Introduction to Information Visualization

Thursday, September 27, 2018 17:59

Week 1

We propose six major ways in which visualizations can amplify cognition.

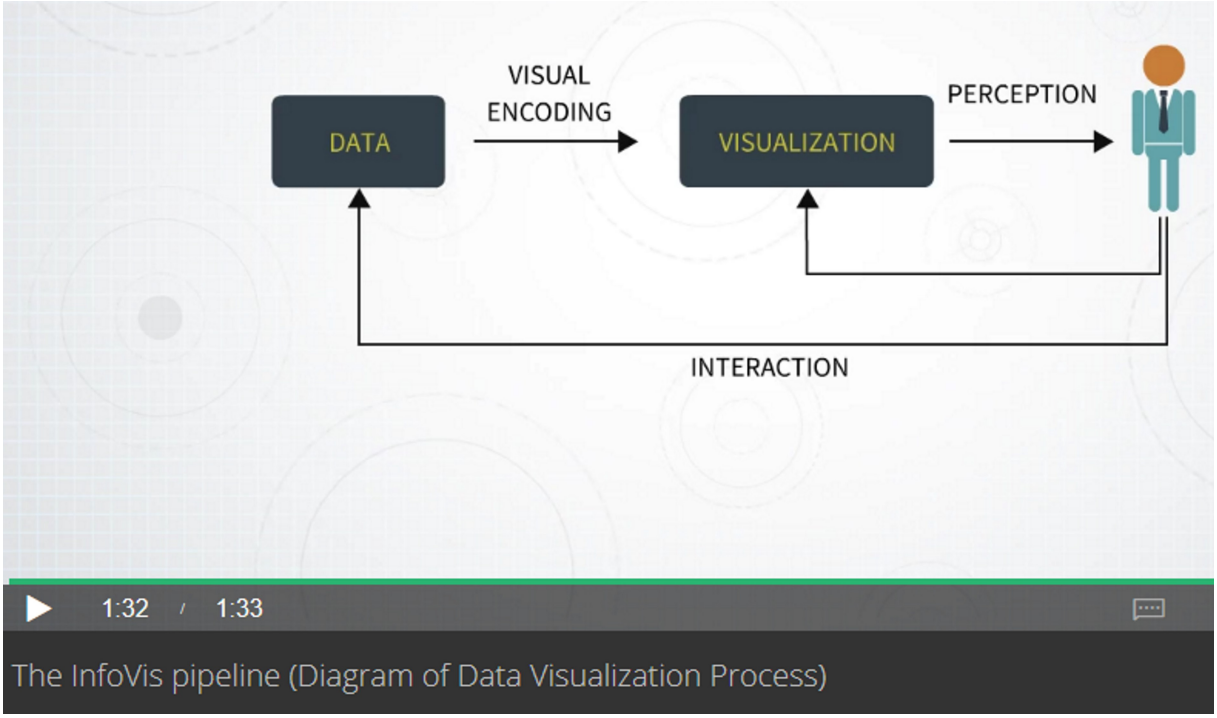
1) by increasing the memory and processing resources available to the users.
2) By reducing the search for information,
3) By using visual representations to enhance the detection of patterns,
4) By enabling perceptual inference operations,
5) By using perceptual attention mechanisms for monitoring,
6) By encoding information in a manipulable medium

(PDF) Readings in Information Visualization: Using Vision To Think. Available from: https://www.researchgate.net/publication/220691172_Readings_in_Information_Visualization_Using_Vision_To_Think [accessed Sep 27 2018].

Key concepts used in the definition of Information Visualization are

- It amplifies cognition.
- It is concerned with the representation of abstract data.
- It's computer based.
- It's interactive.

