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INFORMATION
TECHNOLOGY

FIT3179 Data Visualisation

Week 01: Introduction to Data Visualisation

GROUP OF EIGHT AUSTRALIA

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A definition of a Data Viz.

Vision

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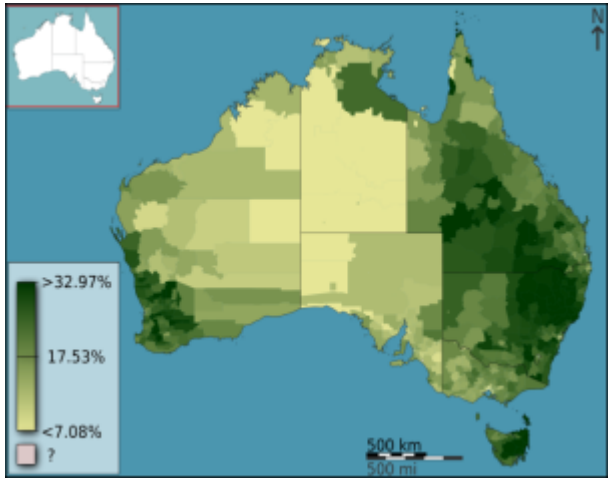
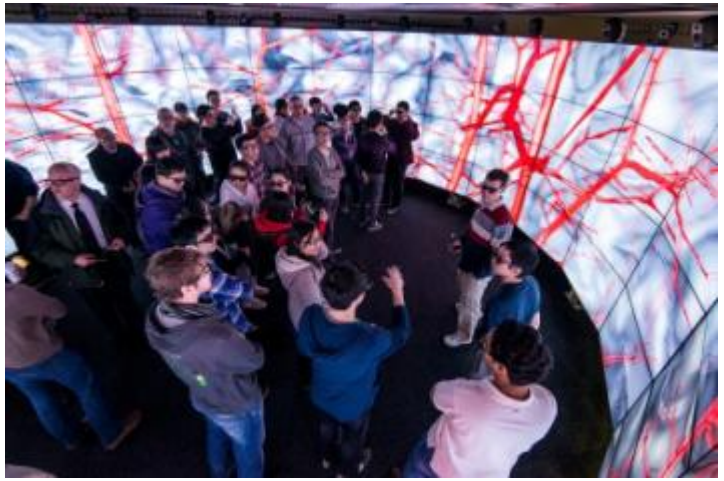
- Humans acquire more information through vision than any of the other senses combined.
- Human Vision
  - Highest bandwidth sense
  - Fast, parallel
  - Pattern recognition
  - Pre-attentive
  - Extends memory and cognitive capacity
  - People think visually
- Creating an image is a really effective way to transmit information.

Can we define Data Visualisation?

There isn't a universal definition! For a starting place though: any visual representation of information.

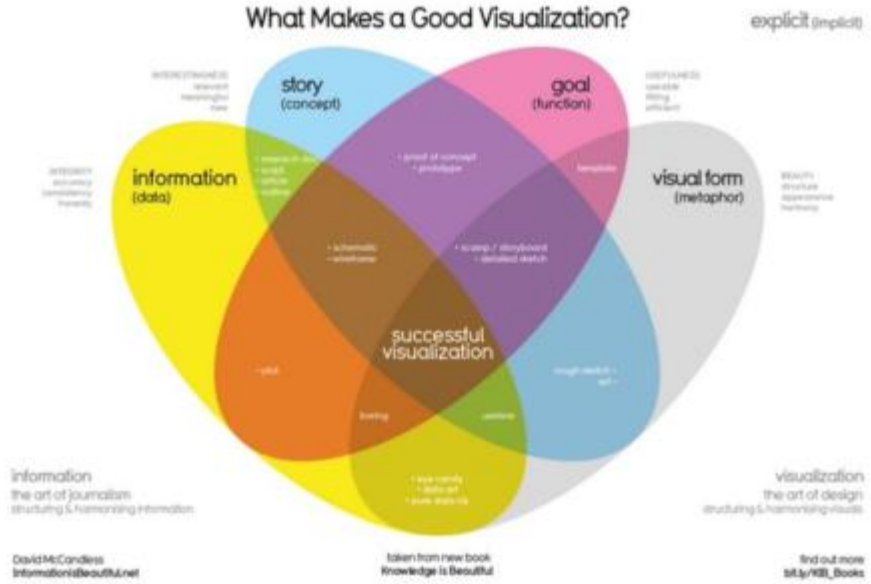
The process of using Data Visualisation in combination with interactive analysis tools is called *Visual Analytics.*





