COMS21202: Symbols, Patterns and Signals
Data Visualisation

[based on Dima Damen lecture notes]

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Data Visualisation

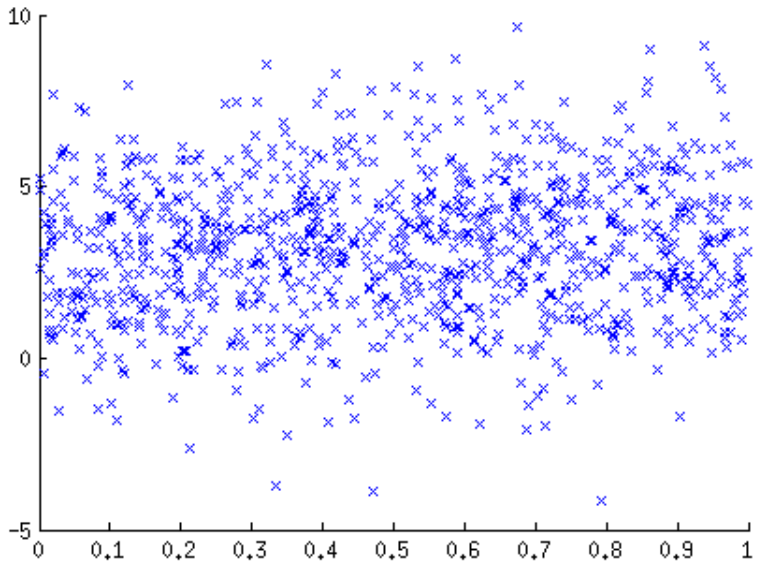
- Information (or data) visualisation, as a research discipline, has emerged over the last 20 years
- Driven by the volumes of data and the accessibility of *big data*
- Characterised by large quantities of data - not necessarily numbers

Data visualisation is important!

Visualising the spread of coronavirus (Feb 2020, Johns Hopkins CSSE)

