Data visualisation

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Deusto

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1. Data visualisation as artefact

1. Data visualisation as artefact

> artefact (*US* **artifact**) **noun**

> [1] An object made by a human being, typically one of cultural or historical interest.
> *'gold and silver artefacts'*

> [2] Something observed in a scientific investigation or experiment that is not naturally present but occurs as a result of the preparative or investigative procedure.
> *'the curvature of the surface is an artefact of the wide-angle view'*

The Oxford Dictionary of English

The atomic level

no. of observations → marks

Maximum data density is `1:1`, and this is not usually the case:

$$\frac{\text{data points}}{\text{observations}} < \text{pixels}$$

The atomic level

Some strategies to overcome this constraint:

1. Filter observations
2. Split data into multiple charts
3. Augmenting visualisations
4. Densify

The atomic level

1. Filter observations TREND

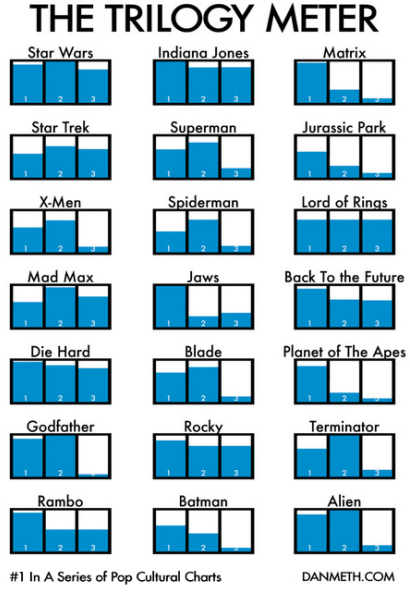
- By design, communicating a selection of data
- By allowing the user to filter according to their interests
  - Innovative filtering INNOVATION (i.e. Smart brushing)

Smart Brushing of Parallel Coordinates, IEEE VIS 2018 talk, 25 Oct, Berlin

The atomic level

2. Split data into multiple charts TREND

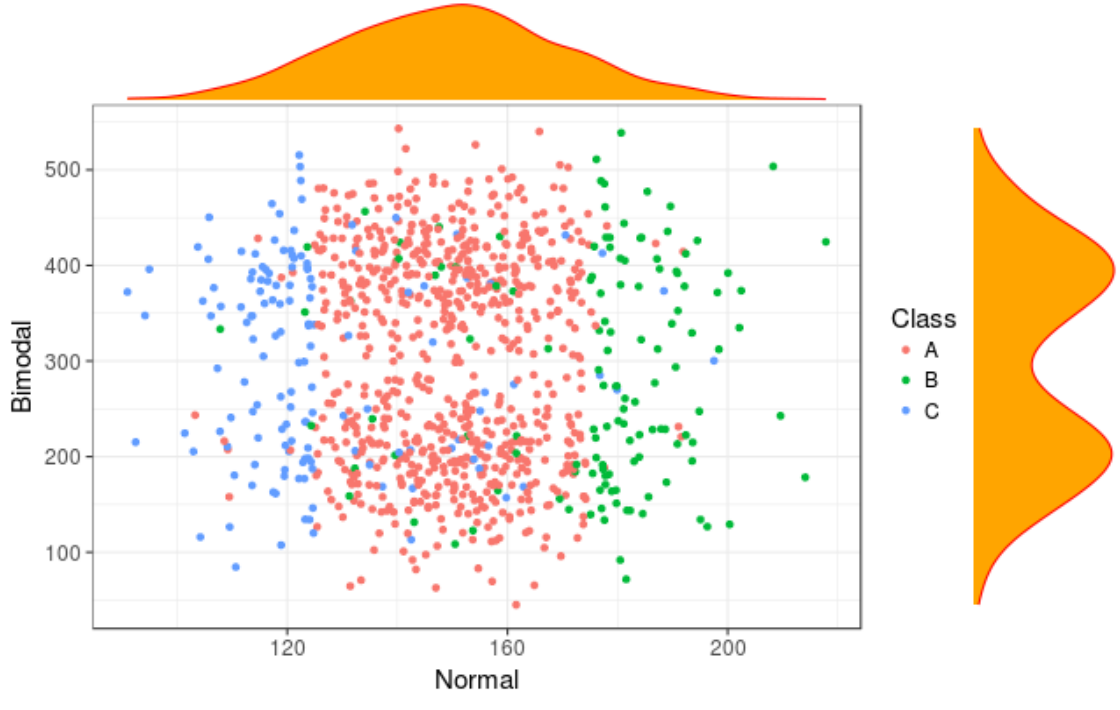
Facets, trellis, small multiples.



Example of small multiples: The Trilogy Meter (Meth 2009)

The atomic level

3. Augmenting visualisations TREND

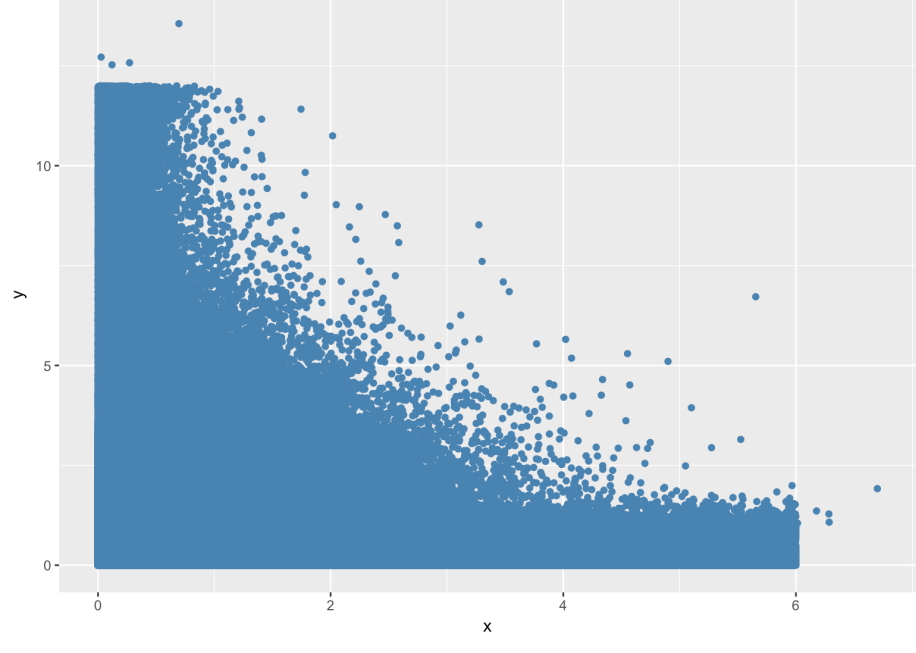


ggExtra, adding marginal histograms to ggplot2 (by Dean Attali)