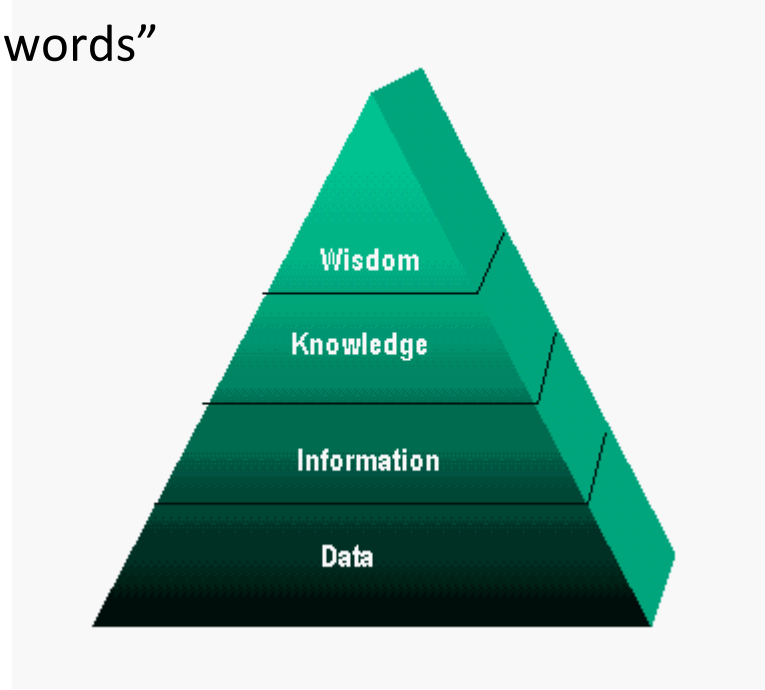
Intersecting fields of knowledge

- It is a conjunction of a number of areas:
  - Knowledge Discovery
  - Cognitive Science
  - Graphic Design
  - Interactive Computer Graphics
  - *Data Science*
- You may have experience in some or all of these already. We just need to put them together.



Transformation

- A visualisation transforms data into information (then *understanding* and *insight*) and makes it useful to people
- Clichés…
  - "Seeing is believing"
  - "A picture is worth a thousand words"



Making a Graphic versus Forming Insight

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- Making a Visualisation is often thought of as process of making a graphic or an image
- But really it is a cognitive process
  - Form a mental image of something
  - Internalize an understanding
  - "The purpose of visualization is insight, not pictures"
  - Insight: discovery, decision making, explanation

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The History of Visualisations

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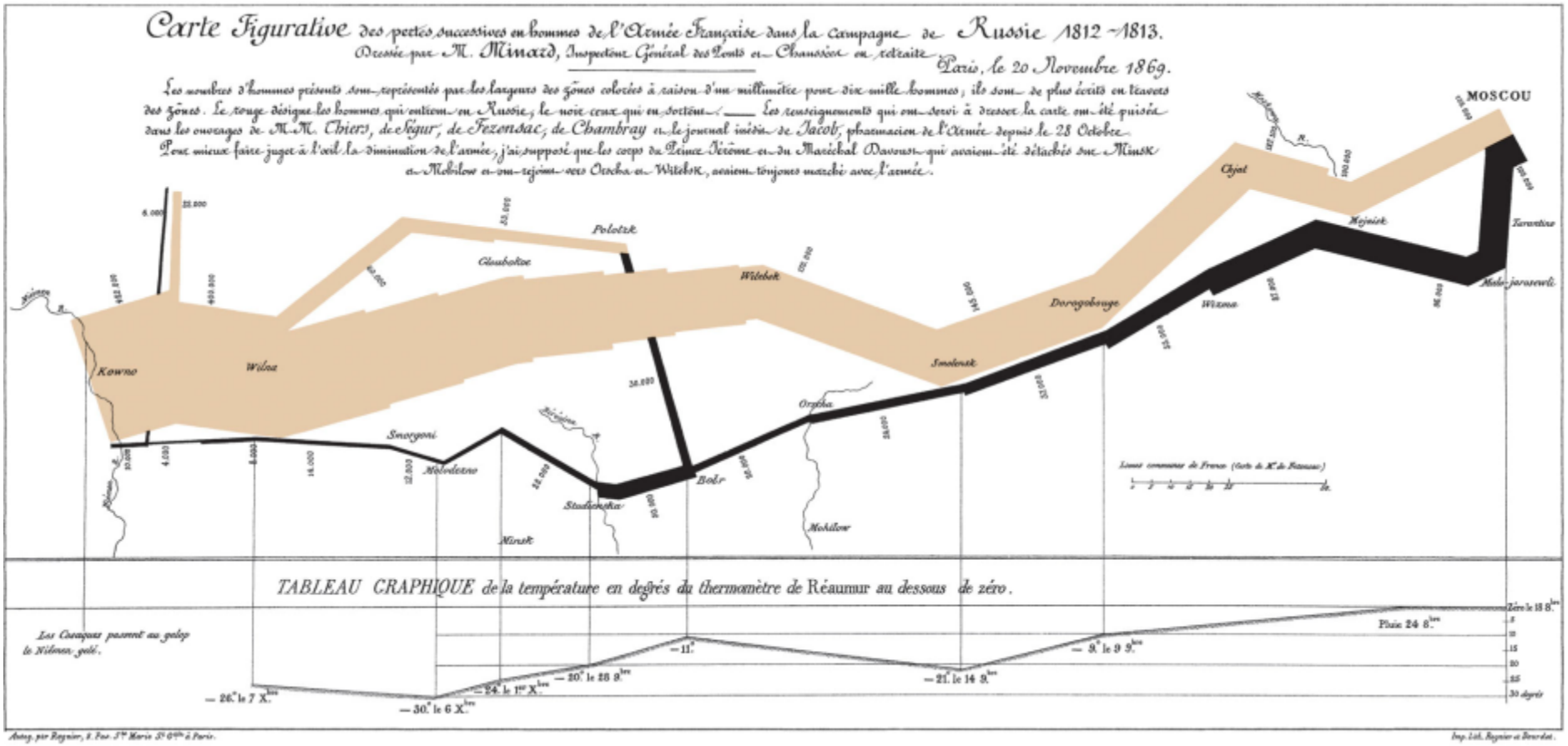
We can argue that the first viz. is the first image!

