

Advanced

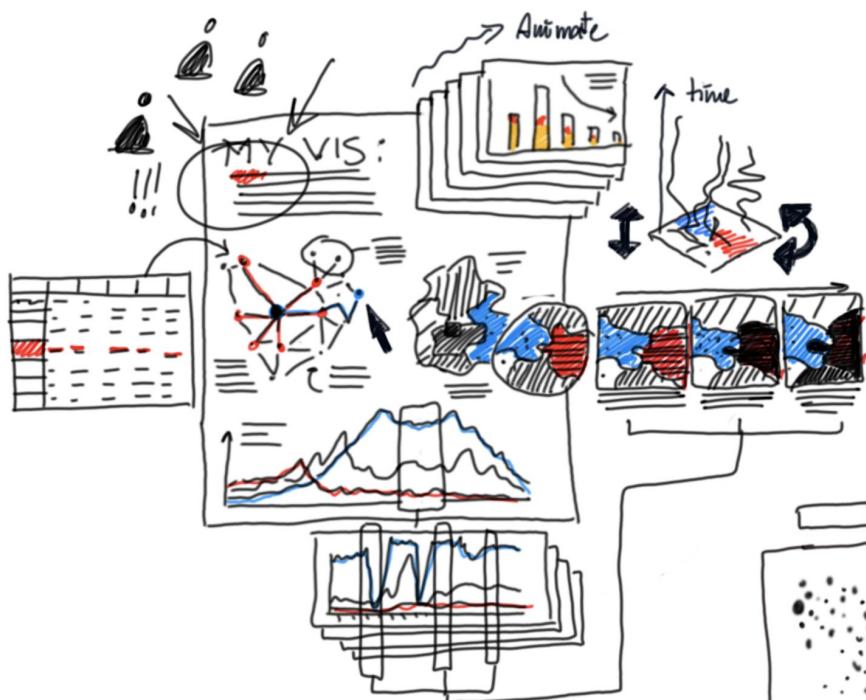
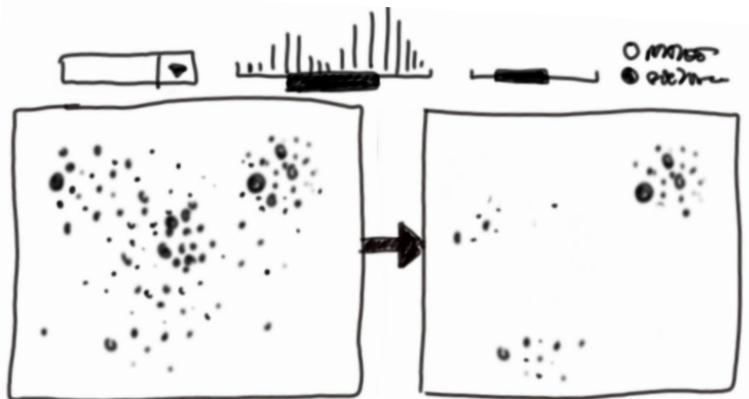
Interaction for visualization

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<http://benjbach.me>

University of Edinburgh

2020



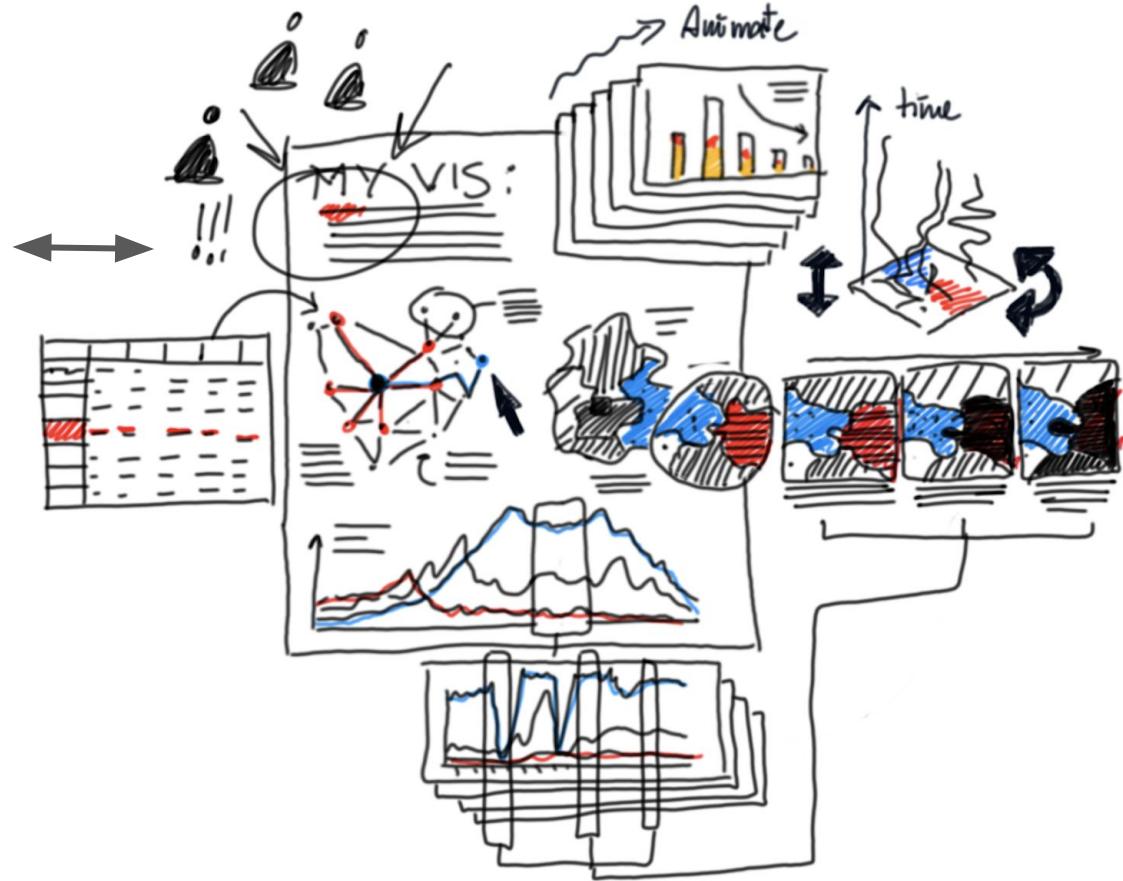
Interaction



Static Visualization

- Single perspective
- **Interaction:** Ask, Move, Search, Annotate, ... a

Interaction



Static Visualization

- Single perspective
- **Interaction:** Ask, Move, Search, Annotate, ... a

Dynamic Visualization

- Multiple perspectives
- Interaction: Click, Filter, change, explore, connect,

Why Interaction?

- Large data
- Multivariate data
- Complex problems
- 3D visualization
- Simulations & parameters

Interaction

Human-Computer Interaction:

Click, point, touch, drag, drop, pan, zoom, select, swipe, scroll, double-click, right-click, search, browse, type, spell, confirm, reject, filter, upload, download, color, customize, expand, collapse, open, close, annotate, flag, tag, rename, rotate, scale ...

Interaction

Human-Computer Interaction:

Click, point, touch, drag, drop, pan, zoom, select, swipe, scroll, double-click, right-click, search, browse, type, spell, confirm, reject, filter, upload, download, color, customize, expand, collapse, open, close, annotate, flag, tag, rename, rotate, scale ...

