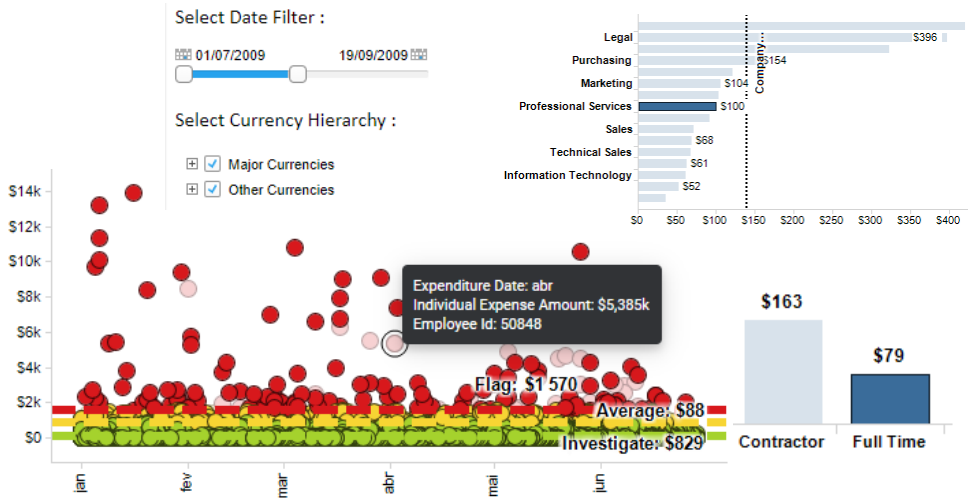
Universidade de Aveiro
Departamento de Electrónica,
Telecomunicações e Informática

Presentation and Interaction



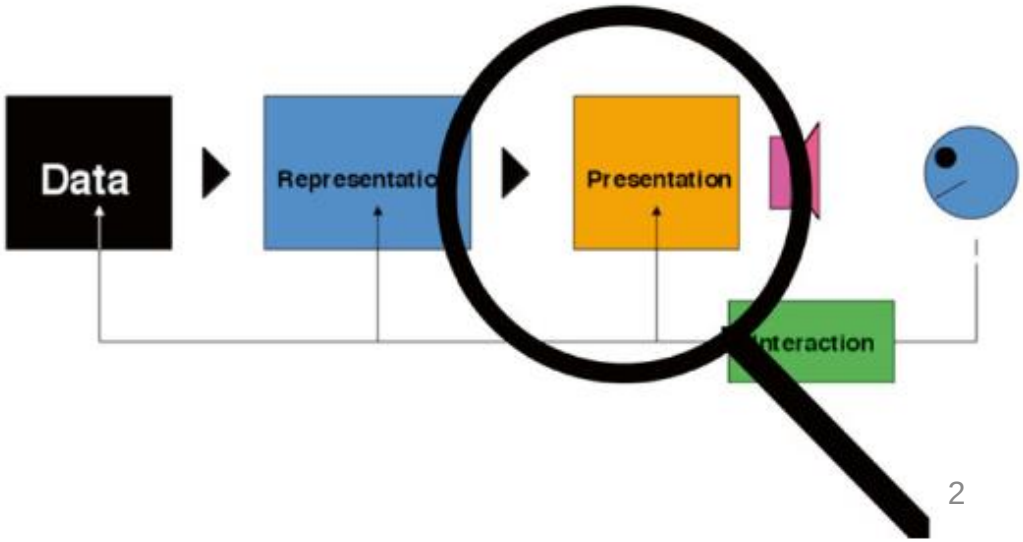
https://www.tibco.com/products/tibco-spotfire/learn/demos

The presentation issue

- The issue of **layout** is important due to the limited screen real estate
- Irrespective of how data may be represented decisions have to be made:
  - **how the representation is to be displayed**
  - **whether it is to be displayed**

(Spence, 2014)

- Links to representation and interaction are important



To help overcome space limitations

- Scrolling
- Overview + detail
- Distortion
- Suppression
- Zoom and pan

- Scrolling consists in moving displayed text or graphics on a screen in order to view different parts of them

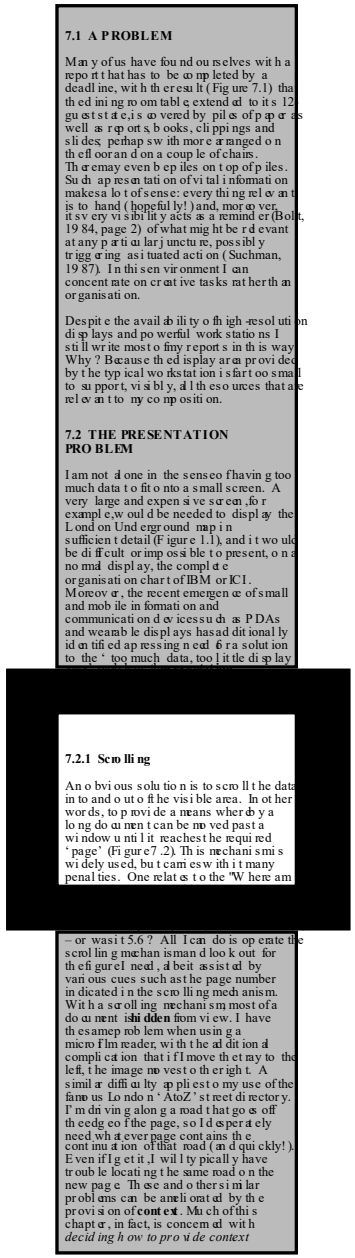
- an obvious solution when a document is larger than the display area

- A long document can be moved past a “window”

- Often it is not a satisfactory solution

- Scrolling hides most of a document:

  there is not a view of context as well as detail



7.1 A PROBLEM

Many of us have found ourselves with a report that has to be completed by a deadline, with the result (Figure 7.1) that the dining room table extended to its 12 guest state is covered by piles of paper as well as reports, books, clippings and slides, perhaps with more arranged on the floor and on a couple of chairs. There may even be piles on top of piles. Such a presentation of vital information makes a lot of sense: everything relevant is to hand (hopefully!) and, moreover, it's very visibility acts as a reminder (Bolt, 1984, page 2) of what might be relevant at any particular juncture, possibly triggering a situated action (Suchman, 1987). In this environment I can concentrate on creative tasks rather than organisation.

Despite the availability of high-resolution displays and powerful workstations I still write most of my reports in this way. Why? Because the display area provided by the typical workstation is far too small to support, visibly, all the resources that are relevant to my composition.

7.2 THE PRESENTATION PROBLEM

I am not alone in the sense of having too much data to fit onto a small screen. A very large and expensive screen, for example, would be needed to display the London Underground map in sufficient detail (Figure 1.1), and it would be difficult or impossible to present, on a normal display, the complete organisation chart of IBM or ICI. Moreover, the recent emergence of small and mobile information and communication devices such as PDAs and wearables displays has additionally identified a pressing need for a solution to the ‘too much data, too little display

7.2.1 Scrolling

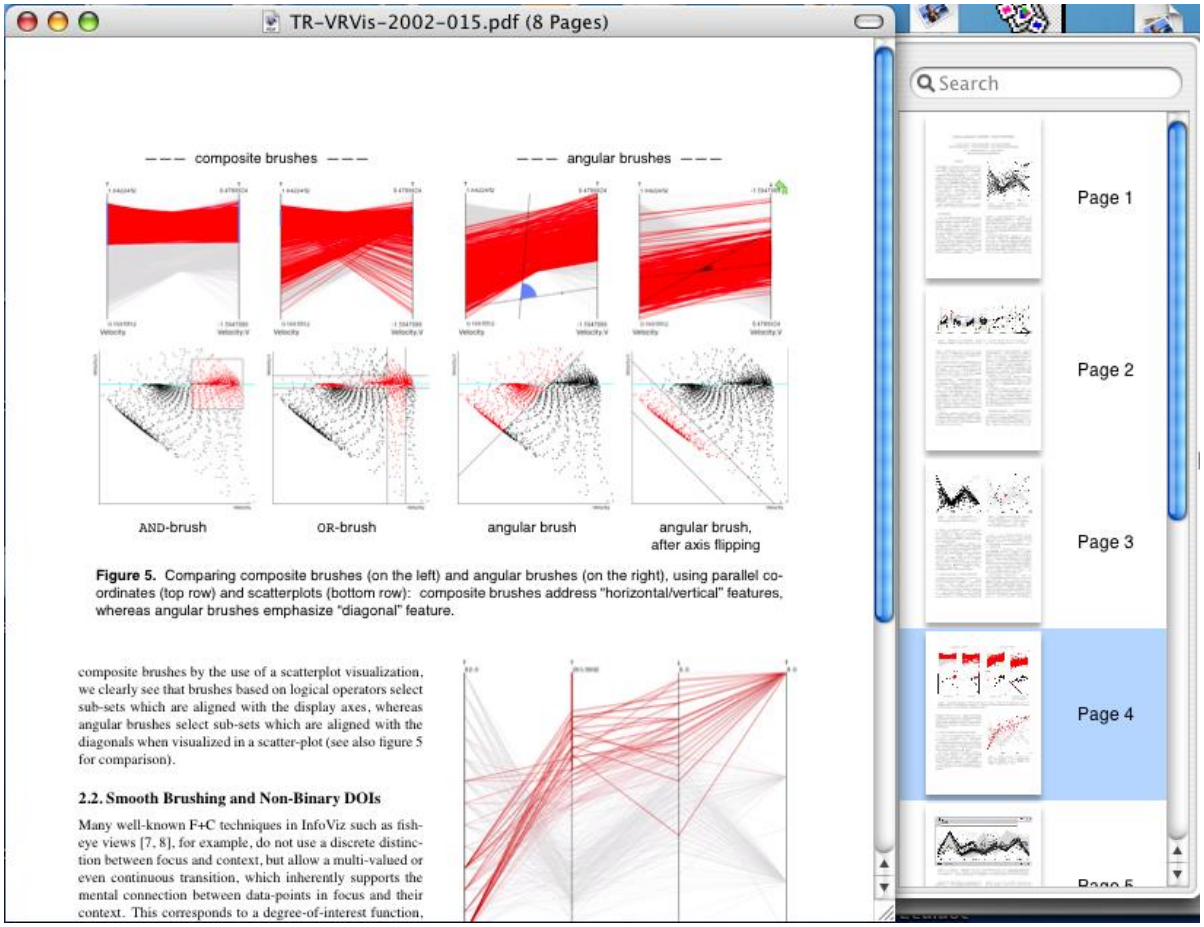
An obvious solution is to scroll the data into and out of the visible area. In other words, to provide a means whereby a long document can be moved past a window until it reaches the required ‘page’ (Figure 7.2). This mechanism is widely used, but carries with it many penalties. One relates to the "Where am

– or was it 5.6? All I can do is operate the scrolling mechanism and look out for the figure I need, albeit assisted by various cues such as the page number indicated in the scrolling mechanism. With a scrolling mechanism, most of a document is **hidden** from view. I have the same problem when using a microfilm reader, with the additional complication that if I move the tray to the left, the image moves to the right. A similar difficulty applies to my use of the famous London ‘AtoZ’ street directory. I'm driving along a road that goes off the edge of the page, so I desperately need what ever page contains the continuation of that road (and quickly!). Even if I get it, I will typically have trouble locating the same road on the new page. These and other similar problems can be ameliorated by the provision of **context**. Much of this chapter, in fact, is concerned with *deciding how to provide context*

- Two separate views of detail and of context can be combined in a overview + detail view helps with the **focus + context** problem

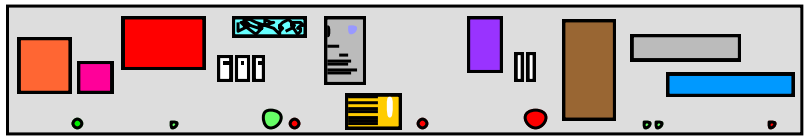
"You are here"

Another example



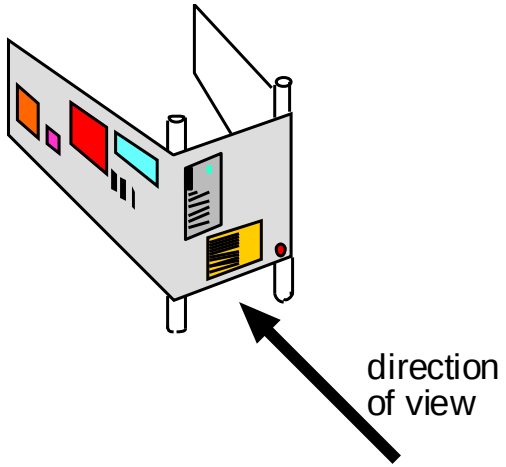
Detail plus Overview. Miniatures of pages of a pdf document provide useful context while attention is paid to detail of one page (Spence, 2007)

- Distortion offers a way of solving the **focus + context** problem



(a) An information space containing documents, emails, etc.