- Narrow View:
  - Started with Computer Graphics
  - 1987 first journal on Computer Graphics and Visualisation
- Wider View:
  - Cave Paintings, Hieroglyphics, Maps, Astrological Charts… Info Graphics
- Which view? Depends on your philosophies

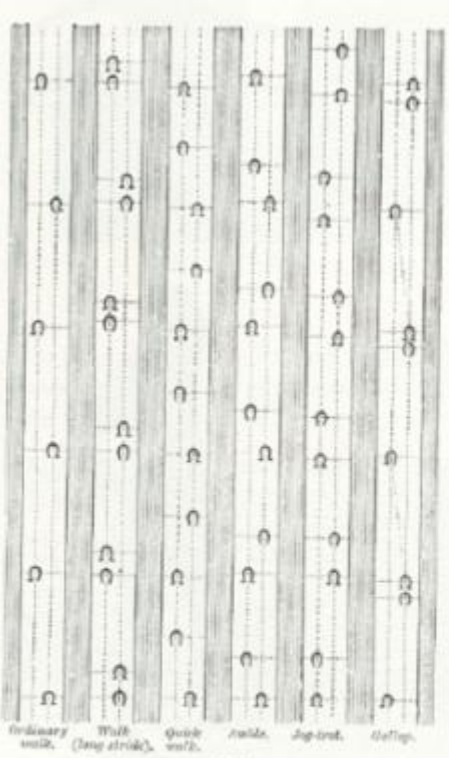
Rock art at Narwala Garbarnmang in Arnhem Land (from D. Bruno et al, 2011)

Napoleon's March by Charles Minard (1861)

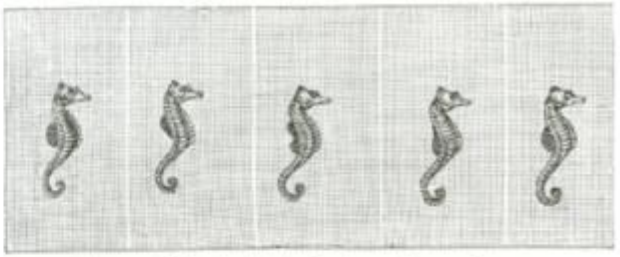


https://en.wikipedia.org/wiki/Charles_Joseph_Minard
Source: http://upload.wikimedia.org/wikipedia/commons/2/29/Minard.png

Time Series (Etienne-Jules Marey, 1800's)



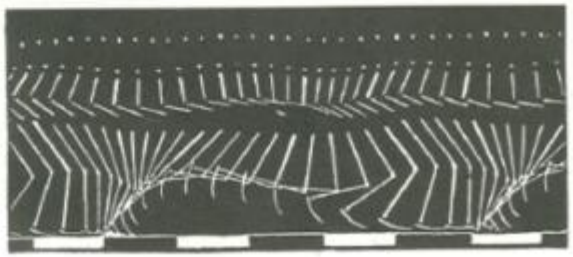
studies horses at different paces



the undulations of the dorsal fin of a descending sea-horse,

the advances of the gecko

Marey's man in black velvet, photographed in stick-figure images, became the time-series forerunner of Marcel Duchamp's *Nude Descending a Staircase*.



https://en.wikipedia.org/wiki/Étienne-Jules_Marey

Source: Tufte, "Visual Display of Quantitative Information"

London Underground Map
based on a design by Harry Beck (1931)