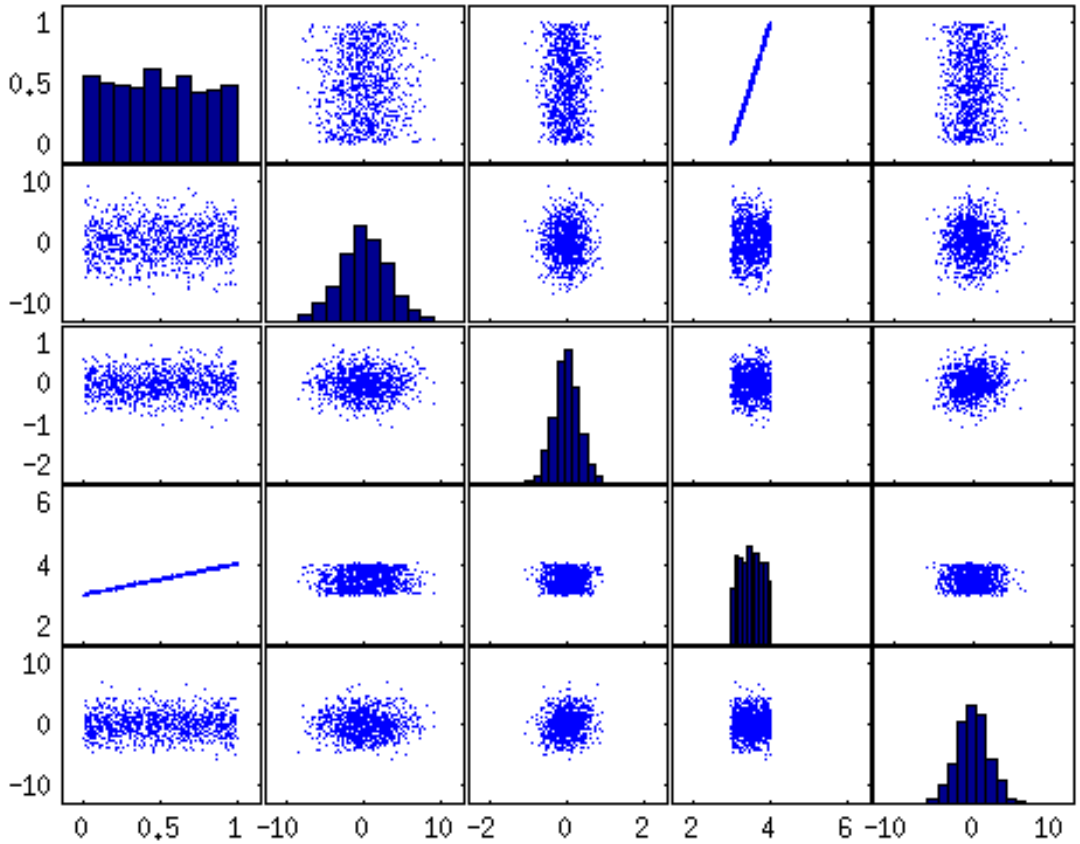
Data Visualisation - Simple Graphs

1. Scatter Plot



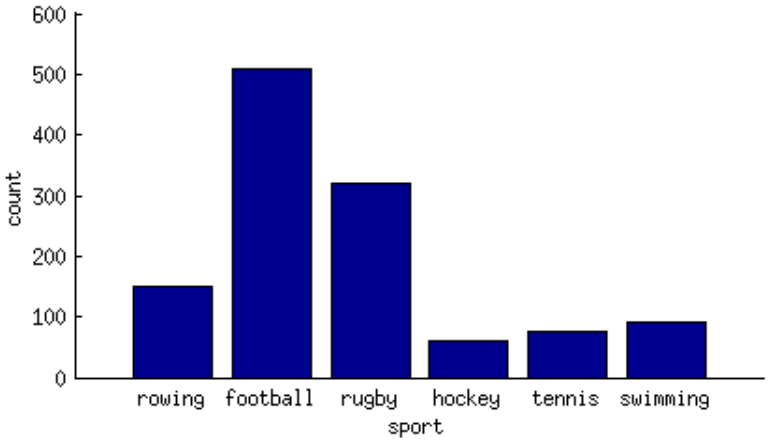
Data Visualisation - Simple Graphs

1. Scatter Plot
2. Scatter Plot Matrix



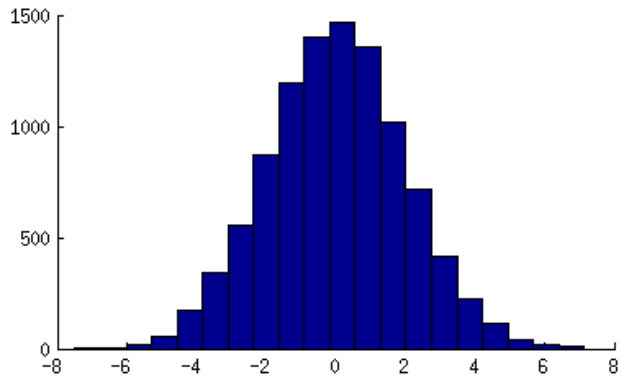
Data Visualisation - Simple Graphs

1. Scatter Plot
2. Scatter Plot Matrix
3. Histogram
   - Discrete Variable (bar chart)



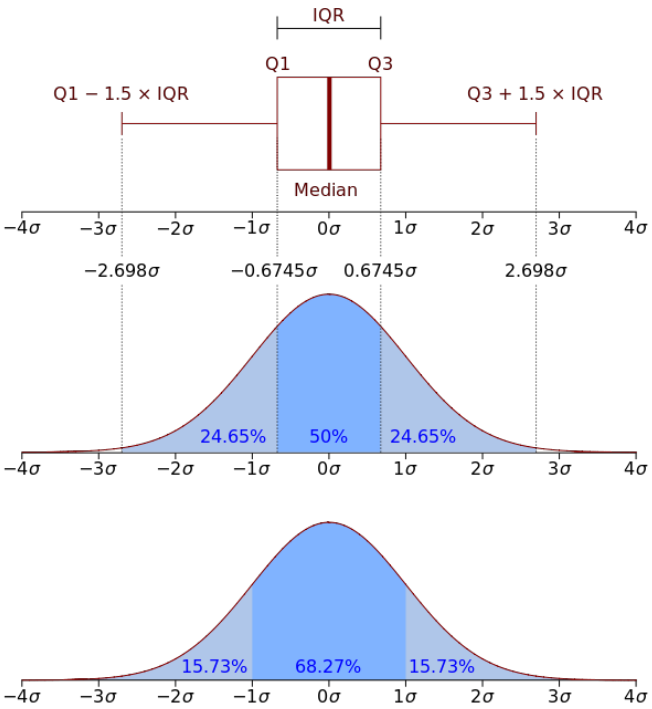
Data Visualisation - Simple Graphs

1. Scatter Plot
2. Scatter Plot Matrix
3. Histogram
   - Discrete Variable
   - Continuous Variable
     Δv: width of bin
     c: bin number; $0 \leq c \leq N$
     $min_x + c\Delta v \leq v < min_x + (c+1)\Delta v$

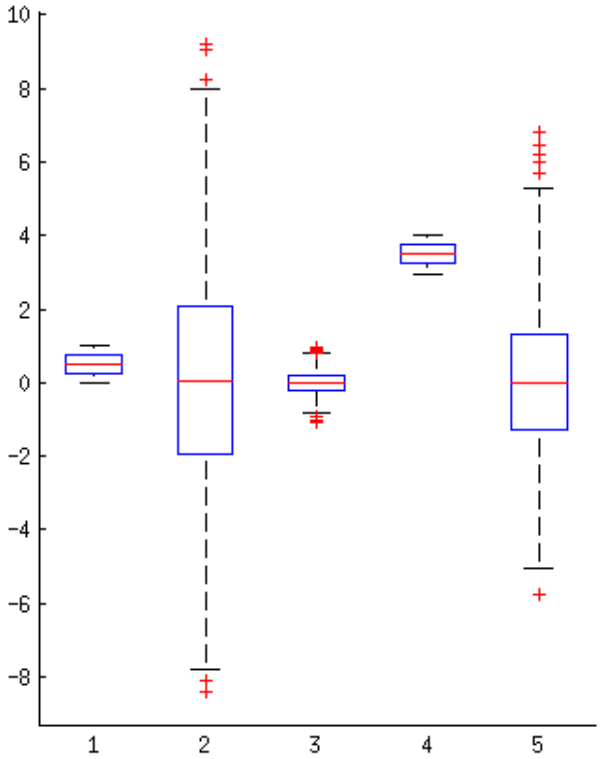


Data Visualisation - Simple Graphs

1. Scatter Plot
2. Scatter Plot Matrix
3. Histogram
4. Box plot

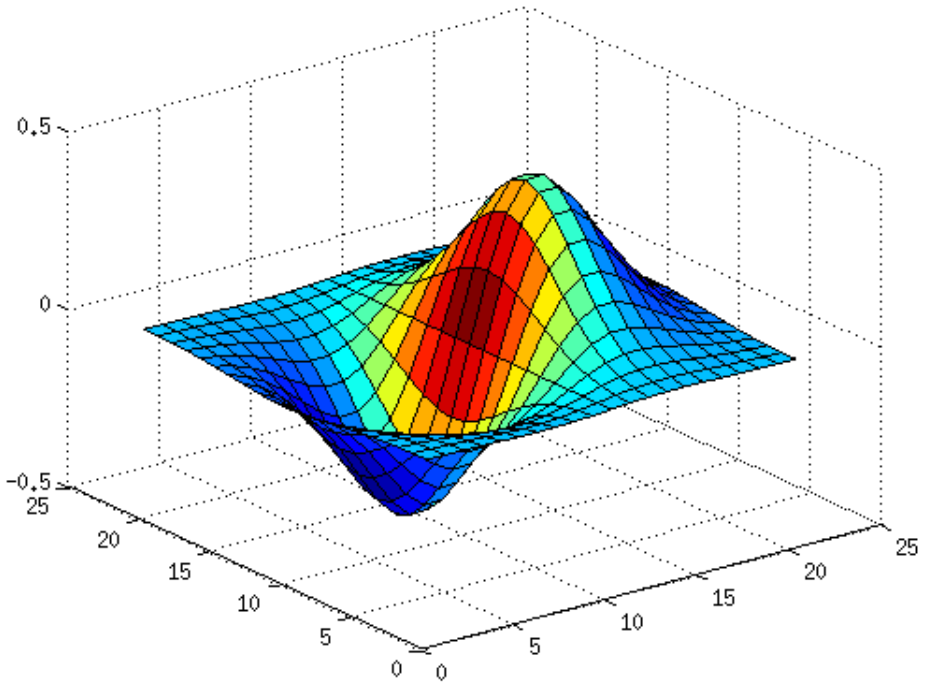


source:Wikipedia(2015)



