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TE PŪTEA MATUA

Thinking About Data Visualisation

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Outline

1. Introduction
2. Fundamentals
3. Design philosophy
4. Special charts
5. Animation
6. Interactivity
7. Colour
8. Perception
9. Storytelling with Data

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Introduction

Fundamentals

Design philosophy

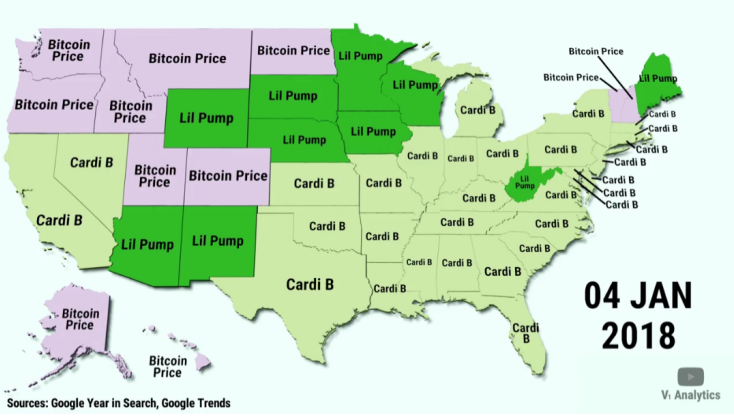
Special charts

Animation

NO!

We accept the reality of the world with which we're presented.

Trending Google Searches by State Between 2018 and 2020



Source: https://old.reddit.com/r/dataisbeautiful/comments/hs9mnz/oc_trending_google_searches_by_state_between_2018/

3 rules for visual storytelling - NY Times

- If you make the reader click or do anything other than scroll, something spectacular needs to happen.
- If you make a tooltip or rollover, assume no one will ever see it. If content is important for readers to see, don't hide it.
- When deciding whether to make something interactive, remember that getting it to work on all platforms is expensive.

Source: https://github.com/archietse/malofiej-2016/blob/master/tse-malofiej-2016-slides.pdf

How has the NY Times changed?

- Most visuals are now static
- They are writing and editing more text
- Animation is ideally triggered by user scrolling
- The bar for interactives is VERY high.

Source: https://github.com/archietse/malofiej-2016/blob/master/tse-malofiej-2016-slides.pdf

Animation taxonomy

- Change the view – Pan over or zoom in on a fixed image, such as a map or a large data space
- Change the charting surface – On a plot, change the axes (e.g., change from linear to log scale).
- Filter the data – Remove (or add) data points from the current view.
- Reorder the data – Change the order of points.
- Change the representation – Change from a bar chart to a pie chart; change the layout of a graph; change the colors of nodes.
- Change the data – Move data forward through a time step, modify the data, or change the values portrayed.

Source: http://www.audentia-gestion.fr/MICROSOFT/bv_ch19.pdf

Animation principles

- Staging – It is disorienting if too many things happen at once. If it is possible to change one thing, do so. Otherwise, use staging for multiple changes.
- Compatibility – A visualization that will be disrupted by animation will be difficult for users to track. For example, it is not disruptive to add another bar to a bar chart (the whole set can slide over), and it may not be disruptive to add another series to a bar chart.
- Necessary motion – In particular, avoid unnecessary motion. This implies that we want to ensure that motion is significant—i.e., we should animate only what changes. In general, the image should always be understandable. Excess motion—even significant motion—can be confusing.

Source: http://www.audentia-gestion.fr/MICROSOFT/bv_ch19.pdf

Animation guidelines

- The Gestalt perceptual principle of common fate states that viewers will group large numbers of objects together, labeling them all as a group, if they are traveling in the same direction and at the same speed.
- Individual objects that take their own trajectories will be seen as isolates, and will visually stand out. If all the items move in different directions, however, observers have far more difficulty following them.
- Perception researchers have shown that viewers have difficulty tracking more than four or five objects independently—the eye gives up, tracking only a few objects and labeling other movement as noise (Cavanagh and Alvarez 2005).

