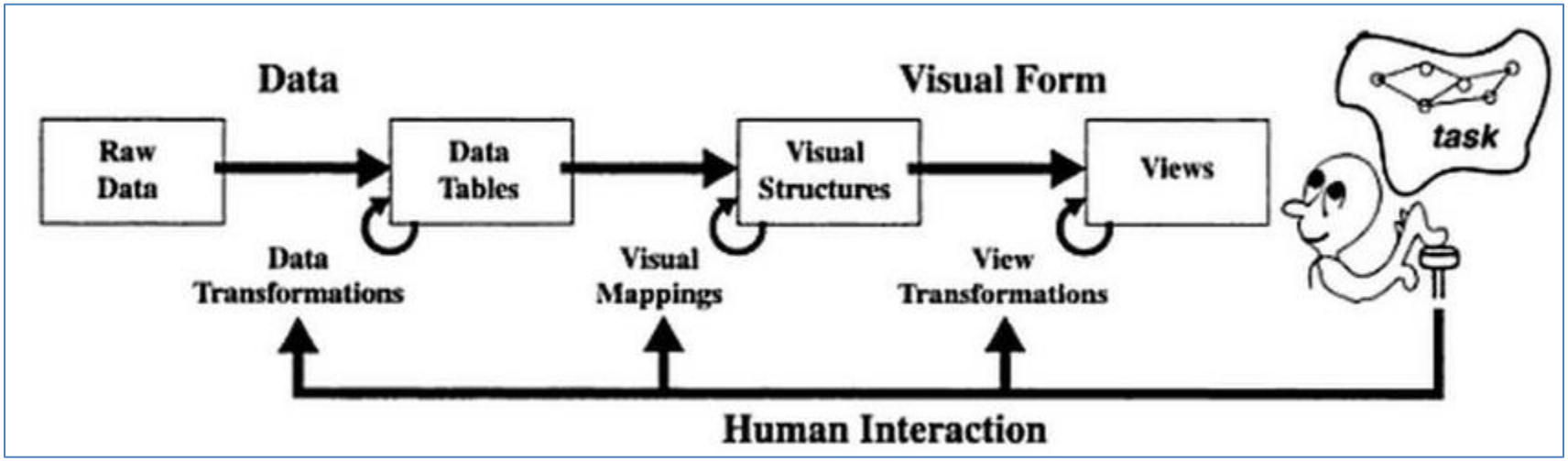
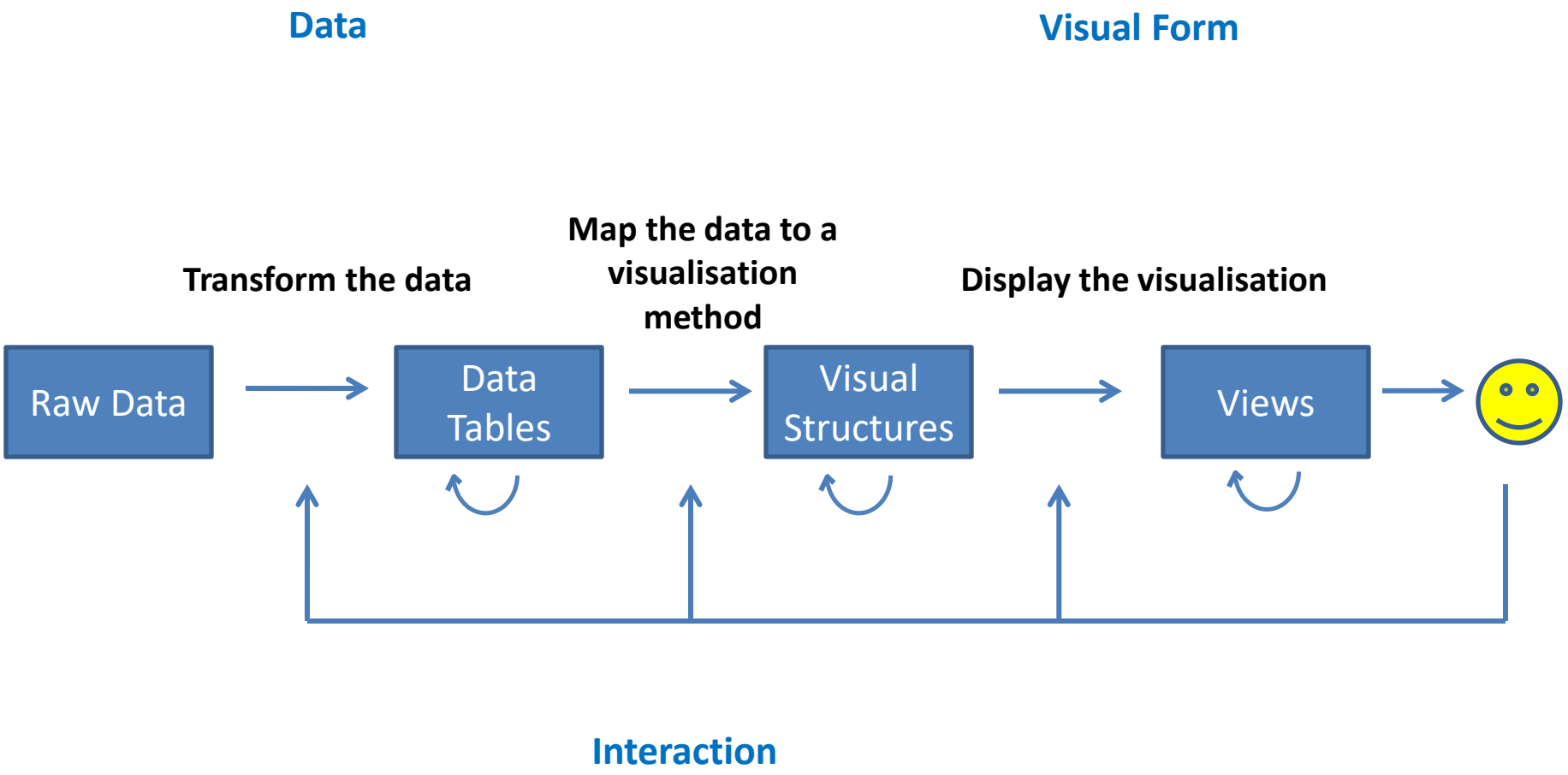
The Visualisation Pipeline & Interaction

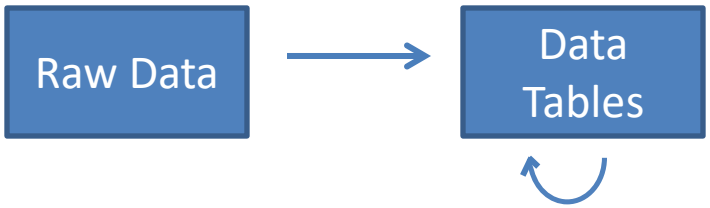
Information visualisation pipeline



Card, Mackinlay, Shneiderman (1999), “Information Visualization”, Introduction to “Readings in Information Visualization: Using Vision to Think”


Data
Visual Form
Transform the data
Map the data to a visualisation method
Display the visualisation
Raw Data
Data Tables
Visual Structures
Views
Interaction

Transform the data



members	male	fees	average finishing position
113	75	15	5
183	167	60	13
175	135	40	6
56	13	20	16
86	45	25	4
200	150	50	16
59	21	40	3
48	16	25	13
107	52	55	91
34	8	45	45
155	122	20	76
92	70	15	22
156	125	10	49
157	130	50	39
57	16	40	18
113	61	15	9
57	11	30	17
137	101	40	19
99	49	35	20
89	53	30	11
… 100 clubs			

members	average finishing position
113	5
183	13
175	6
56	16
86	4
200	16
59	3
48	13
107	91
34	45
155	76
92	22
156	49
157	39
57	18
113	9
57	17
137	19
99	20
89	11
… 100 clubs	

%male	number of clubs
0-15	0
15-19	1
20-24	4
25-29	5
30-34	9
35-39	2
40-44	1
45-49	7
50-54	8
55-59	5
60-64	4
65-69	8
70-74	16
75-79	10
80-84	6
85-89	5
90-94	5
95-99	4
100	0

fees	
min	5
Q1	18.75
median	30
Q2	40
max	60
mean	29.85
std dev	14.02

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113	5
183	13
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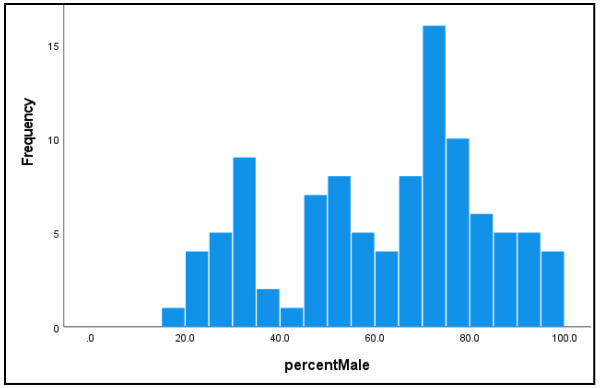
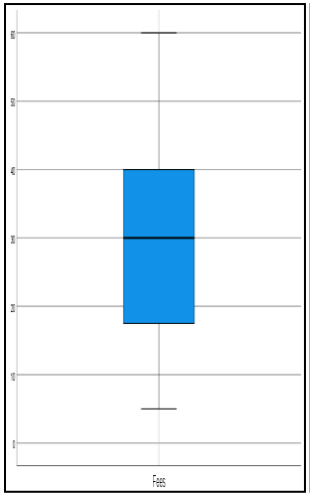
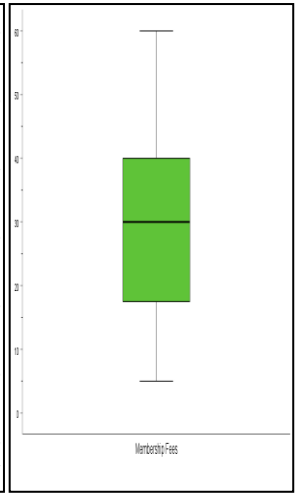
Map the data to a visualisation method