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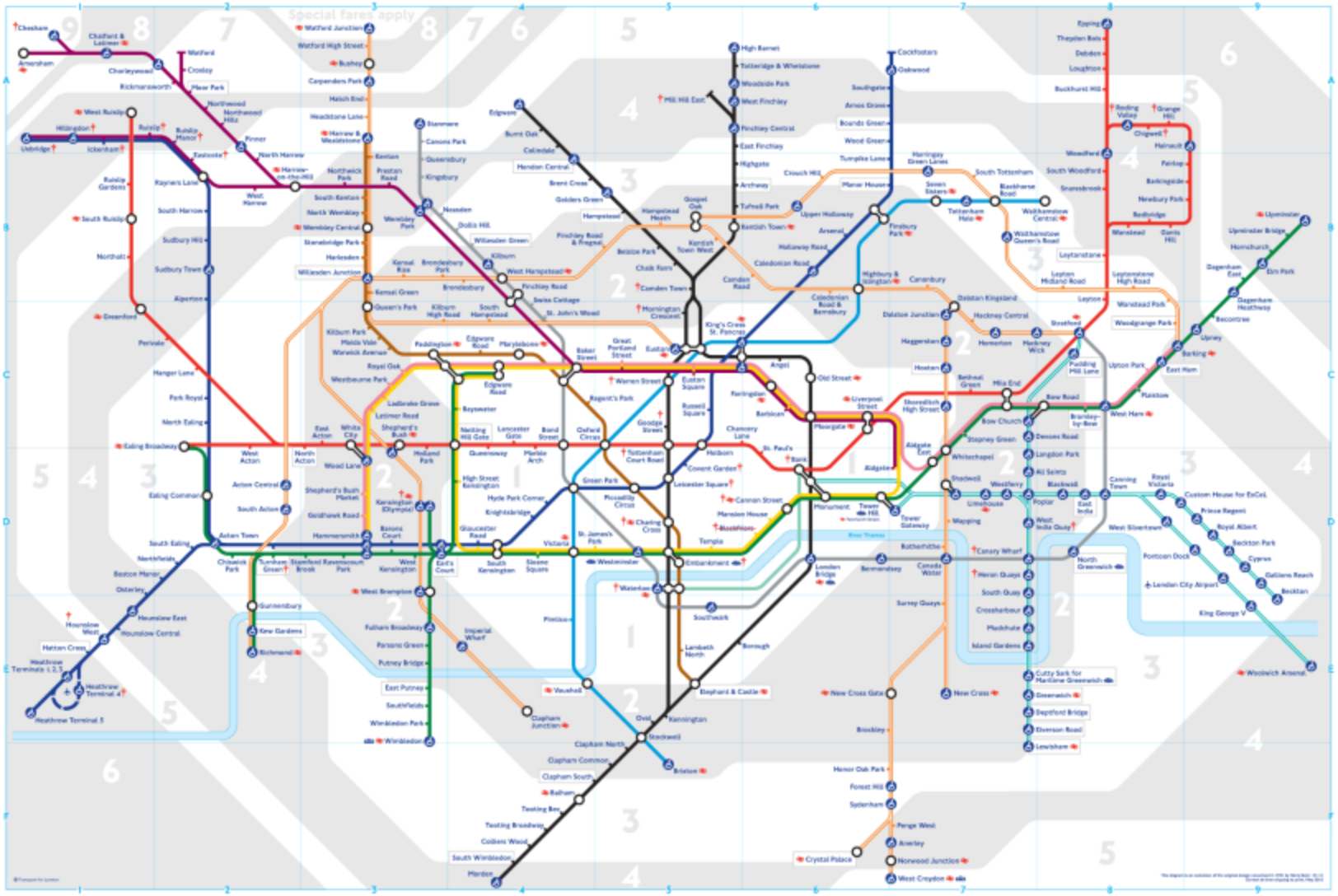
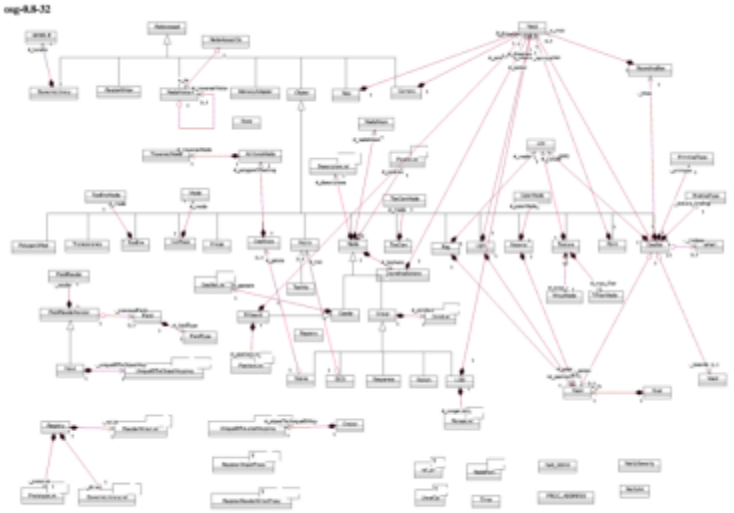


https://en.wikipedia.org/wiki/Harry_Beck
Source: http://www.tfl.gov.uk/

Source: http://ni.chol.as/media/geoff-files/sillymaps/large_geographical_map.gif

Source: Jenny, B. 2006. Geometric distortion of schematic network maps.