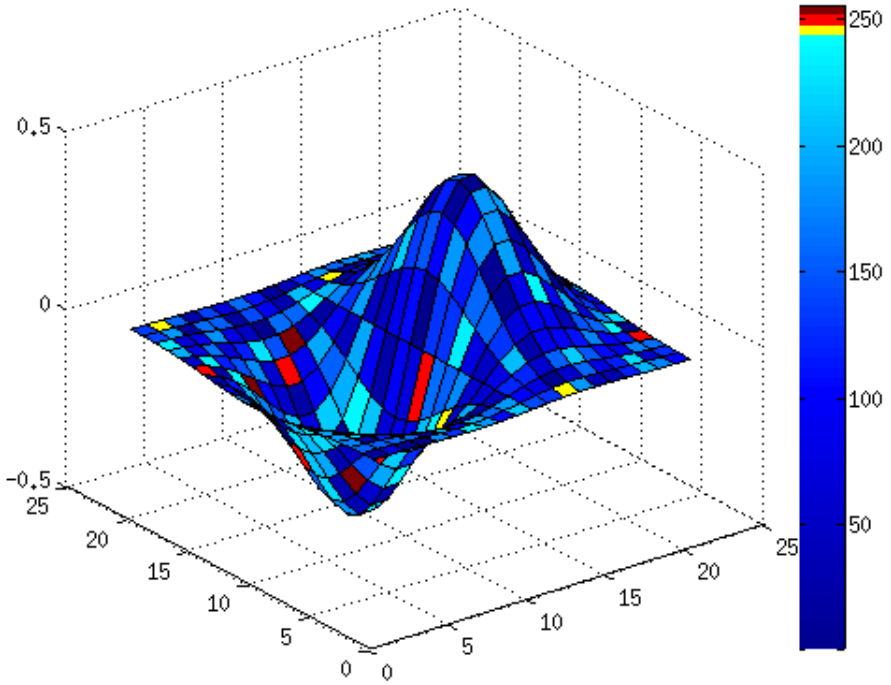
Data Visualisation - Simple Graphs

1. Scatter Plot
2. Scatter Plot Matrix
3. Histogram
4. Box plot
5. Surface
   - 3D Data



Data Visualisation - Simple Graphs

1. Scatter Plot
2. Scatter Plot Matrix
3. Histogram
4. Box plot
5. Surface
   - 3D Data
   - 4D Data



Data Visualisation - Simple Graphs

1. Scatter Plot
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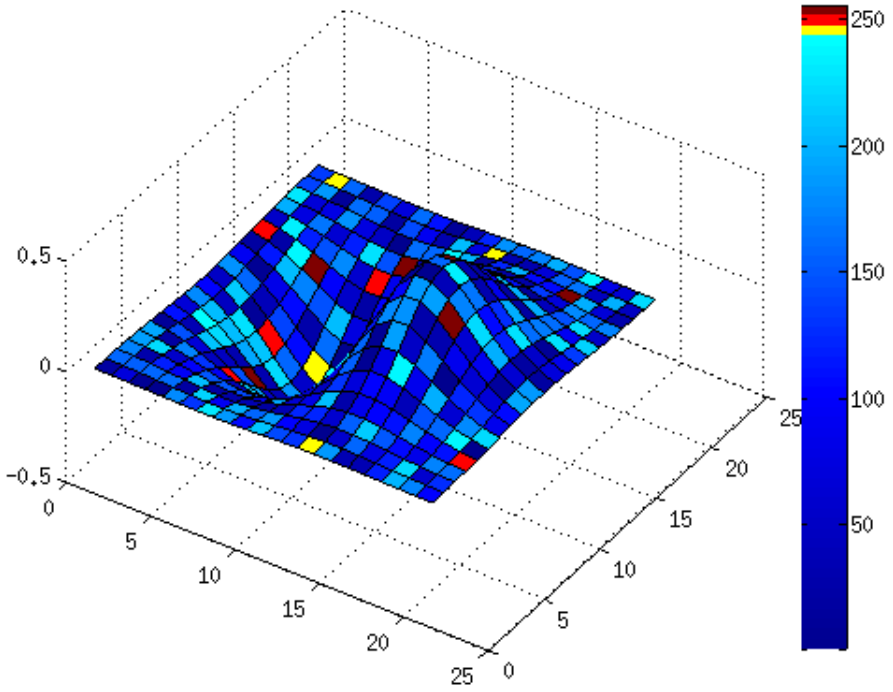
   - 3D Data
   - 4D Data

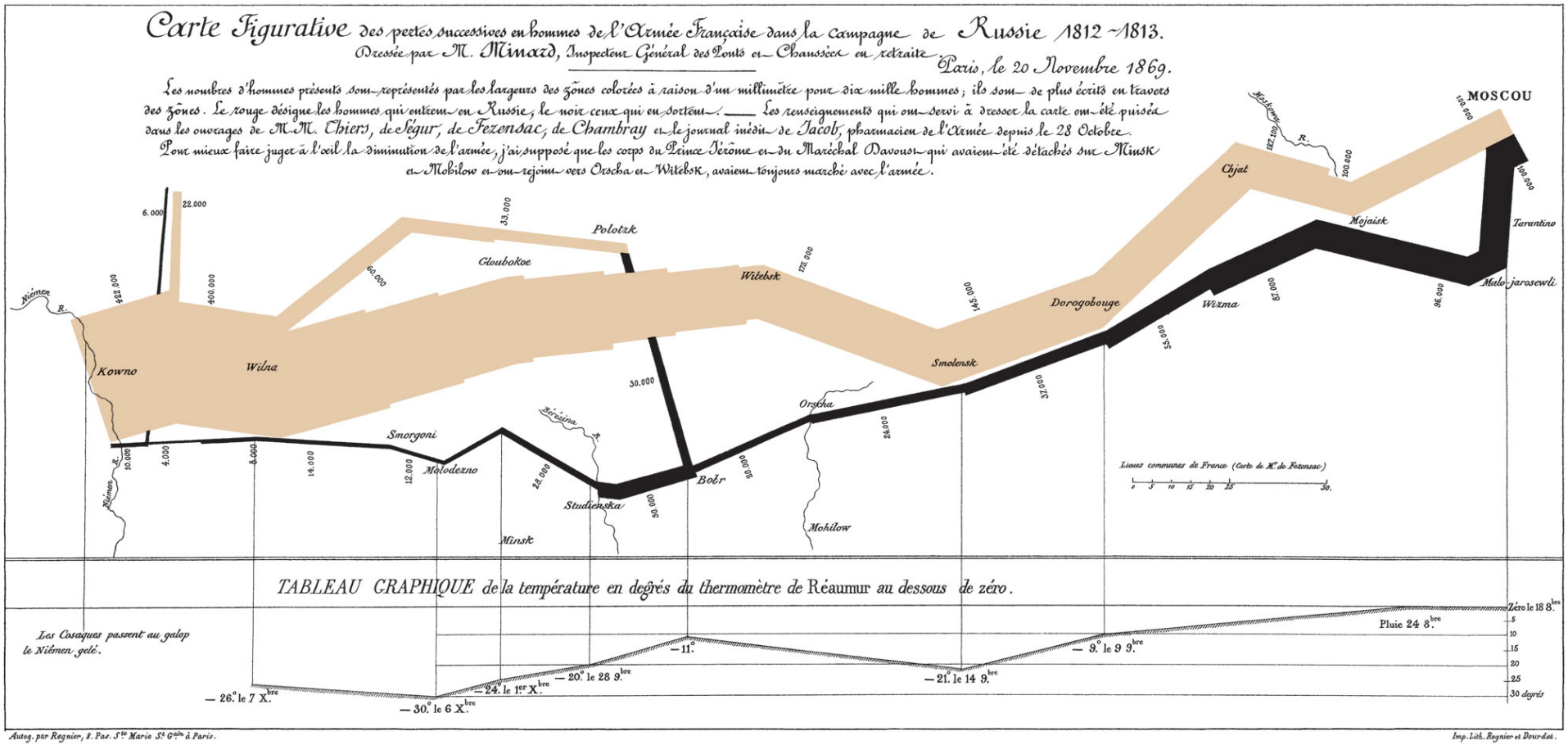


Data Visualisation

- Is that all?
- **Problem:** How to understand massive datasets?
- **Solution:** Convert information into a graphical representation to take advantage of human perception
- Data visualisation – what can you vary?
  - Colour / Colour Maps
  - Size / contour width
  - Shape / line stroke
  - Location (2 dimensions)
  - Transparency
- Information visualisation: “The use of computer-supported, interactive, visual representations of abstract data to simplify cognition.” (Card, Mackinlay, Shneiderman, 1999)
- But it existed before computers!