Data Tables → Visual Structures

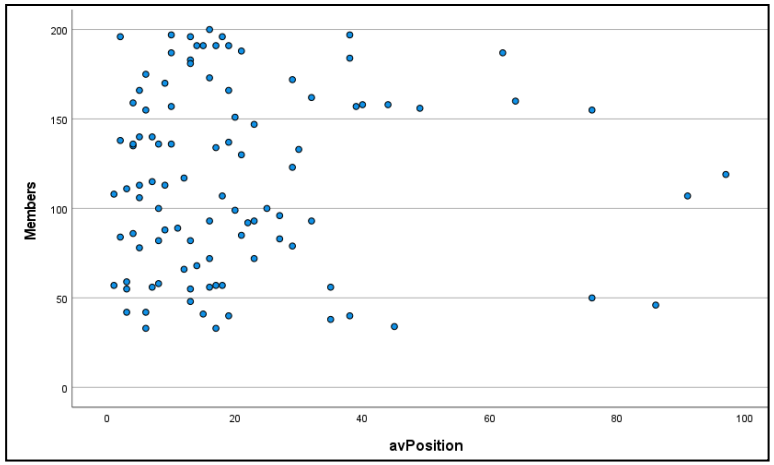


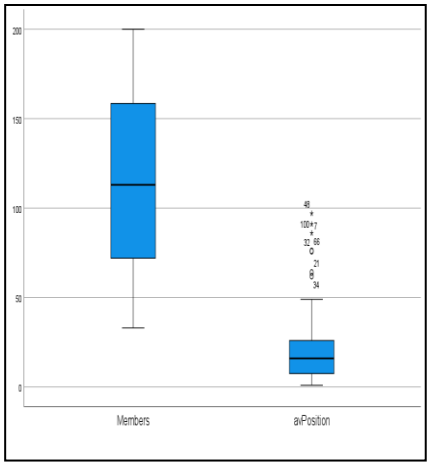


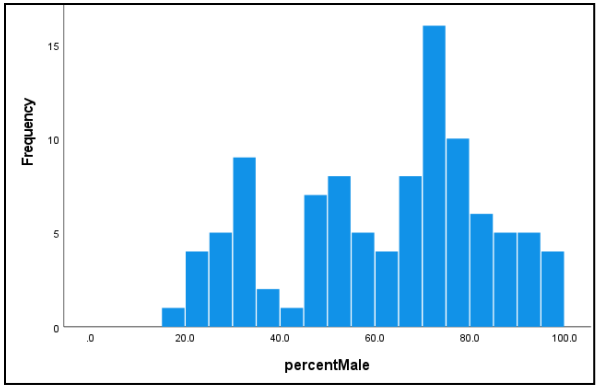


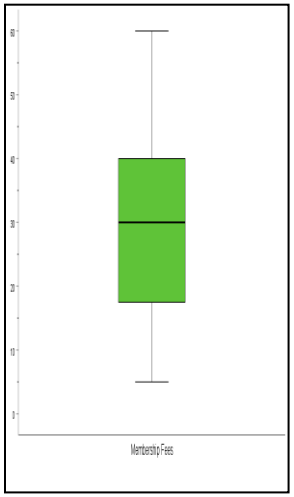
Effective:
depicts the data well

Expressive:
all (and only) the data in the data tables are shown

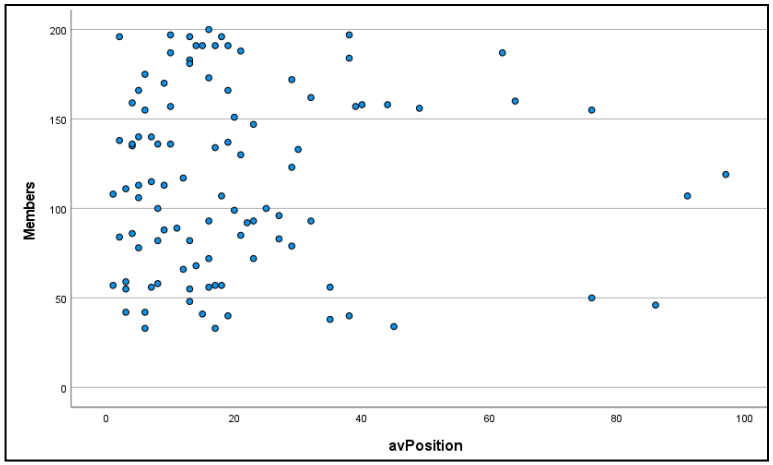








Display the visualisation



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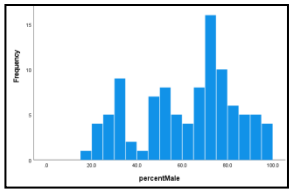
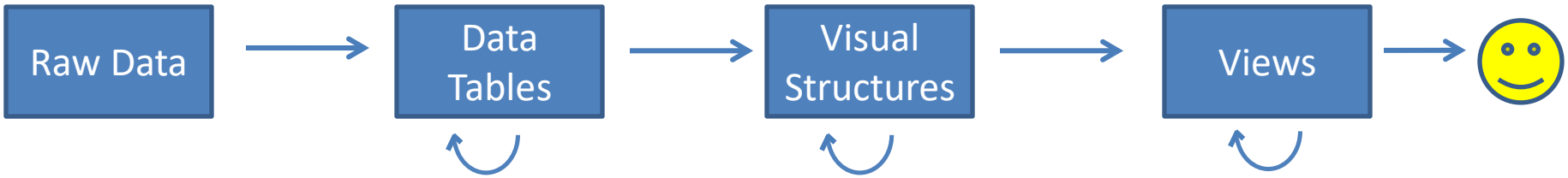


Transform the data

Map the data to a visualisation method

Display the visualisation



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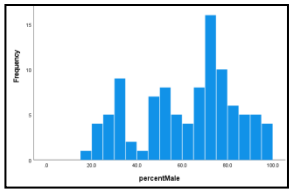

Transform the data

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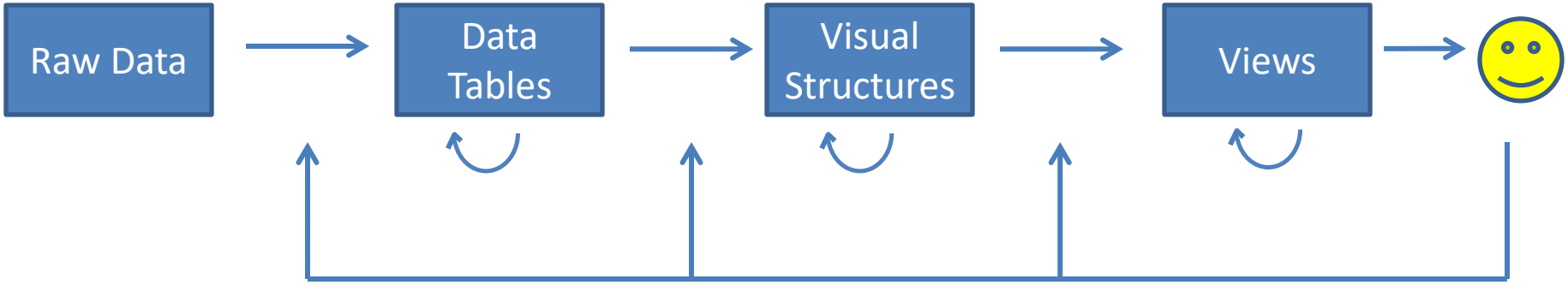


Interaction

- **1996: B. Shneiderman**, "The eyes have it: a task by data type taxonomy for information visualizations," *Proceedings 1996 IEEE Symposium on Visual Languages*, 1996, pp. 336-343. *[Sh]*

- **2003: R. Kosara, H. Hauser, and D. Gresh**, "An Interaction View on Information Visualization," *2003 EUROGRAPHICS Conference State of the Art Report*, 2003, pp. 123-137. *[K]*

- **2007: J. S. Yi, Y. a. Kang, J. Stasko and J. A. Jacko**, "Toward a Deeper Understanding of the Role of Interaction in Information Visualization," in *IEEE Transactions on Visualization and Computer Graphics*, vol. 13, no. 6, pp. 1224-1231, 2007. *[Yi]*

- **2015: A. Figueiras**, "Towards the Understanding of Interaction in Information Visualization," *2015 19th International Conference on Information Visualisation*, 2015, pp. 140-147. *[F]*

Interaction: HCI *vs* InfoViz

(Yi et al., 2007)

"Foley et al. (1995) define an interaction technique as a way of using a physical input/output device to perform a generic task in a **human-computer dialogue**.

The definition of interaction techniques in the context of Infovis should extend Foley's definition, however, it was grounded in the general context of HCI. As Ware (2000) identifies via the phrase, "**asymmetry in data rates**", the amount of data flowing from Infovis systems to users is far greater than from users to systems.

Thus, interaction techniques in Infovis seem more designed for **changing and adjusting visual representation** than for entering data into systems, which clearly is an important aspect of interaction in HCI.

We view interaction techniques in Infovis as the features that provide users with the ability to **directly or indirectly manipulate and interpret representations.**"

J. D. Foley, A. van Dam, S. K. Feiner, and J. F. Hughes, *Computer Graphics: Principles and Practice in C*, 2nd ed: Addison-Wesley Professional, 1995.

C. Ware, *Information Visualization: Perception for Design*. San Diego, CA, USA: Academic Press, 2000.

Shneiderman Mantra

Overview first,

Shneiderman Mantra

Overview first,

zoom and filter,

Shneiderman Mantra

Overview first,

zoom and filter,

then details-on-demand

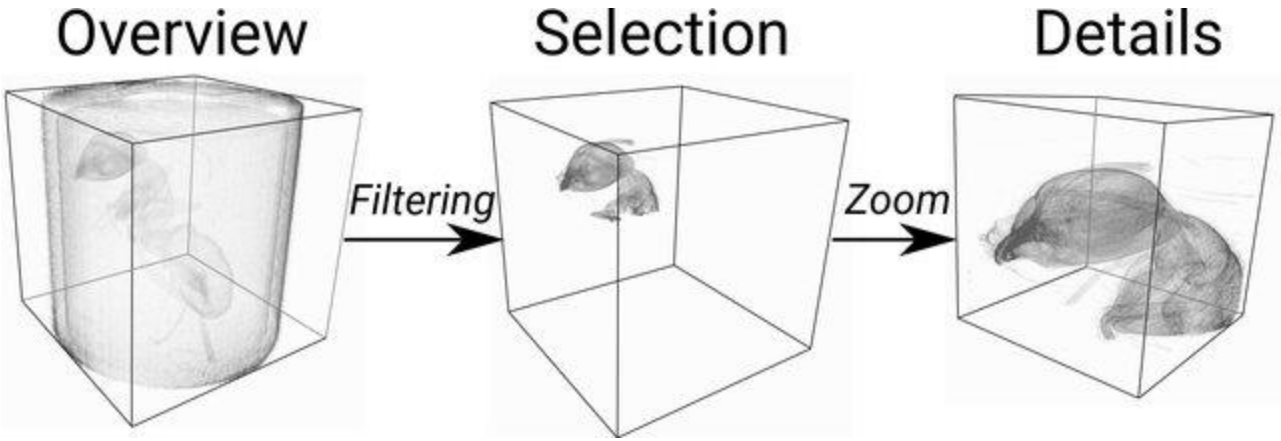


Image taken from: Tan Jerome, N. et al (2017). **WAVE: A 3D Online Previewing Framework for Big Data Archives**. *Proc. IVAPP, pp152-163*