Visualisation of Scientific and Engineering Data



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Basic steps in Building a Viz.

Basic steps in building a Viz

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So maybe all this talk has made you interested in building your own viz. What would you need to do?

- Get data
  - Evaluate data in some way
  - Consider Interaction principles
  - Compose data into useful sets (build the viz)
  - Reduce data clutter
  - Design
  - Add user interaction

We'll cover these steps in detail during the semester!

Basic Data Availability *(Munzner)*

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Data input can be:

- Static (AKA *discrete*) information (e.g. one point in time)
- Dynamic (AKA *continuous*) information – what reality is
  - Hard for use to see continuous info from discrete data
  - Visualisation helps us see the continuous

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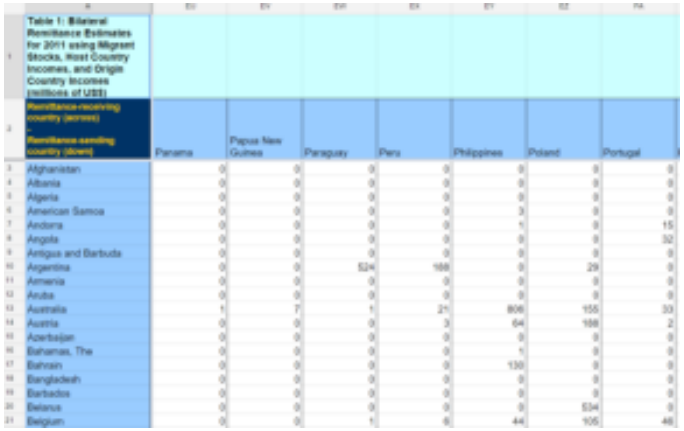
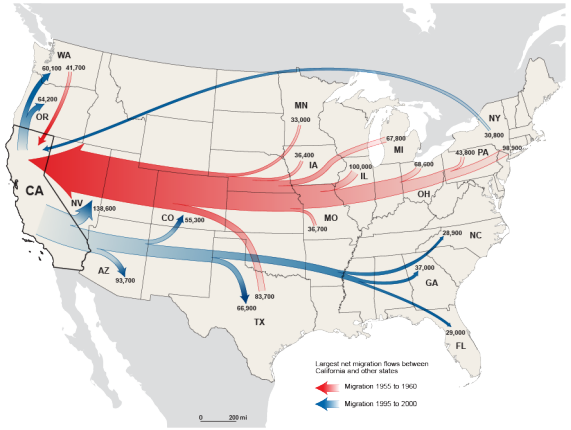
Data can belong to different dataset types:

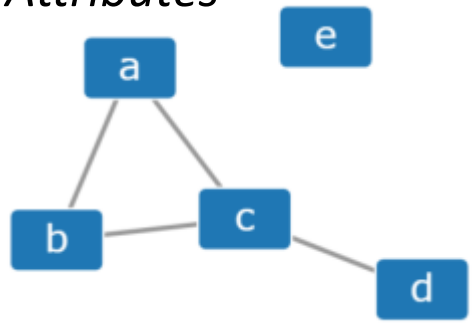
- Tables: *Items, Attributes*



- Geometry: *Items, Positions*



- Networks and Trees: *Items (nodes), Links, Attributes*



Attribute Types

Data attributes can allow sorting/grouping in different ways

- Categorical (nominal data): *departments, gender, state…*
- Ordered (ordinal data): *age bracket, day of the week…*
- Quantitative: *$, voltage, degrees Celsius, latitude/ longitude…*

http://intellspot.com/nominal-vs-ordinal-data/
http://intellspot.com/categorical-data-examples/

Numbers vs Images

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Generally it's better to have an image than a number

Humans are not good at interpreting numbers

- Better to combine multi-dimensional information into a single, easily understandable form
- Easier to extract and emphasise important info