Historical Note - Ex1

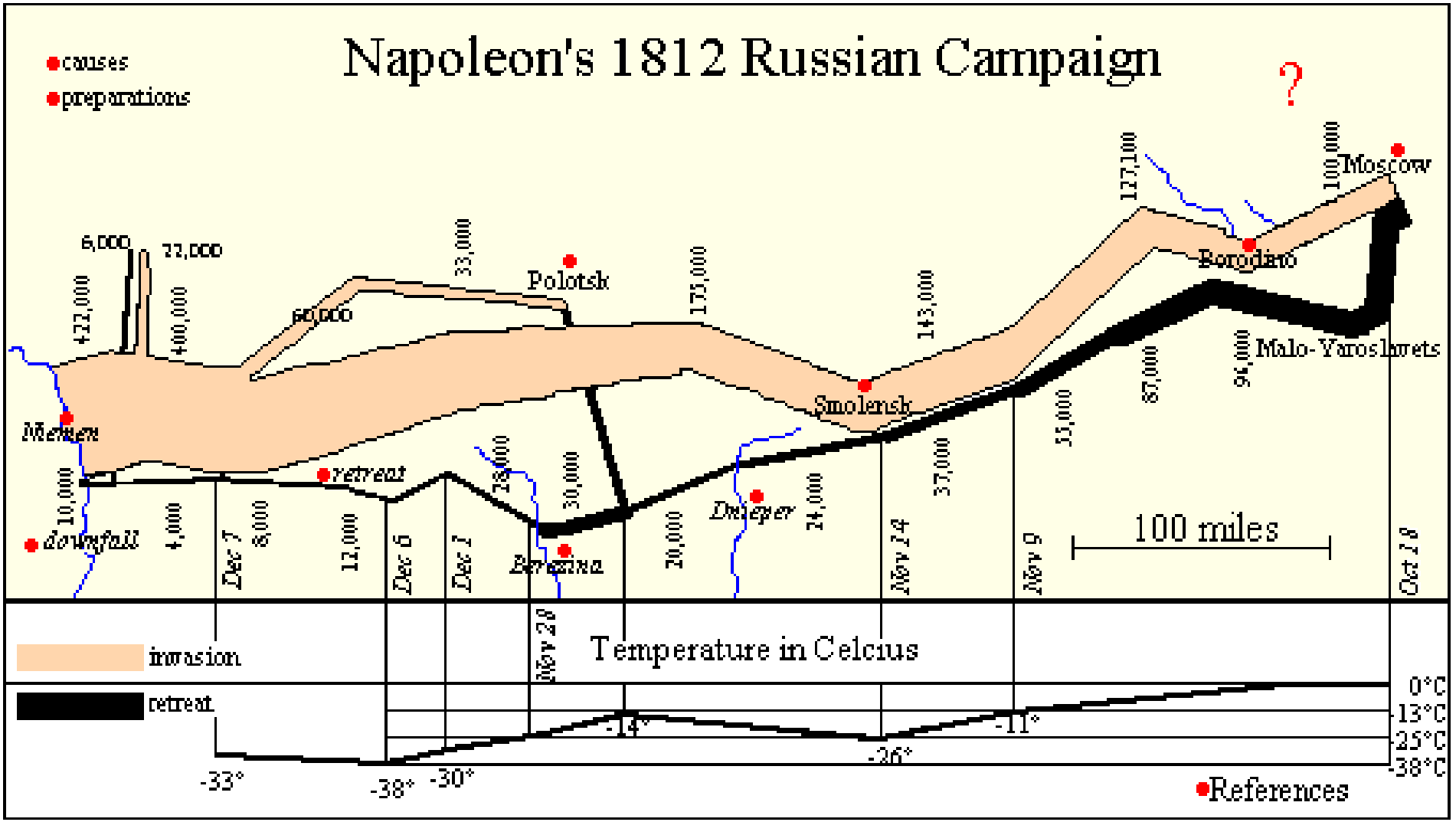
Napoleon's (disastrous) Russian invasion (1812)



Further info `http://www.datavis.ca/gallery/re-minard.php`

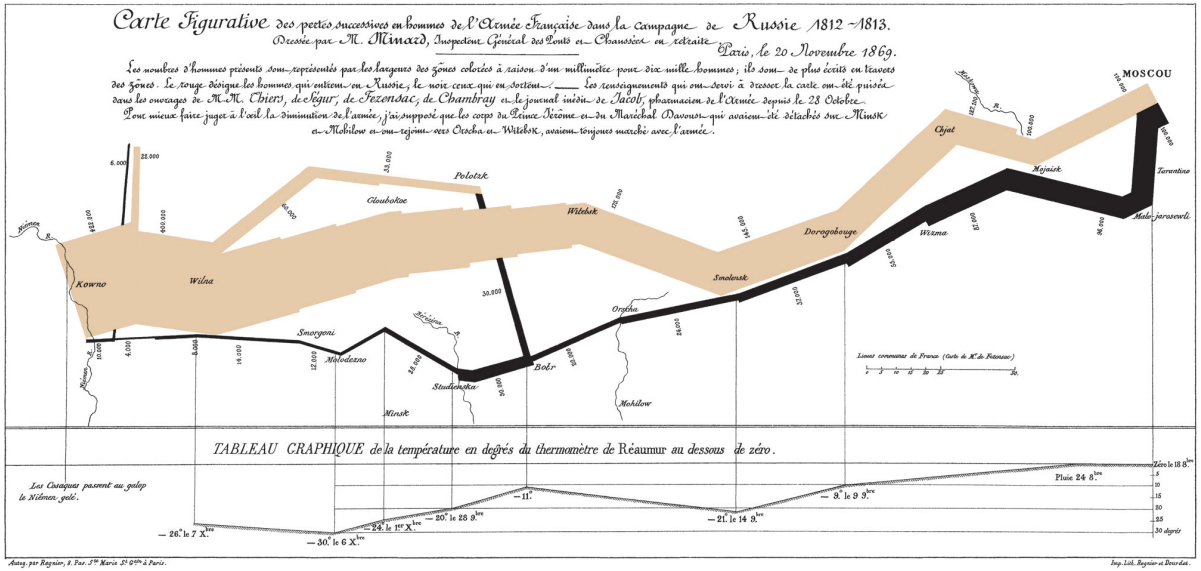
Historical Note - Ex1

Napoleon's (disastrous) Russian invasion (1812)



Further info `http://www.datavis.ca/gallery/re-minard.php`

Historical Note - Ex1



- Charles Minard
- Six dimensions of data
  - Number of Napoleon's troops
  - Direction
  - Distance
  - Temperature
  - Location: Longitude and Latitude
  - Dates
- *Acclaimed* best statistical graphic ever drawn