The atomic level

4. Densify

- Escaping overplotting in scatterplots TREND

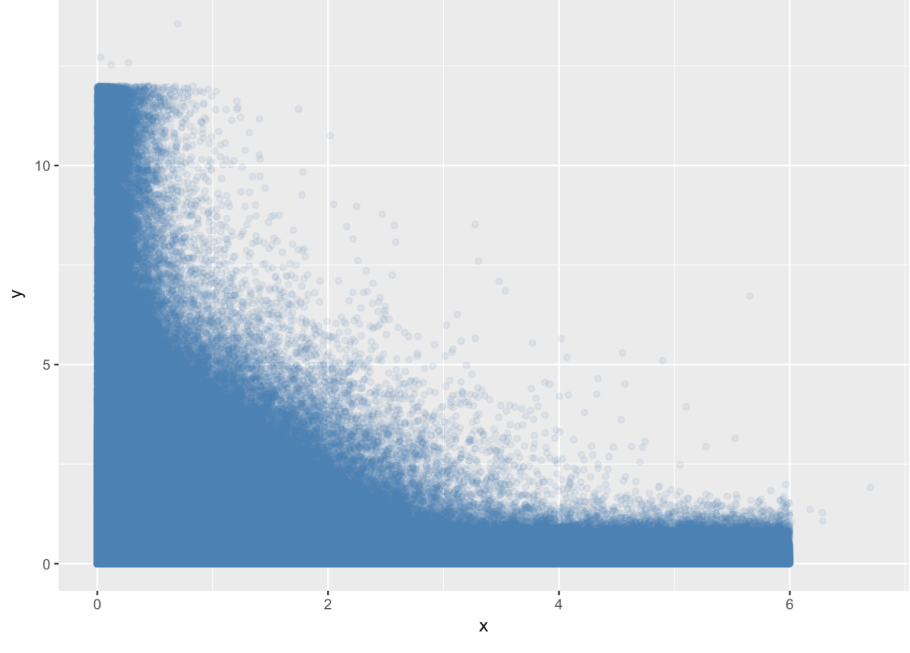


Clearly overplotted scatterplot (Kovalyshyn 2017)

The atomic level

4. Densify

- Escaping overplotting in scatterplots TREND

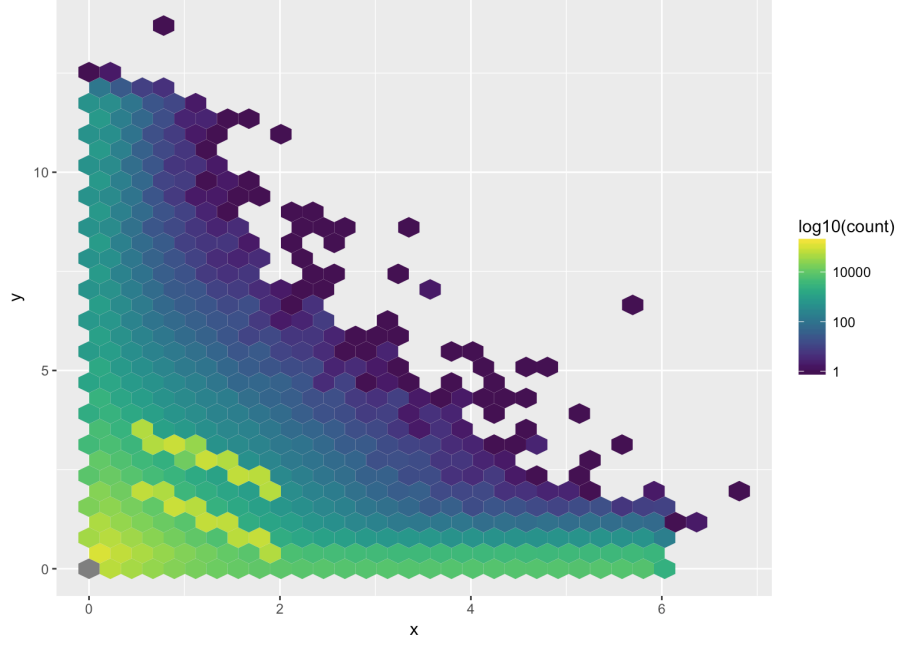


Using transparency is not helpful (Kovalyshyn 2017)

The atomic level

4. Densify

- Escaping overplotting in scatterplots TREND

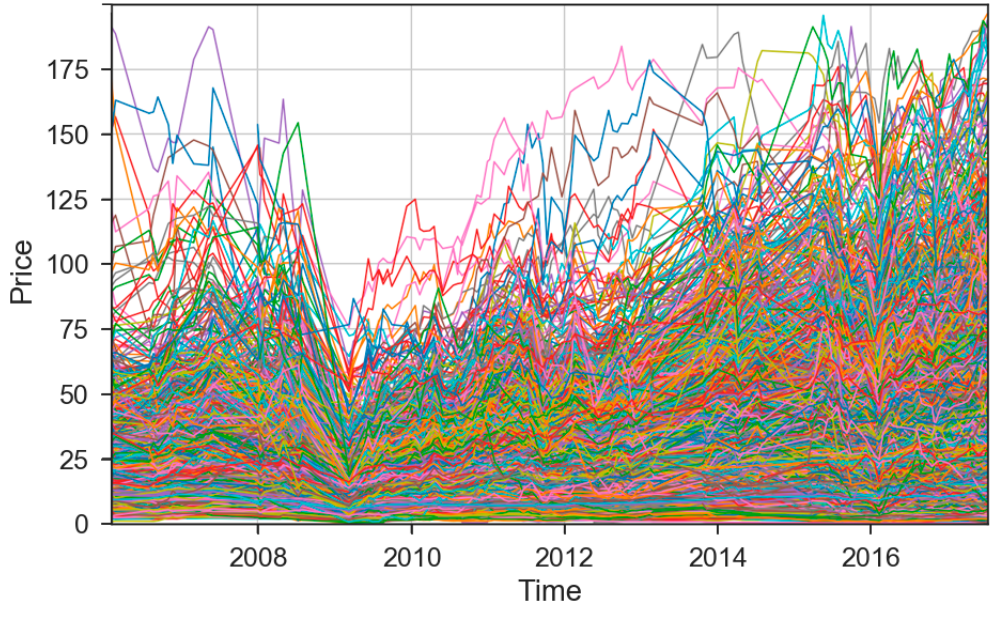


Now we can **see** density (Kovalyshyn 2017)