Problems with building an InfoViz

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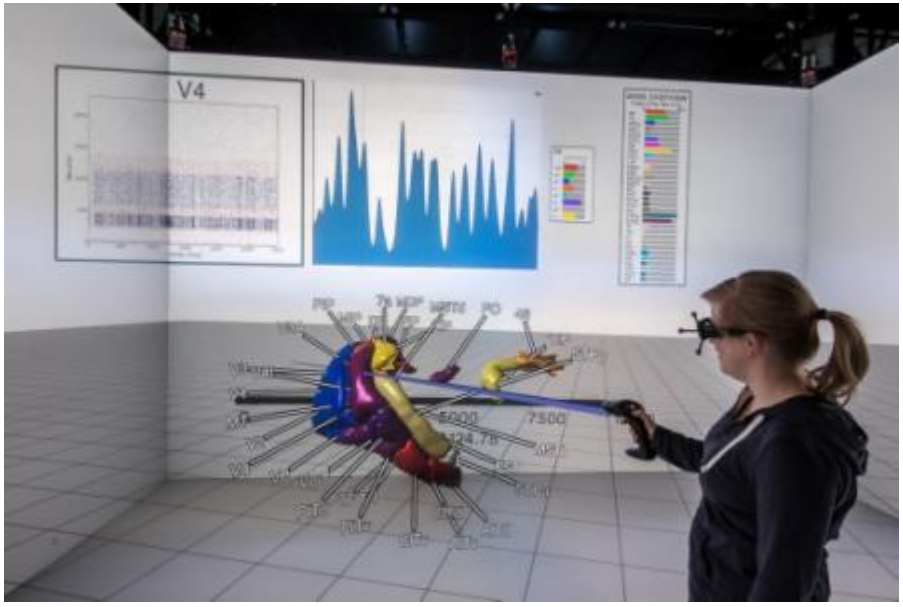
- In building a viz., there are three basic limitations to visualisations
  - Computer limits (for interactive vis)
  - Human perceptual & cognitive limits
    - http://en.wikipedia.org/wiki/Misleading_graph
    - http://www.abc.net.au/news/2013-05-08/jericho--read-between-the-lines/4674322
  - Display limits (run out of pixels to show fine changes)
- The designer always needs to *trade-off* between showing as much data as possible and reducing clutter.