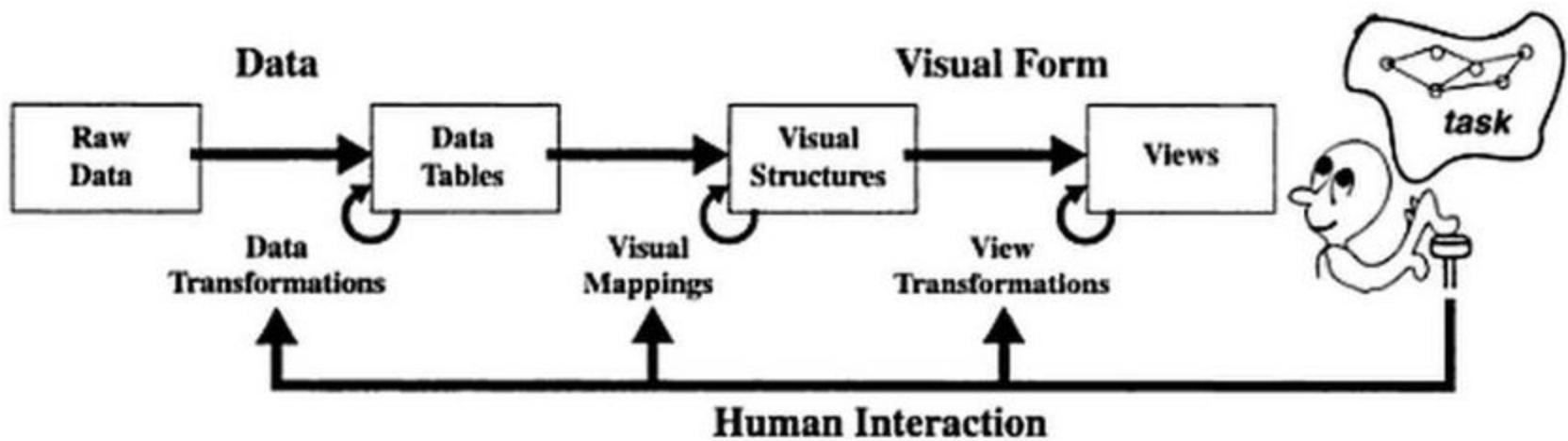
Visualization:

"features that provide users with the ability to directly or indirectly manipulate and interpret representations"

Yi, Ji Soo, Youn ah Kang, and John Stasko. "Toward a deeper understanding of the role of interaction in information visualization." *IEEE transactions on visualization and computer graphics* 13, no. 6 (2007): 1224-1231.

Info Visualization Pipeline:

(A technical view on interaction)



Interaction Techniques

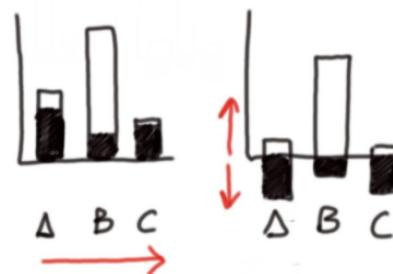
Interaction



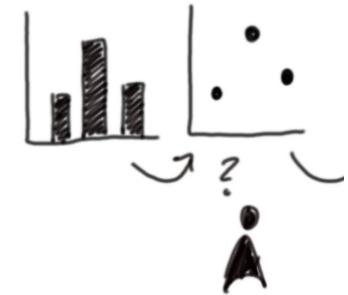
Select



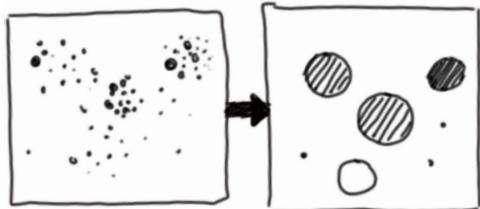
Explore



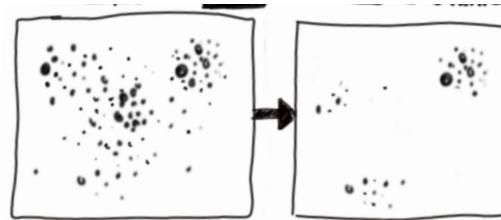
Reconfigure



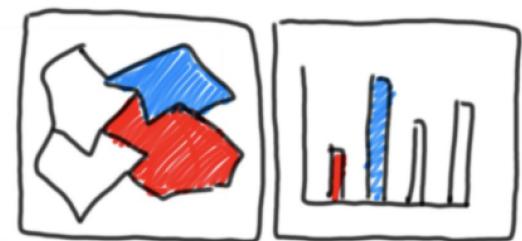
Encode



Abstract

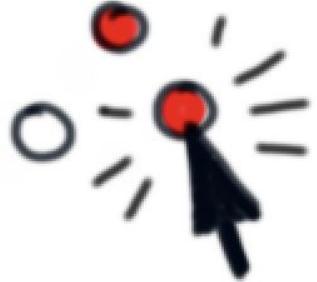


Filter

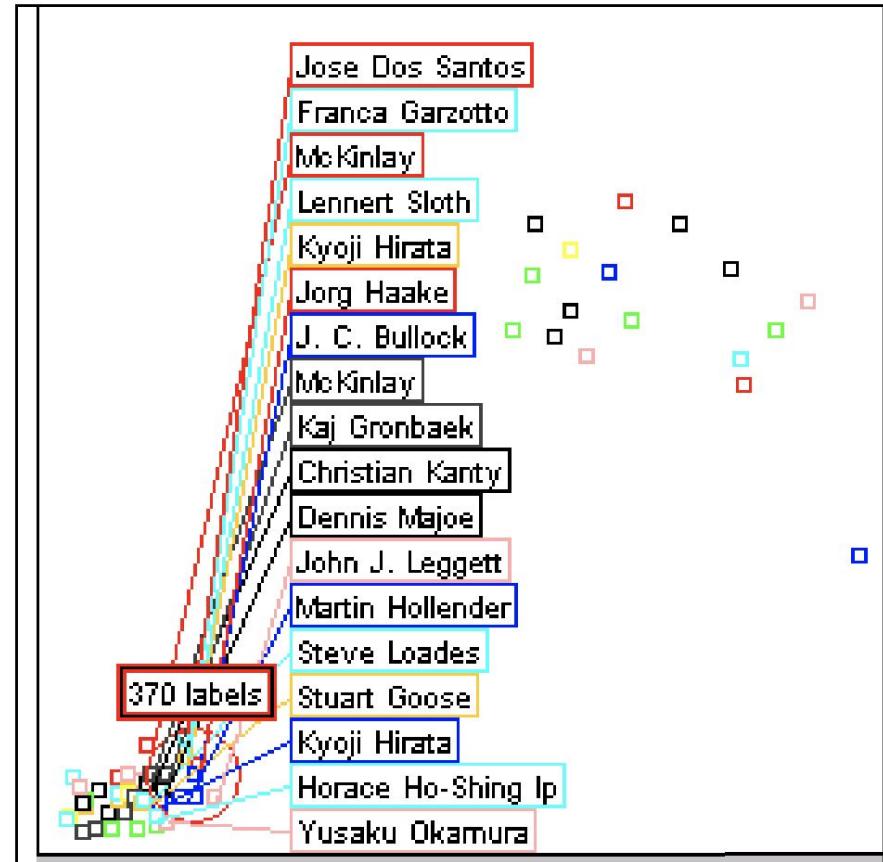
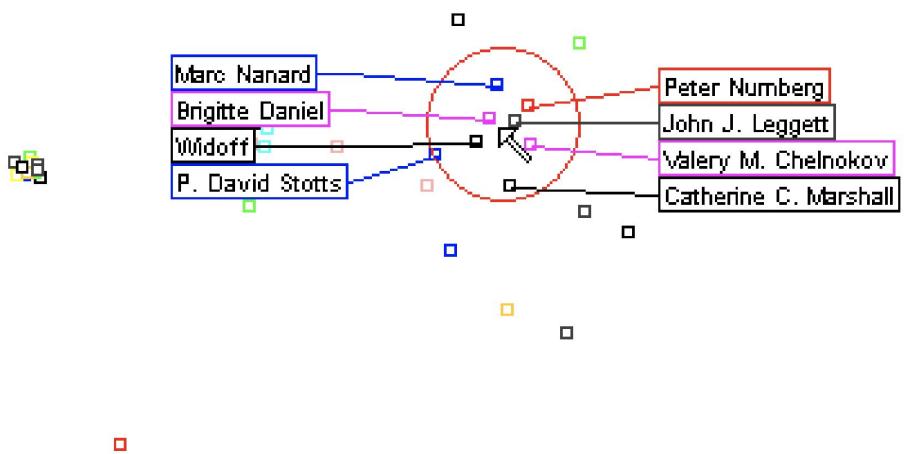