The atomic level

4. Densify

- Timelines INNOVATION

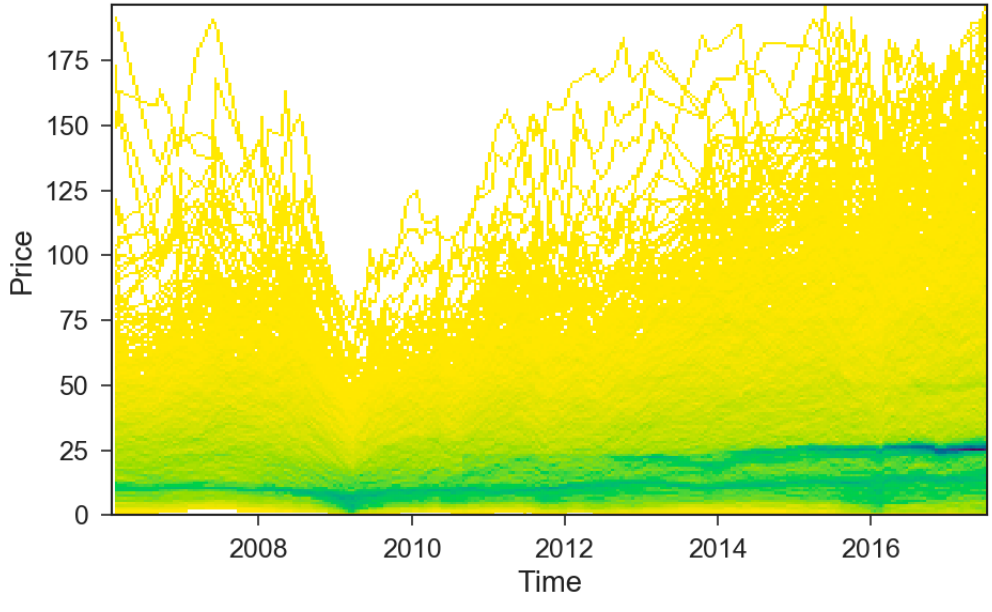


DenseLines, a density representation of many time series as a heatmap (Moritz & Fisher 2018)

The atomic level

4. Densify

- Timelines INNOVATION



DenseLines, a density representation of many time series as a heatmap (Moritz & Fisher 2018)

The atomic level

Adding the time factor:

- Static visualisations with real data (at the time of loading)
- Real-time visualisations, static and auto-refreshed
- Streaming data visualisations showing the flow of data

Require an additional effort for operational intelligence, where immediate decision making could be a requirement.

Source: Aragues 2018

The atomic level

How to communicate *nothingness*? (Kirk 2014)

Andy Kirk - The Design of Nothing: Null, Zero, Blank

The atomic level

How to communicate *nothingness*?

- **Null** Absence of measurement
- **Zero** Absence of amount/magnitude
- **Blank** Try to use *nothing* to represent *something*

Andy Kirk - The Design of Nothing: Null, Zero, Blank

The atomic level

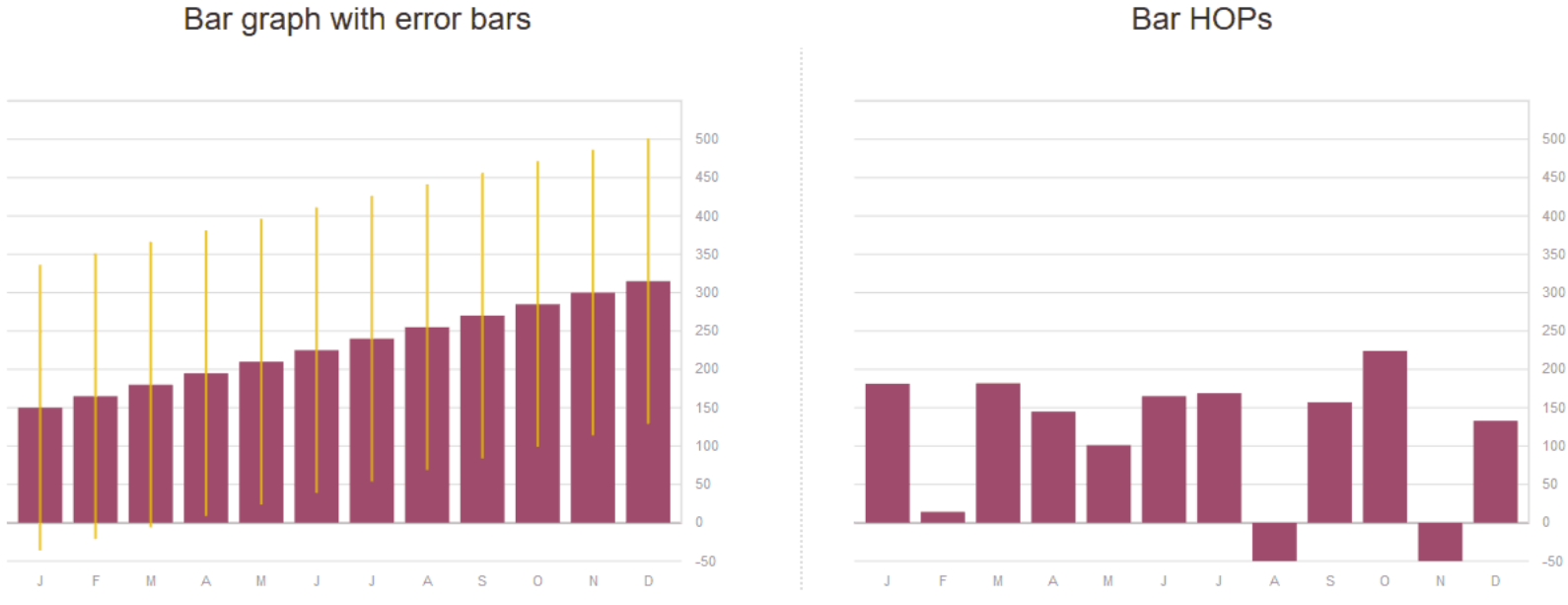
How to communicate *nothingness*?