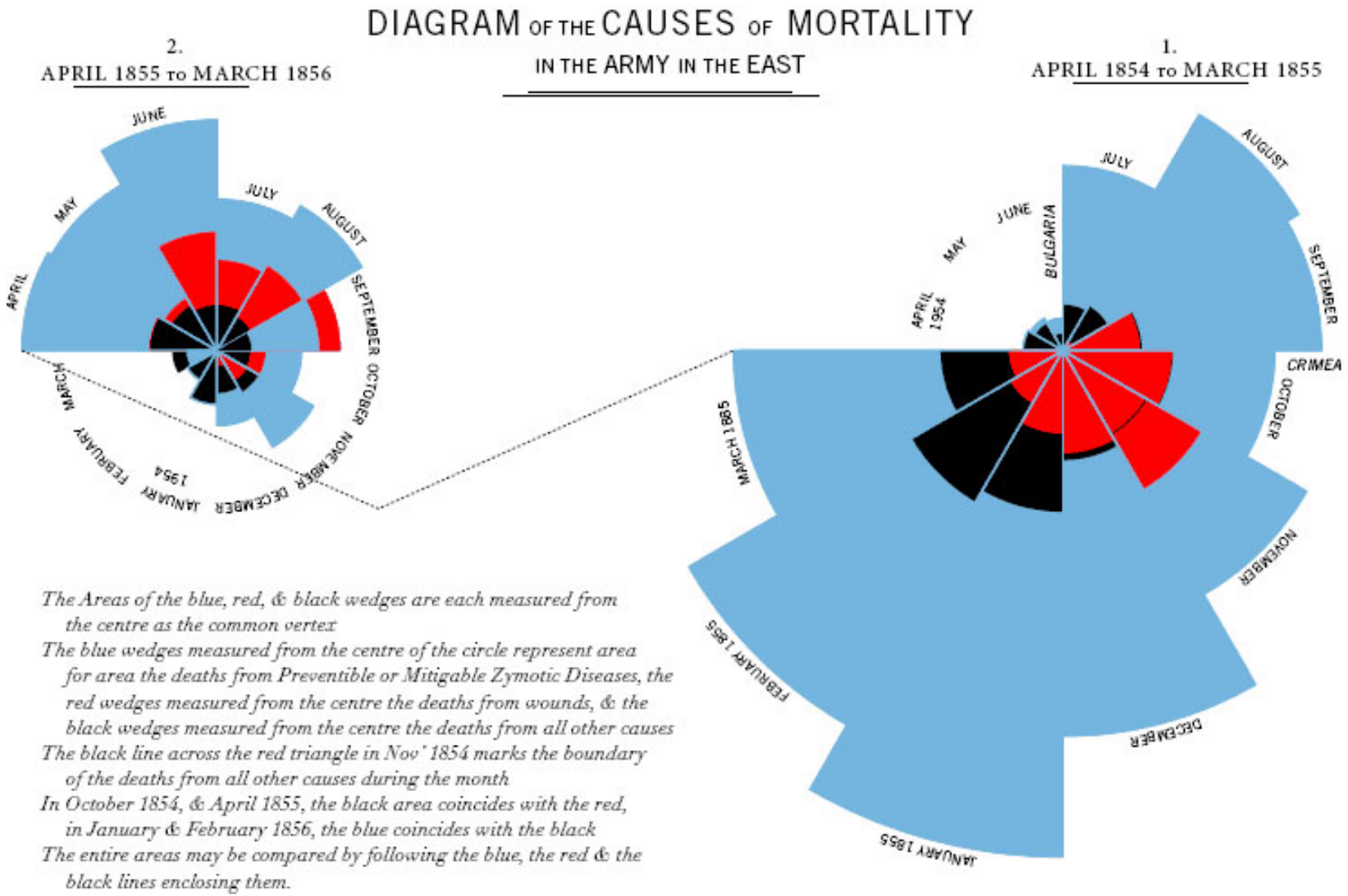
Information Visualisation

- Data is almost always multi-variate / multi-dimensional
- Visualisation should tell the truth about the data (or nearly)

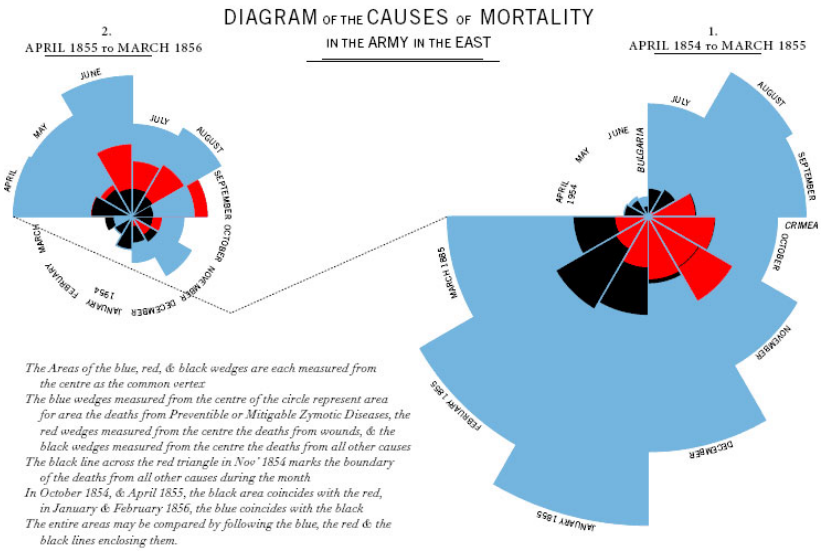
$$\text{Lie Factor (LF)} = \frac{\text{size of effect in visualisation}}{\text{size of effect in data}}$$

  - $LF > 1 \rightarrow$ over stating
  - $LF < 1 \rightarrow$ under stating
  - $2 \leq LF \leq 5$ is common

Historical Note - Ex2



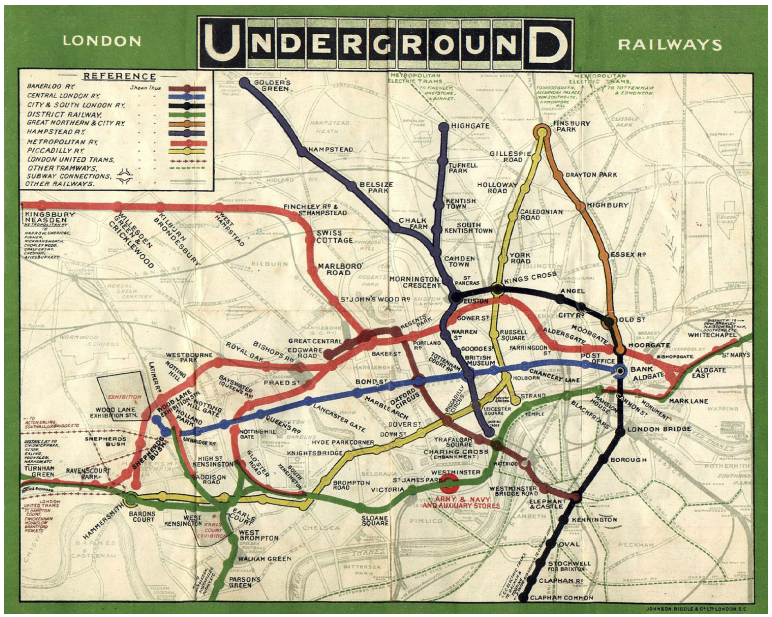
Historical Note - Ex2

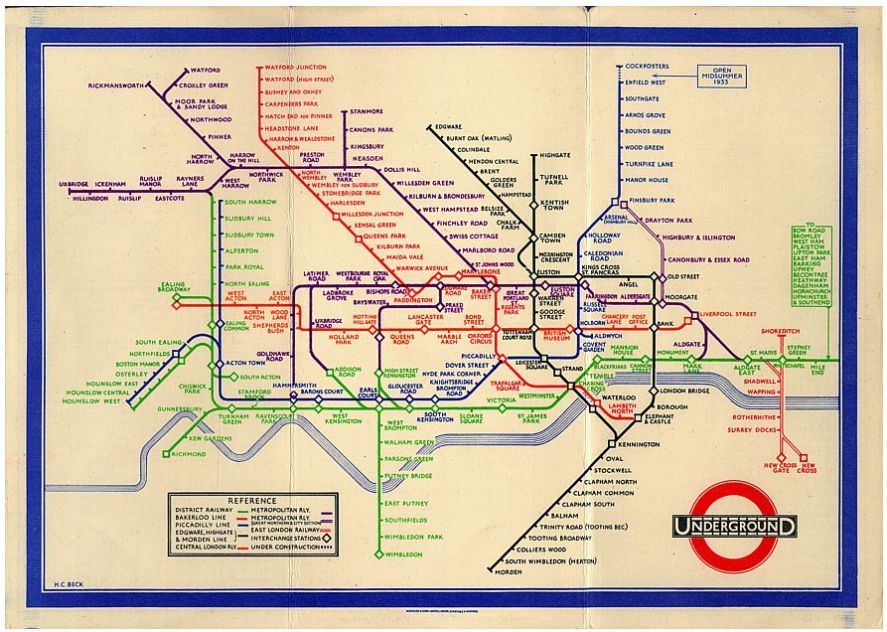


- Florence Nightingale
- Four dimensional data (date, disease1, disease2, disease3)
- Histogram-style (area instead of height)
- colours for the various dimensions (ordered max to min)