Connect

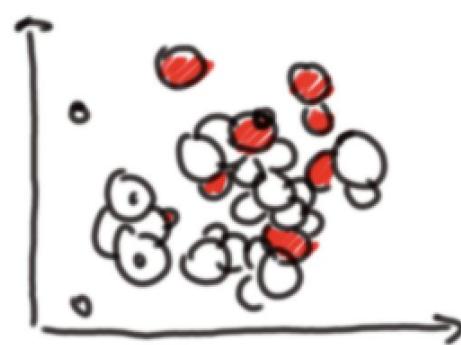
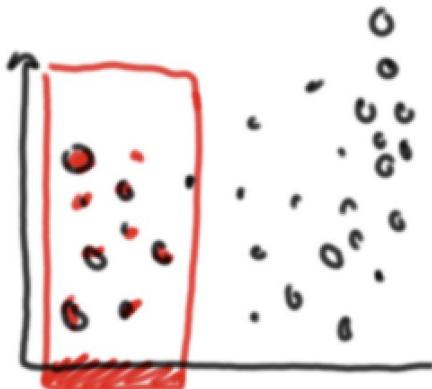
Select: "Mark data items"



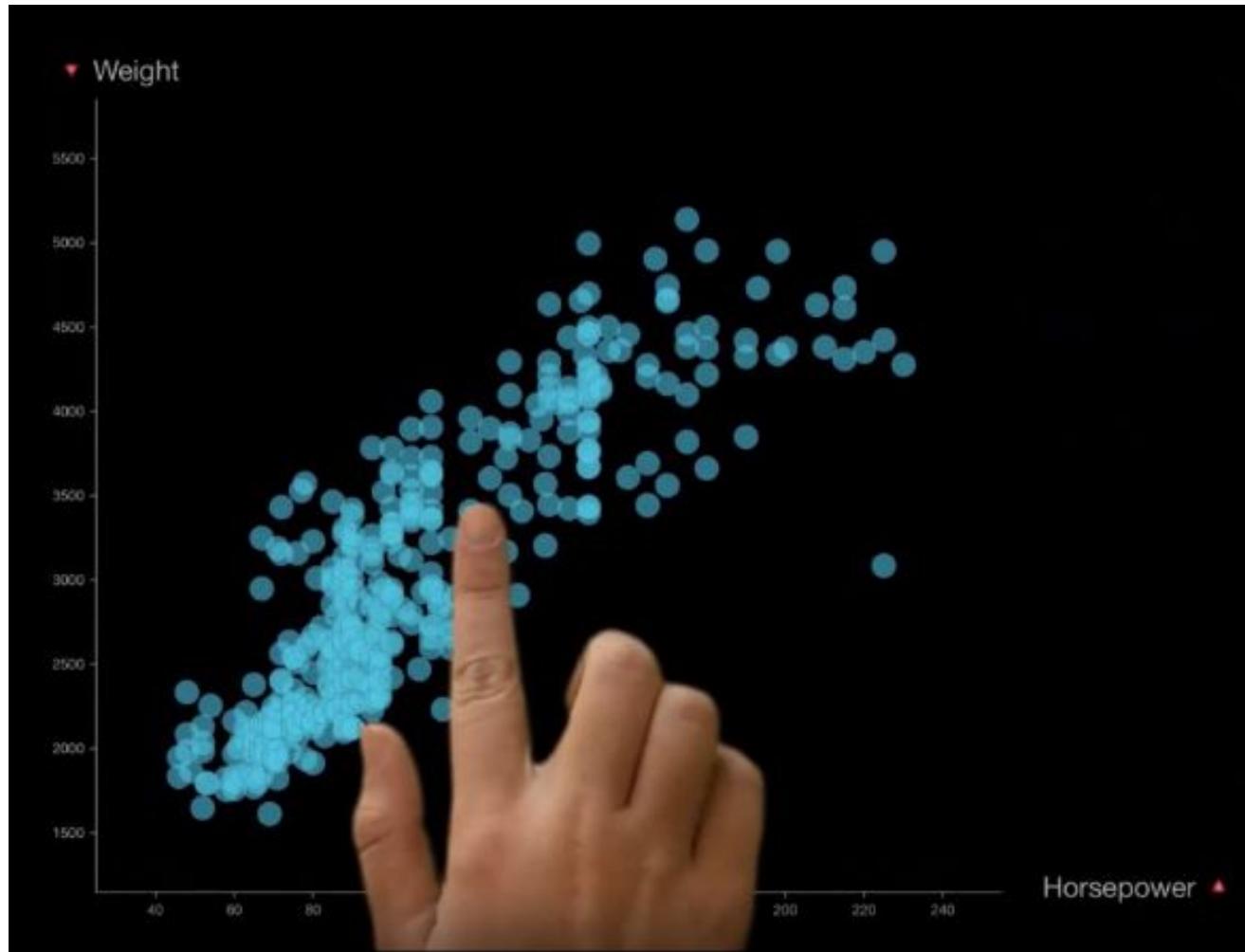
Select: Excentric labeling



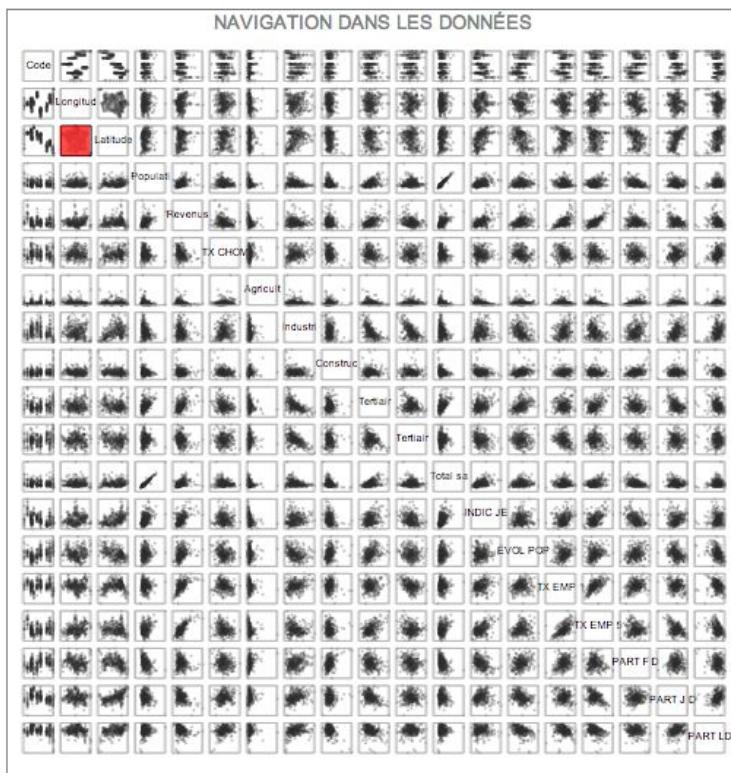
Select: "Mark data items"



Select: "Mark data items"