- **Null** Absence of measurement
- **Zero** Absence of amount/magnitude
- **Blank** Try to use *nothing* to represent *something*
- The design should be **invisible**

Andy Kirk - The Design of Nothing: Null, Zero, Blank

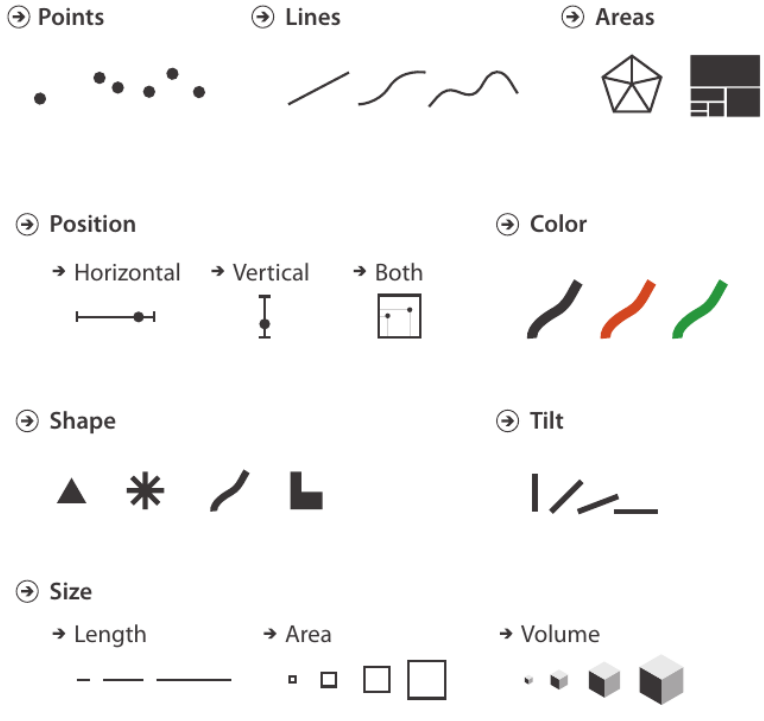
The atomic level

Communicating uncertainty, projections, and other non-factual data is challenging.



Uncertainty visualisations tested in experiments (Kale *et al.* 2019)

Number of variables TREND



Visual marks and channels (Munzner 2014)

Number of variables TREND

It is required to reduce dimensionality (statistically): PCA, factors, clustering.

Generating new idioms INNOVATION

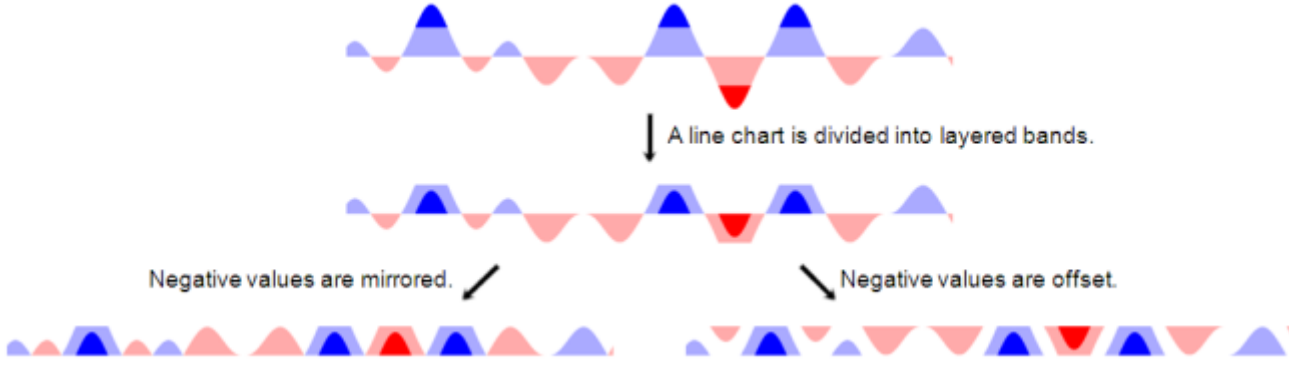
A word of caution:

- will need to be custom coded
- readers will require training
- correct interpretation may be more time demanding

Xenographics: Weird but (sometimes) useful charts

Generating new idioms

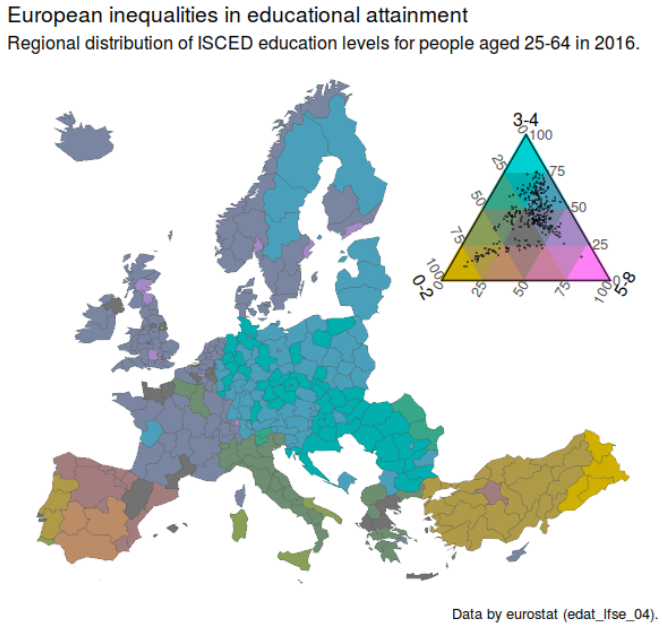
INNOVATION



Horizon charts (Heer 2009)

Generating new idioms

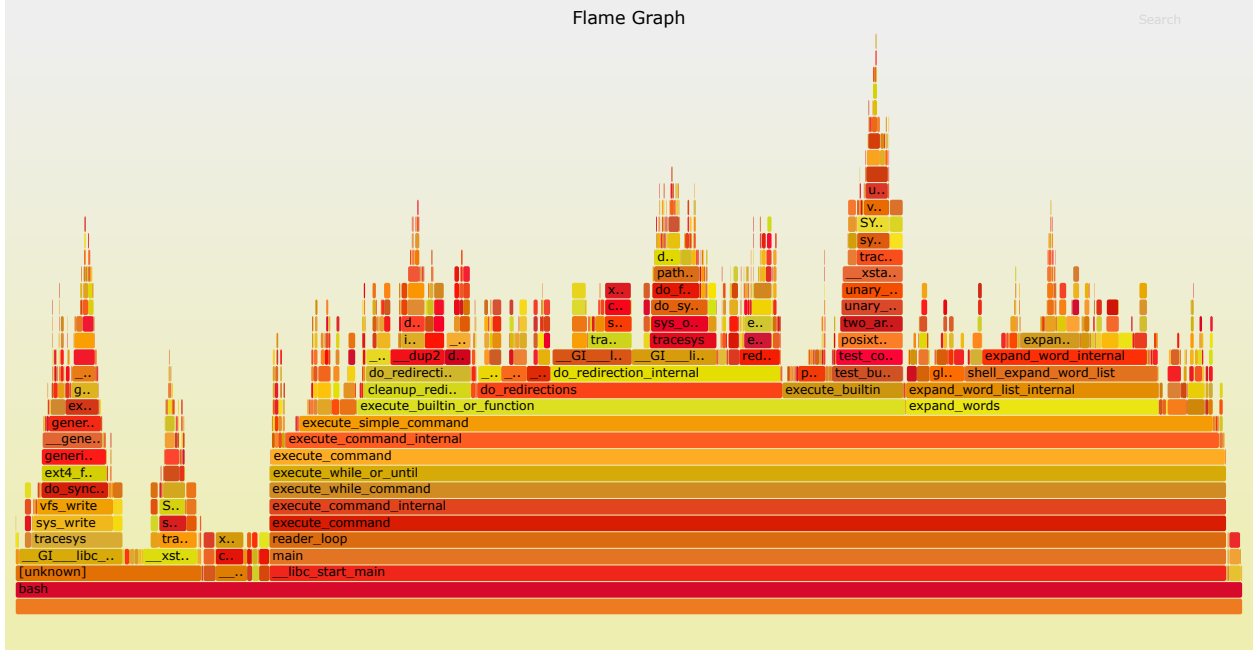
INNOVATION



Choropleth maps with `tricolore` (Schöley 2018)