- The bifocal display (Spence and Apperley, 1982) uses distortion and is based on a simple metaphor

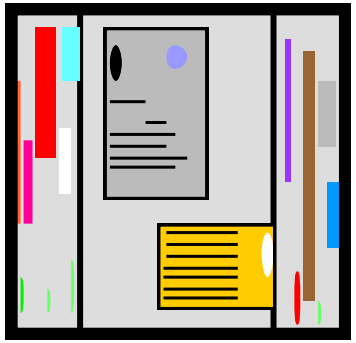


(b) The same space wrapped around two uprights.

- Part of an information space can be viewed in detail; a bird's eye view is provided of the remainder

Original videos:
http://www.youtube.com/watch?v=DaF5brrdpJw

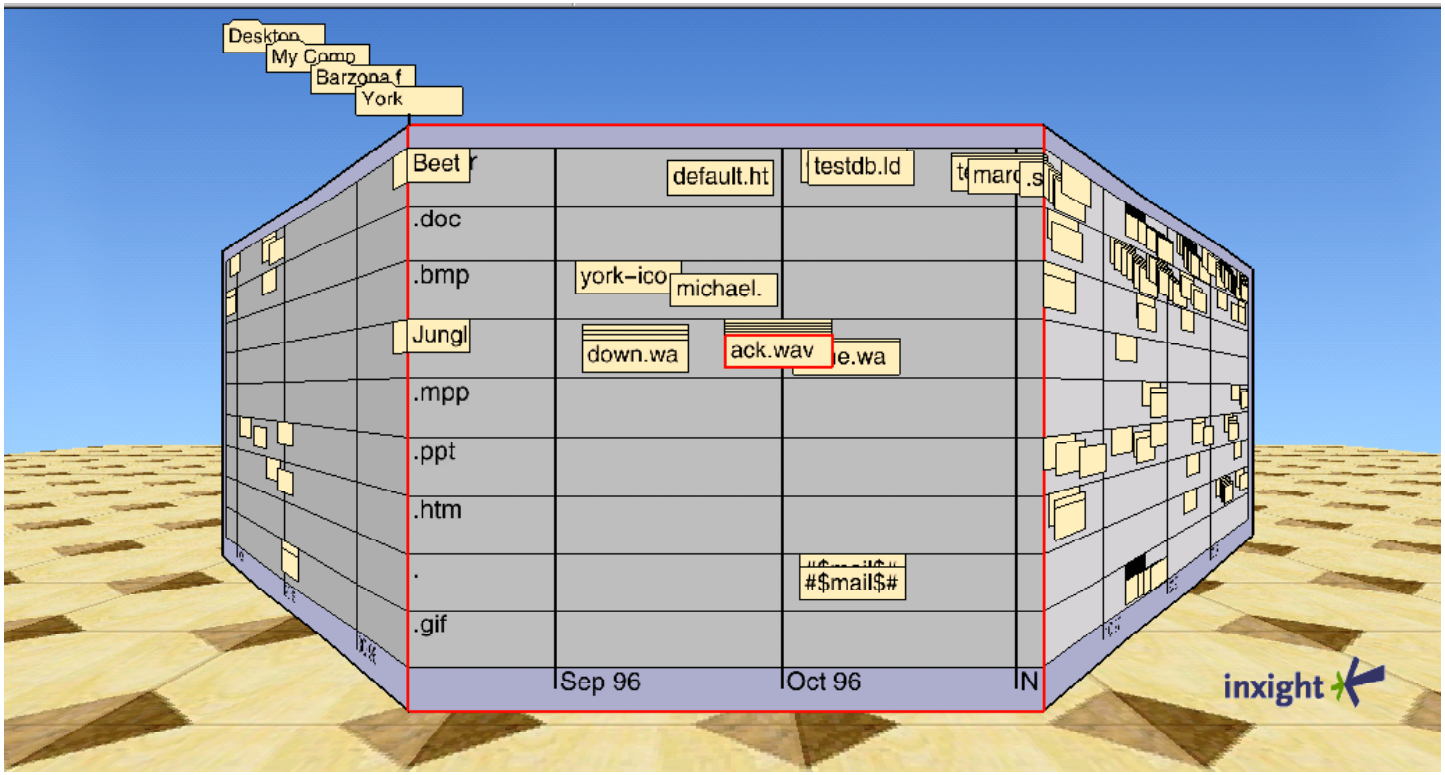
http://www.youtube.com/watch?v=gNTQaH8MM98&NR=1



(c) Appearance of the information space when viewed from an appropriate direction

The Bifocal Display is an information presentation technique which allows a large data space to be viewed as a whole, while simultaneously a portion is seen in detail. The detail is seen in the context of the overview, with continuity across the boundaries, rather than existing in a disjoint window

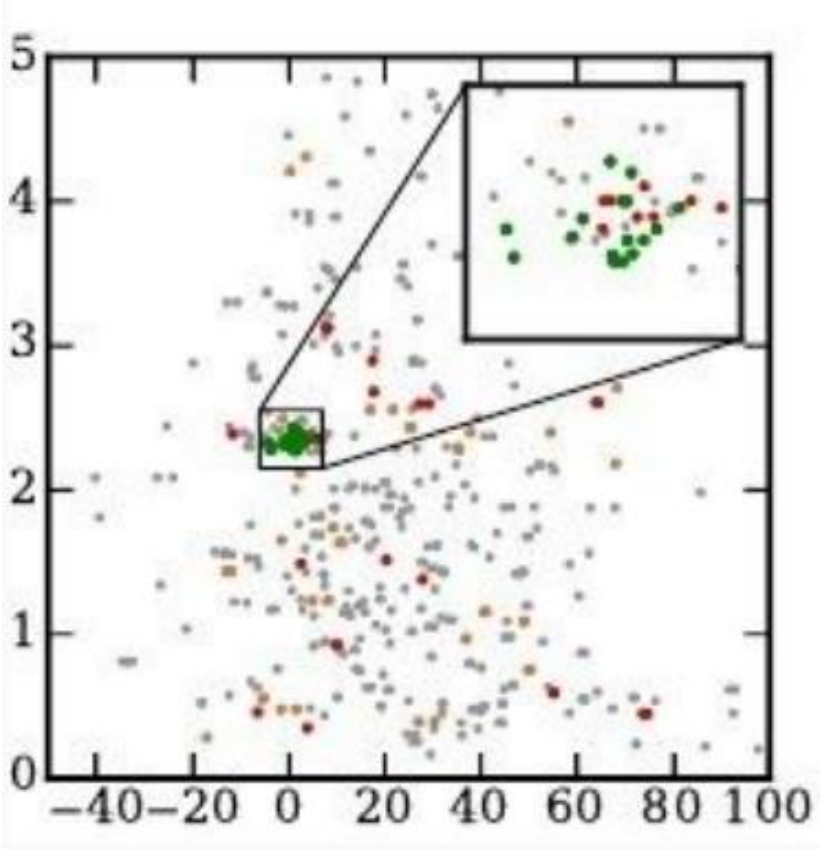
https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/bifocal-display



The Perspective Wall applies a 3D effect to the Bifocal Display (Mackinlay et al.,1991)

http://www.youtube.com/watch?v=hYUZbrWtCZg

Another example

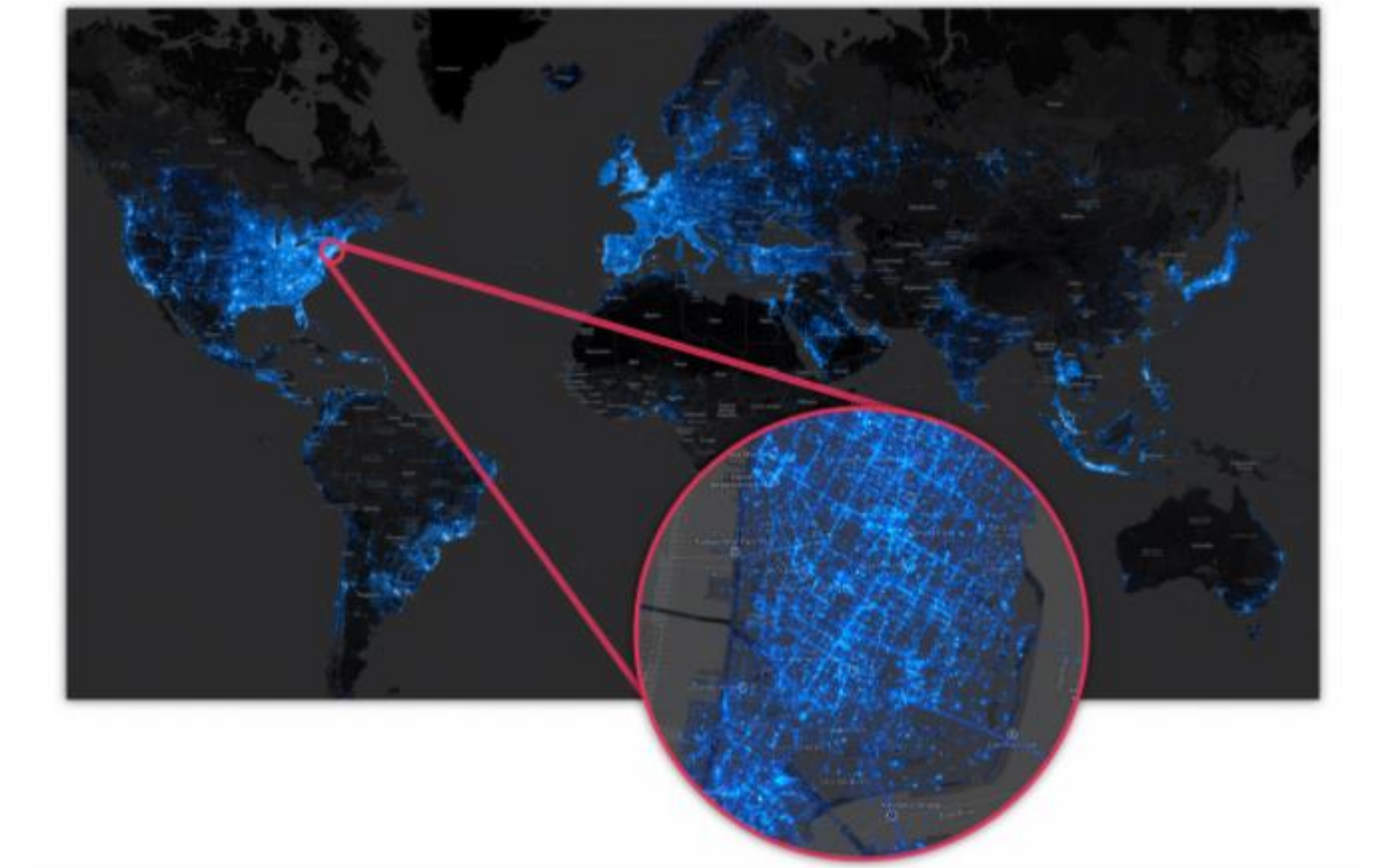


(Tao et al., 2021)

- The use of a "magnifying glass" helps minimize the **focus + context** problem

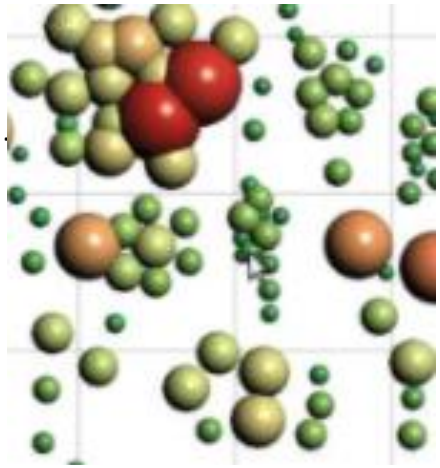
- a small region of interest is shown amplified and the context is maintained

Example: a small region of interest a context map can be flexibly positioned to provide a magnified view

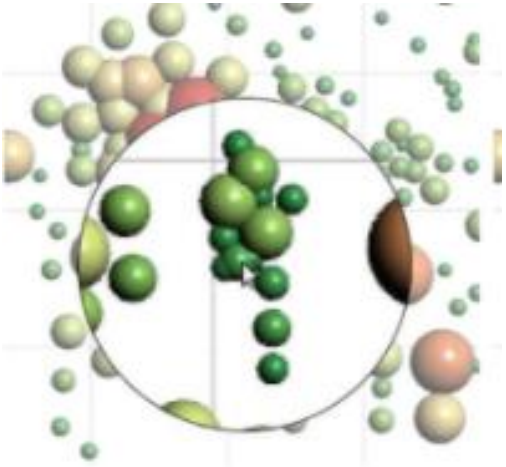


https://databricks.com/blog/2015/03/19/pantera-big-data-visualization-leverages-the-power-of-the-databricks-cloud.html