Scatterdice

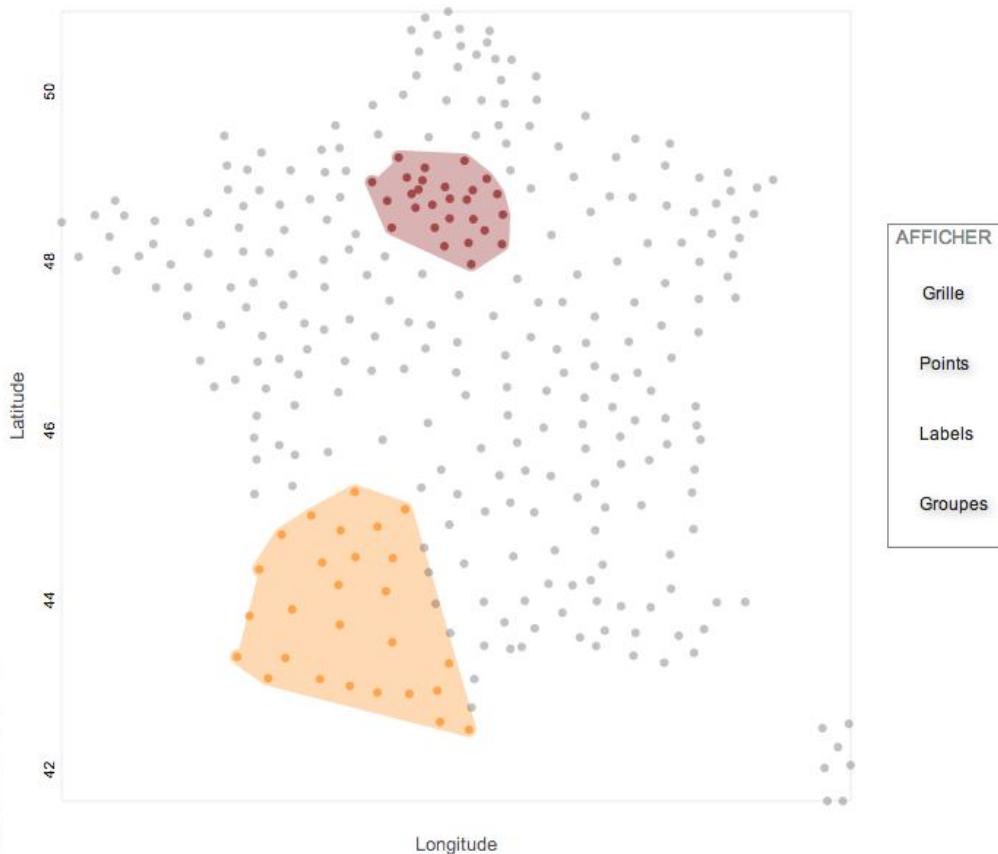


En savoir plus sur cette visualisation.
Testé avec Chrome, Safari et Firefox.
[Ecrivez-nous](#) pour toute question ou commentaire.



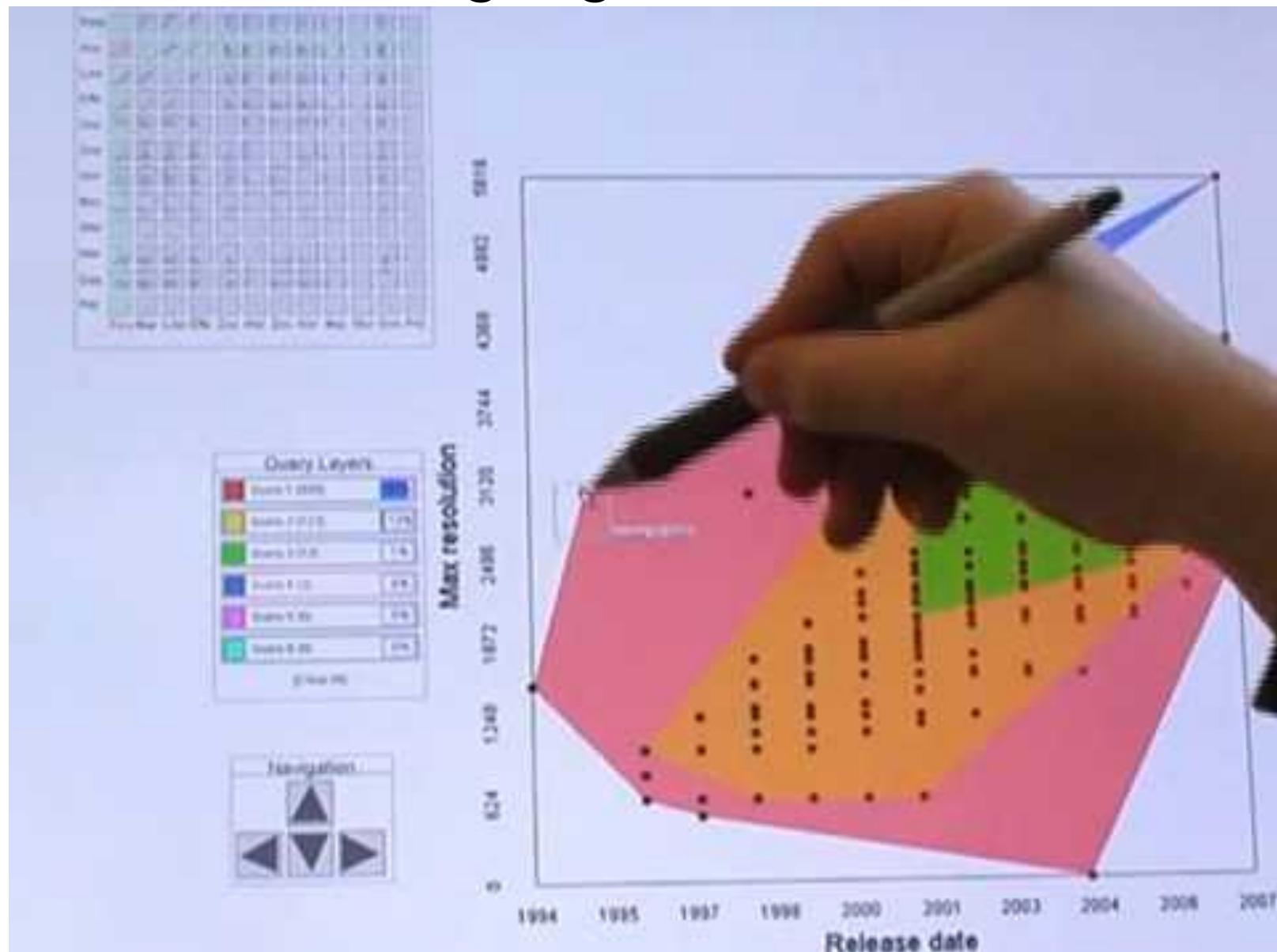
LISTE DES SÉLECTIONS	
Sélection 1	27/304
Sélection 2	27/304
Sélection 3	0/304
Sélection 4	0/304
[Effacer]	

Exploration des zones d'emploi en France



Sources: Data Publica, INSEE. L'Observatoire des Territoires. Données 2003-2011 en France Métropolitaine.

Select: Lasso+highlight (Scatterdice)