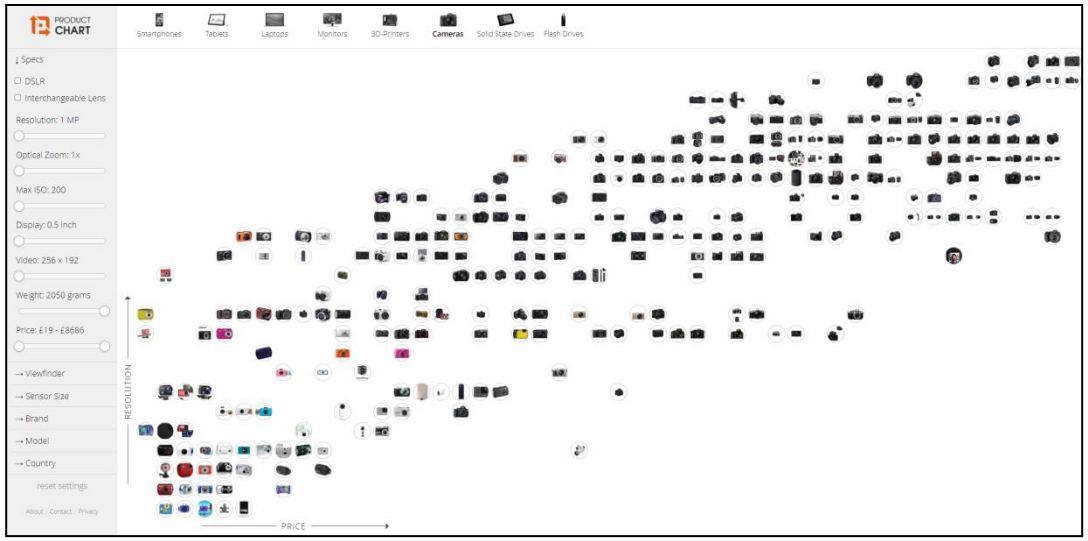
Types of interaction

- **Filtering**: only show me the data I am interested in *[F,Yi,Sh,K]*
- **Selecting**: mark or track items I am interested in *[F,Yi]*
- **Abstract & Elaborate**: show me more or less detail *[F,Yi,K]*
- **Overview & Explore/Focus & Context**:

  overview first, zoom and filter, details on demand *[F,Sh,K]*
- **Connect/Relate**: show me how this data is related *[F,Yi,Sh,K]*
- **Reconfigure**: show me a different arrangement of the data *[F,Yi,K]*
- **Encode:** show me a different representation of the data *[F,Yi]*

- **Extraction of features**: allow me to extract data that interests me *[F,Sh]*
- **History**: allow me to retrace the steps I take *[F,Sh]*
- **Participation/Collaboration**: allow me to contribute to the data *[F]*
- **Gamification**: show me the data in a more playful way *[F]*

Filter: dynamic queries

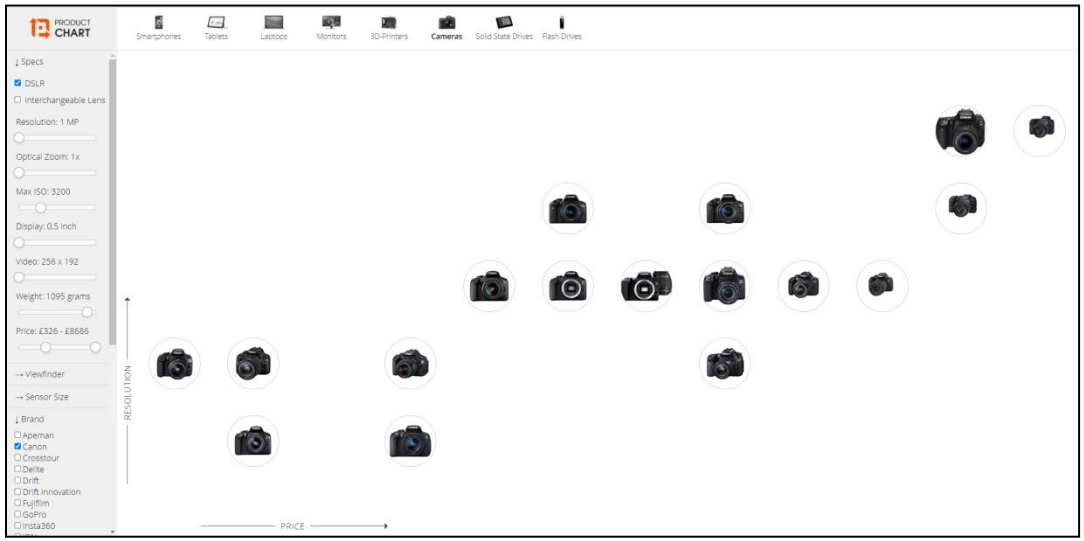


Camera Filters:

- DSLR
- Max ISO: 3200
- Price: £326-£8686
- Canon

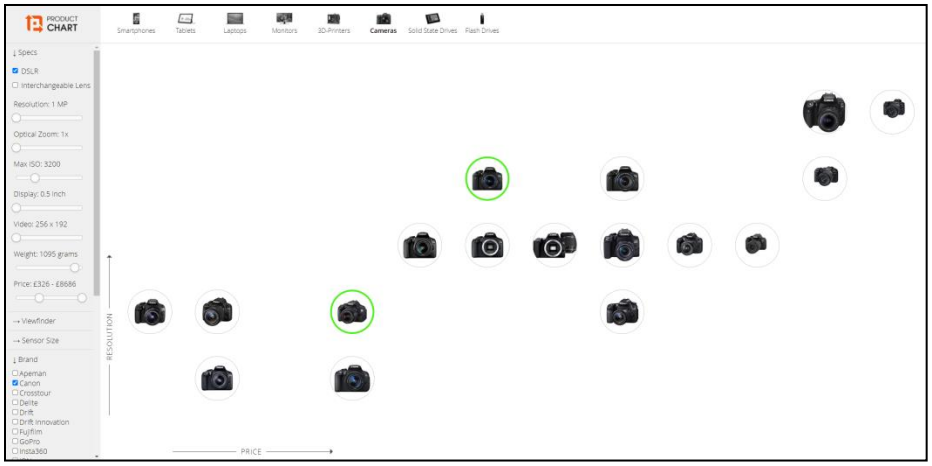
Quantitative attributes: sliders
e.g. Price: £190 - £3429

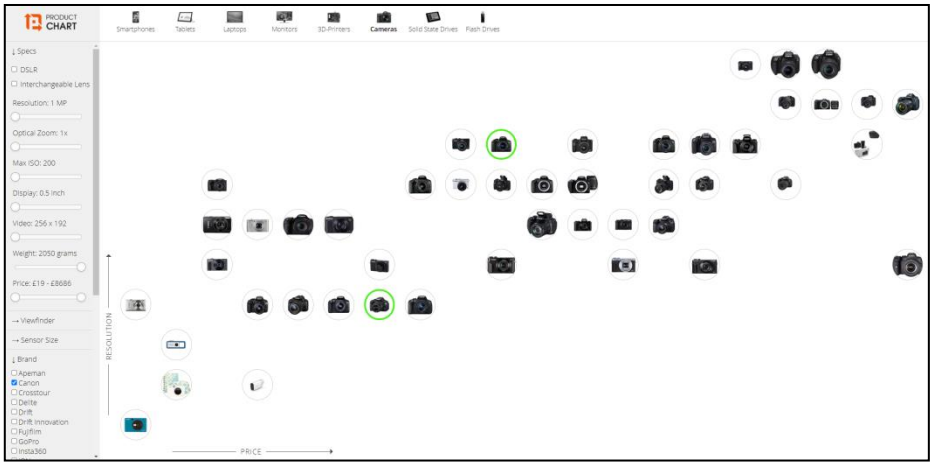
Categorical attributes: check boxes
e.g. ☐ Interchangeable Lens

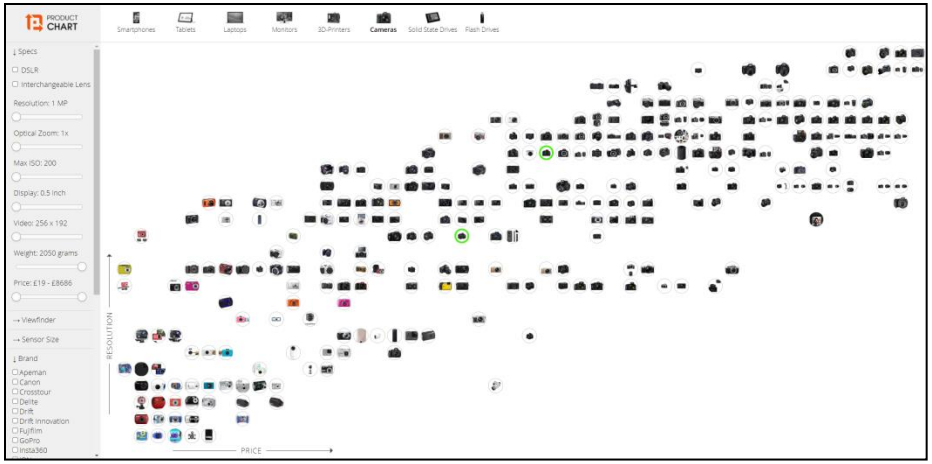


https://www.productchart.co.uk/cameras/ (accessed 26/05/21)

Select: highlighting items





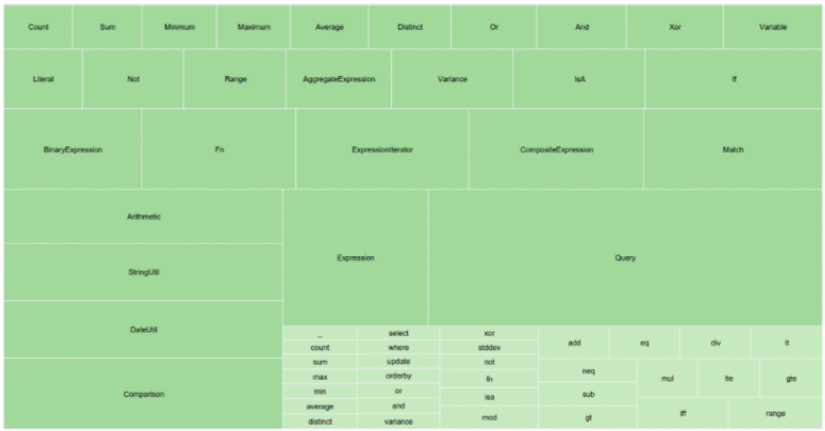


https://www.productchart.co.uk/cameras/ (accessed 26/05/21)