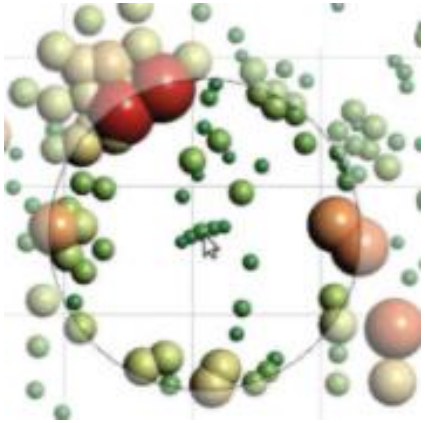
- The magic lens offers another way of solving the focus + context problem



Original view



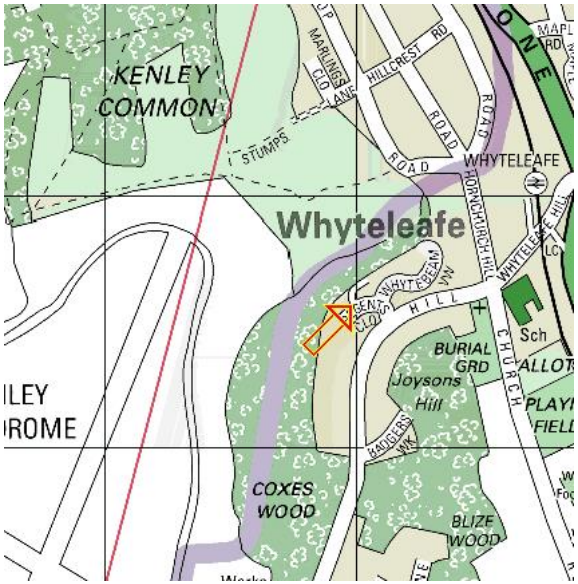
Simple magnification

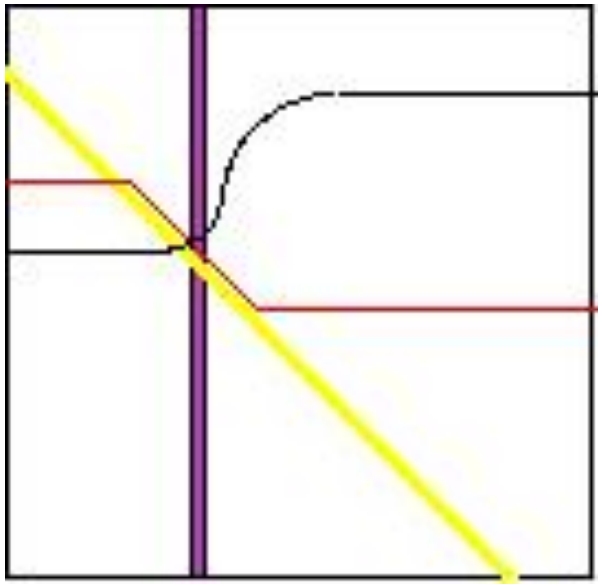


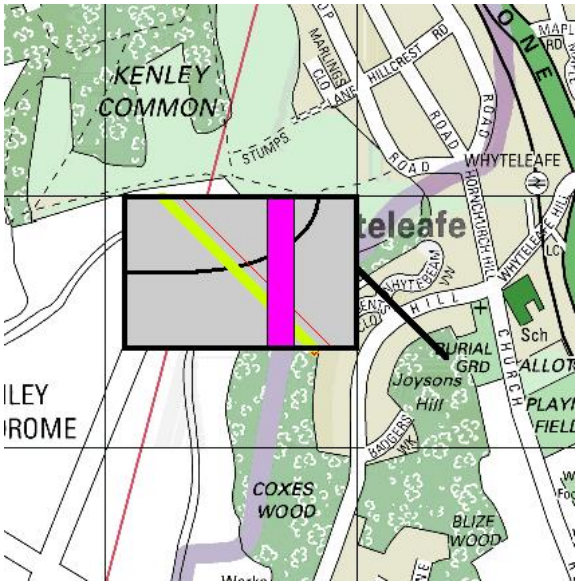
Fish-eye distortion

(Tominski et al., 2016)

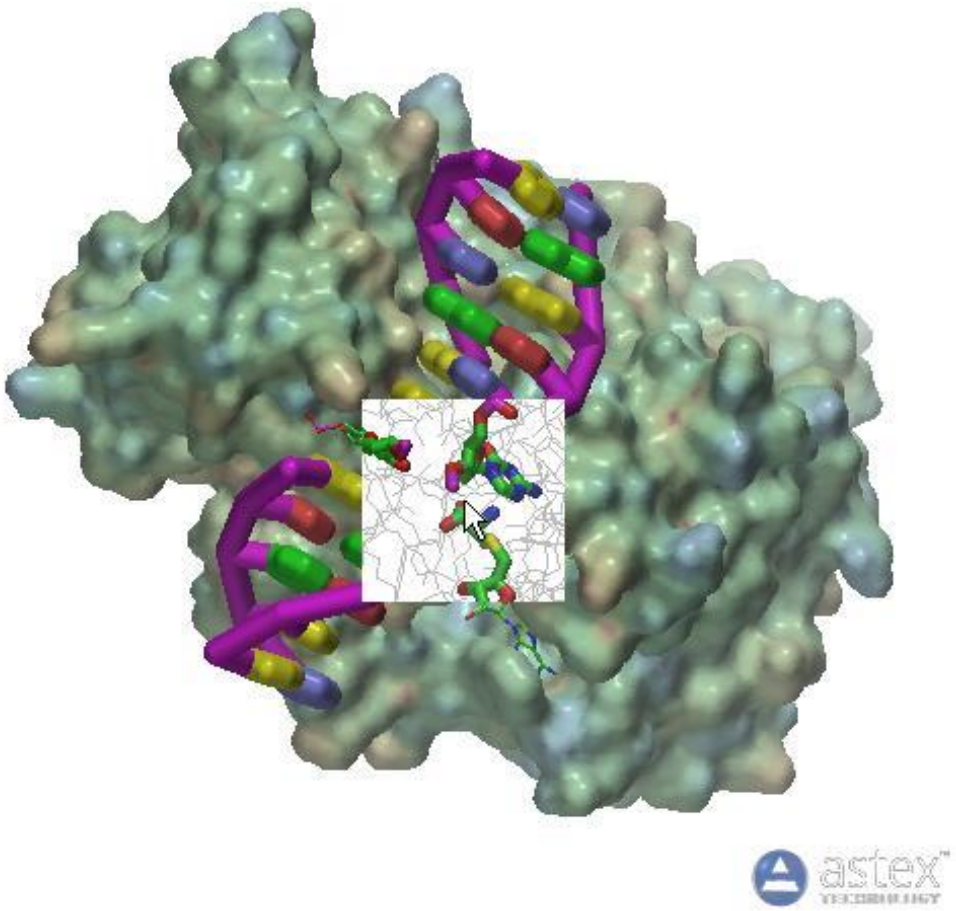
Suppression finds valuable application in the Magic Lens (Stone et al., 1994)





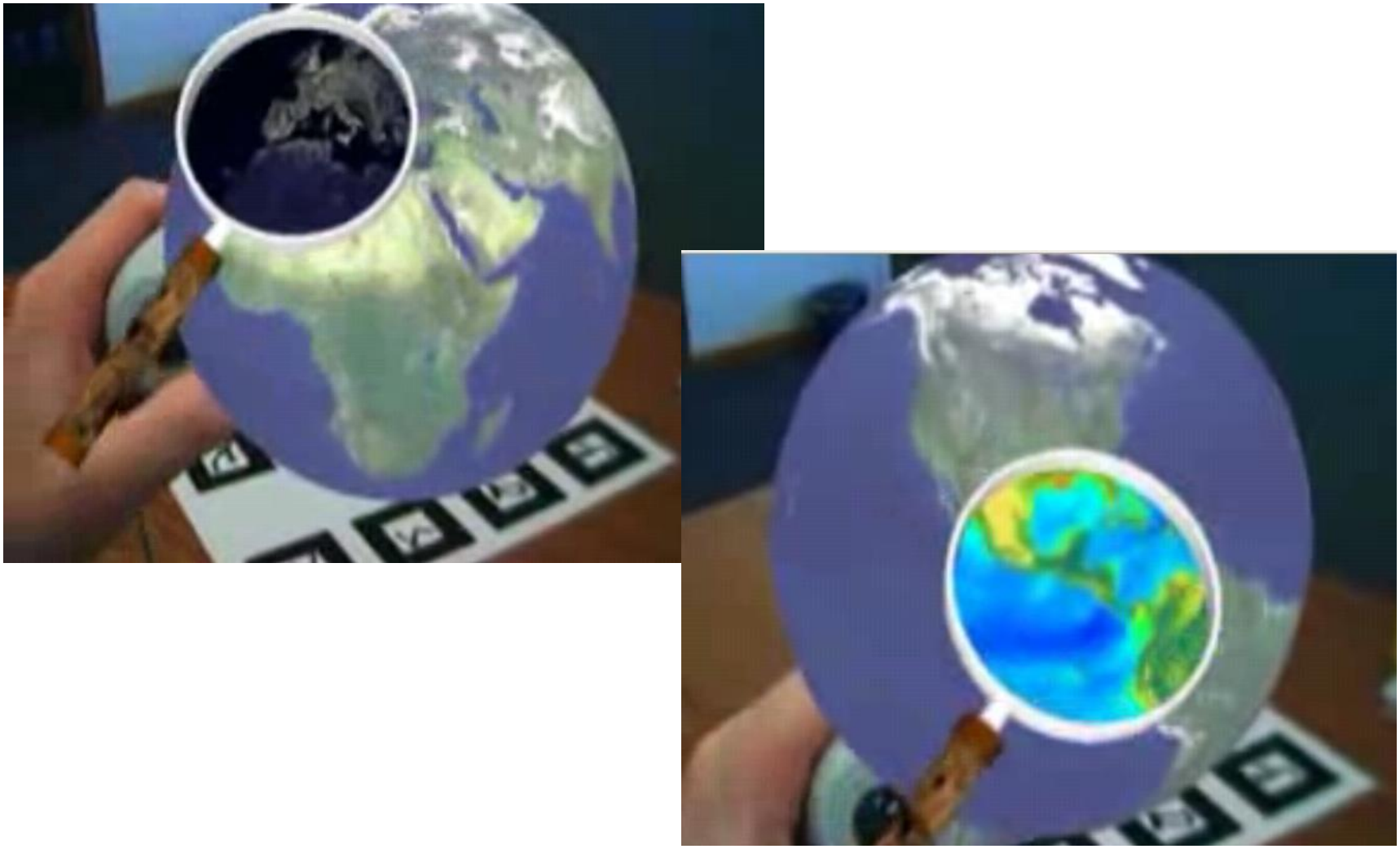


Magic Lens:
(a) shows a conventional map of an area,
(b) shows the location of services (gas, water and electricity pipes)
(c) a (movable) Magic Lens shows services in an area of interest, in context (Spence, 2007)