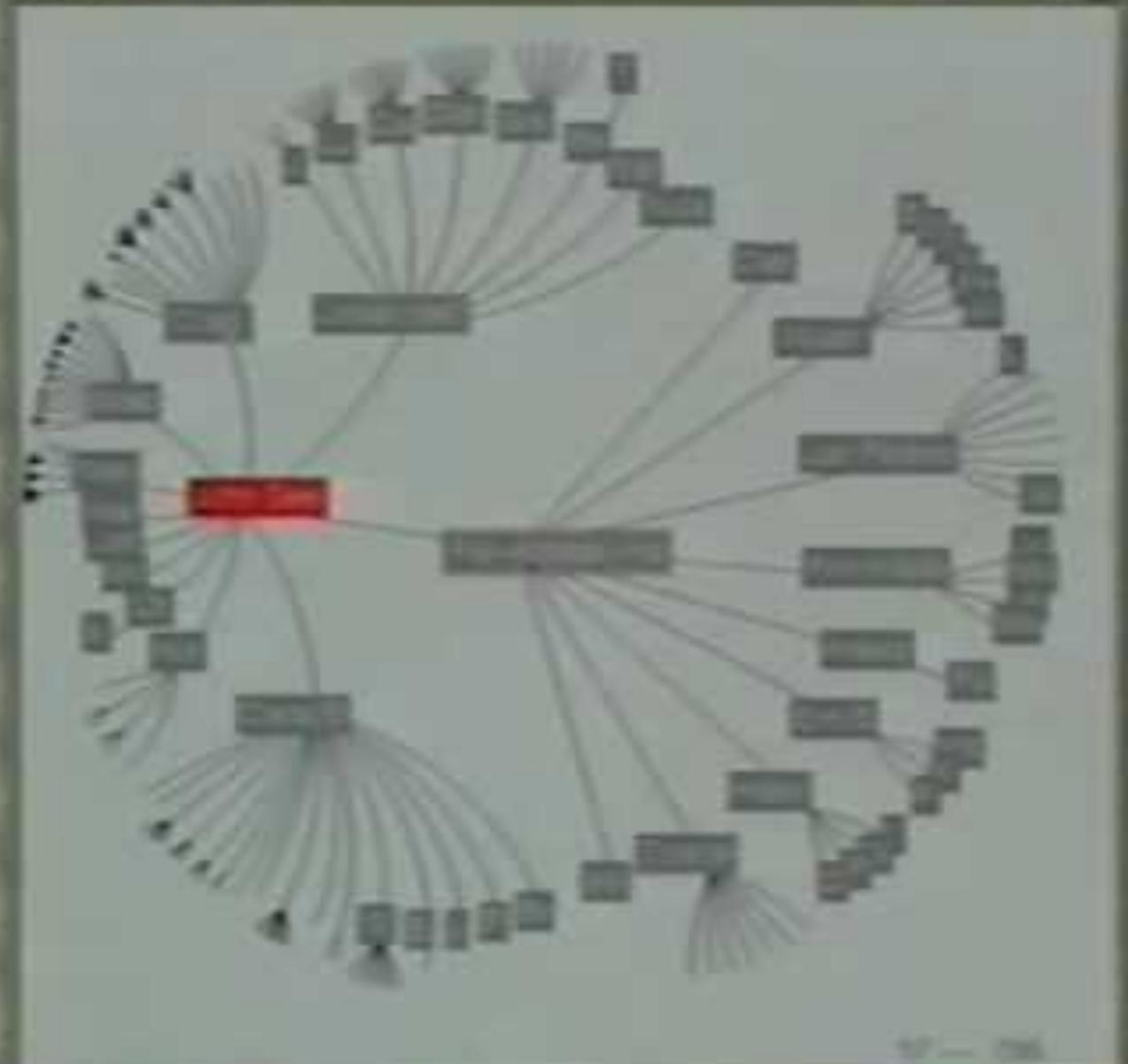


Elmqvist, Niklas, Pierre Dragicevic, and Jean-Daniel Fekete. "Rolling the dice: Multidimensional visual exploration using scatterplot matrix navigation." *IEEE transactions on Visualization and Computer Graphics* 14.6 (2008): 1539-1148.

Explore: "Show me something else"

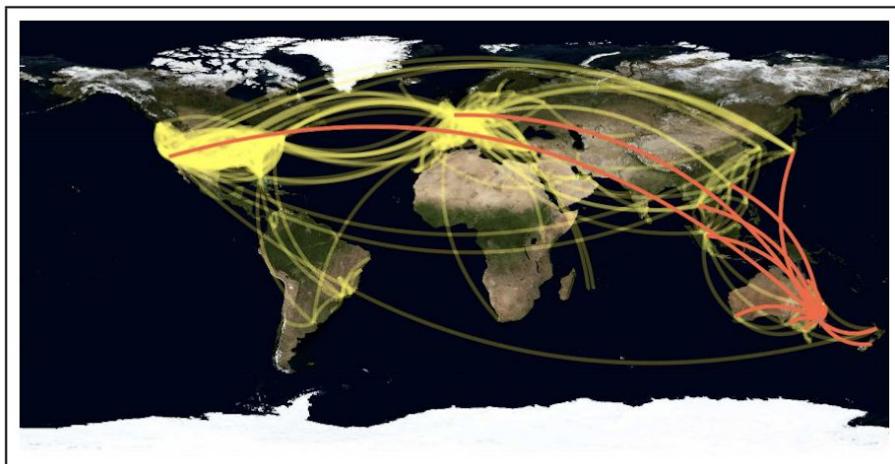


Explore: Hyperbolic trees

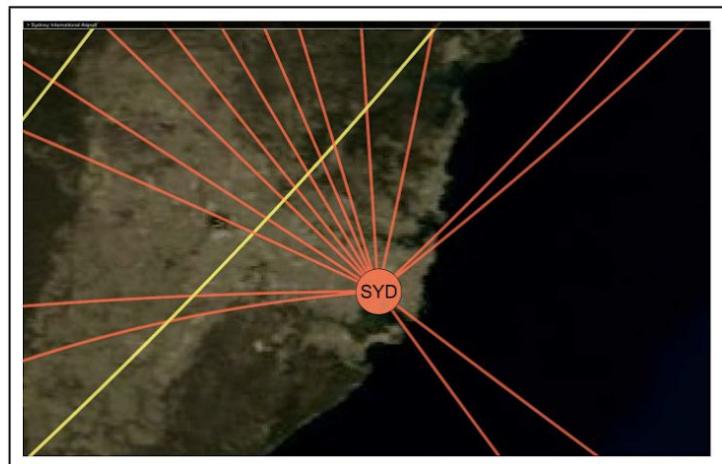


Lamping, John, and Ramana Rao. "Laying out and visualizing large trees using a hyperbolic space." *Proceedings of the 7th annual ACM symposium on User interface software and technology*. 1994.

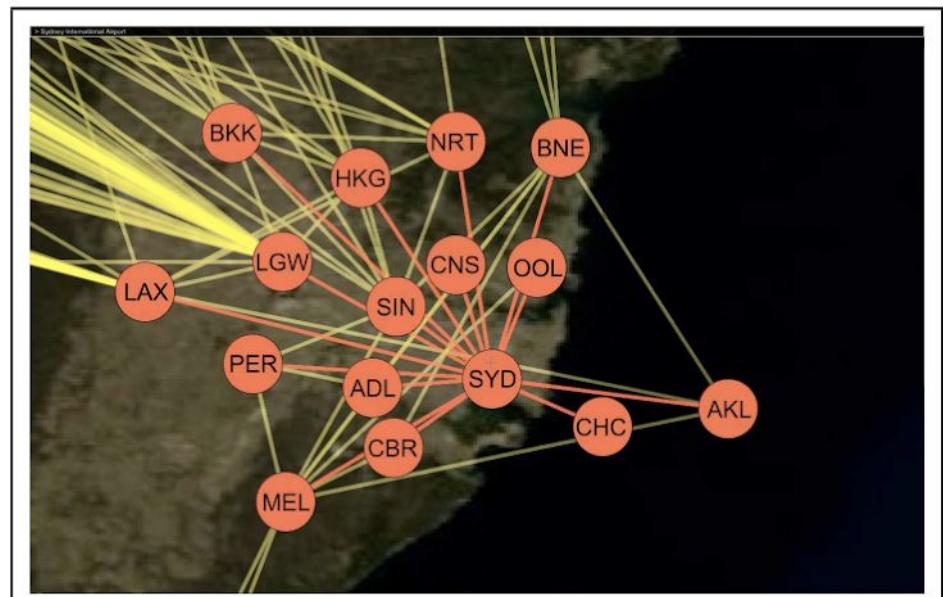
Bring and go (for networks)



(a)



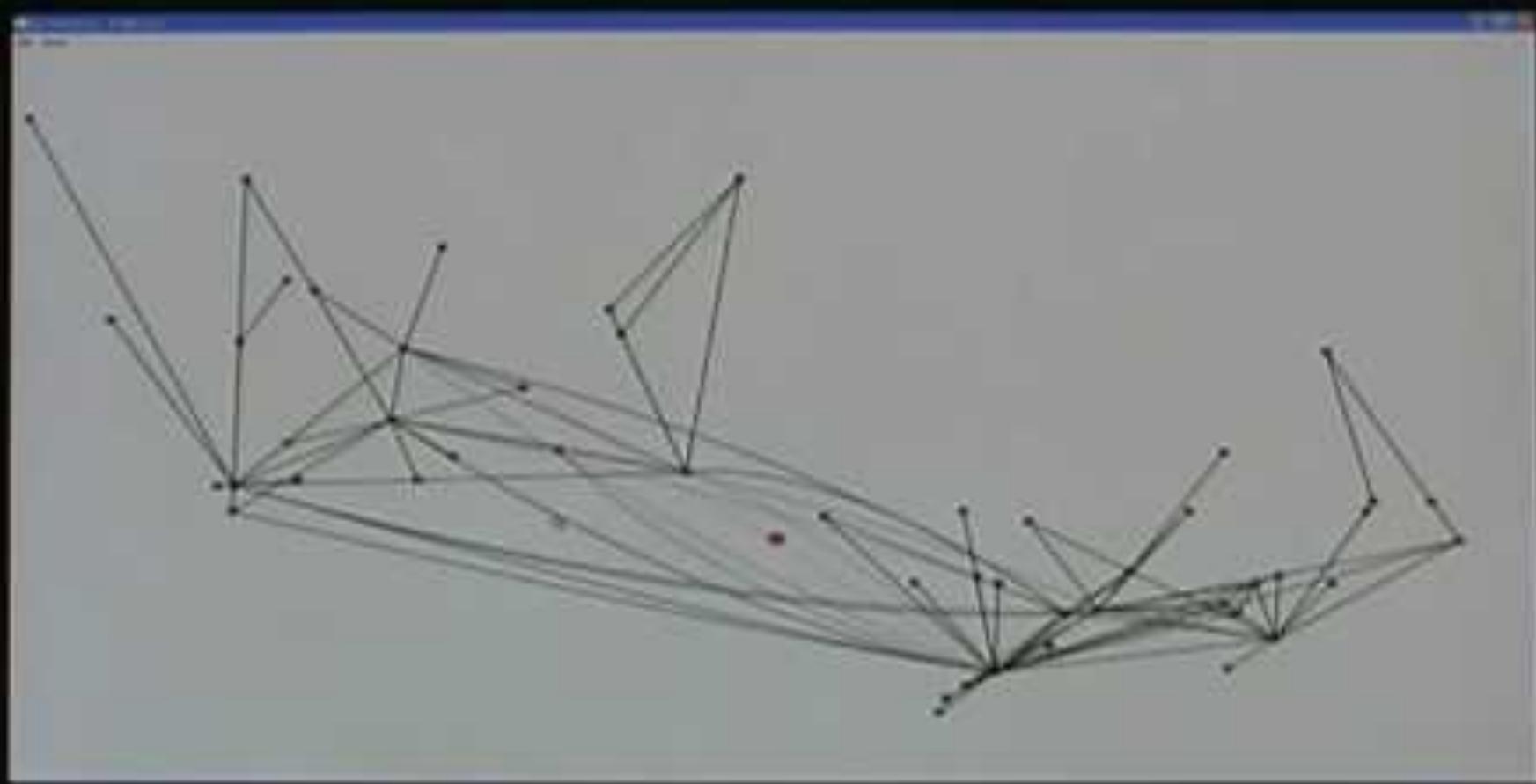
(b)