Source: http://www.audentia-gestion.fr/MICROSOFT/bv_ch19.pdf

Animation effectiveness I

- “Animation: Can It Facilitate?” (Tversky, Morrison, and Bétrancourt 2002), reviews nearly 100 studies of animation and visualization. In no study was animation found to outperform rich static diagrams.
- Christopher Hundhausen, Sarah Douglas, and John Stasko (2002) tried to understand the effectiveness of algorithm visualization in the classroom, but half of the controlled studies they examined found that animation did not help students understand algorithms.
- Zongker and Salesin (2003) warn that many animation techniques can be distracting or deceptive, suggesting causality where none might exist. Also, they are often meant to give an illusion of emotion, which may be quite inappropriate for data visualization.

Animation effectiveness II

- Whether they had interactivity or not, users in the animation condition were less accurate than small multiples.
- Users took a very long time to answer questions when given an interactive animation, scrolling back and forth. When we took that control away, they'd quickly make their best guess. Despite that, interactive animation wasn't much more accurate then non-interactive!
- But we also found that users really liked the animation view: Study participants described it as "fun", "exciting", and even "emotionally touching." At the same time, though, some participants found it confusing: "the dots flew everywhere."

Source: https://medium.com/@FisherDanyel/effectiveness-of-animation-in-trend-visualization-ten-years-later-e2f52b433526

Selective attention

Source: https://www.youtube.com/watch?v=IGQmdoK_ZfY

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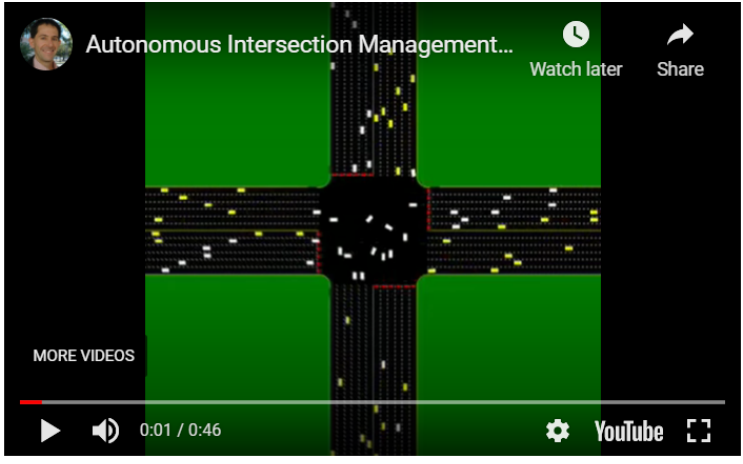
Selective attention

- This information loss is in large part due to change blindness, a phenomenon where attending to one change leaves us blind to others.
- For example, counting the number of times a basketball is passed causes us to miss a gorilla dancing through the passers. We can replace a conversant mid-discussion without notice.
- In data visualizations, change blindness means that if we don't tell the analyst what aspects of an animated visualization to pay attention to, they may never see important changes in their data. Even if they see these changes, our limited memory prevents us from recalling precise differences over time.

Source: https://interactions.acm.org/archive/view/july-august-2018/the-good-the-bad-and-the-biased