Generating new idioms

INNOVATION



Flame graphs (Gregg 2016)

Multiple Linked Views (MLV) TREND

INNOVATION

Making Data Visual

[VIS'18] Multiple Coordinated Views at Large Displays for Multiple Users

(Lagner, Kister & Dachselt 2019)

Beyond 2 dimensions

INNOVATION

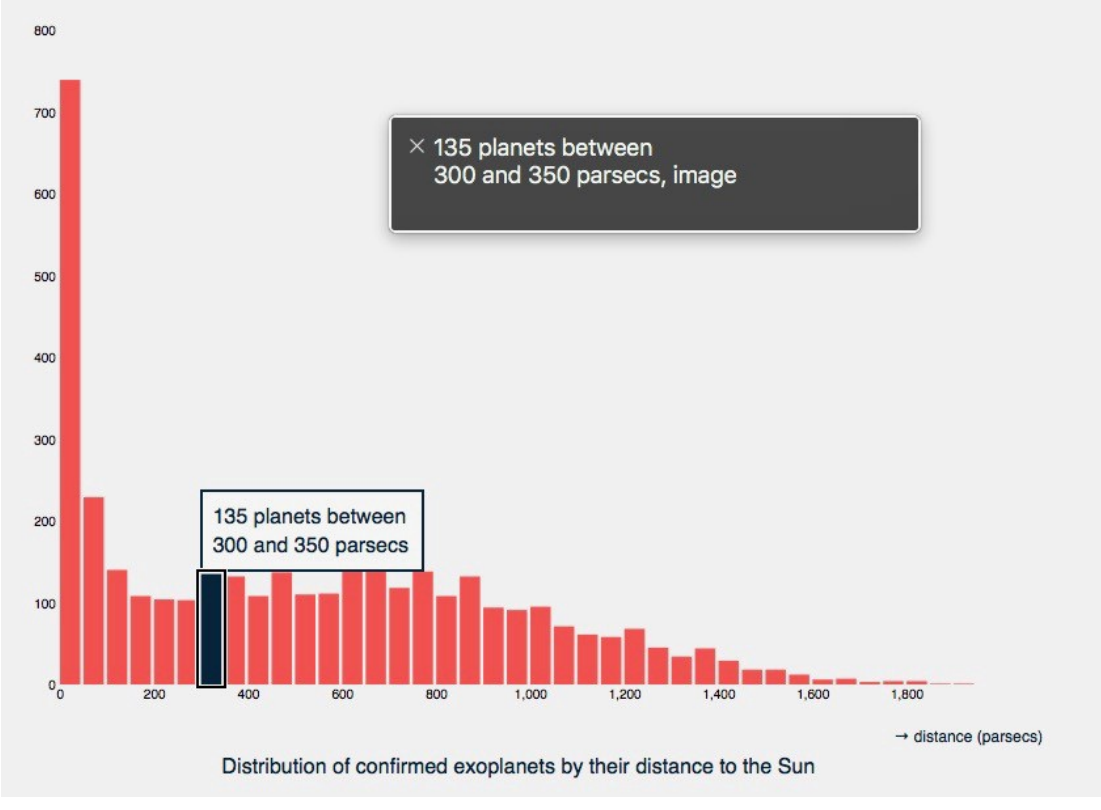
virtual / augmented reality

FiberClay: Sculpting Three Dimensional Trajectories to Reveal Structural Insights

DXR Overview

Other senses

INNOVATION



Sonification example and demo (Guillemot 2018)

Other senses

INNOVATION

Smell necklace designed to be used with an immersive VR display (via Twitter)

2. Data visualisation as a tool for communication

2. Data visualisation as a tool for communication

> *The modern approach to data visualisation is focused on quickly making data visualisation.*

(Meeks 2018)

2. Data visualisation as a tool for communication

Focus on speed affects:

- how data visualisation products are designed
- what tools are used to create them
- the role of the creator in relation to the product
- how engagement with readers in envisioned

2. Data visualisation as a tool for communication

> *Ultimately, data visualisation is not a technical problem, it's a design problem and, more than that, a communication problem .*

(Meeks 2018)

Let's look at what charts **say**, **mean**, and **do**.

What charts say

Explicitly

Charts *do* "show me the data" (but remember that it's more that they **tell** the data than actually show it).

Means chosing the right specific chart to use in order to display and query the data.

How to improve: Expose data cleanly and clearly. Accuracy *vs.* precision.