(c)

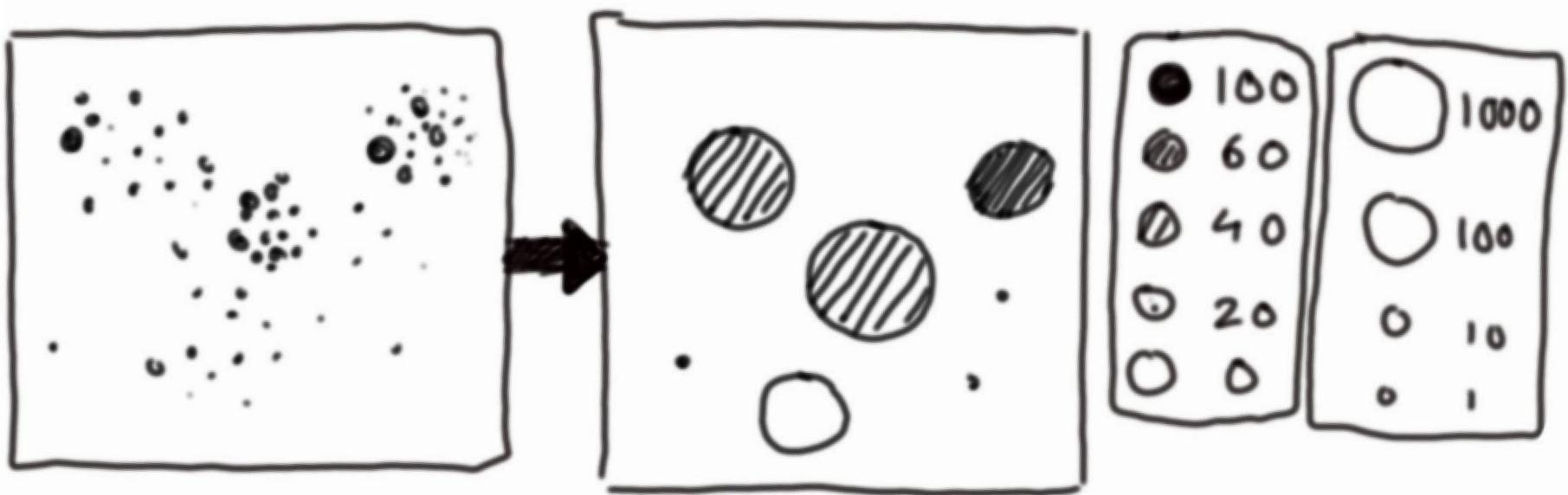
Moscovich, Tomer, et al. "Topology-aware navigation in large networks." *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 2009.

Explore: EdgeLens

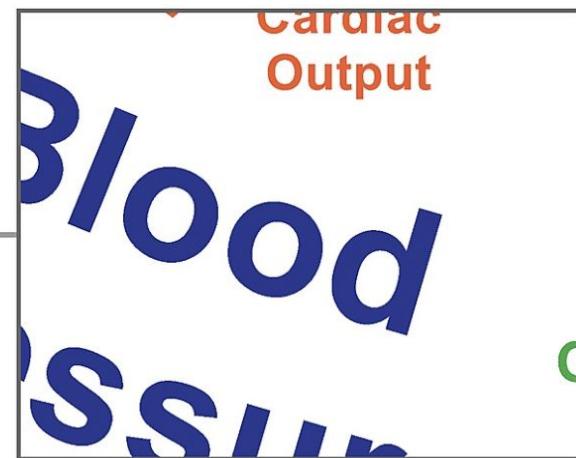
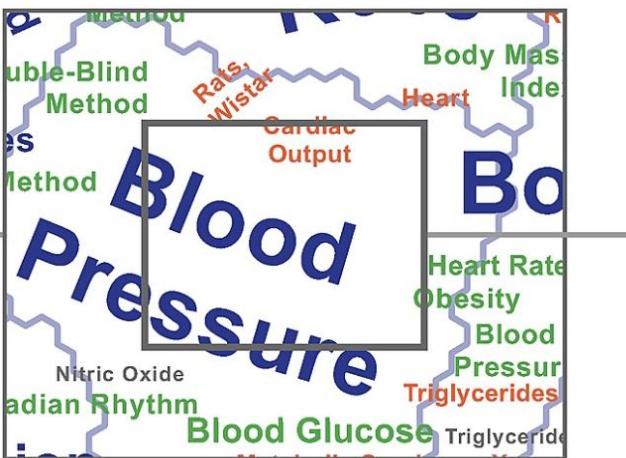
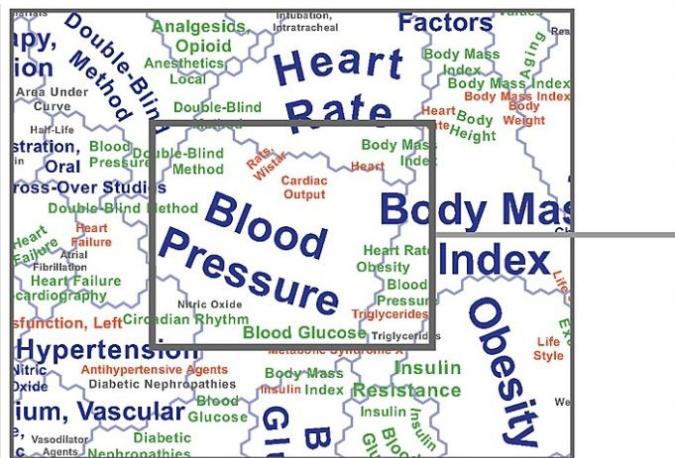


Wong, Nelson, Sheelagh Carpendale, and Saul Greenberg. "Edgelens: An interactive method for managing edge congestion in graphs." *IEEE Symposium on Information Visualization 2003 (IEEE Cat. No. 03TH8714)*. IEEE, 2003.