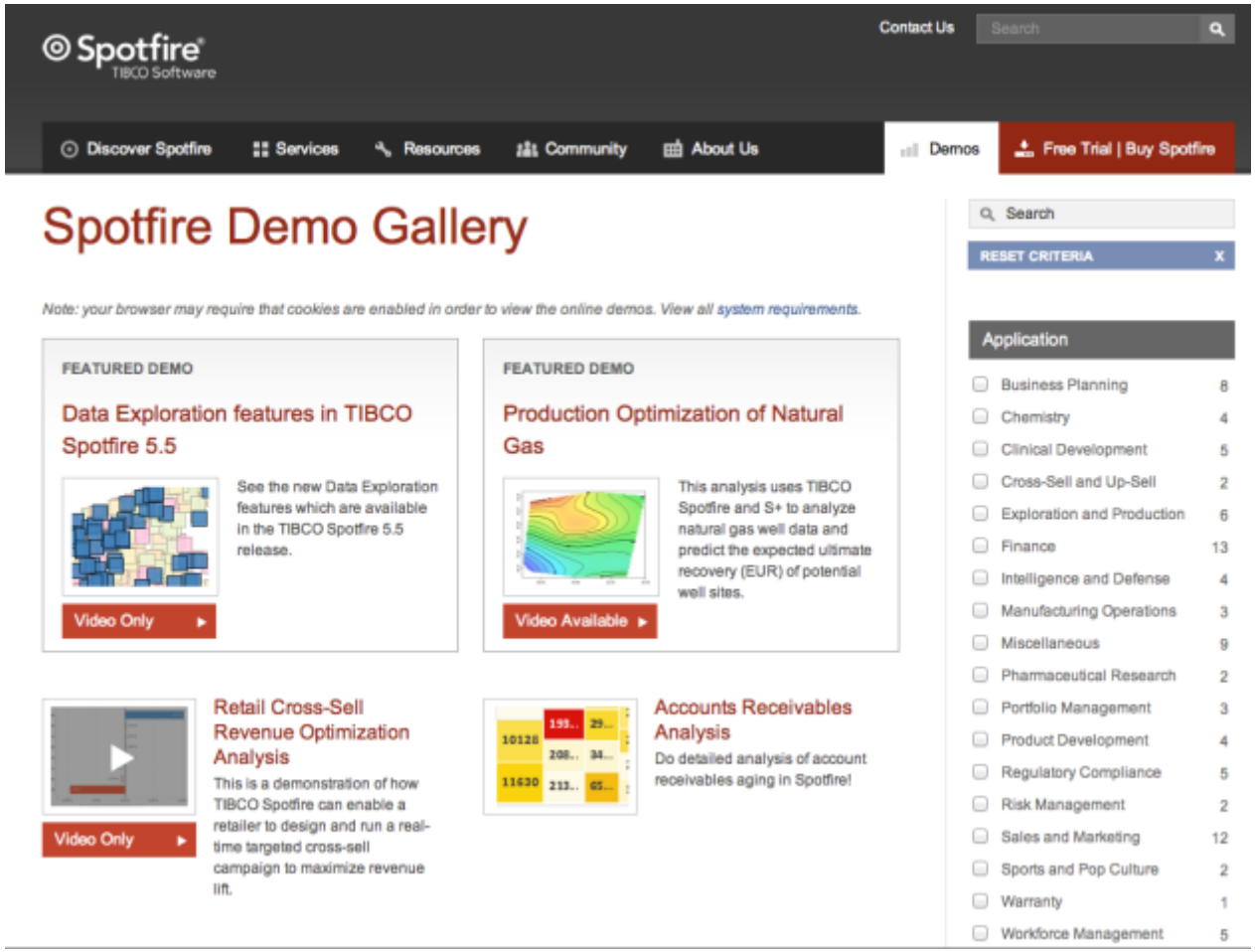
Modern Interactive Visualisations

Where Have We Evolved To?

To resolve the inherent tension between ‘more data’ vs ‘less clutter’, computers allow us to provide *interactivity.*

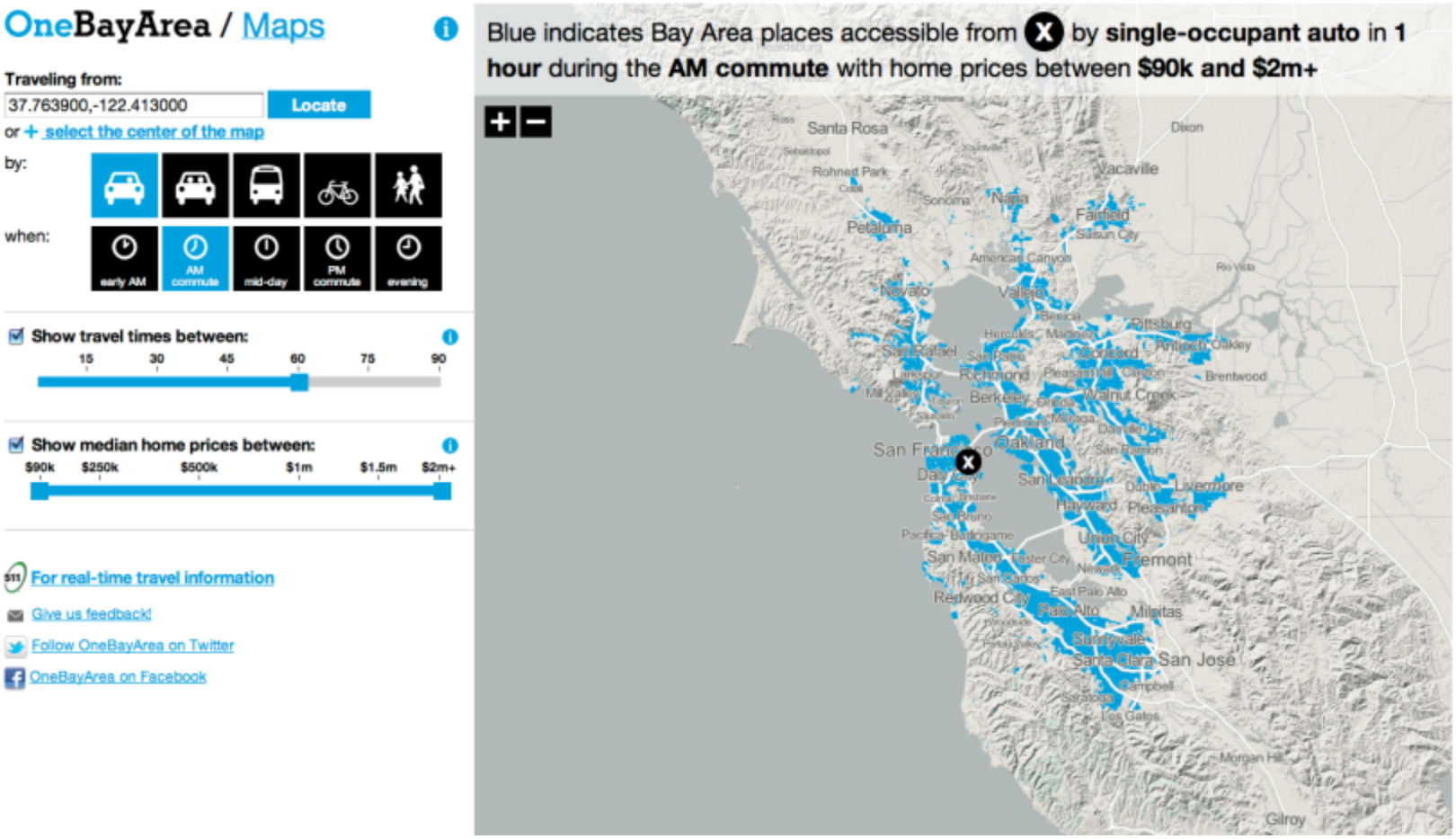
- Allows us to show multiple different perspectives on the data.
- Larger data sets maybe easier to work with now too (zooming, expanding, clicking down into data).
- The user can see what they need without distraction.