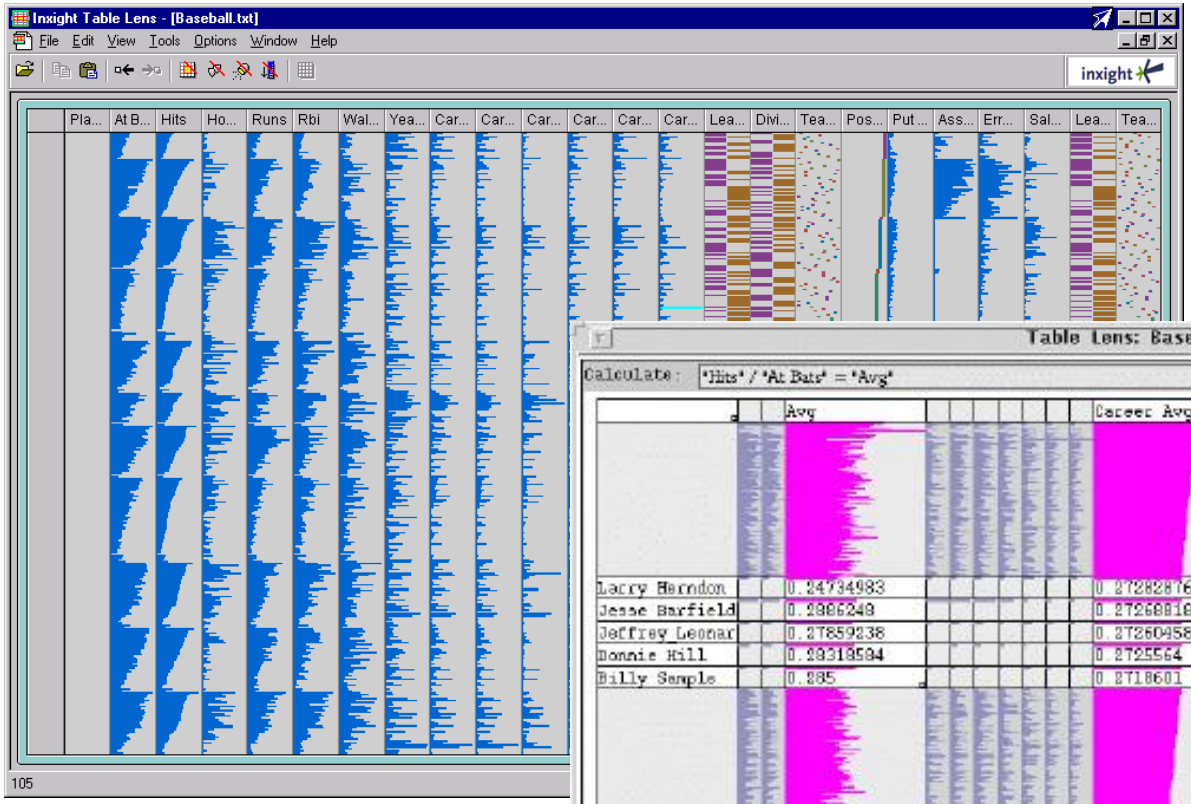
A molecular surface of the protein transferase colored by electrostatic potential bound to DNA shown as a schematic. The magic lens window allows a view of the atomic structure bonding to be shown, with the bound ligand structure highlighted as cylinders, thereby providing a view inside the protein (Spence, 2007)

The Magic Lens using Augmented Reality for Data Visualization



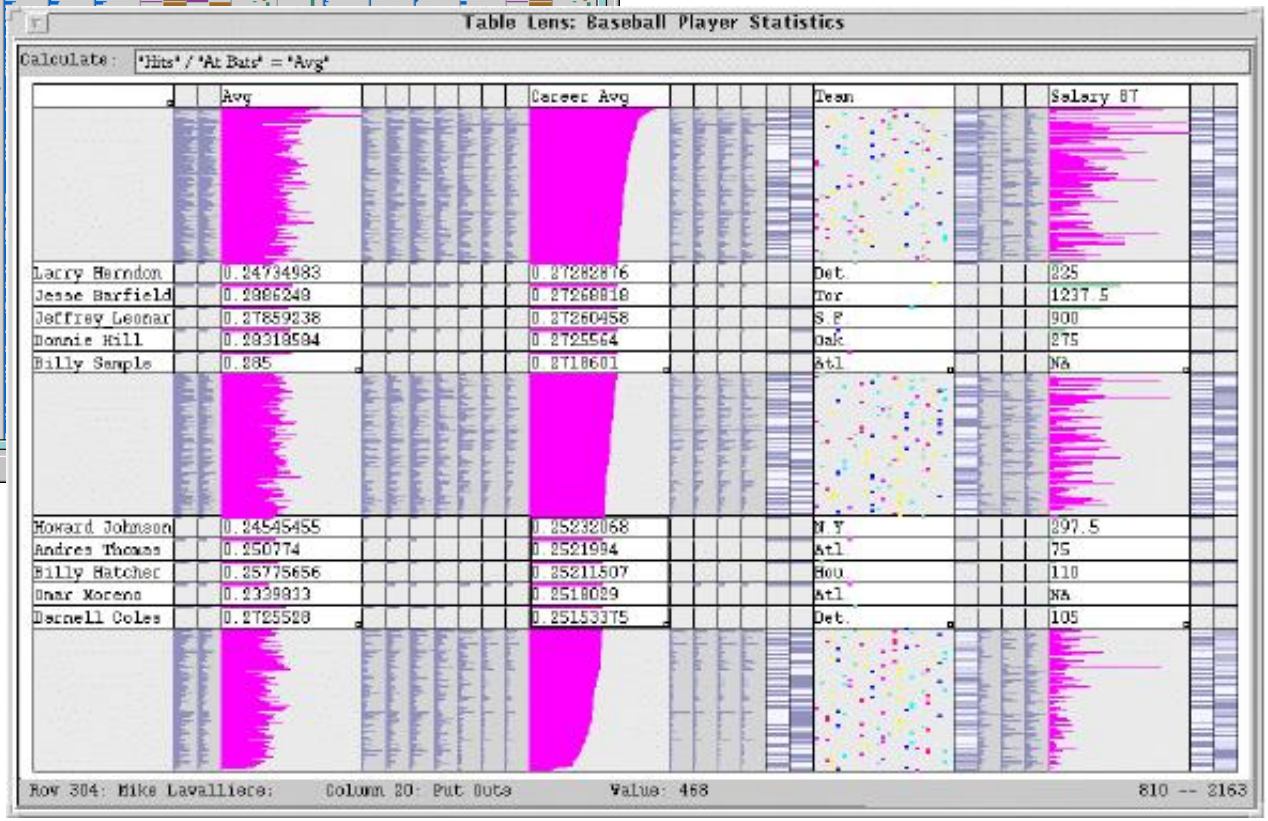
http://www.youtube.com/watch?v=3zIq_qb8CSE&NR=1

The Table Lens is method to dynamically explore large amounts of tabular data



The Table Lens
(Rao and Card, 1995)

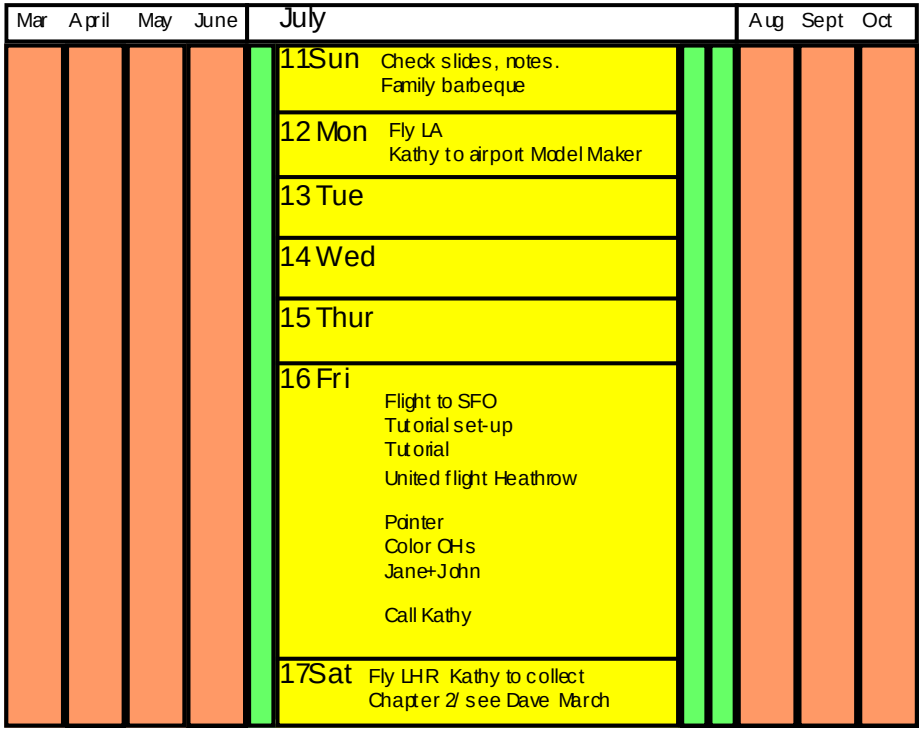
- without distortion;
- with distortion (expansion) to show names



http://www.youtube.com/watch?v=qWqTrRAC52U

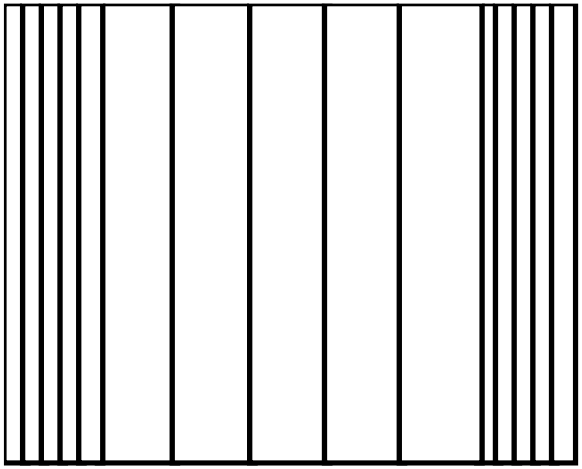
- This simple but powerful concept can be generalized

- It is possible to use X and Y distortion

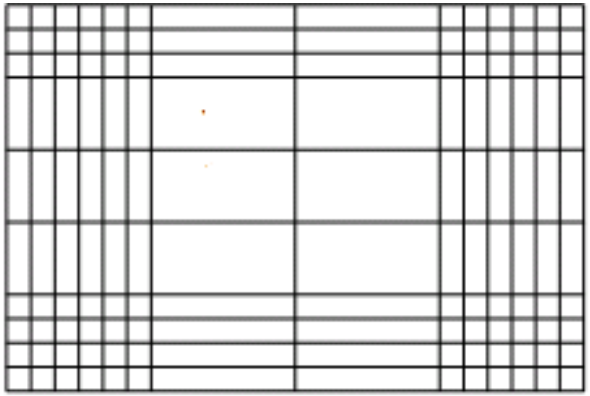


Calendar interface using X and Y distortion
(Bederson et al., 2003, 2004)

X-distortion



X and Y -distortion



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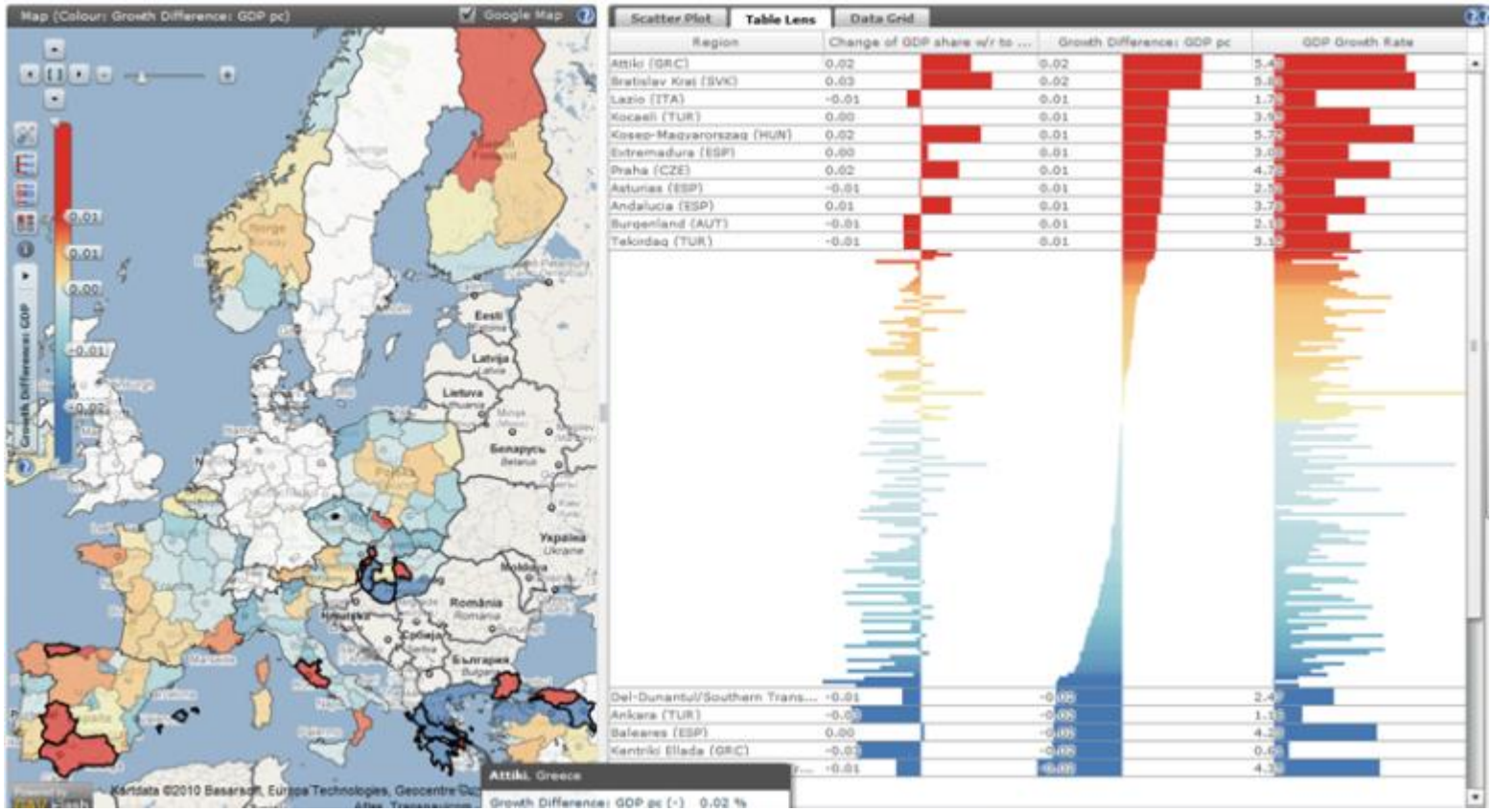