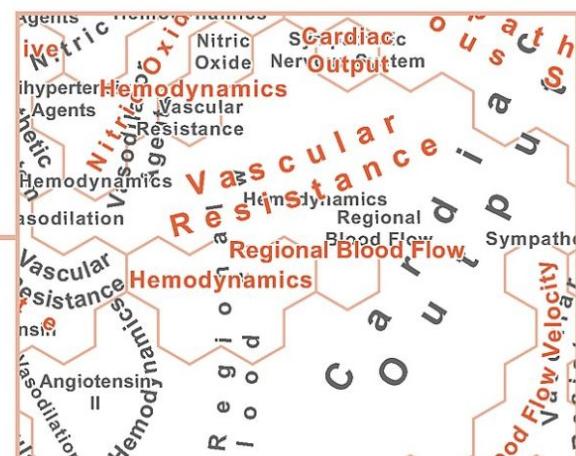
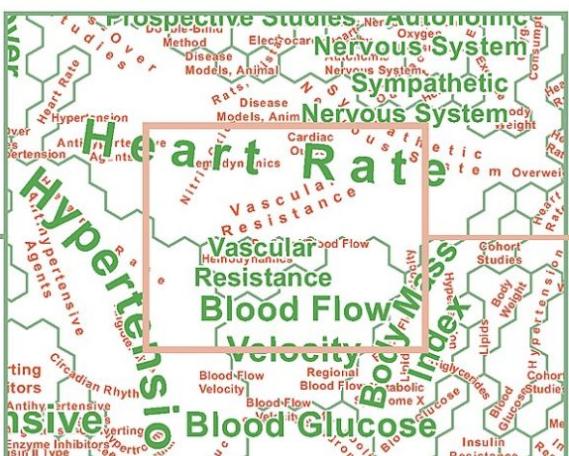
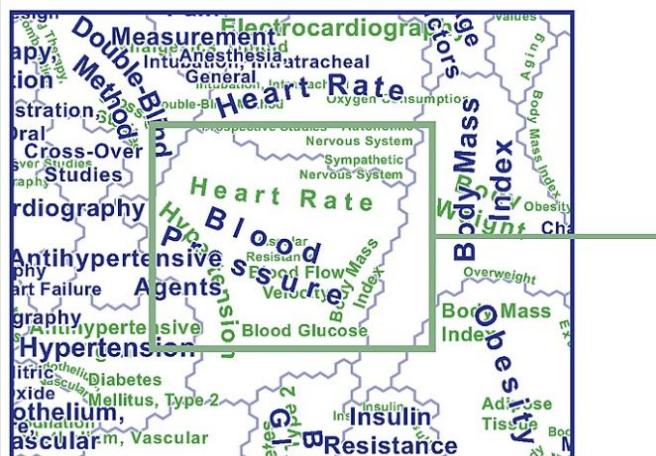
Abstract/Elaborate



Geometric Zoom ..

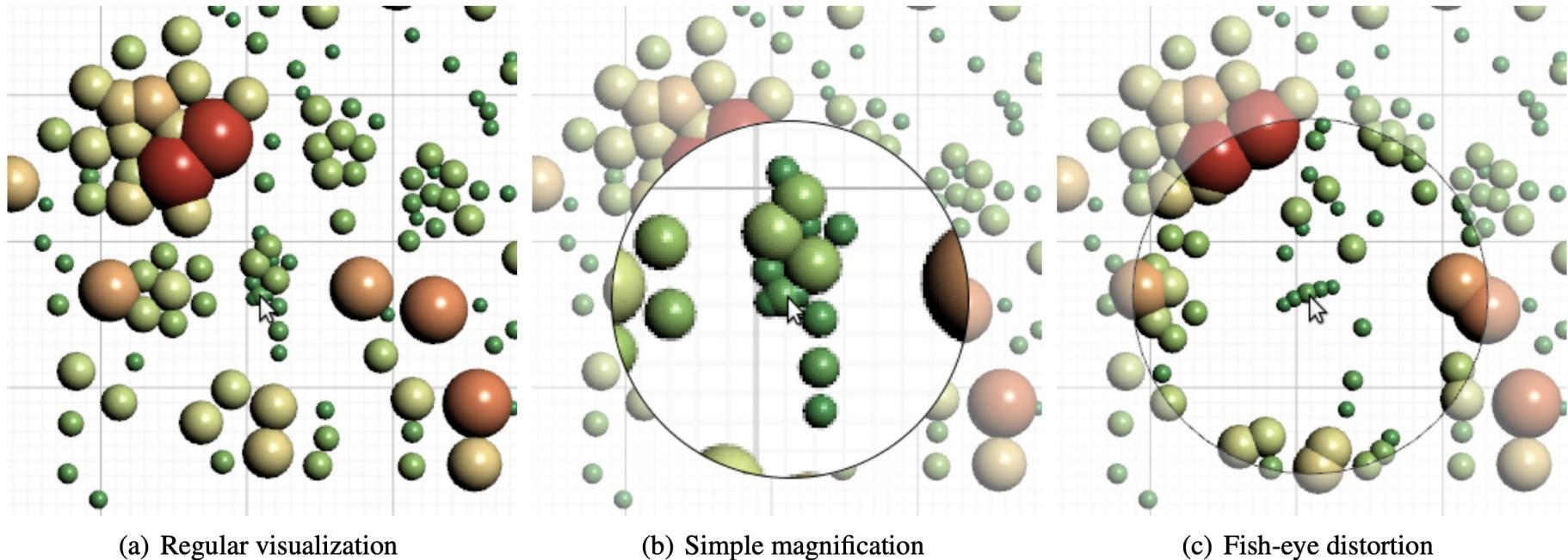


vs. Semantic Zoom:



https://www.researchgate.net/figure/Juxtaposed-are-examples-of-geometric-zooming-into-the-static-display-of-multiple-levels_fig8_236105790