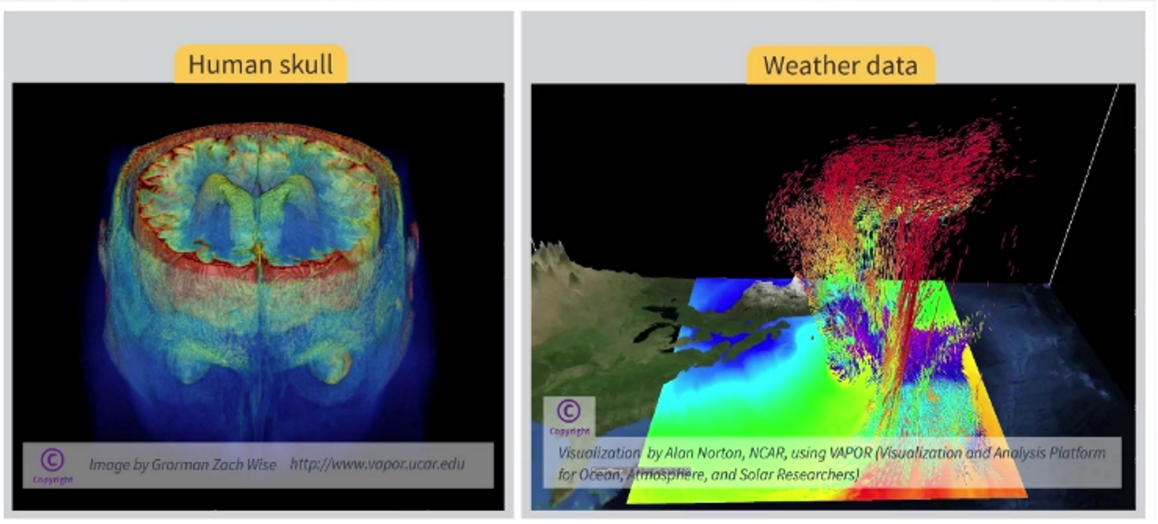
From <https://www.coursera.org/learn/information-visualization-fundamentals/lecture/kGpnn/key-concepts-and-definitions>



Abstract data
Data with no obvious/natural visual representation.

In the large majority of cases, we have a somewhat obvious way of visualizing data related to physical objects/phenomena.

Realism is a good thing -> An important goal is to visualize the phenomena as close as possible to the natural representation.



It is harder to visualize data that is related to **abstract** objects/phenomena…

How do you visualize time, duration, activity, etc...?

Interactivity
Users can change WHAT is visualized and HOW it is visualized.

Amplify cognition
It means to solve problems better:

- Less mental effort
- Shorter time
- More accurately
- Been able to do things it would be impossible to do without a computer

Cognitive artifact
In general, producing tools that make people think better.

Distributed cognition
Our cognitive system is not exclusively made of our brain/mind/sensors but is also made of the artifacts and environment we have around us and we use to store and manipulate information.

Why visualize data?

Data is a description -abstract representation- of some phenomena of interest.

User has an existing knowledge and mental model -> Goal: understanding better the phenomena

Visualization helps the people to understand the phenomenon better.

Purpose of visualization

1. Explanatory -> *Communicate*
   There is a person with some idea needs to be explained and communicated visually. The person needs to design the visualization that is appropriate for explanation.

2. Exploratory -> *Analysis*
   There is a person that needs to extract information out of data and doesn't know what the content of the data is.

Visualization here helps the person answer questions and generate new hypotheses.

3. Confirmatory -> *Analysis*
   The person using visualization has some hypotheses in mind that need to be verified.

Why use graphical representation?