Automated Intersection Management

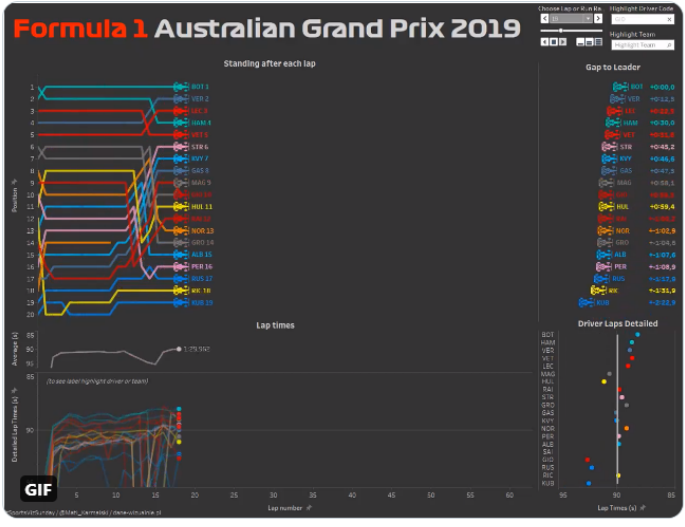


Source: https://www.youtube.com/watch?v=r7_lwq3BfkY

Hourly Manhattan population

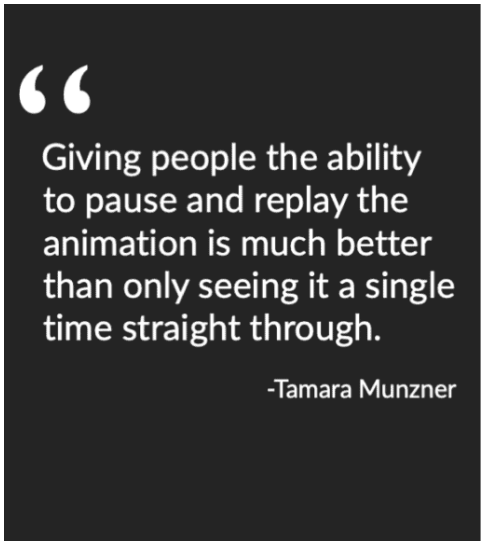
Source: https://twitter.com/i/status/994210834887921670

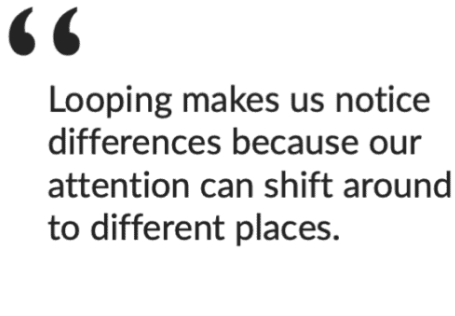
Australian Grand Prix



Source: https://twitter.com/i/status/1234902415155003394

Recommendation – Looping





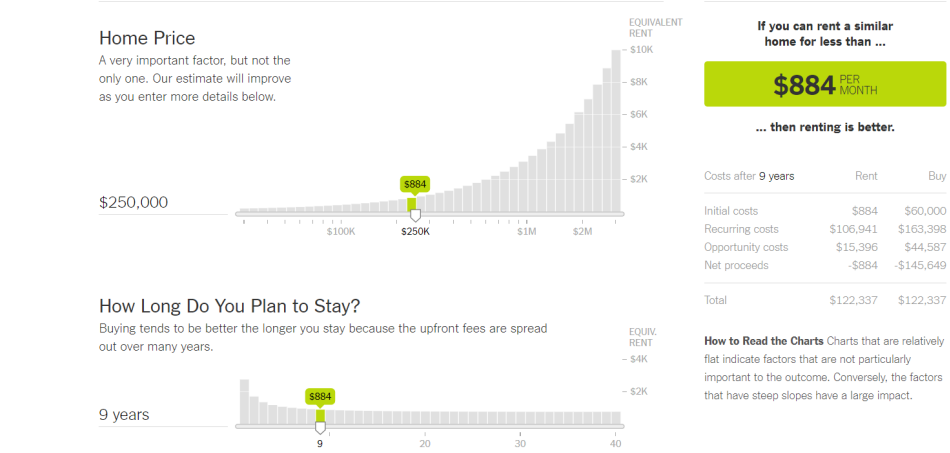
Interactivity

Interactive tools

- Zoom
- Filter
- Search/locate
- Extract
- Highlight
- Drag/reposition
- Tooltips
- Mouse-over
- Compute derived value
- Sort/order

Source: https://idl.cs.washington.edu/files/2017-VegaLite-InfoVis.pdf

NY Times - Rent or Buy?