https://ncva.itn.liu.se/education-geovisual-analytics/table-lens?l=en

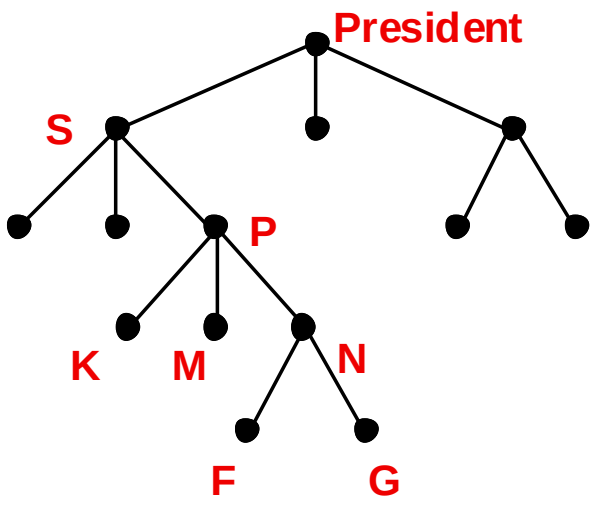
It allows to sort records, focus “zoom” in on interesting areas in the data (to reveal exact numerical information) using “focus + context''

- Furnas proposed a Degree of Interest (DoI) to determine which data should be represented and presented and which should be suppressed

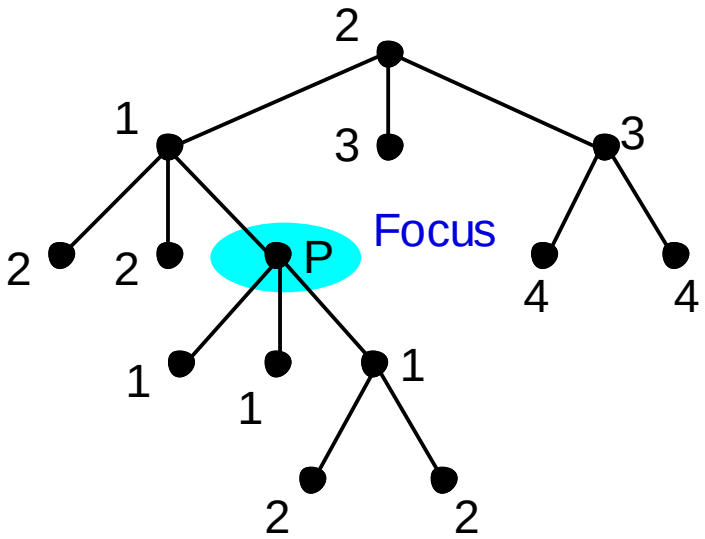
- The Degree of Interest of any item is expressed as a function of:
  - *A priori* importance (API)
  - Distance (D) between that item and the item which is currently the user's focus of interest

Example (Spence, 2007)
Considering only Distance:

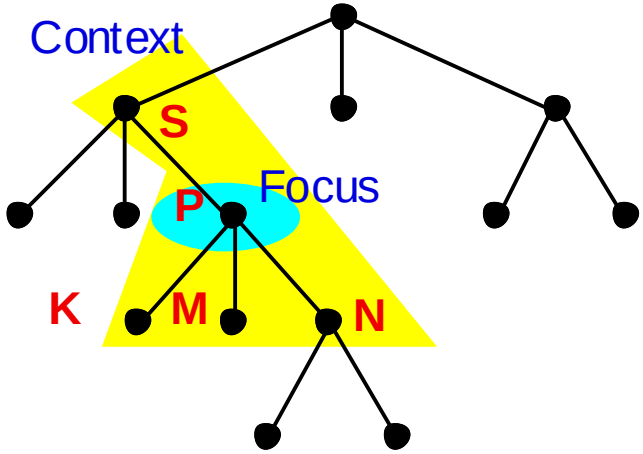
1-The organization tree of a company



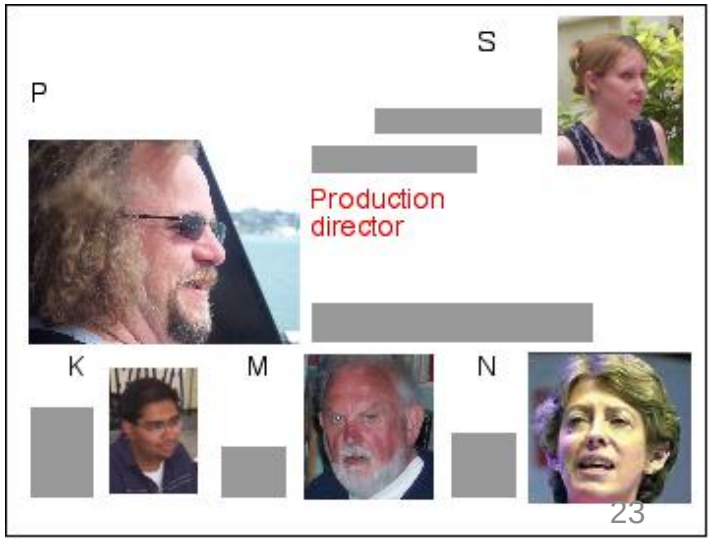
2- Distance 'D' of each node from the focus of attention



3- The context defined by setting an upper threshold of unity for distance from a focus



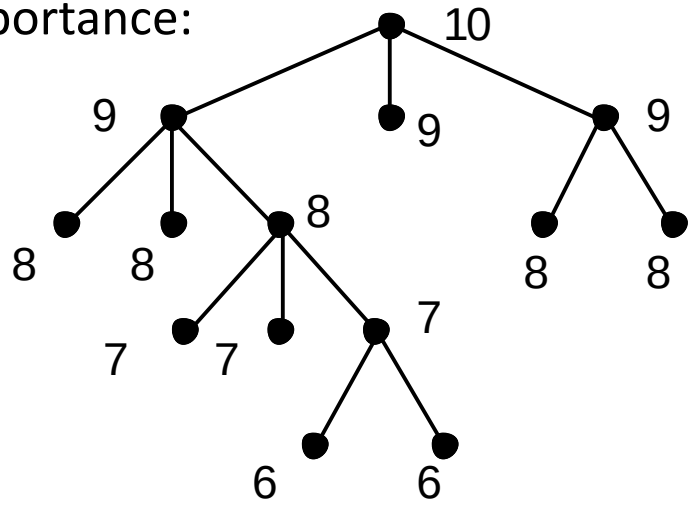
4- Display that might be associated with the focus and context defined



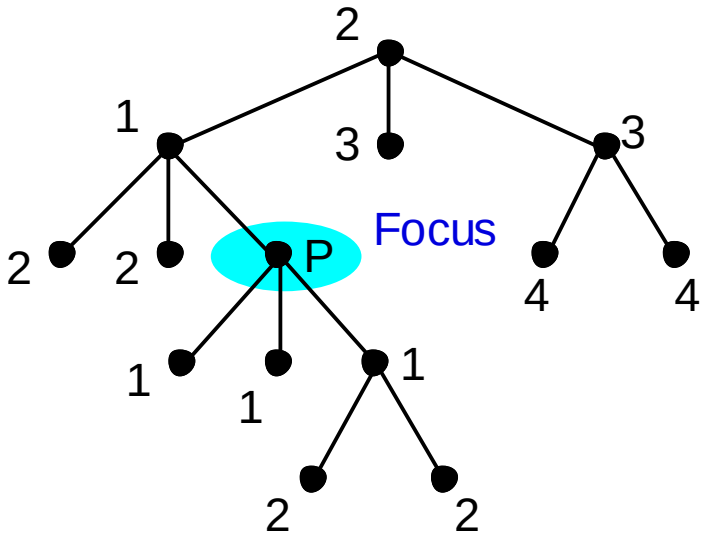
Example (Spence, 2007)

Considering a priori importance:

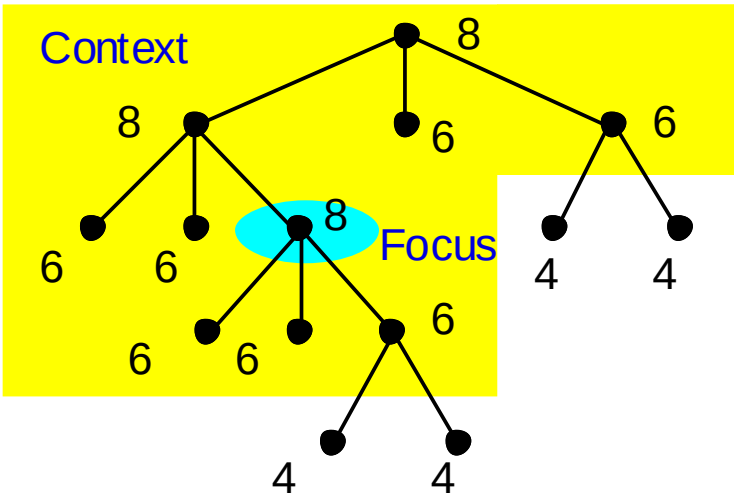
A priori importance:



Distance to the focus:



What is shown/suppressed:

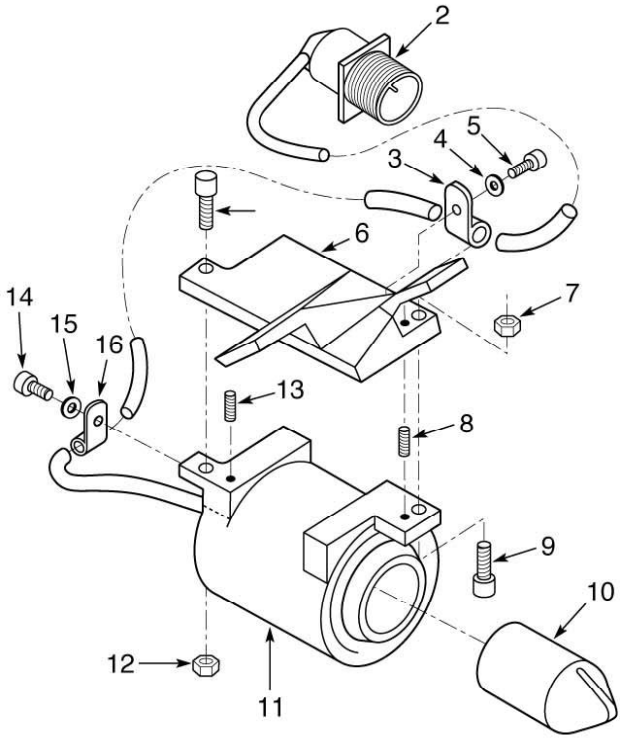


⇐ Nodal values of Degree of Interest:

DoI =API – D

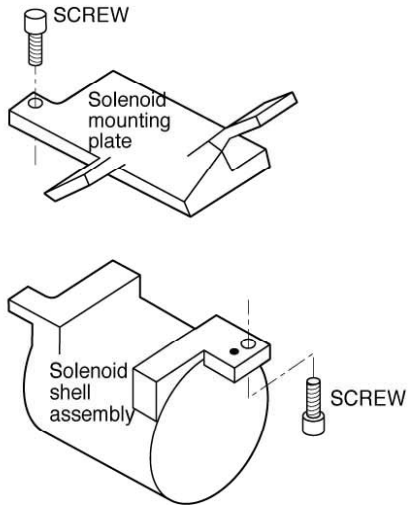
Setting a lower limit of 6 for DoI identifies the nodes within the shaded region