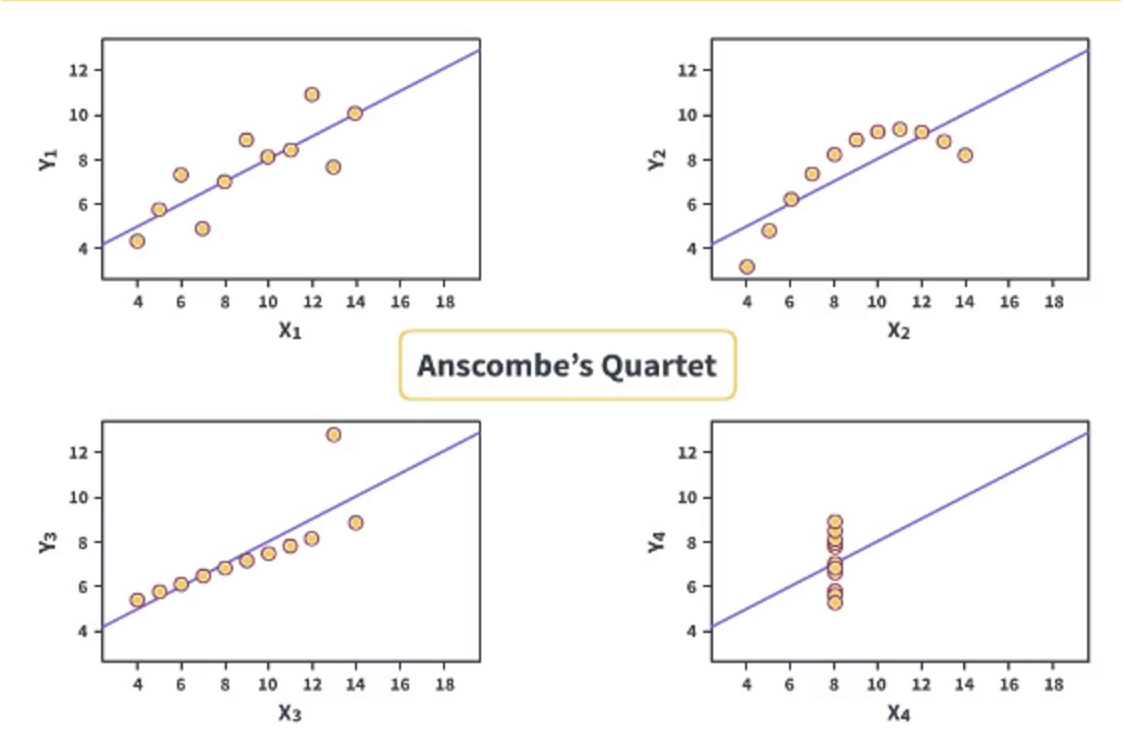
- Humans are visual animals: up to 30% of the cortex of brain is devoted to vision.
  We are very good at processing visual information.

- What are other ways to communicate information?
  - Verbal -> we are forced to process the information sequentially.
  - Numeric -> we have to process numbers that don't match directly visually for some quantities.
  - Graphical -> information is processed in a parallel fashion, all at once.

Problems with summary statistics

Statistics are summaries of information contained in the data, so we can communicate the MOST important information.

Statistics **aggregate** information and **remove** a lot of details.



Why use a computer to visualize data?

1. With a computer we can visualize lots of data (millions of registers). They can use automatic algorithms that take data and transform it into visual representation.

2. Computers enable interaction with digital graphical representations. -> we can interact with the represented abstract world. *Interacting with data is very helpful!*

Why use interaction?

- Not all question can be answered by looking at one single visual representation.
- It helps the user answer multiple questions.

->Area of research: How to use different modes of interactions in different kind of devices.

Assessing the quality of a visualization?

- Is it subjective? Not necessarily.
- Some visual representations are better than others at solving particular problems.

Designing effective visualizations requires:

1. Knowing the design space
   One typically come up with a first idea/design. If you don't know enough about design space, it'd be harder for you to create visualization alternatives -**which is a crucial skill for visualization design**.

2. Being able to compare solutions in an effective way... in turn comparing the solutions requires understanding human perception and how graphical representations work.

A Tour through the Visualization Zoo

From <https://queue.acm.org/detail.cfm?id=1805128>

Creating a visualization requires a number of nuanced judgments. One must determine which

questions to ask, identify the appropriate data, and select effective *visual encodings* to map data values to graphical features such as position, size, shape, and color. The challenge is that for any given data set the number of visual encodings—and thus the space of possible visualization designs—is extremely large. To guide this process, computer scientists, psychologists, and statisticians have studied how well different encodings facilitate the comprehension of data types such as numbers, categories, and networks. For example, *graphical perception* experiments find that spatial position (as in a scatter plot or bar chart) leads to the most accurate decoding of numerical data and is generally preferable to visual variables such as angle, one-dimensional length, two-dimensional area, three-dimensional volume, and color saturation. Thus, it should be no surprise that the most common data graphics, including bar charts, line charts, and scatter plots, use position encodings. Our understanding of graphical perception remains incomplete, however, and must appropriately be balanced with interaction design and aesthetics.

From <https://queue.acm.org/detail.cfm?id=1805128>