Abstract & Elaborate: zoom

"Filter by navigation"
results in loss or gain of information

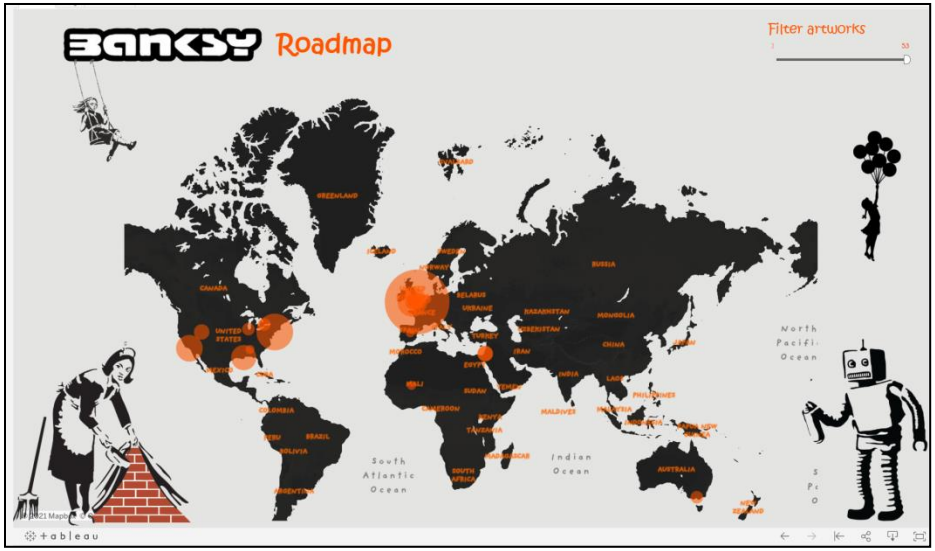
(a) Overview of the treemap

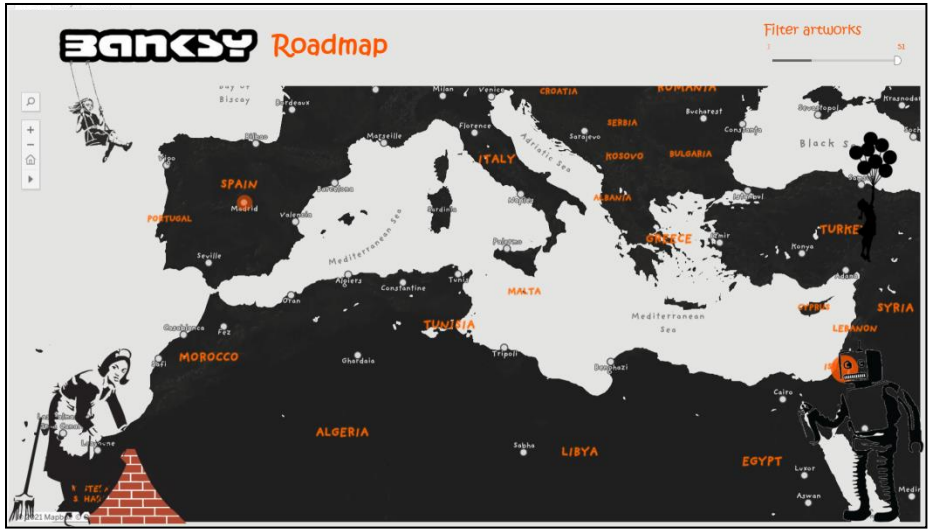


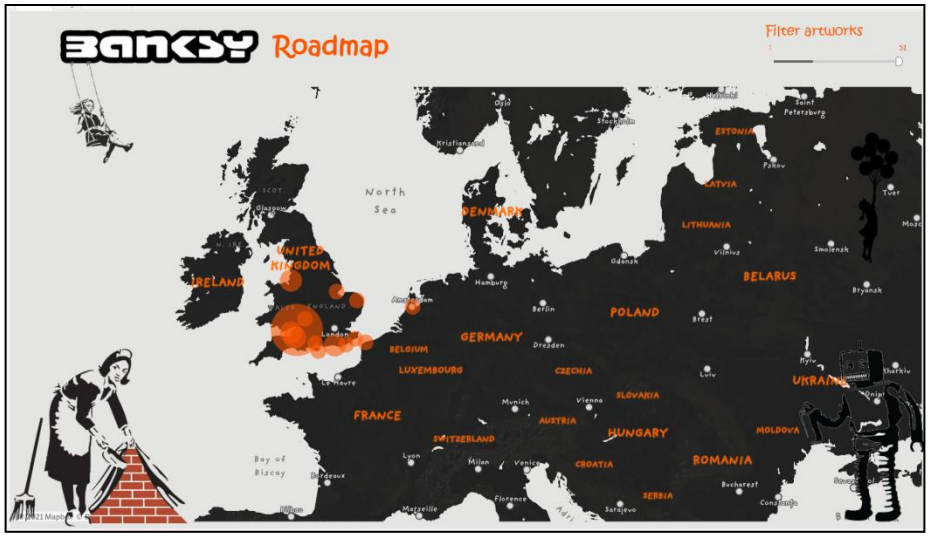
(b) After click on the light green area

A. Figueiras, "Towards the Understanding of Interaction in Information Visualization", 2015.

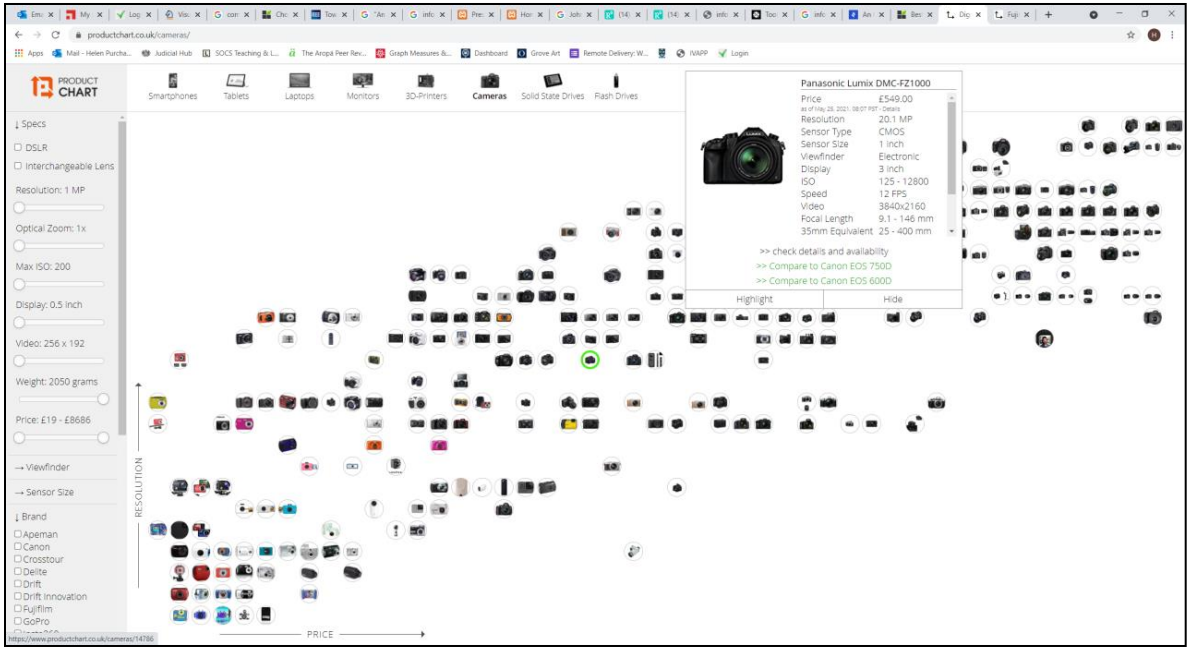
Location of Banksy's murals



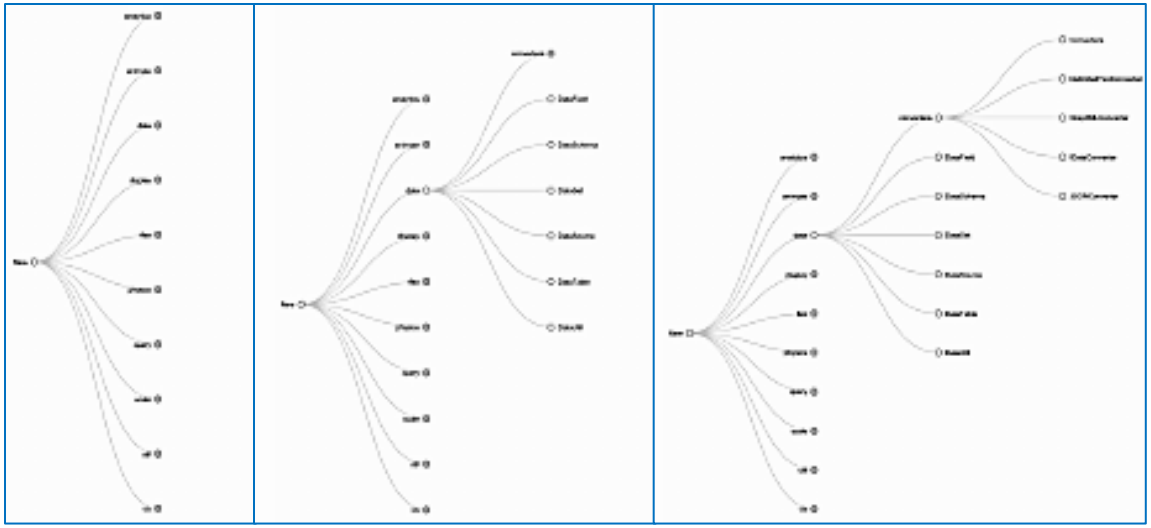




https://public.tableau.com/en-gb/gallery/banksy-graffiti-around-world (26/05/21)