Example:
Part of an engineering drawing



The engineering drawing simplified in the context of a suspected fault

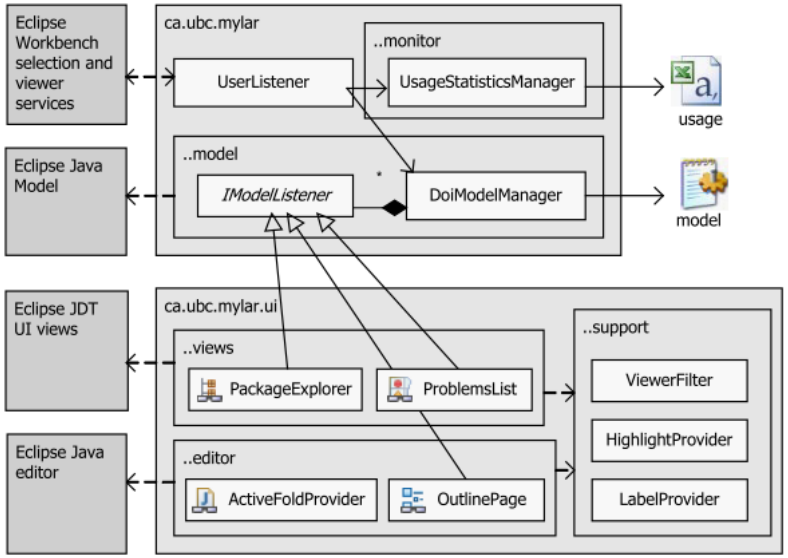
(Spence, 2007)

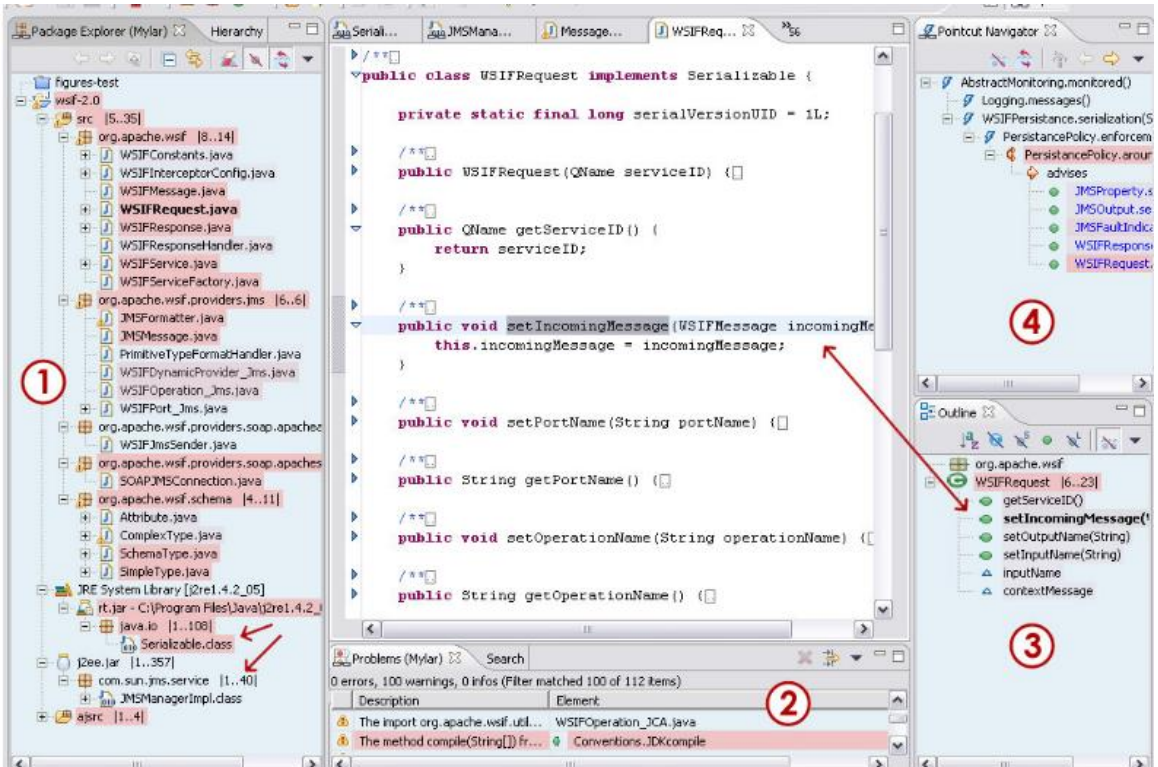


Another example :
Encoding the DOI of program elements by monitoring the programmer's activity

1- Package explorer: Only the files and libraries relevant for the task are visible

2- Problems list: highlights problems of interest





(Kersten & Murphy, 2005)

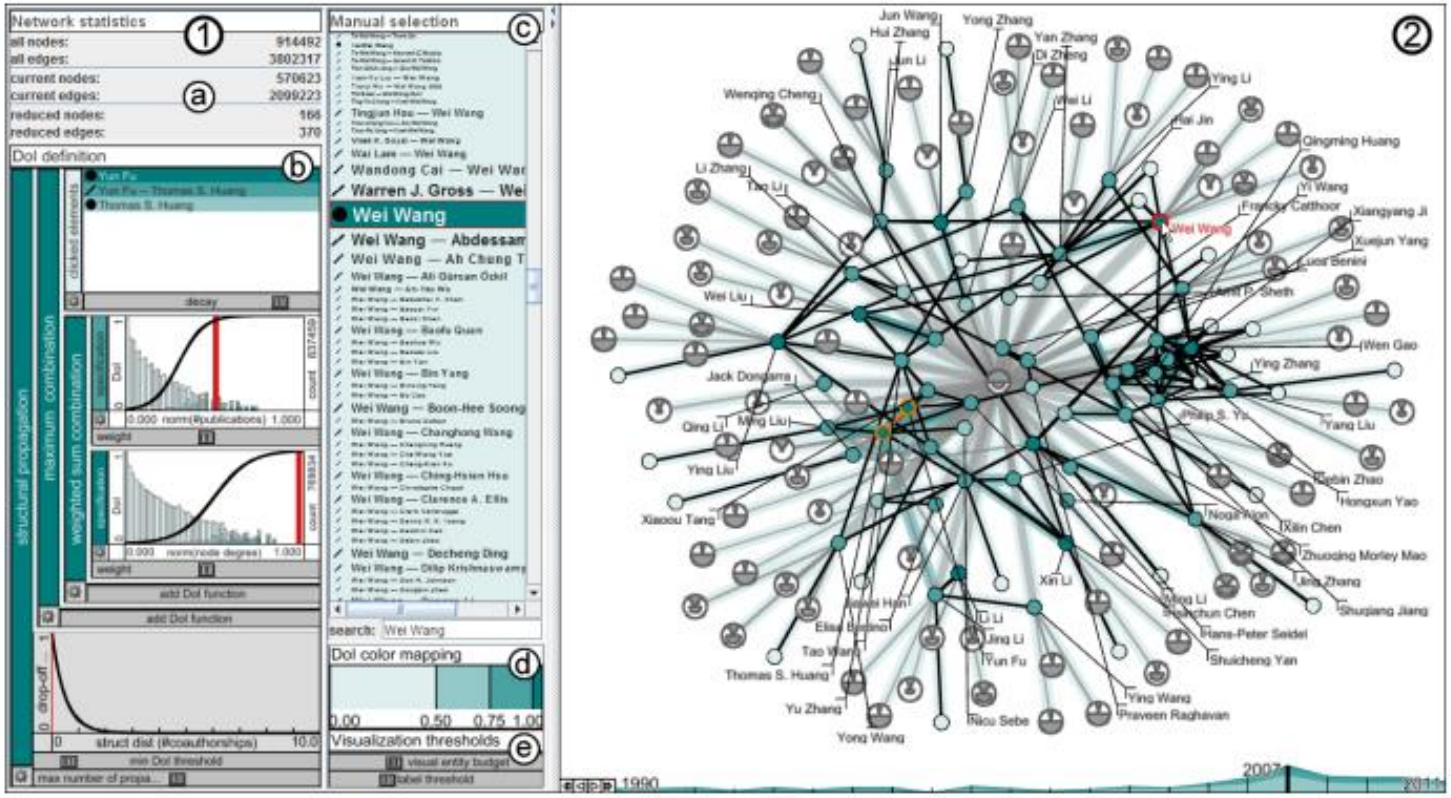
3- Outline: interest-based filtering shows only what is related to the task

4- Active Pointcut Navigator: actively updated

Another example :

• providing both overview and detail on a dynamic citation network is a challenge, and small changes can be drowned out by larger ones

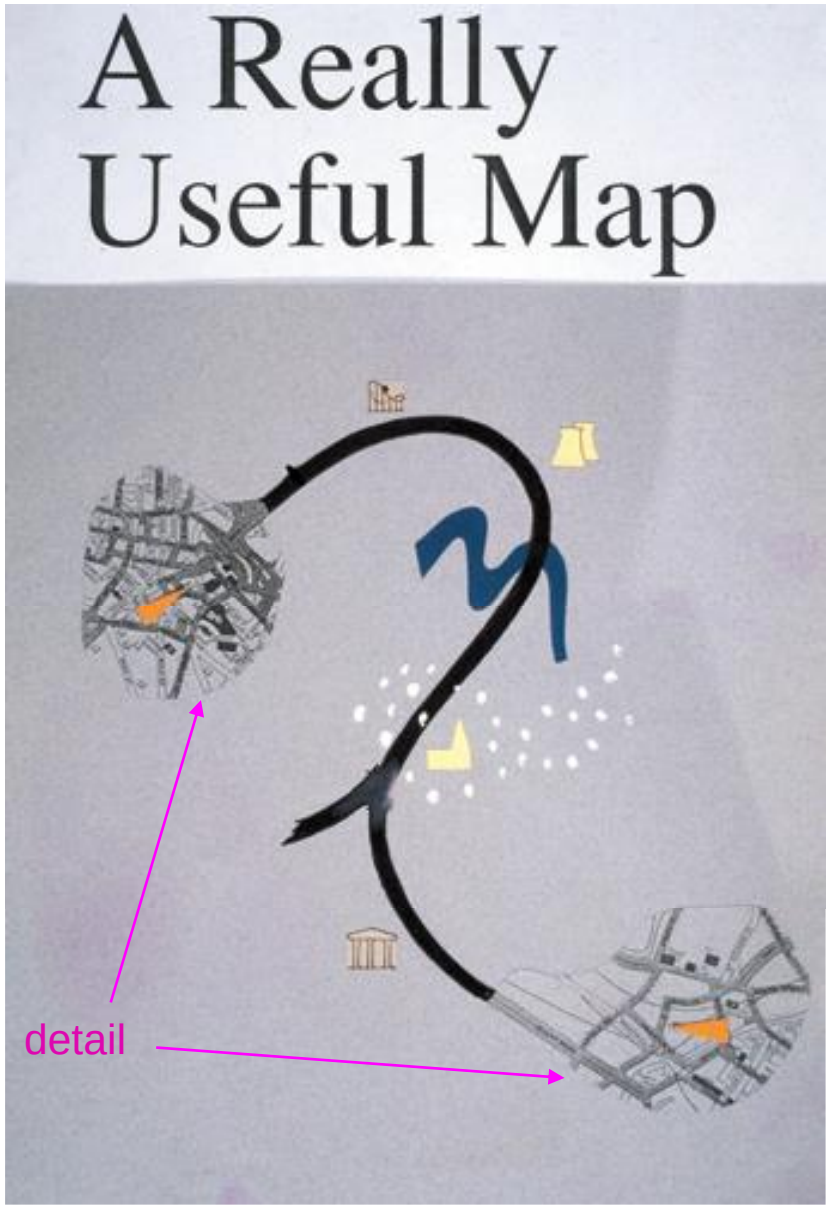
• a degree-of-interest specification by which the user can identify salient changes at the desired scale and importance may help



Two main views: (1) the DoI view and (2) the Network view (a snapshot of the DBLP dataset for the year 2007 reduced according to the defined DoI function).