Source: https://www.nytimes.com/interactive/2014/upshot/buy-rent-calculator.html

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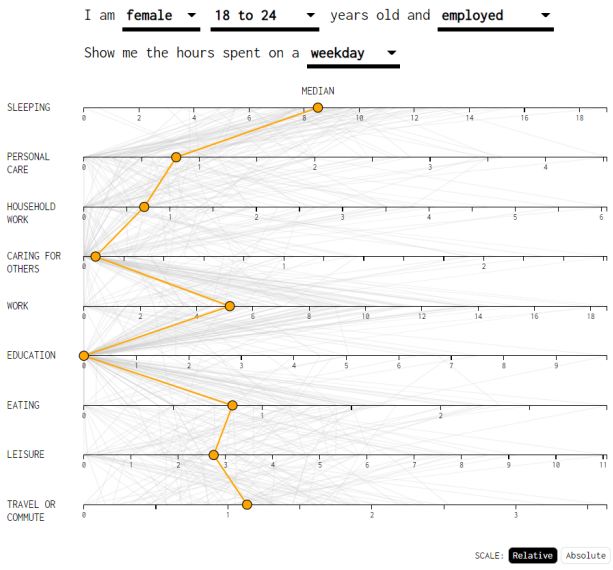
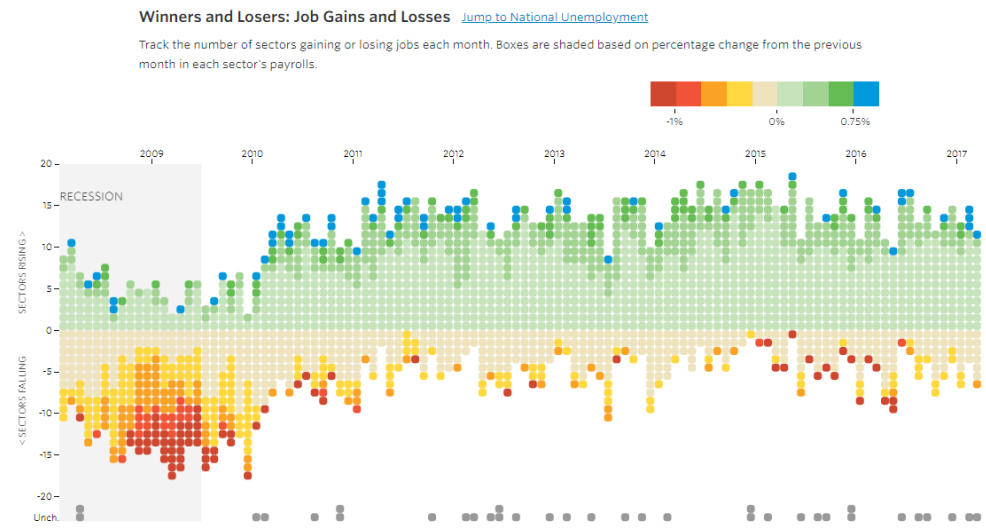
Time use



Source: https://flowingdata.com/2016/12/06/how-people-like-you-spend-their-time

Job Gains and Losses



Source: http://graphics.wsj.com/job-market-tracker/

Design

Analysis Design decisions must be based on facts and details elicited from discussions with the users and observations of the work. These are used to create models of the work environment, the work, and the resources required to do the work.

Design Design begins by developing an abstract conceptual model. From this, an interface architecture is designed that groups related actions into interaction spaces and shows how the user will navigate between these spaces. The visual interface and interactions are designed from the various analysis and design models.

Prototyping Prototypes provide a way to envision and experience how the new system will affect work, to explore technical alternatives, and to discuss flaws in the design and specific ideas for how it might be improved. Prototypes should be quick and inexpensive to build and relatively easy to change.

Evaluation Evaluation is intended to provoke discussion about better ways to structure the system, or to uncover tasks that aren't necessary or may be more or less important than initially thought.

Source: https://www.wiley.com/en-us/Making+Sense+of+Data+III%3A+A+Practical+Guide+to+Designing+Interactive+Data+Visualizations-p-9781118121603

Design II

Organize the application Complex applications require organization and navigational aids that allow users to move between interaction spaces. Designers use signage, maps, and clues to help users know what path takes them to the place where the next required action can be performed and to keep them from getting lost.