What charts say

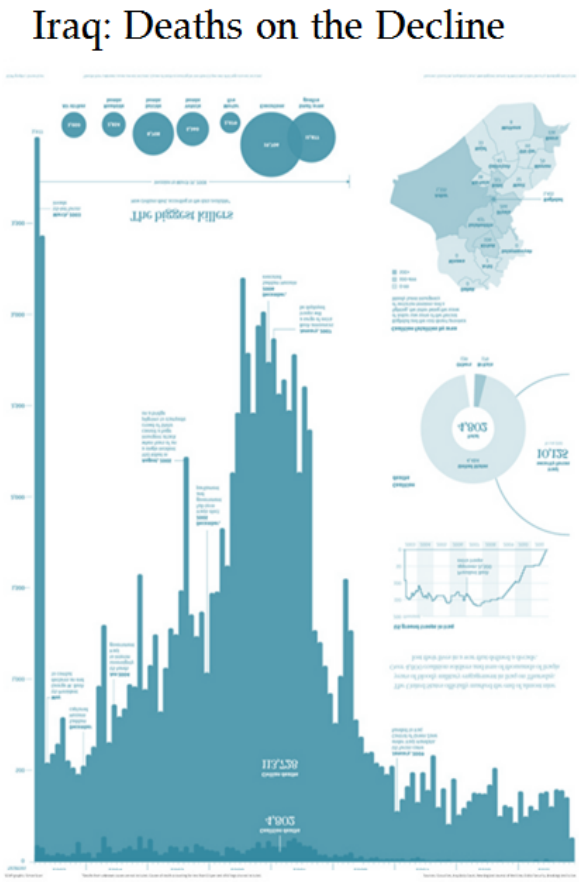
Implicitly

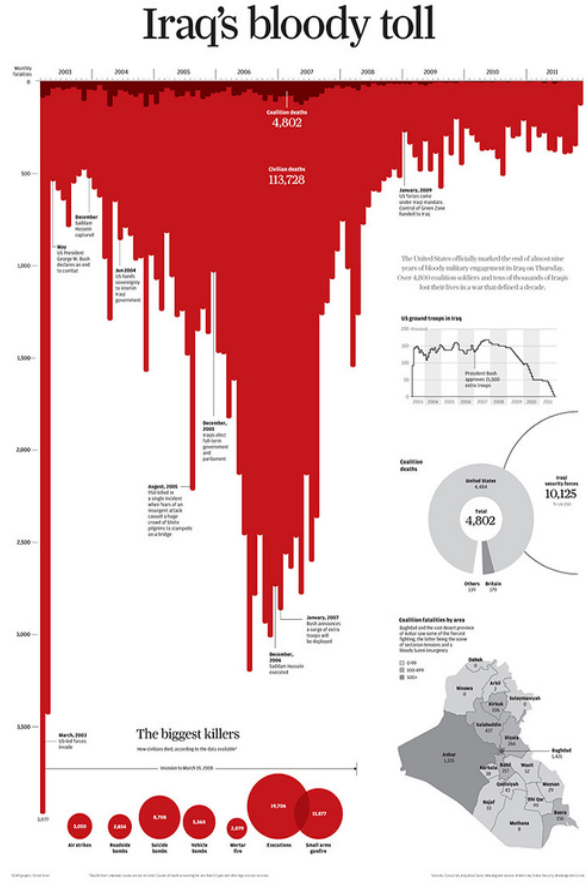
No chart is an unbiased view of the data, as data visualisation is a manufactured artefact.

> *All data is transformed to be in a chart, and the inaction of not designing that transformation carries just as strong an implication as the action of transforming it.*

(Meeks 2018)

What charts say





Original infographic (right) by Simon Scarr and redesigned, more default representation of an histogram (left), redesigned by Andy Cotgreave (Meeks 2018)

What charts say

Implicitly

The implicit channel of a data visualisation (the title and other framing elements) can be even more powerful than the explicit channel.

How to improve: Style should be intentional, purposeful and thematically appropriate, not the result of defaults or superficial decisions.

What charts say

Systematically

> *[…] all charts display data and all data is a proxy for the systems that created and measured that data.*

(Meeks 2018)

How to improve: Caution not to reveal an underlying system that is proprietary or confidential.

What charts say

Descriptively

- internally: axes, labels, annotations
- externally: surrounding text, figure descriptions, discussions

Unlike the implicit channel, the descriptive channel is active and purposeful (not subconscious).

How to improve: Consider annotations, labels, axis elements as part of the data visualisation.

What charts say

> *By being more explicit in our own understanding of what charts say and how we can systematically describe what they say, we can grow more capable of using the channels available in that expression to our advantage.*

(Meeks 2018)

What does your chart say that you didn't intend?

What charts mean

Charts mean more than just what they say.

What charts mean

Intentionally

> *The mode and purpose of a chart should be well understood by the chart maker and immediately apparent to the chart reader.*

(Meeks 2018)

What charts mean

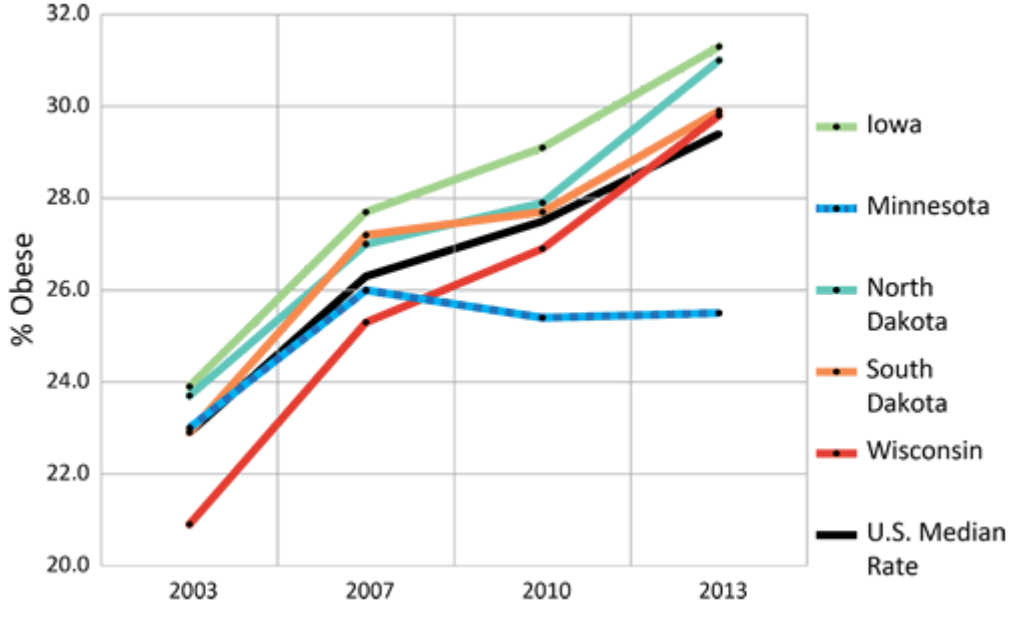
Historically

Charts are products of their time.

It is important to provide background about the data sources, to enable checking whether they are still based on relevant priorities, dimensions and metrics.

What charts mean

Historically



A Minnesota Department of Health chart on changing obesity rates that relies on BMI will still be around long after we develop a more sophisticated measure of health and yet nowhere on this chart does “BMI” appear (Meeks 2018)

What charts mean

Culturally

Charts should be adapted to the culture they will be consumed in (think user-centered design techniques).

What charts mean

Contextually

Enable removing and adjusting data visualisation elements to reduce complexity, not based on screen size as in responsive data visualisation, but on priority.

What charts mean

> *Meaning-making may sound too soft to the kind of technical professionals that make and read data visualisation but communication without meaning is just noise.*

(Meeks 2018)

What charts do

The most important thing about a chart is its impact.

What charts do

Provide insights

Identify and emphasize the insights that the readers might expect.

A simple line chart (left) and the features of that line chart (right) which may be considered insights by an audience (Meeks 2018)

What charts do

Cause change

As difficult to measure as it is important.