(Abello et al., 2014)

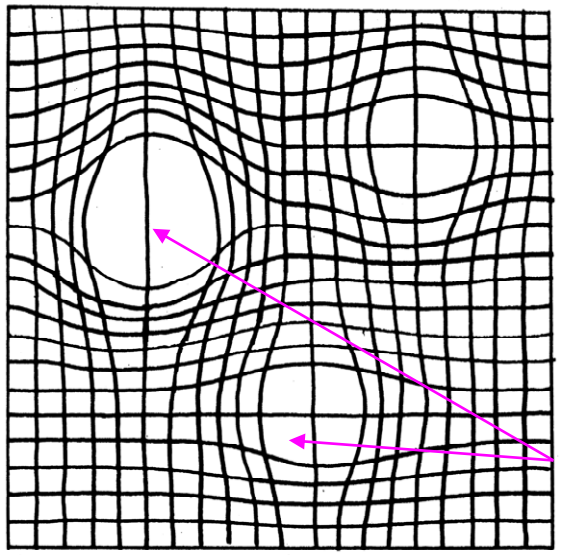
(Spence, 2007)

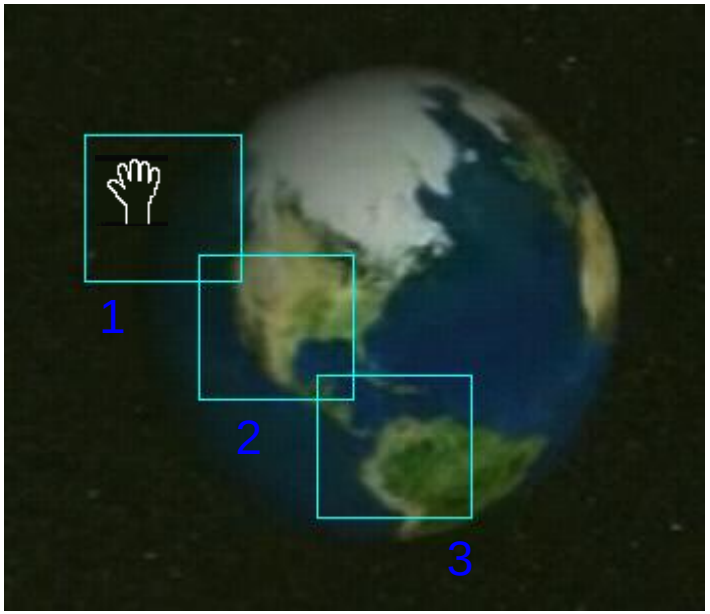


A combination of distortion and suppression can be beneficial

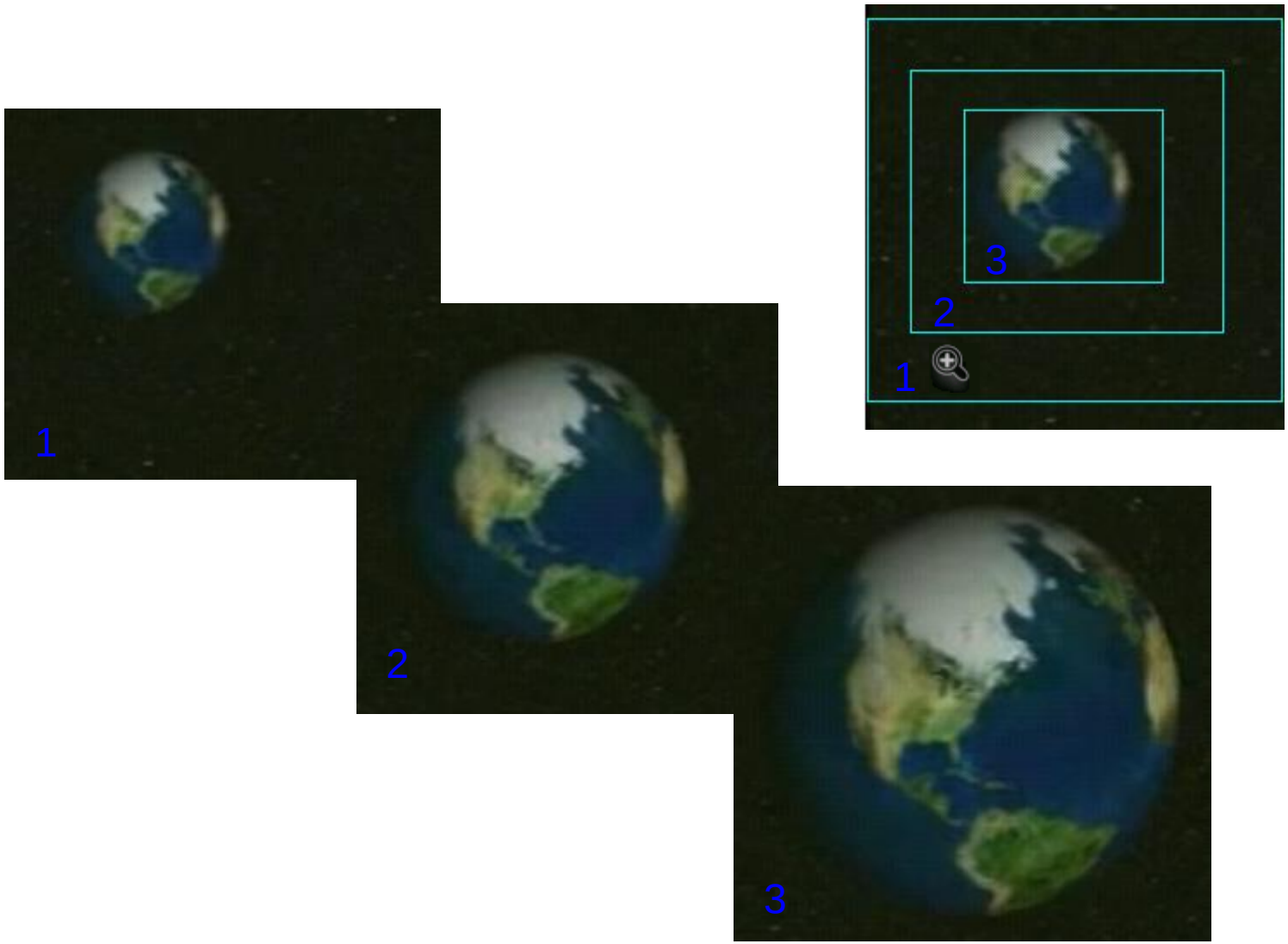
It is a map appropriate to a journey from one city to another

This example uses the concept of rubber sheet distortion

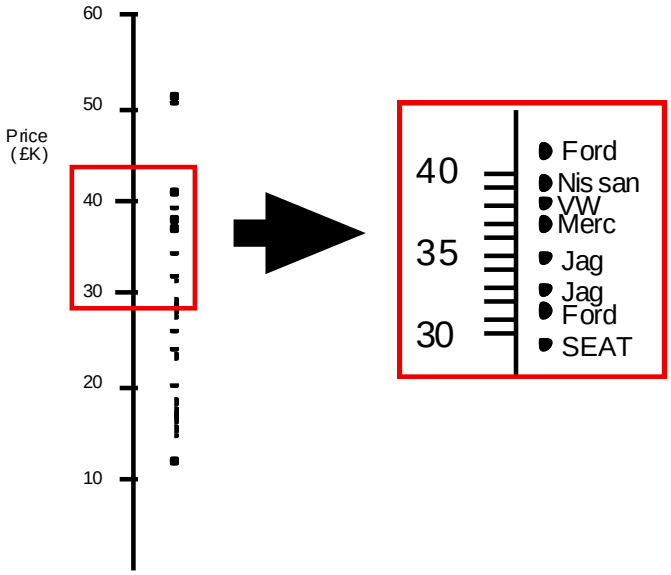




Panning is the smooth movement of a viewing frame over a 2D image



Zooming is the increasing magnification of a fraction of an image (or *vice versa*)



In semantic zoom the meaning conveyed by the new view differs from the conveyed by the previous one

(Spence, 2007)

Visual Information-Seeking Mantra

(Shneiderman, 1996)

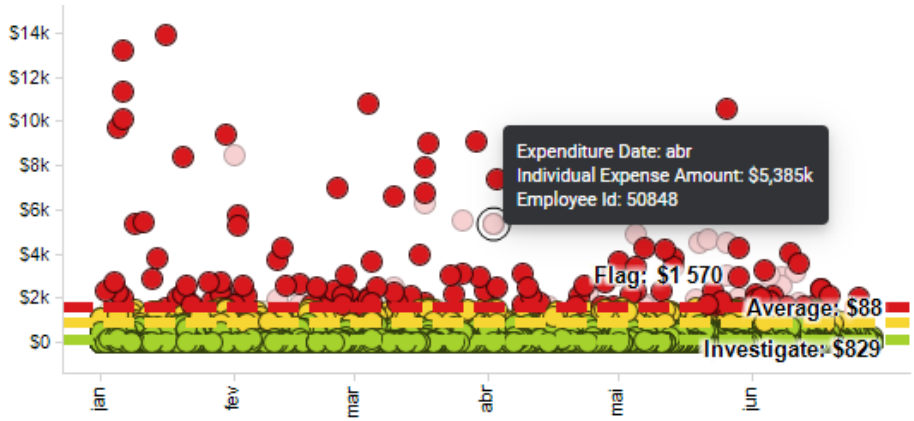
"Overview first, zoom and filter, then details-on-demand"

Few, S., The Surest Path to Visual Discovery

https://www.perceptualedge.com/articles/b-eye/path_to_visual_discovery.pdf

Not always… (some domain experts operate under a Details-first model (not Overview-first)

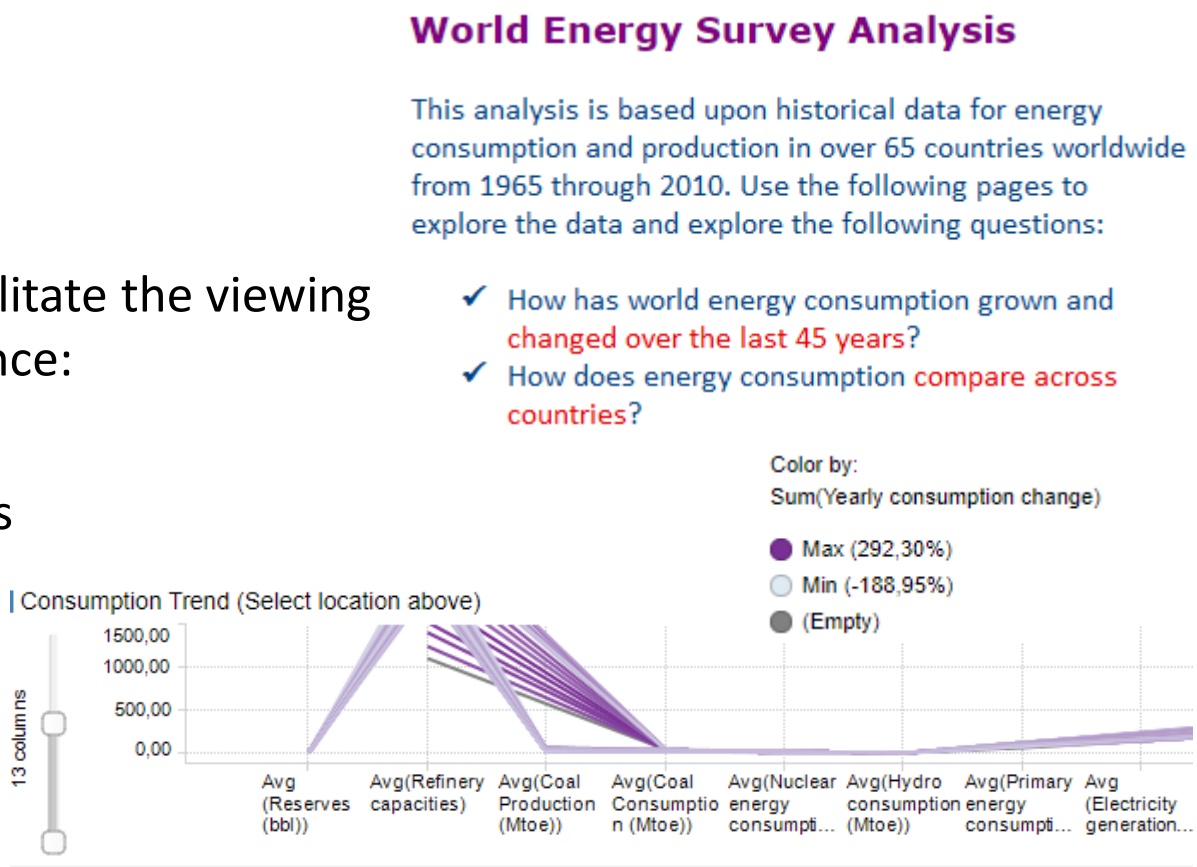
Annotation



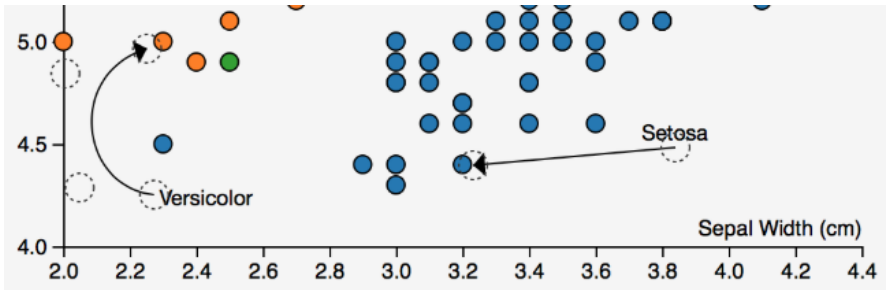
- Is about creating extra layers of data detail through interactive events such as hovering or clicking
- This is particularly useful to reveal actual data values or extra detail about a given category or event
- By having the backup of absolute data accuracy through the values, allows using a more creative visual representation
- It's almost like having a “perceptual safety net” (Kirk, 2019)