Historical Note - Ex3

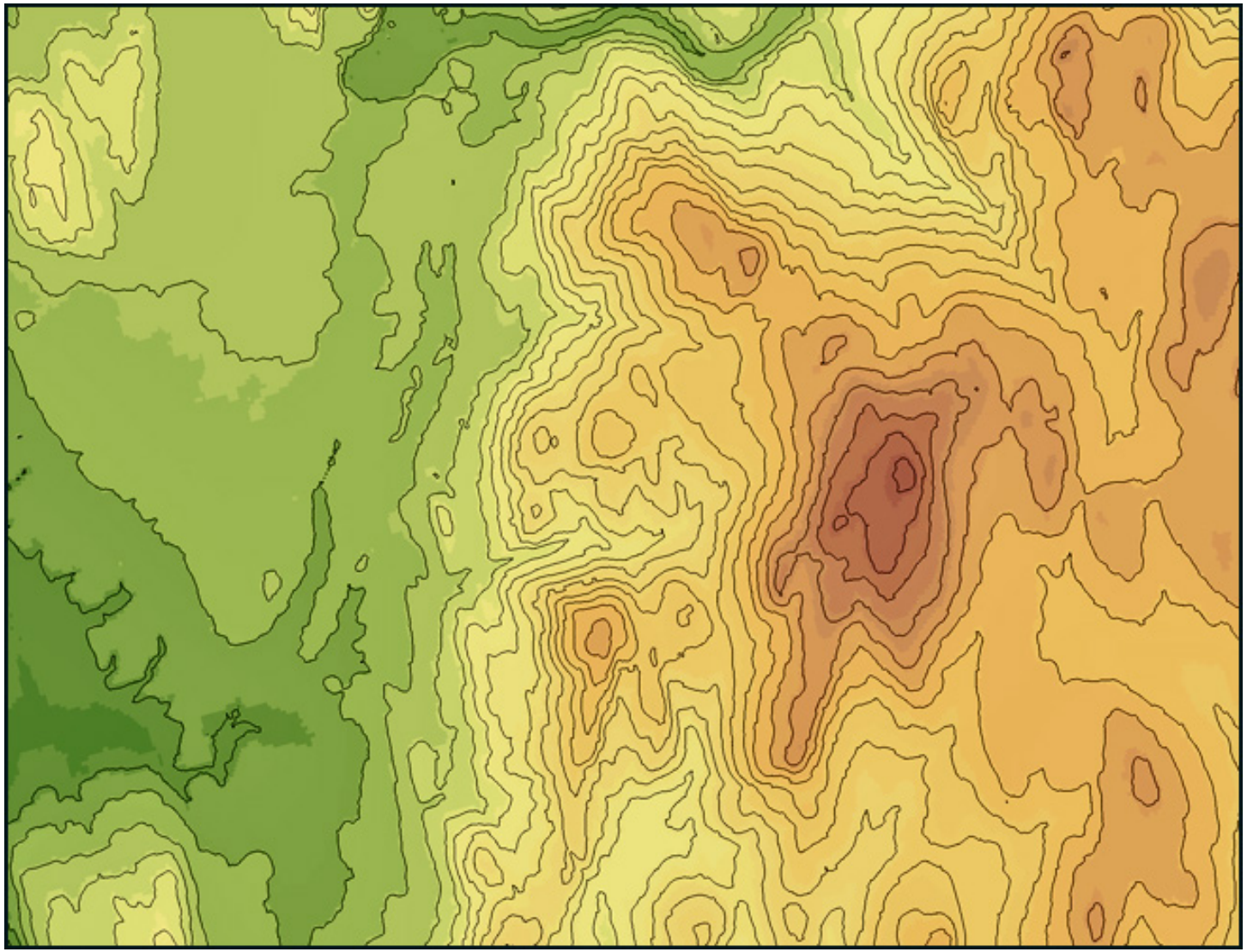
- A clean/structured representation is often more important [Harry Beck (1933)]



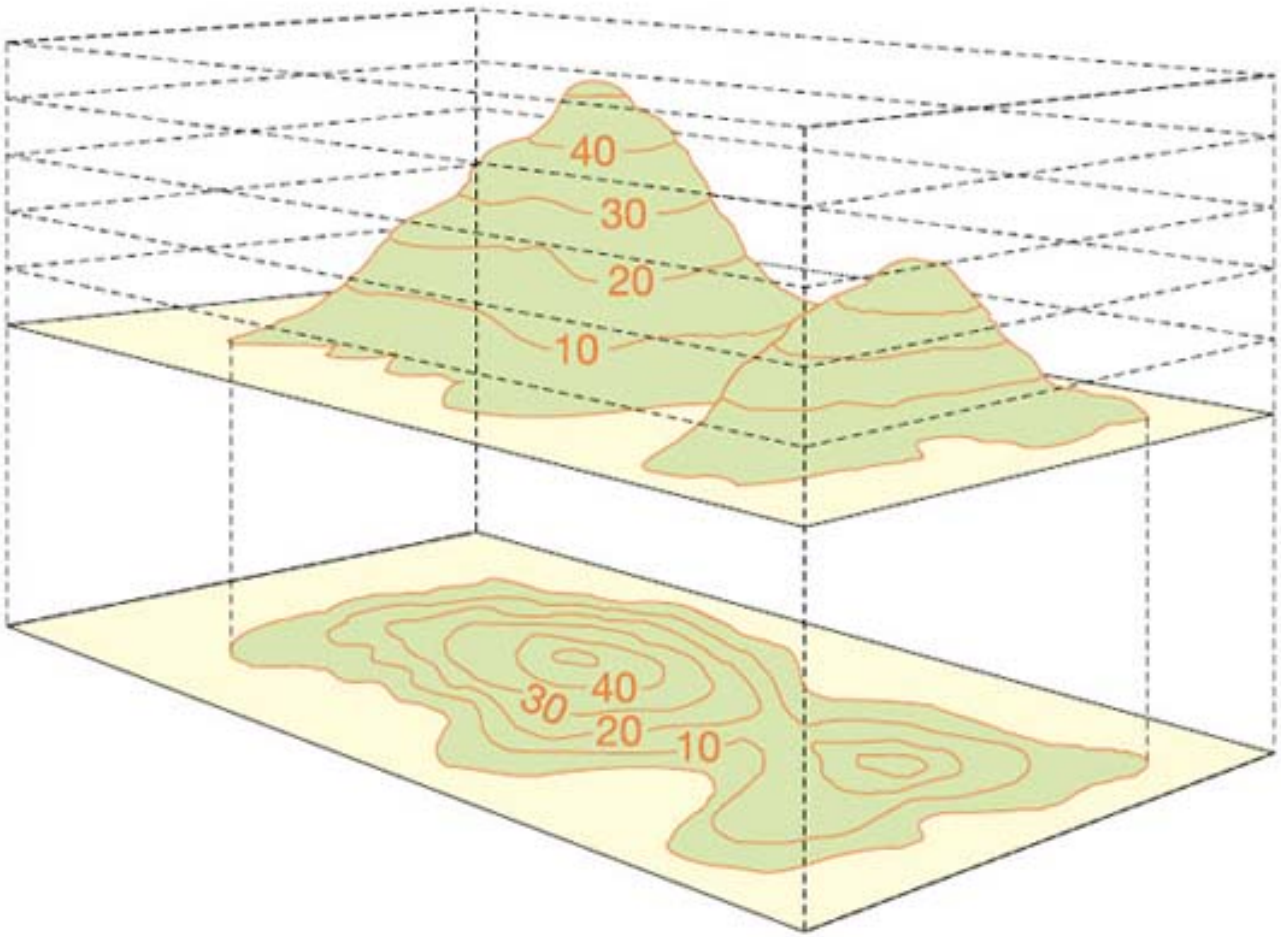


Contour Maps

Colour map as a third dimension:



Contour Maps



source: ordnancesurvey.co.uk

Flow Charts

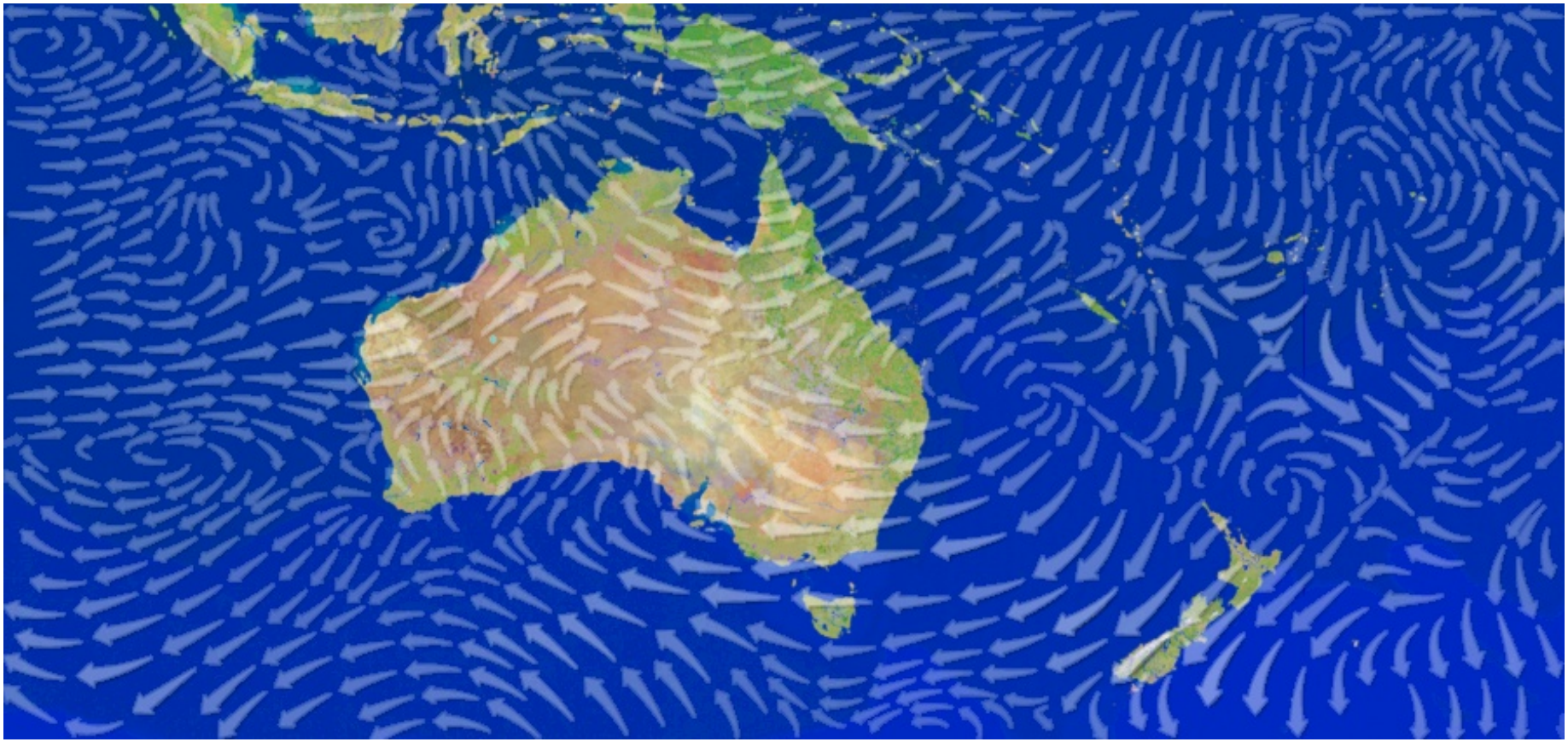
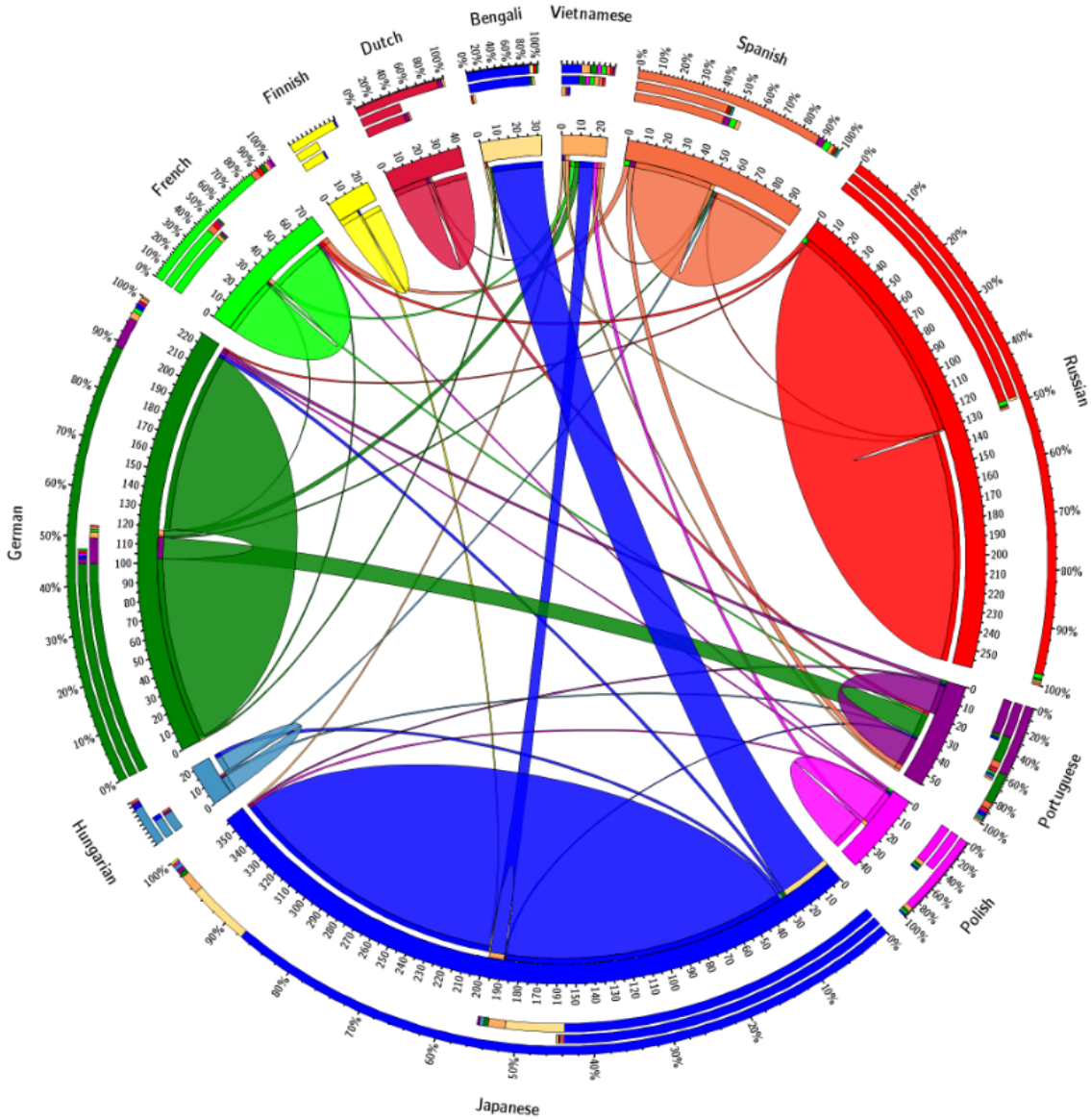