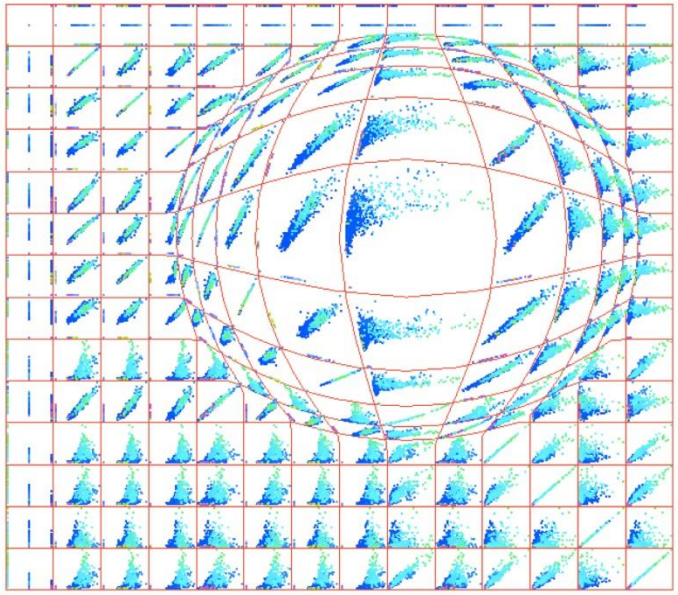
Details-on-demand



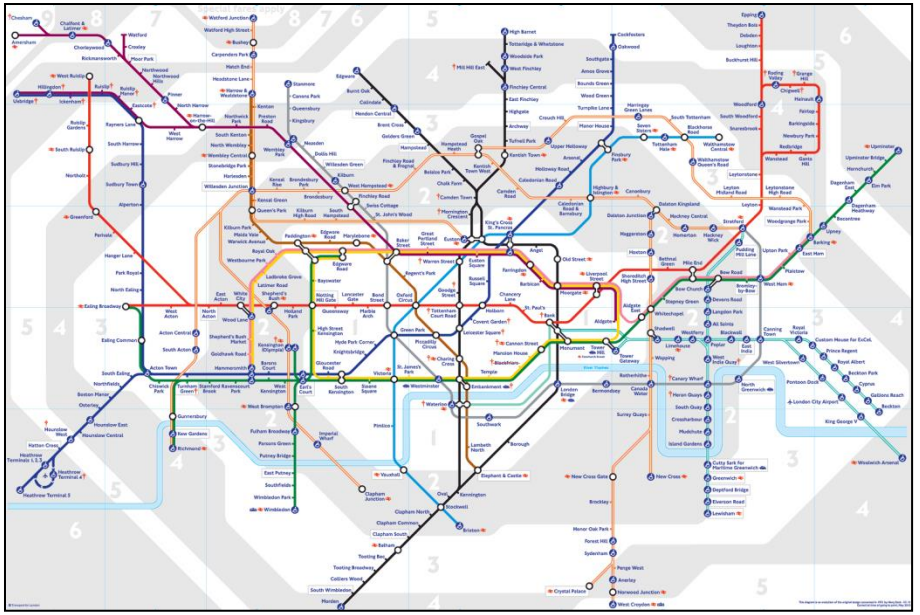
https://www.productchart.co.uk/cameras/ (accessed 26/05/21)

A. Figueiras, "Towards the Understanding of Interaction in Information Visualization", 2015.

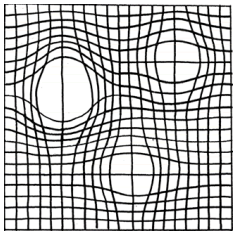
Focus & Context: distortion

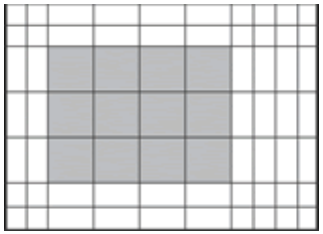


Fish eye view of scatterplot matrix

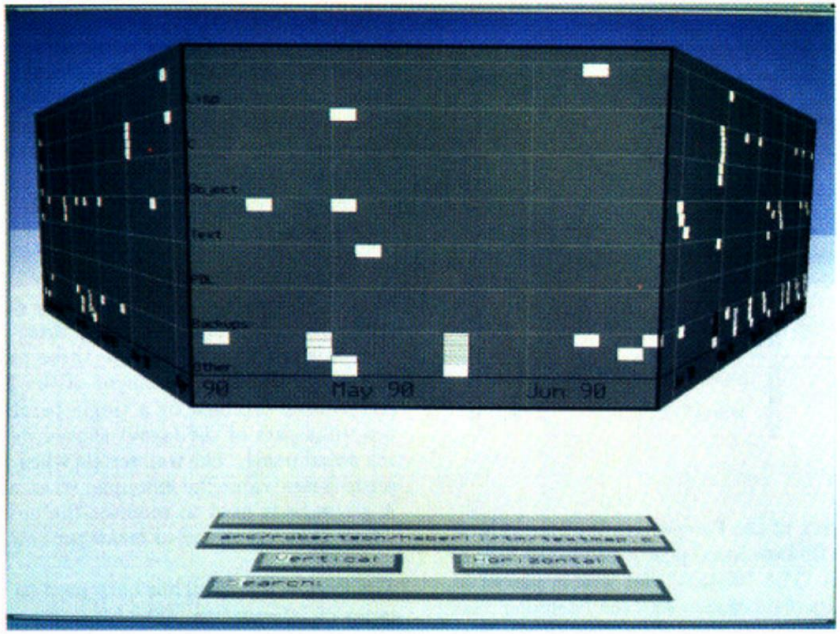


Linear **distortion** of metro map

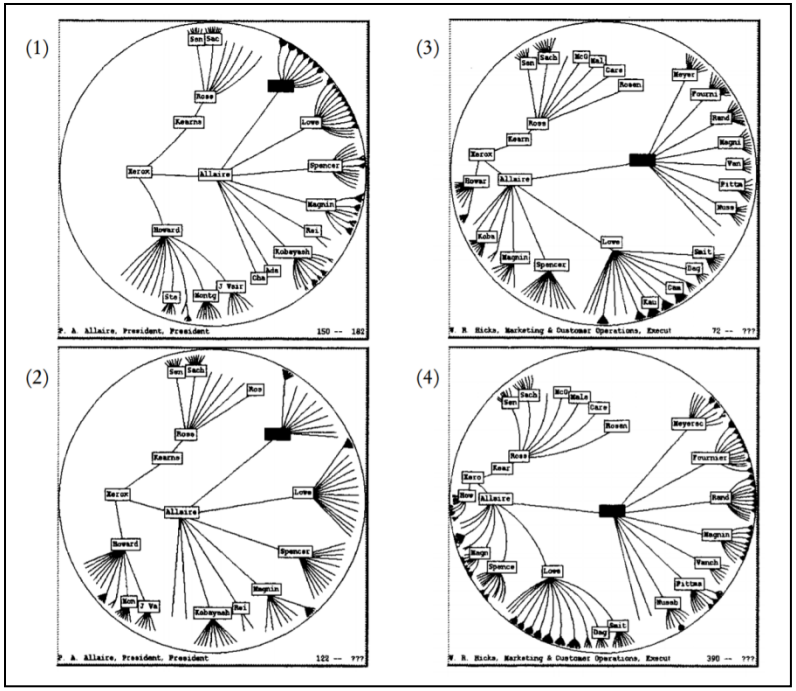




Loren K. Rhodes, “Presentation”, jcsites.juniata.edu/faculty/rhodes/ida/presentation.html (accessed 26/05/21)



Perspective Wall, for large volumes of linear data (e.g. chronological or alphabetical)

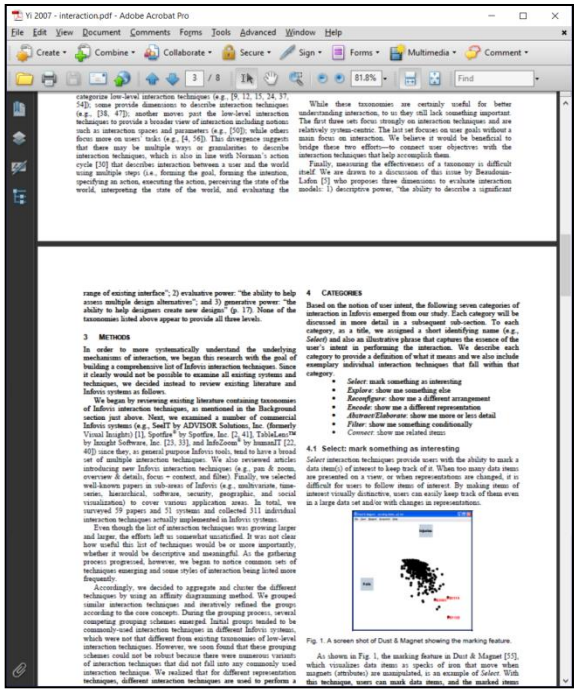


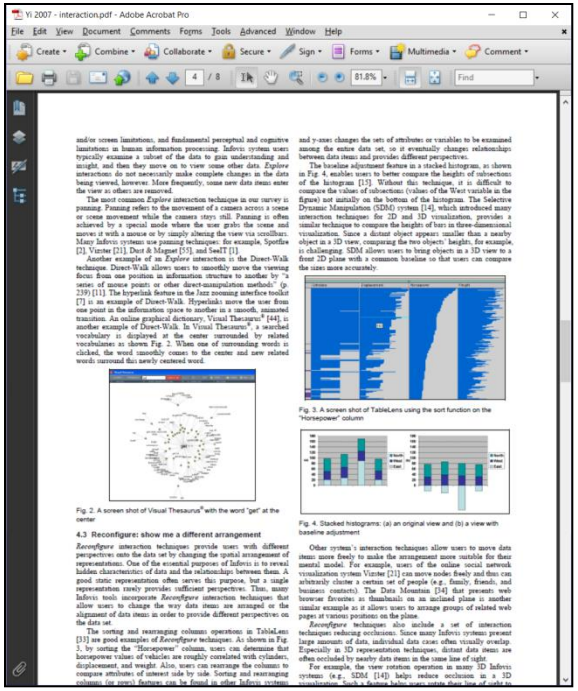
Hyperbolic trees, for large hierarchies

George Robertson, Jock D. Mackinlay, Stuart Card. The Perspective Wall: Detail And Context Smoothly Integrated, 1991.