How have they impacted business decisions? How were they used in presentations? Where they modified (changed colours, cropped, annotated) somehow?

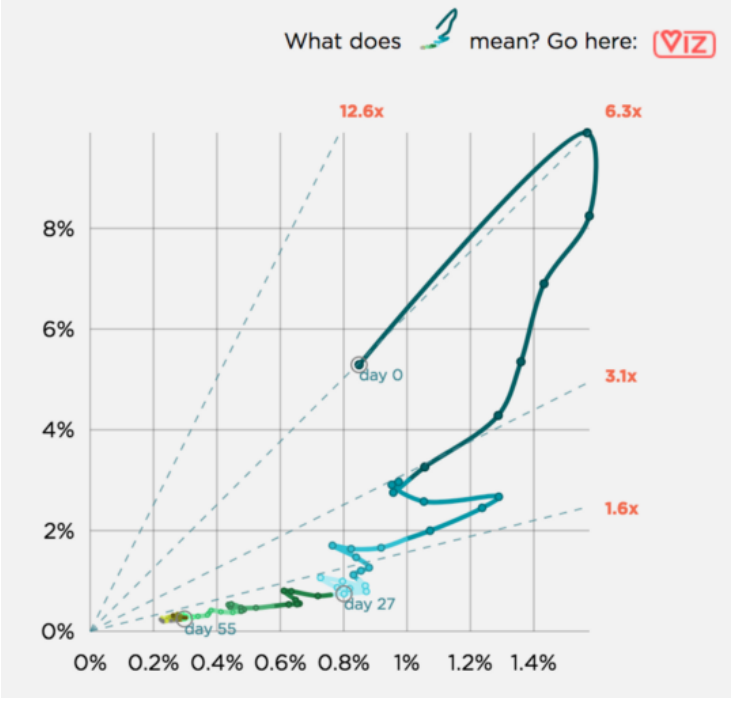
What charts do

Cause visual literacy

> *All data visualisation was, at some point, complex data visualisation, until an audience grew comfortable and literate enough to read it.*

(Meeks 2018)

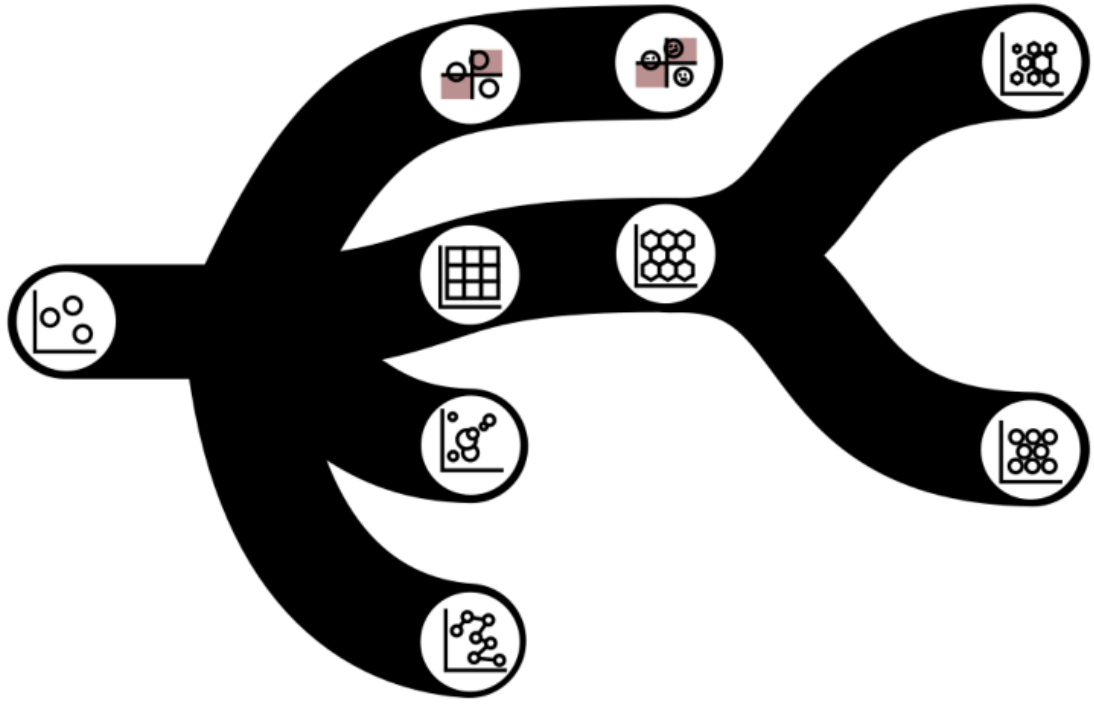
What charts do



This example of a connected scatterplot, used in production at Netflix, has built into it a link to an animated explanation of how to read the new chart along with more familiar charts around it to reduce friction (Meeks 2018)

What charts do

Create new charts



Imaginary genealogy for charts with scatterplots as a common ancestor (Meeks 2018)

What charts do

> *All communication is evaluated based on content, but persuasive communication, which is all data visualisation unless it is purely decorative, is rightly also evaluated based on effect.*

(Meeks 2018)

3. The artefact goes social

Data counseling

> *[…] brings domain expertise into the operationalization process to help inform decisions about good proxies as well as to uncover insights using the resulting visualisations.*

(Meyer & Fisher 2018)

Data counseling

Based on **interviews** (1) for

- gaining an understanding of the questions and data
- get feedback on proxies, explorations, and visualisation **prototypes** (2)

Data counseling

Interviews

> *The role of the interviewer is to ask questions that will guide the stakeholders toward elucidating the information necessary for working through an operationalization process and designing visualisations.*

(Meyer & Fisher 2018)

Data counseling

Interviews

Identify stakeholders:

- analysts
- data producers
- gatekeepers
- decision makers
- connectors

Data counseling

Interviews

Require practice and experience.

Semistructured: be prepared, but also be open.