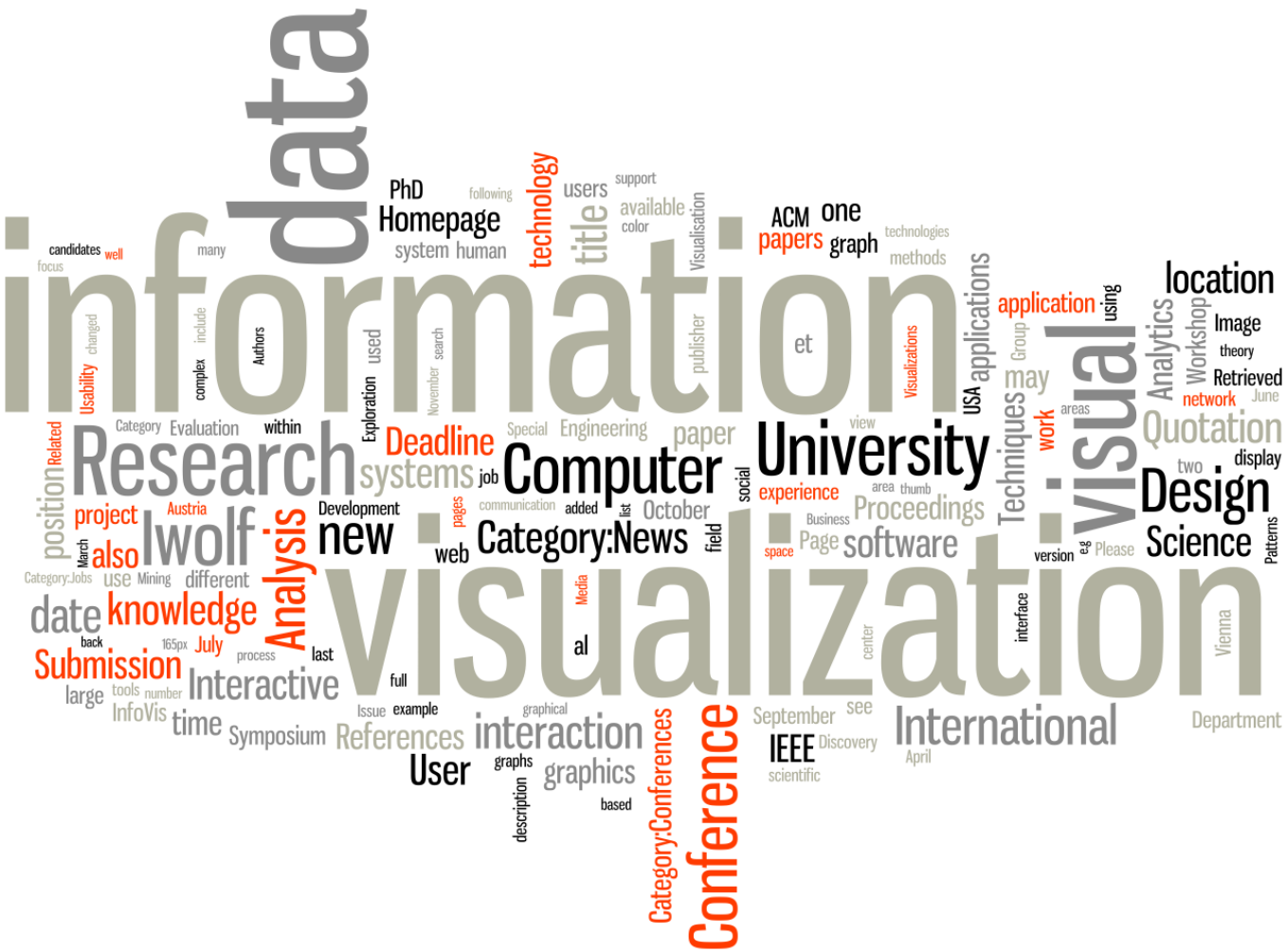
Image courtesy of Greg Turk

Circular Graphs



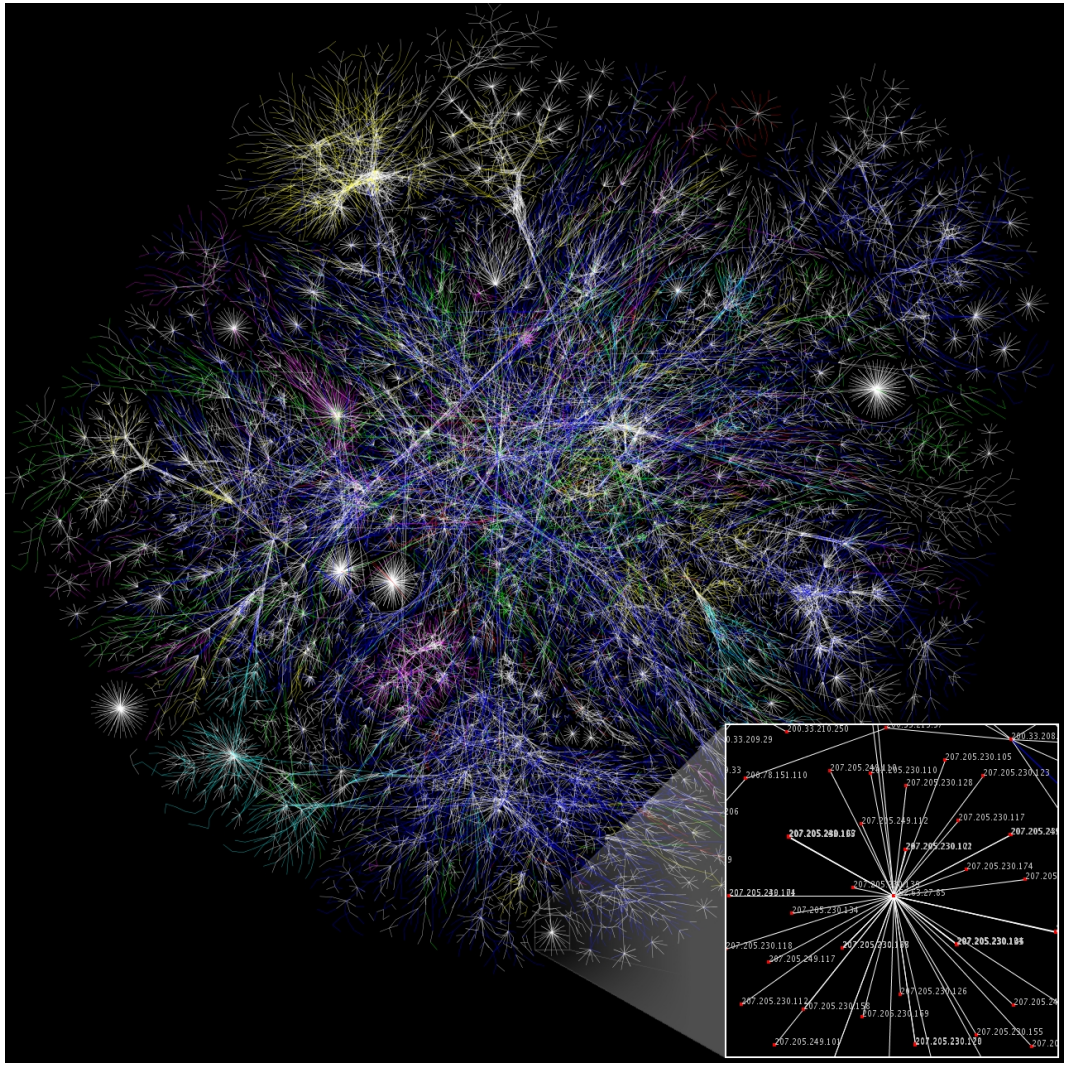
Internet links between languages. AlNoamany et al (2013). Who and What Links to the Internet Archive

Word clouds



Source: Wikipedia(2015)

Graphs and Hierarchies



Complex networks: Universe or internet? [Wikipedia (2015)]

Data visualisation as (informative) art

- Empires decline: vimeo.com/11506746 [Cruz and Machado, SIGGRAPH 2010]
- Lisbon traffic: vimeo.com/10218235 [Cruz and Machado, 2009] [1]

[1] More at cdv.dei.uc.pt

Further Reading

- Visualization Handbook
  Hansen and Johnson (2004)