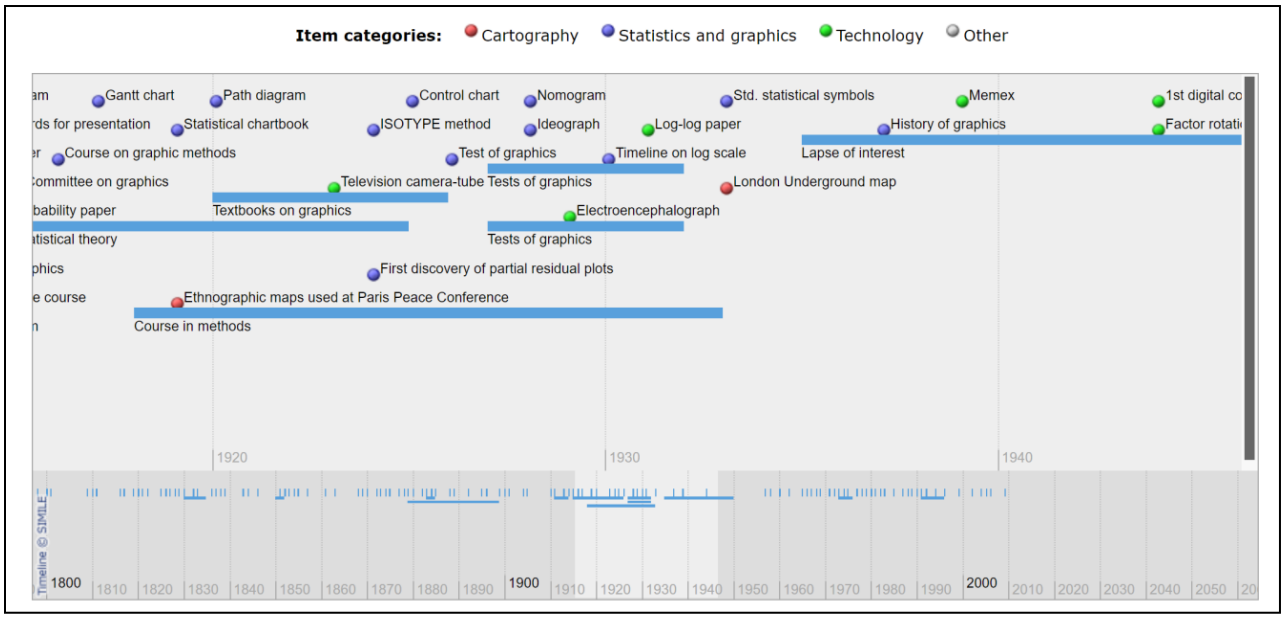
John Lamping, Ramana Rao, and Peter Pirolli. A focus+context technique based on hyperbolic geometry for visualizing large hierarchies, 1995

Focus & Context: overviews

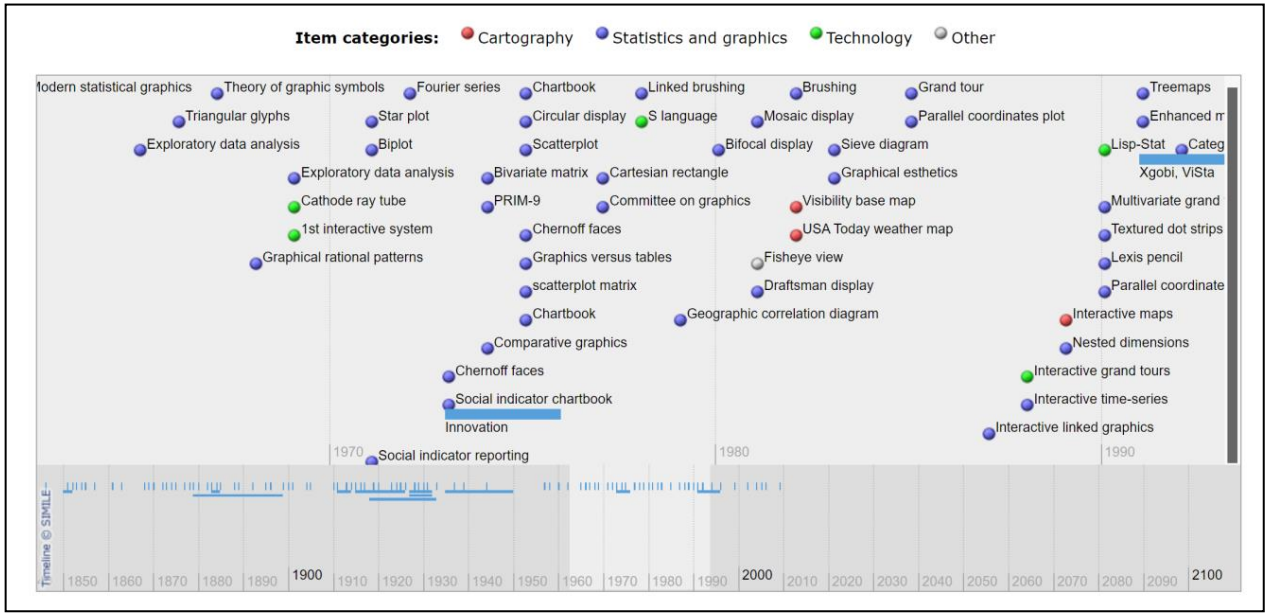




Visualisation Milestones



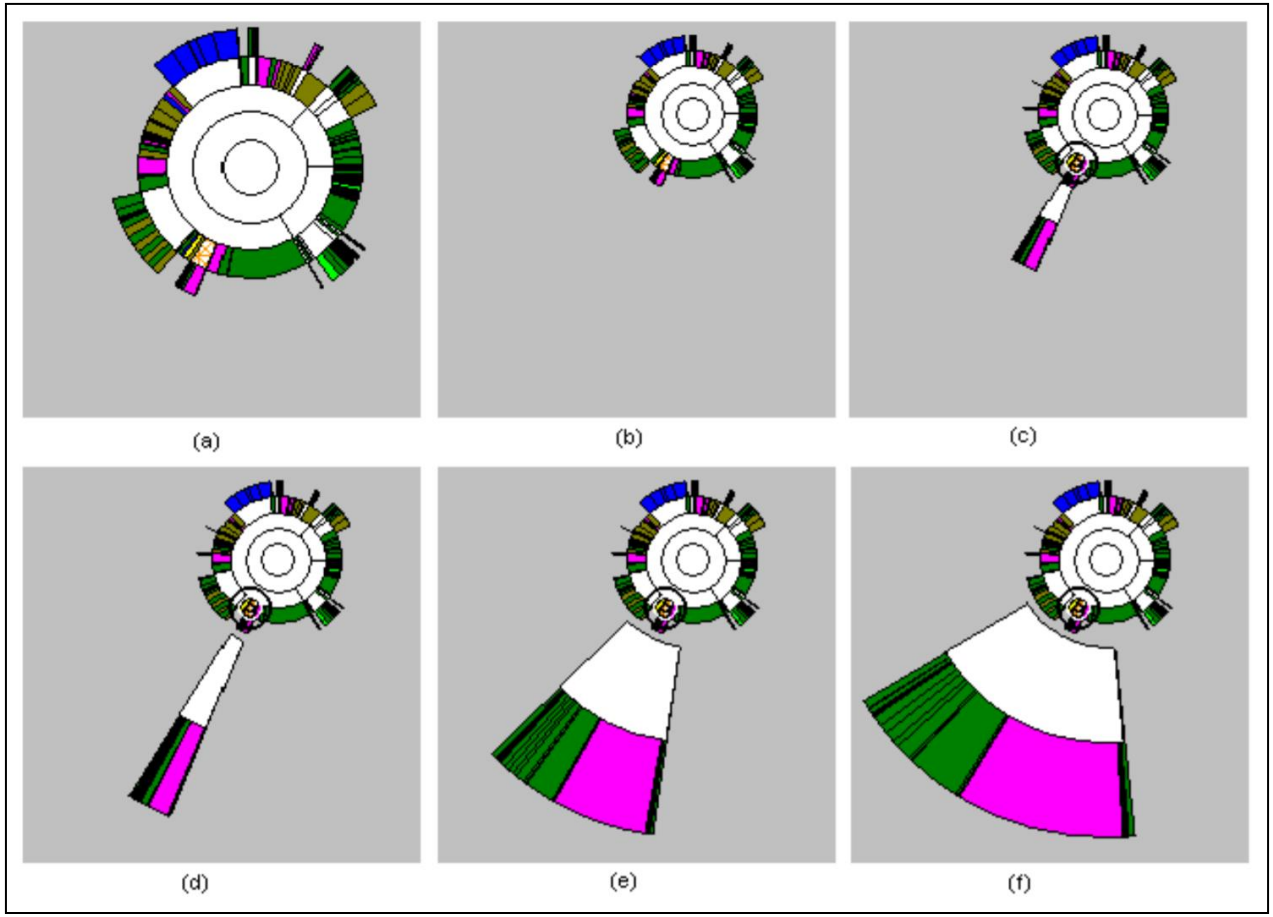
1905-1938



1961-1994

M. Friendly & D. Denis, Milestones in the History of Thematic Cartography, https://www.datavis.ca/milestones/ (accessed 26/05/21)

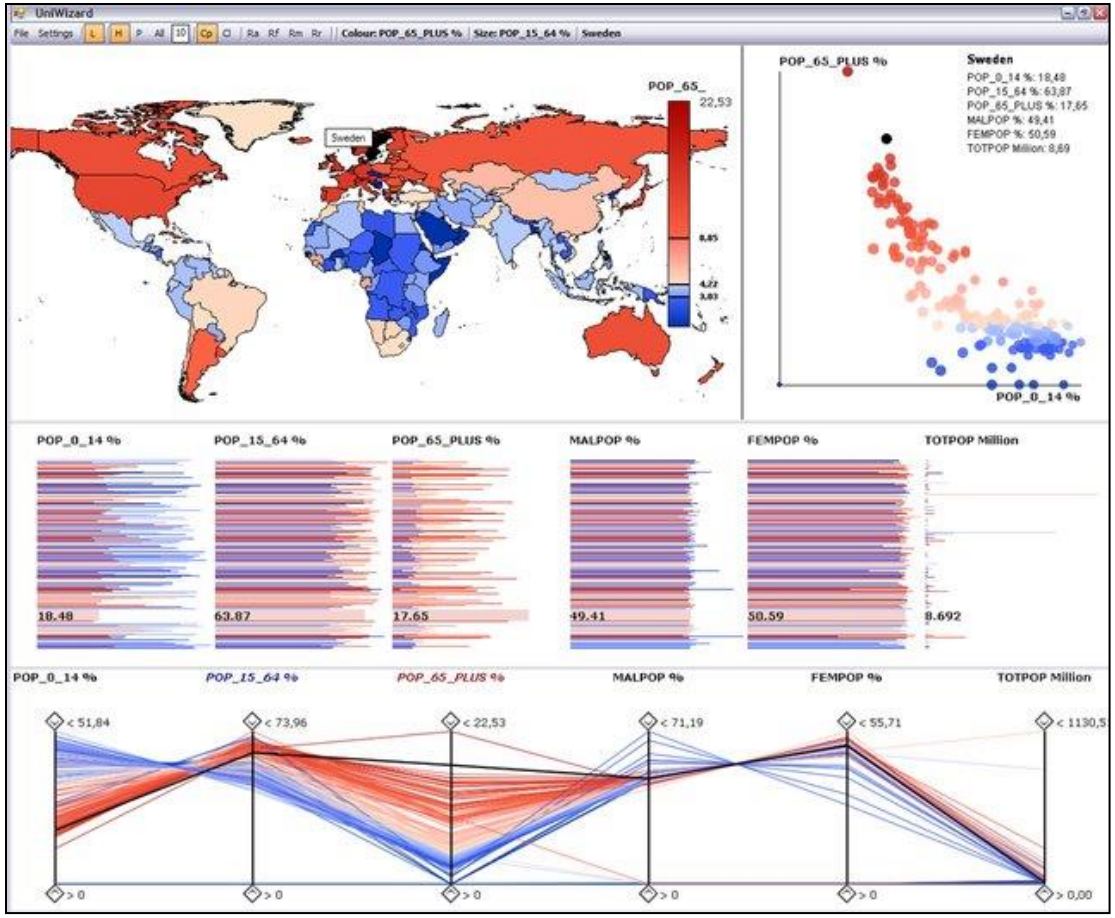
Focus & Context: exposing details



Sunburst - for large hierarchies

J. Stasko & E. Zhang. Focus+context display and navigation techniques for enhancing radial, spacefilling hierarchy visualizations, 2000.