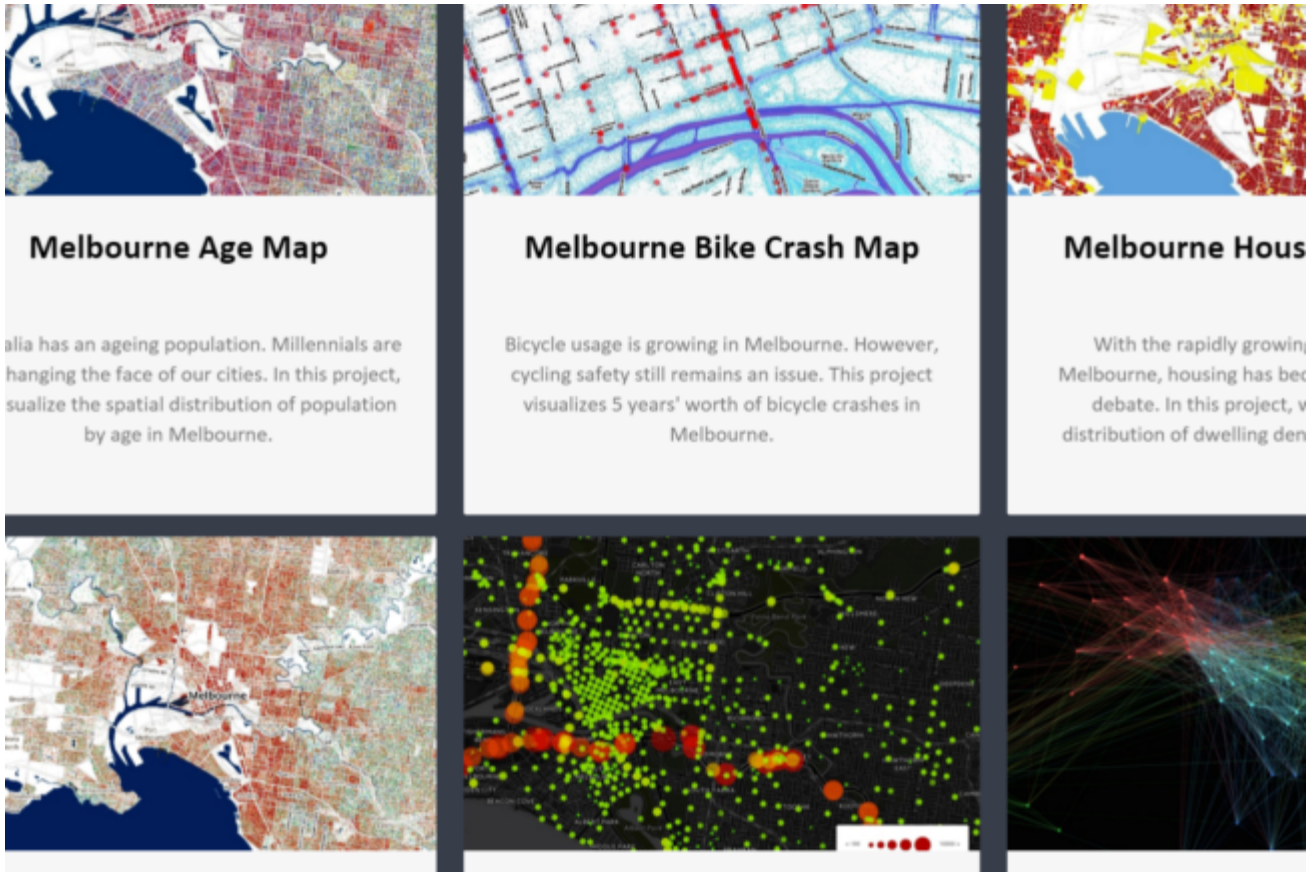
http://spotfire.tibco.com/en/demos/

OneBayArea



Source: http://maps.onebayarea.org/travel_housing/

Monash CityX (formerly *City Science*)



Source: http://monash.edu/research/city-science/#visualization/

Science Isn't Broken

Source: http://fivethirtyeight.com/features/science-isnt-broken/#part1

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Research and Readings

Some Links to Get Started

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- http://flowingdata.com
- http://www.visualcomplexity.com/vc/
- http://www.informationisbeautiful.net/
- http://datavisualization.ch/
- http://www.visualizing.org/
- http://www.smashingmagazine.com/2009/09/11/25-useful-data-visualization-and-infographics-resources/