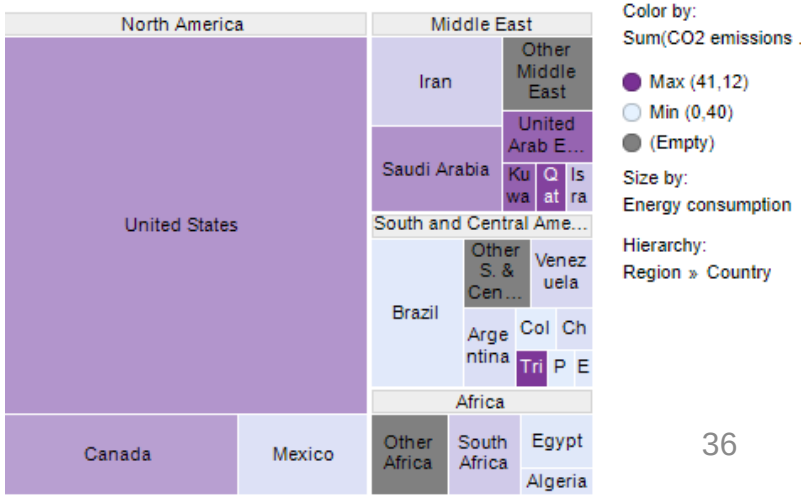
Annotation

- Can help explain and facilitate the viewing and interpretive experience:
  - Titles and introductions
  - Captions, labels and units
  - User guides
  - Attribution
  - Data sources



https://medium.com/@Elijah_Meeks/making-annotations-first-class-citizens-in-data-visualization-21db6383d3fe





Creating Interaction

Enhancements in technology over the past decade have created incredible opportunities to construct powerful interactive visualizations

The development of an interactive design requires technical capabilities

Technical constraints should be pondered:

- as platform compatibility,
- data loading speed,
- server capacity
- …

If not correctly tackled the usefulness and UX is compromised

Creating Interaction

- When the complexity of the data is incompatible with a static portrayal, interaction is vital

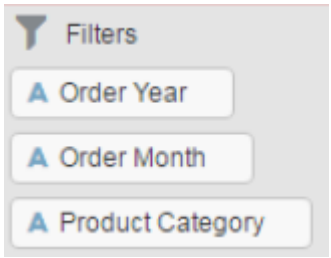
- Careful consideration of the motivation and intention is still needed; specifically: what functional experience is the goal of the design?
  - exploratory,
  - explanatory,
  - or maybe a combined design?

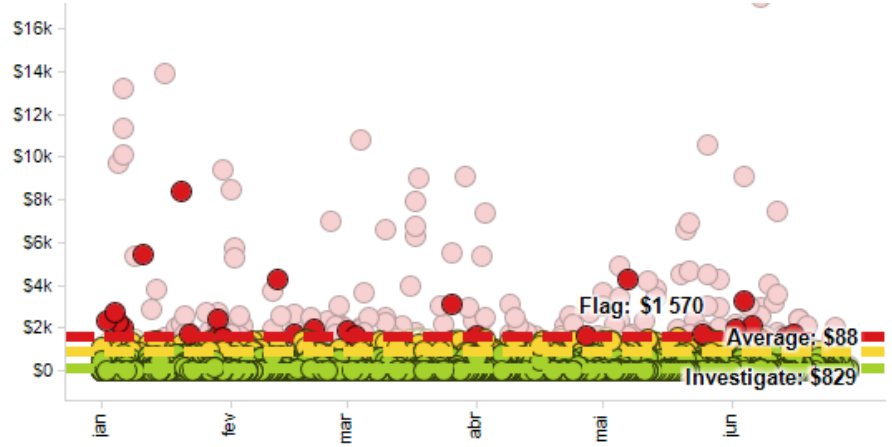
- Different features and functions should be considered:
  - Manipulating variables and parameters (e.g. select, filter, modify, sort, …)
  - Adjusting the view
  - Annotating details
  - Animation

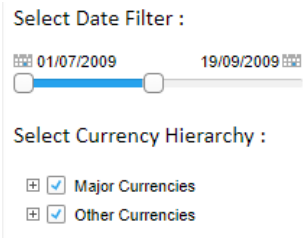
Manipulating variables and parameters

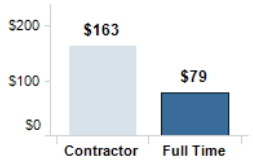
- The ability to select, filter, exclude, or modify certain variables is a valuable way of letting the user interact with different slices of the data
- Grouping and sorting options are common for extracting new insights
- You can also modify a variable using a slider to see changes across numerous values of the variable
- Brushing —highlighting a set of data marks—is a powerful way of focusing in on a subset view the presented data

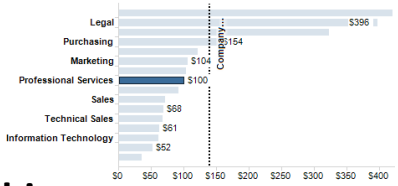
Manipulating variables and parameters (e.g. select, filter, modify, sort, …)





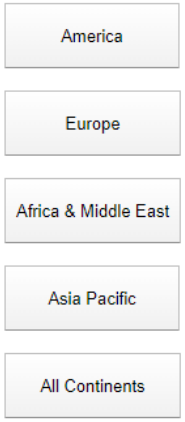


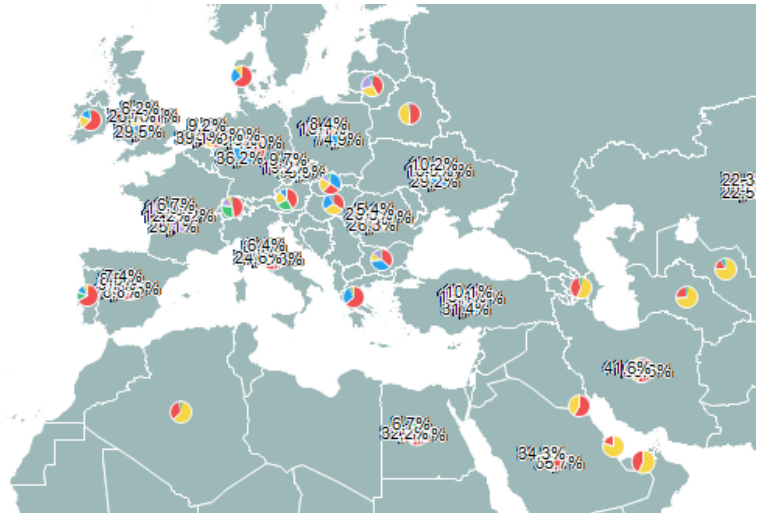




brushing

select

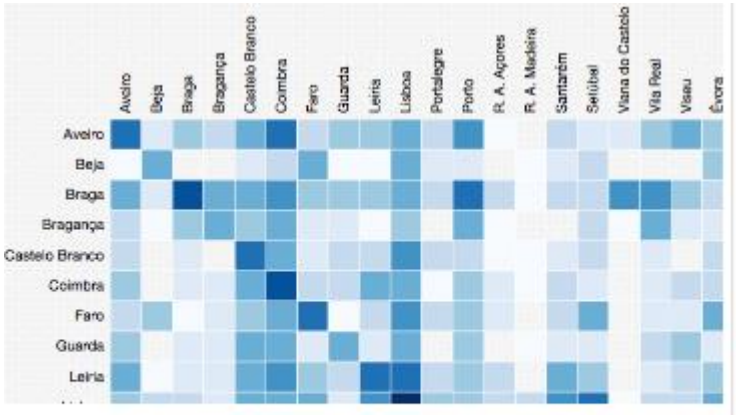




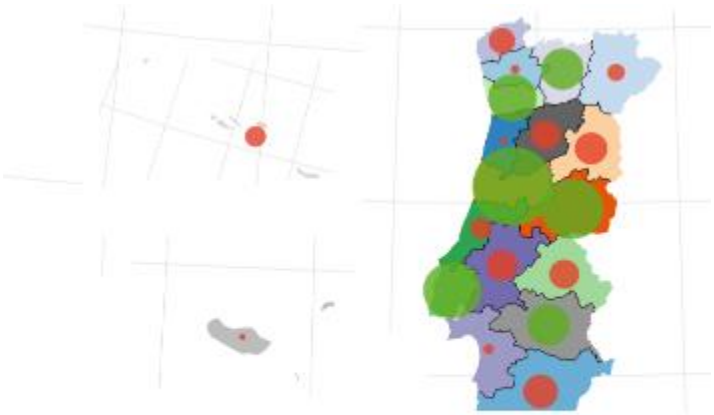
sort

Example: Portuguese Higher Education access data

Candidates and institutions data were provided by [Direcção Geral do Ensino Superior] (2012, 2013 and 2014) of Portuguese students applications to Higher Education (115636 students applications from 20 districts to 305 institutions).



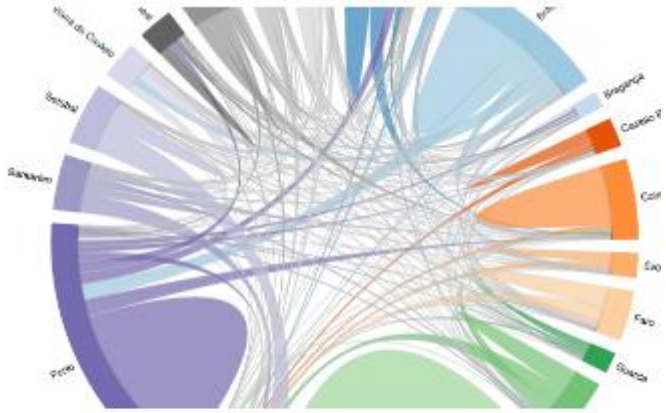
Adjacency Matrix



Map

by Tiago Brito
(MSc thesis, UA)

https://migration-flow.herokuapp.com/



Chord Diagram

Main bibliography

- Spence, R., *Information Visualization, An Introduction*, 3rd ed., Springer, 2014
- Spence, R., *Information Visualization, Design for Interaction*, 2nd ed., Prentice Hall, 2007
- Kirk, A., *Data Visualisation: A Handbook for Data Driven Design*, SAGE Publications, 2019
- Kirk, A., *Data Visualization: a successful design process*, Packt Publishing, 2012
- Munzner, T., Visualization Analysis and Design, A K Peters/CRC Press, 2014
- Ware, C., Information Visualization: Perception for Design, 3rd ed Morgan Kaufmann 2012

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Other bibliography

- Abello, J., S. Hadlak, H. Schumann and H. Schulz, "A Modular Degree-of-Interest Specification for the Visual Analysis of Large Dynamic Networks," *IEEE Transactions on Visualization and Computer Graphics*, vol. 20, no. 3, pp. 337-350, March 2014 https://ieeexplore.ieee.org/document/6574858/citations?tabFilter=papers#citations
- Cockburn, A., Karlson, A., and Bederson, B., "A Review of Overview + Detail , Zooming , and Focus + Context Interfaces," *ACM Comput. Surv.*, January, 2009. https://dl.acm.org/doi/10.1145/1456650.1456652
- Kersten, M. and Murphy G., "Mylar : a degree-of-interest model for IDEs," *Proceedings of the 4th international conference on Aspect-oriented software development AOSD'05*, pp. 159–168. https://dl.acm.org/doi/10.1145/1052898.1052912
- W. Tao, et al, "Kyrix-S: Authoring Scalable Scatterplot Visualizations of Big Data," IEEE Transactions on Visualization and Computer Graphics, vol. 27, no. 2, pp. 401-411
- Tominski, C., Gladisch, S., Kister, U., Dachselt, R. and Schumann, H., "Interactive Lenses for Visualization : An Extended Survey," *Comput. Graph. Forum*, vol. 36, no. 6, pp. 173–200, 2017. https://onlinelibrary.wiley.com/doi/abs/10.1111/cgf.12871

- Visualization Wiki, http://www.wikiviz.org/wiki/Main_Page

Examples: https://www.tibco.com/products/tibco-spotfire/learn/demos