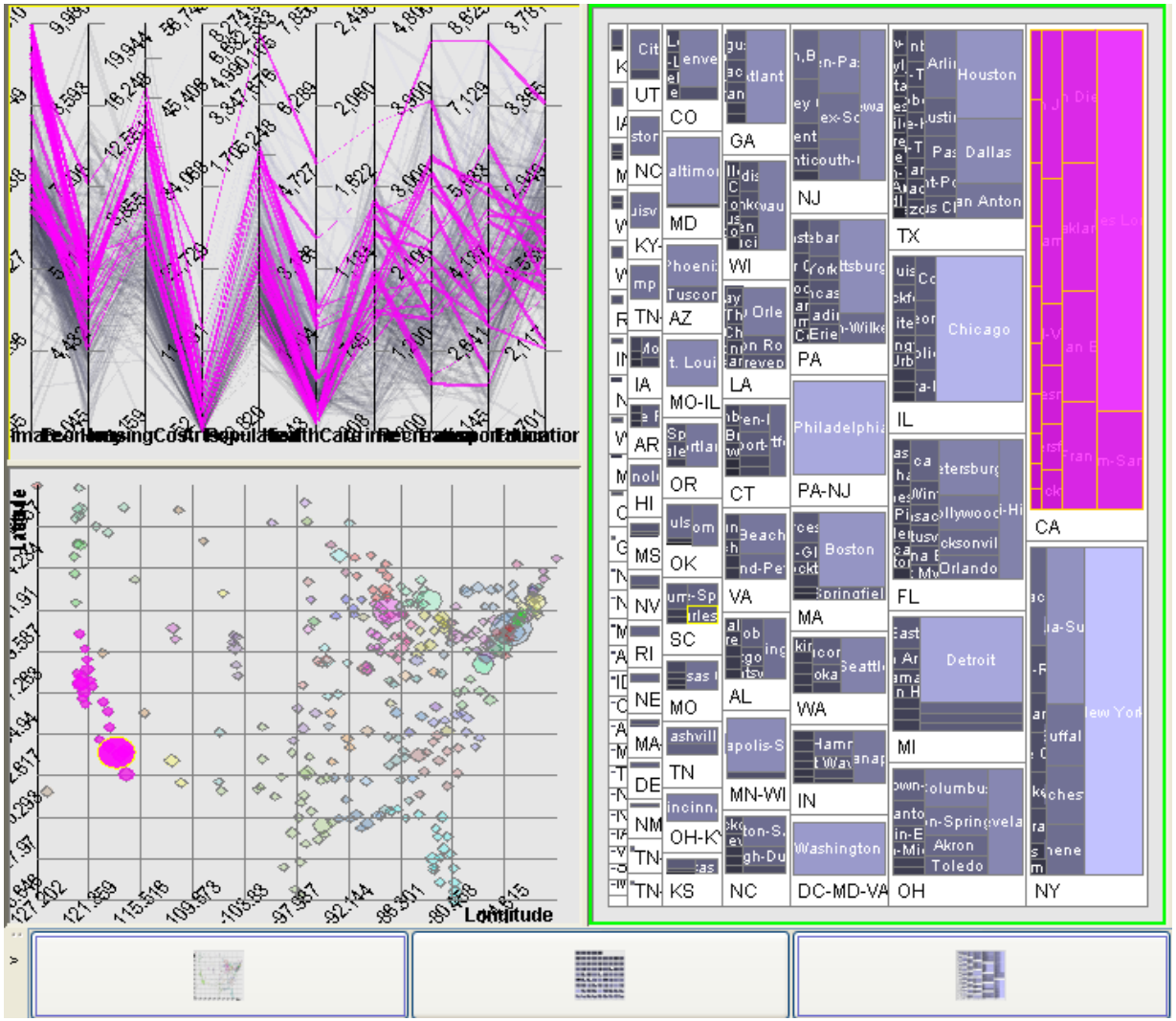
Connecting: multiple views



Multiple-linked and coordinated views:

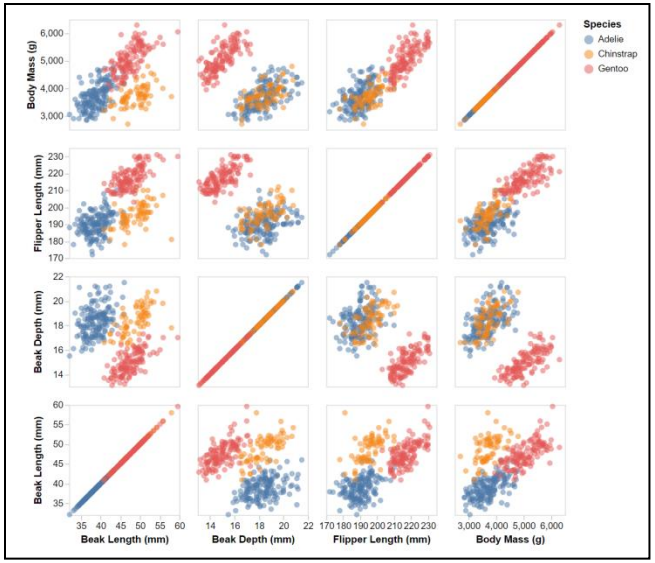
- world map
- colour legend
- scatter plot
- table lens
- parallel coordinates

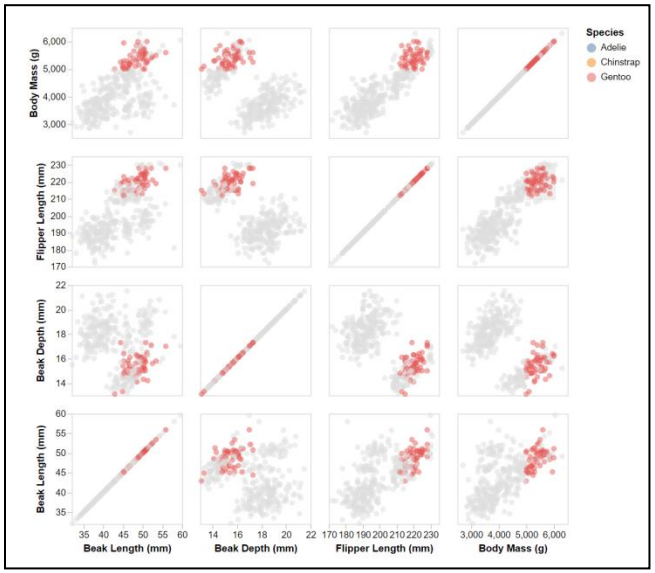
S. Johansson and M. Jern. 2007. GeoAnalytics visual inquiry and filtering tools in parallel coordinates plots.

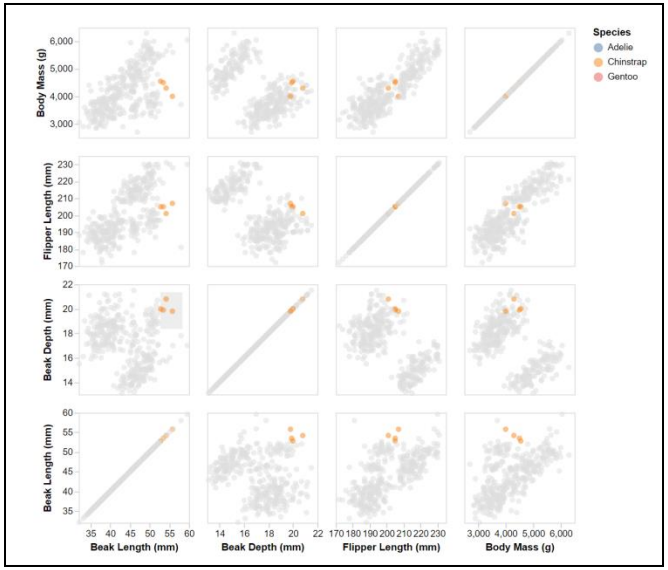


https://infovis-wiki.net/wiki/Multiple_Views (primary source unavailable)