- start with open ended questions (problem, data, context)
- use the conversation to search out the more abstract question

Data counseling

Interviews

Use traditional conversation / interpersonal communication skills to prevent dead ends: keep them talking

- rephrase responses back to the stakeholder
- ask the same or similar questions in different ways
- explore a completely different conversational topic

Data counseling

Interviews

Contextual interviews

- take place in the stakeholder's work environment
- consist of demonstrations of the tools and data inspection methods currently in use

Data counseling

Rapid prototyping

> *[…] is a process of trying out many visualisation ideas as quickly as possible and getting feedback from stakeholders on their efficacy.*

(Meyer & Fisher 2018)

Data counseling

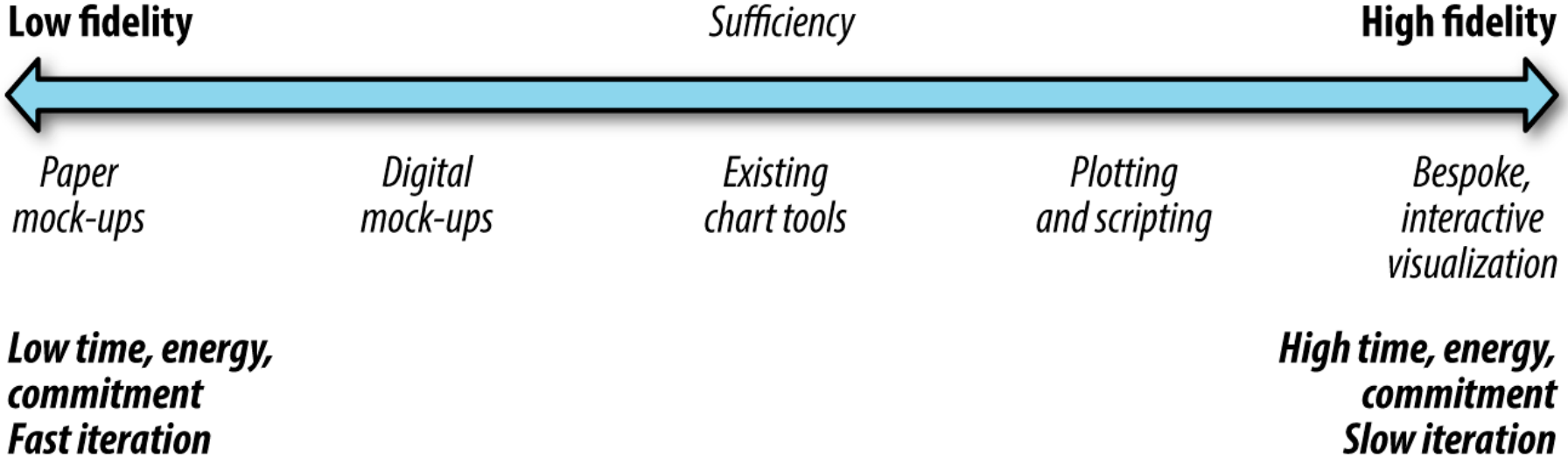
Rapid prototyping

≠ *fast* data visualisation

≈ agile/lean methodologies
and user-centered design

Data counseling

Rapid prototyping



Prototypes range from low-fidelity sketches to high-fidelity working models (Meyer & Fisher 2018)

Data counseling

Rapid prototyping

Prototypes are made to obtain feedback on them: get to the stakeholders early and often.

Focus not on whether they like it or not, but rather on **what the visualisation can and cannot do** (contextual interview where the stakeholder uses the visualisation).

Responsive data visualisation

> *Responsive web design, and responsive data visualisation are not simply a way to make our content accessible on smaller screens. We need to build an ergonomic web that feels natural regardless of device type.*

(Hinderman 2018)

Responsive data visualisation

Unknowns require adaptability.

- the context in which **the user** is trying to consume the visualisation
- changes in **the data** that is being displayed

Responsive data visualisation

Output side (the client)

Making things work in all screen types by redrawing charts to fit its container.

Match CSS breakpoints + add any new ones as the content requires: group data to fit (trade-off precision for reduced rendering complexity and performance).

Responsive data visualisation

Input side (the data)

Adapting at breakpoints. No need to just redraw the exact same elements:

> *As long as the message being conveyed by the data is the same, and the point you're trying to prove is always present, you should prove it with as much firepower as you have available.*

(Hinderman 2018, p.361)

Responsive data visualisation

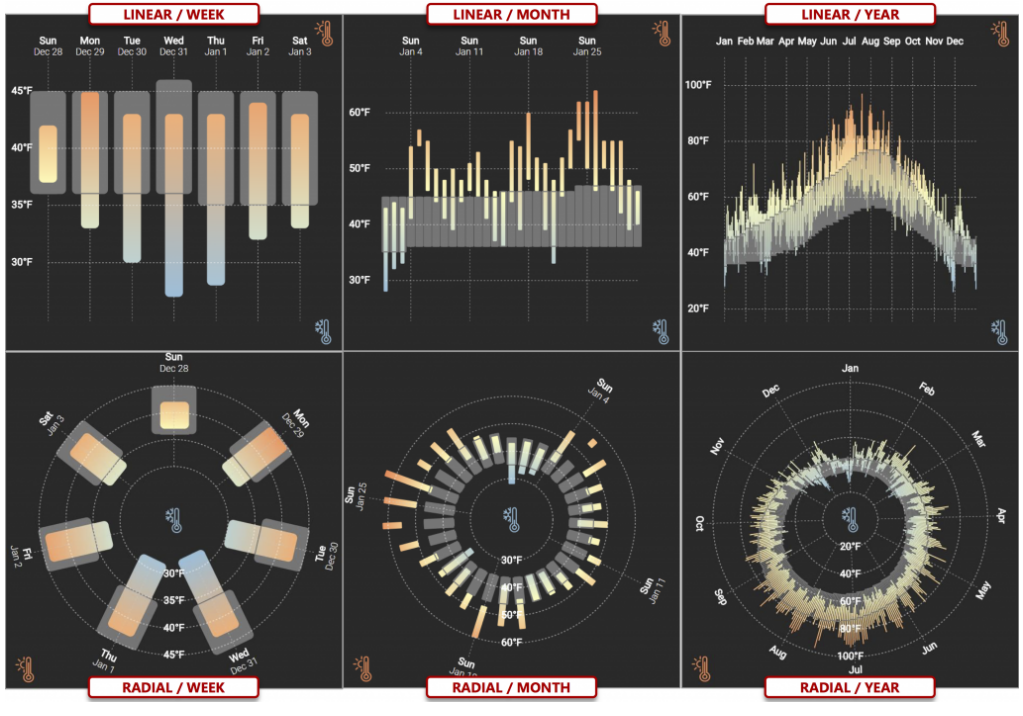
Input side (the data)

Adapting at interaction points.

> *[…] present a rational default but enable users to dig into more complex or specific layers of data when the device's capabilities limit the presentation of both at the same time.*

(Hinderman 2018, p.362)

Responsive data visualisation



Linear and radial temperature range charts designed for mobile phone displays (Brehmer *et al.* 2019)

Glanceable Visualization: Studies of Data Comparison Performance on Smartwatches

Epilogue

Resources

- Xenographics
  Weird but (sometimes) useful charts.
- Open Access Vis
  A collection of open access visualisation research at the VIS 2018 conference.
- IEEEVIS 2018
  Conference on Scientific Visualisation, Information Visualisation and Visual Analytics. Papers from the 2018 edition.

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Thank you!

This presentation is available at

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