Organize the page Page layout uses techniques to create a visual hierarchy of the content that gives weight to what is most important and a visual flow that leads the user through the page. A visual hierarchy structures the content that incorporates focal points that lead into secondary regions of less important content. Visual flow is designed to manipulate the path the eye takes as it scans the page.

Organize the actions Actions may be visible or invisible. Visible actions must provide visual feedback when they are manipulated by the user. Invisible actions are invoked through combinations of keystrokes, drag-and-drop operations, and double-clicking or right-clicking on visible objects.

Source: https://www.wiley.com/en-us/Making+Sense+of+Data+III%3A+A+Practical+Guide+to+Designing+Interactive+Data+Visualizations-p-9781118121603

Design III

- Designing the physical structure of interactive visualizations is often guided by a well-known mantra: “Overview first, zoom and filter, then details on demand.”
- Several interface schemes incorporate the mantra: overview & detail (spatial separation), zooming (temporal separation), and focus & context.
- Interactive techniques such as filtering, creating subsets of the information, or sorting and rearranging the information provide support for creating different views of the information.

Source: https://www.wiley.com/en-us/Making+Sense+of+Data+III%3A+A+Practical+Guide+to+Designing+Interactive+Data+Visualizations-p-9781118121603

UI/UX Lessons

Nielsen Norman Group

Jakob's Ten Usability Heuristics

1 Visibility *of* System Status

Designs should *keep users informed* about what is going on, through appropriate, timely feedback.

Interactive mall maps have to show people where they currently are, to help them understand where to go next.

2 Match between System and the Real World

The design should speak the users' language. Use words, phrases, and concepts *familiar to the user*, rather than internal jargon.

Users can quickly understand which stovetop control maps to each heating element.

3 User Control *and* Freedom

Users often perform actions by mistake. They *need a clearly marked "emergency exit"* to leave the unwanted action.

Just like physical spaces, digital spaces need quick "emergency" exits too.

4 Consistency *and* Standards

Users should not have to wonder whether different words, situations, or actions mean the same thing. *Follow platform conventions.*

Check-in counters are usually located at the front of hotels, which meets expectations.

5 Error Prevention

Good error messages are important, but the best designs *carefully prevent problems* from occurring in the first place.

Guard rails on curvy mountain roads prevent drivers from falling off cliffs.

6 Recognition Rather Than Recall

***Minimize the user's memory load* by making elements, actions, and options visible. Avoid making users remember information.**

People are likely to correctly answer "Is Lisbon the capital of Portugal?".

7 Flexibility *and* Efficiency of Use

Shortcuts — hidden from novice users — *may speed up the interaction* for the expert user.

Regular routes are listed on maps, but locals with more knowledge of the area can take shortcuts.

8 Aesthetic *and* Minimalist Design

Interfaces should not contain information which is irrelevant. Every extra unit of information in an interface *competes* with the relevant units of information.

A minimalist three-legged stool is still a place to sit.

9 Recognize, Diagnose, *and* Recover from Errors

Error messages should be expressed in plain language (no error codes), precisely indicate the problem, and constructively suggest a solution.

Wrong-way signs on the road remind drivers that they are heading in the wrong direction.

10 Help *and* Documentation

It's best if the design *doesn't need* any additional explanation. However, it may be necessary to provide documentation to help users complete their tasks.

Information kiosks at airports are easily recognizable and solve customers' problems in context and immediately.

NN/g

www.nngroup.com/articles/ten-usability-heuristics/

Don’t go chasing waterfalls

Concluding thoughts on animation and interactivity:

- Seek professional help. Animated and interactive data visualisations are technically difficult, time consuming and often misleading – even when the professionials are involved early.
- Well-desinged static alternatives are usually superior.
- If you are going ahead anyway treat it like designing a user interface and put the user’s experience (& opinion) at the center of the design process.
- Treat animation and interactivity as a last resort for publications.

Colour

Perception

Storytelling with Data