Connect: linking and brushing

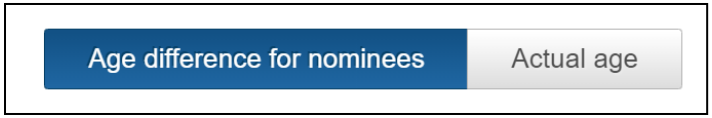


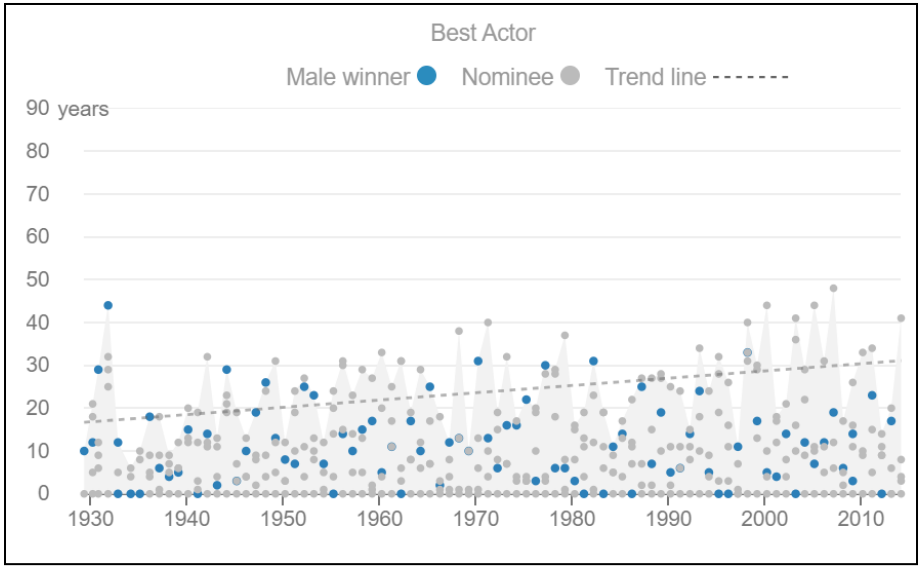


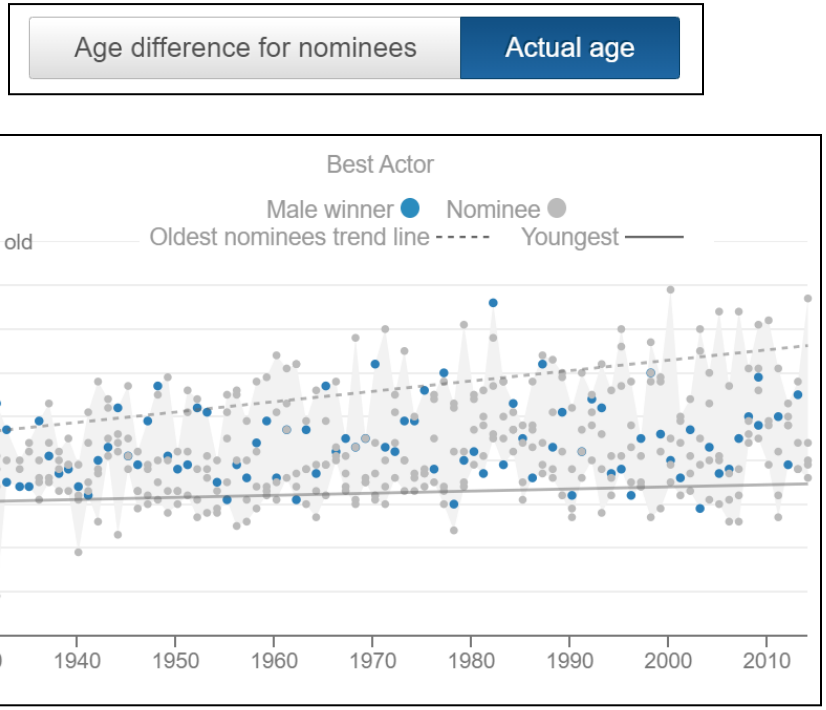


https://vega.github.io/vega/examples/brushing-scatter-plots/ (accessed 26/05/21)

Reconfigure:
data choice

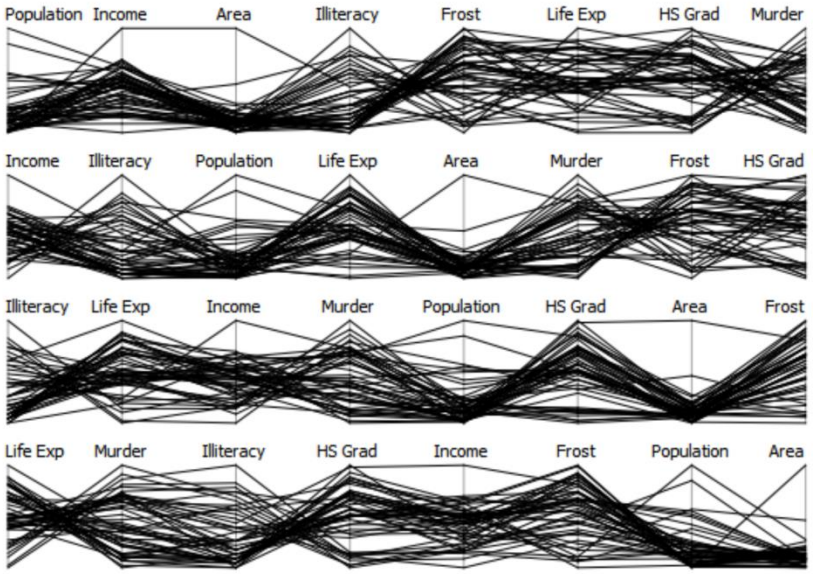


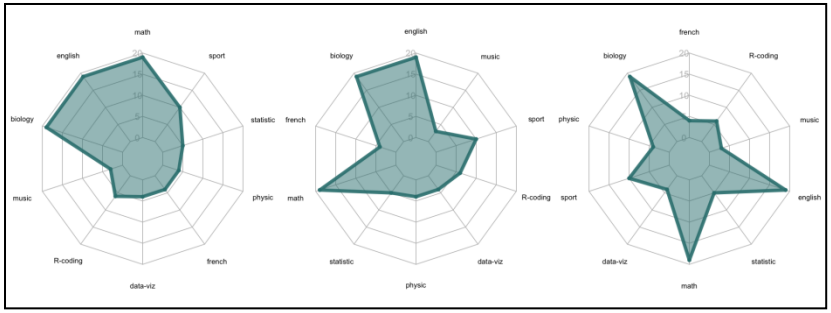




https://www.theguardian.com/film/interactive/2014/mar/02/oscars-award-nominees-age-best-actress-actor

Reconfigure: dimension order





The number of students studying different subjects in a high school

- left shows the set of popular and unpopular subjects clearly

Census data for 50 US states, showing relationships:

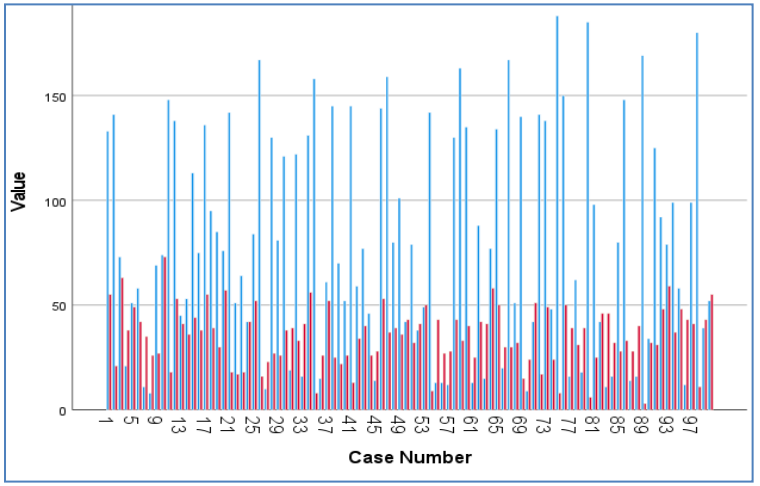
- top: Illiteracy/Frost (negative)
- bottom: Life Expectancy/Murder (negative)
- bottom: Illiteracy/HS Grad (negative)

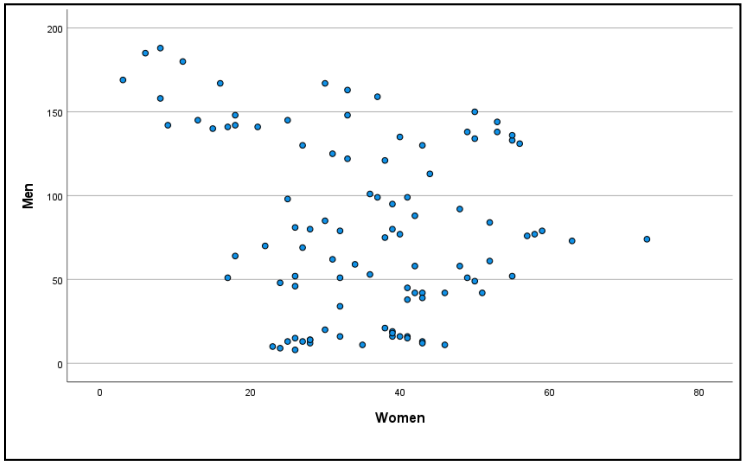
J. Heinrich, D. Weiskopf (2013),
State of the Art of Parallel Coordinates

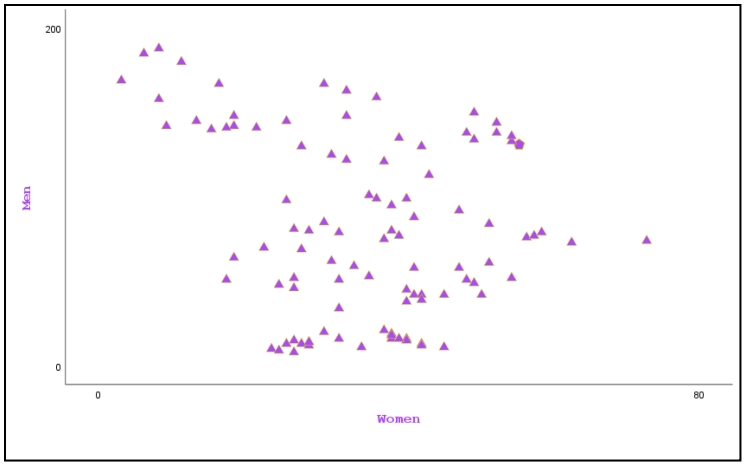
https://www.data-to-viz.com/caveat/spider.html
(accessed 26/05/32)

Encode

- Switch between views of the same data
  - e.g. scatterplot to clustered bar chart
- Change visual variables
  - e.g colour, shape, line width







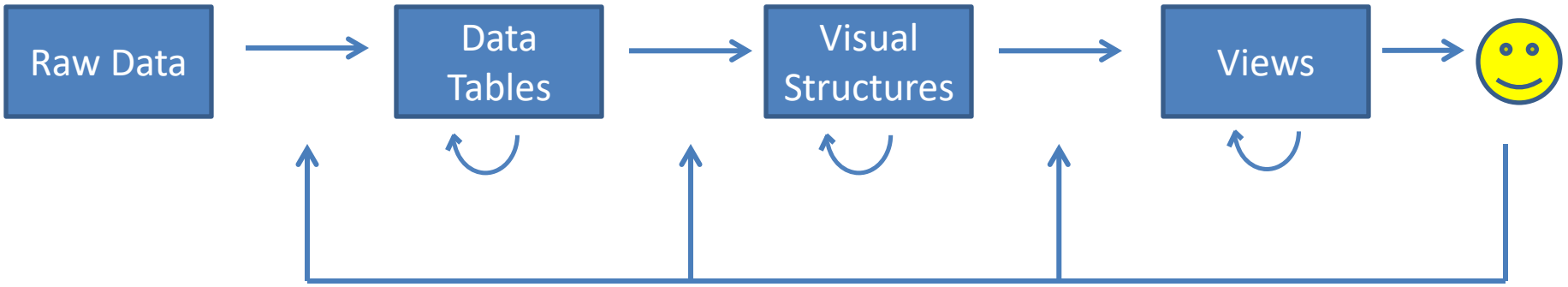
Data

Visual Form

Transform the data

Map the data to a visualisation method

Display the visualisation



Interaction

Filter, Select, Abstract & Elaborate, Focus & Context, Connect, Reconfigure, Encode

The Visualisation Pipeline & Interaction