His efforts are part of the next generation of research concerning the science around graphic perception, drawing from psychology, neuroscience, and economics

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# Why is Data Viz important?

Presently, data viz may be used artistically, which some professionals consider an embellishment and the aesthetics as a distraction that creates an emotional response, superseding numerical understanding. Some professionals use data viz as a means of persuasion, while news media use it to bolster reporting. Due to the ubiquitous use of data visualization, no one can own how it should be presented any longer. This is why it is so important that the user experience designer understands what will best tell the story in the most usable and efficient way without distorting it.

Data visualization is not just for scientists and analytics teams; data is all around us. We are inundated in our lives with data whether it be in print or on the web or through the television media. We are information processing machines. What we take in and how we interpret it has an enormous impact and shapes our points of view, our decisions, thought patterns and to some degree even affects who we become. Given the volume of data we consume this is a huge opportunity for user experience practitioners to have an impact. By taking what you know about how humans perceive and process information and leveraging tips and tricks in this course, you will be able to greatly reduce the time spent to discern and extract the information

conveyed. Given this is a big part of our lives, this is a huge benefit when multiplied by the millions that consume the data. In addition, we will also learn ways that data is manipulated which will give us a finer eye to know what to believe. Moreover, this will allow us to best present a story when tasked to incorporate data into presentations, websites, application, proposals, and so on.

You will be able to apply what you learn in your projects. This may come in the form of developing a fitness app as we proceed through this era of the quantified self. You may be tasked to develop data visualizations for sales team to help with their strategies. You may work on medical applications to provide data to doctors to make the best decisions or provide system administrators real time data to prevent their companies from being compromised.

In my own experience, as I think back to projects where data visualization was involved, I recall working on The Weather Channel app where I had to figure out ways to display lots of information in a scannable way on a small screen to help folks plan their day. I recall working on a project to provide an interface to hotel management to not only show occupancy rates and pricing but allow them to predict what it would likely be in the future to guide their decisions based on seasonal and year-over-year data. Another project was one for a big pharma company that wanted to use an information dashboard to help market their drugs to doctors and hospitals and see who and where the most prescriptions were being written. Finally I recall working on mobile games and designing how to display a proper HUD to provide the player with vital information to aid in their game play and navigation. Examples are everywhere: science, social science, music, business, finance, sports, arts, medicine, architecture, and so on.

This course is not about using Excel, or a data visualization software tool, or statistical software. This course is about conveying a message, as a user experience designer, to your target user through the representation of data, how best to do so, factoring in their context of use, the best visualization type for the data type and message, how to persuade when needed, and how to avoid unintentional deception by cherry picking.

Through the readings you will review both bad and good examples of data visualization and learn tactics and strategies on what data works best with what visualization type so you will feel empowered to create usable and persuasive information dashboards when your industry projects call for them.

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[4] James R. Beniger and Dorothy L. Robyn (1978). “Quantitative graphics in statistics: A brief history”. In: The American Statistician. 32: pp. 1–11.
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https://www.edwardtufte.com/tufte/