Explore: Lenses



(a) Regular visualization

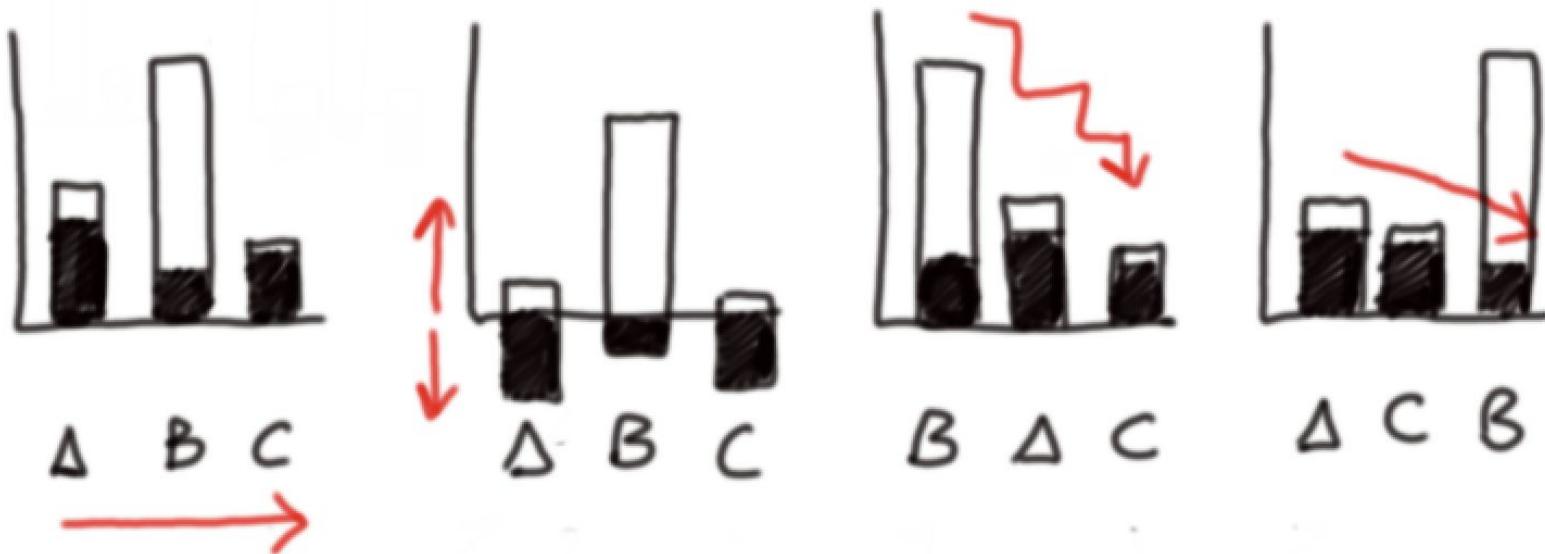
(b) Simple magnification

(c) Fish-eye distortion

Explore: Zoom

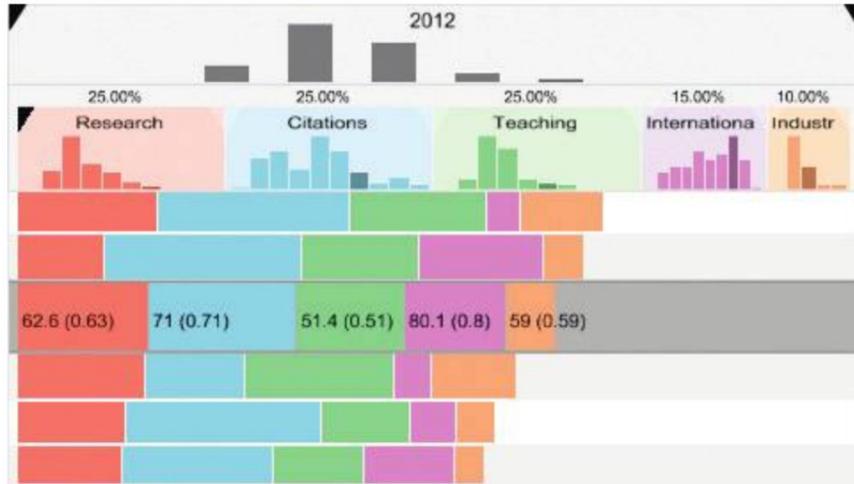


Reconfigure: "Show me a different arrangement"

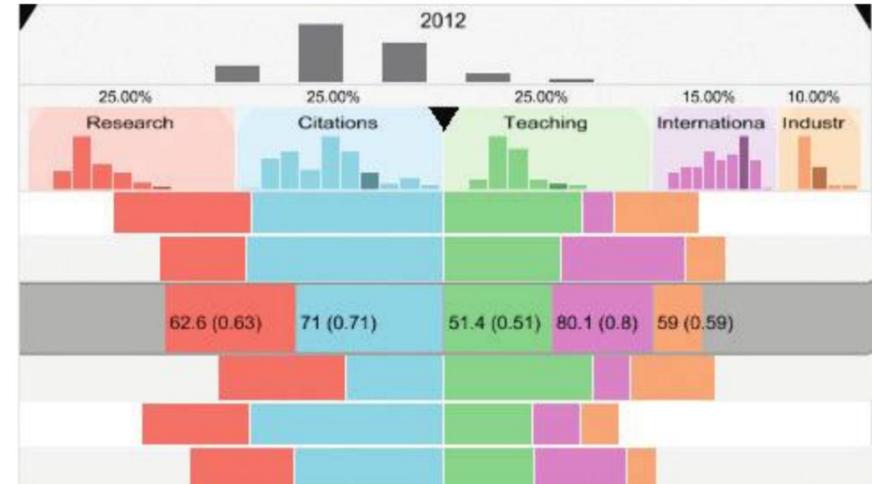


Stacked Bar Charts

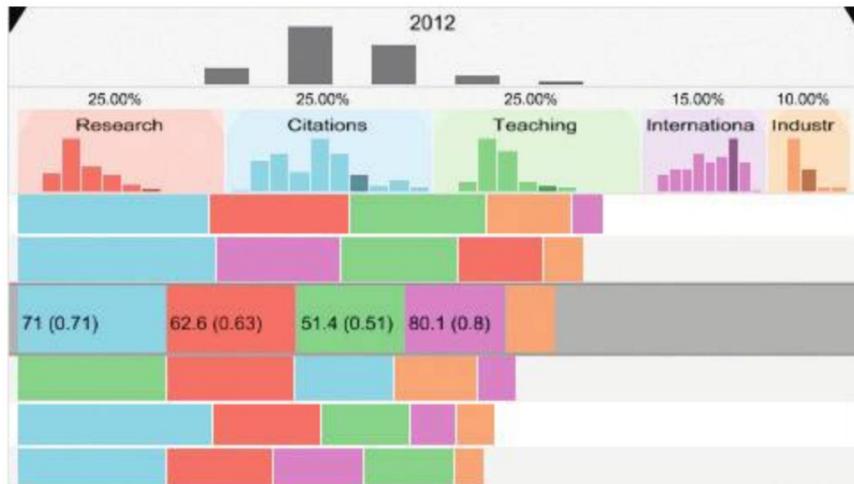
Gratzl, Samuel, et al. "Lineup: Visual analysis of multi-attribute rankings." *IEEE transactions on visualization and computer graphics* 19.12 (2013): 2277-2286.



(a)



(b)



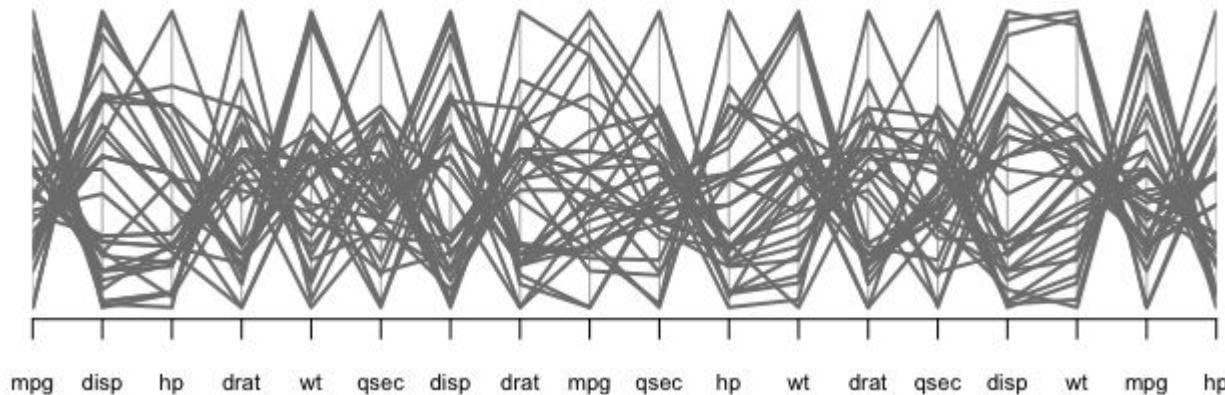
(c)



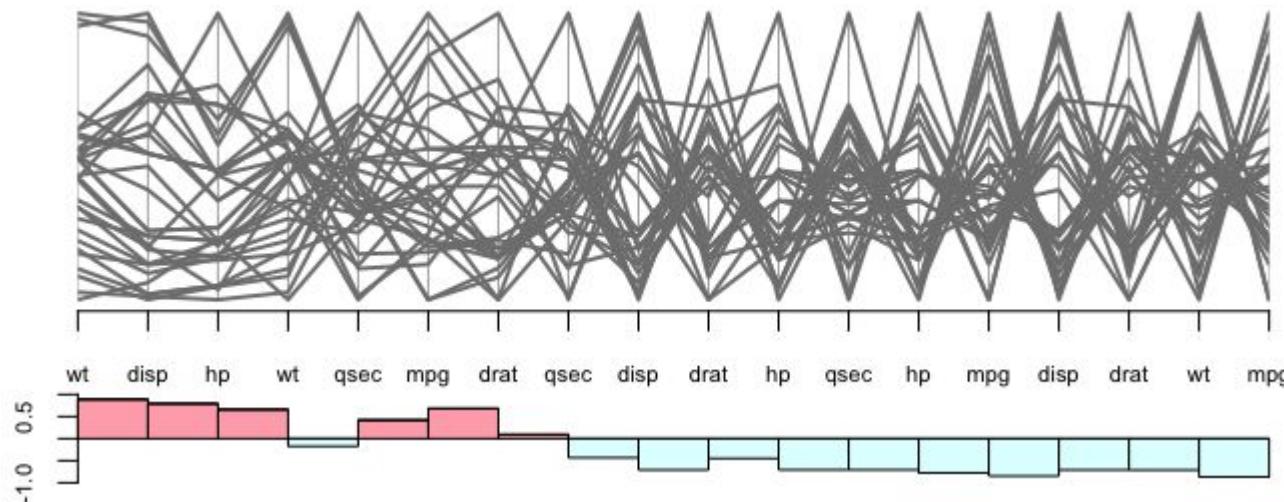
(d)

Reconfigure: Axes in PCP

Hamiltonian decomposition

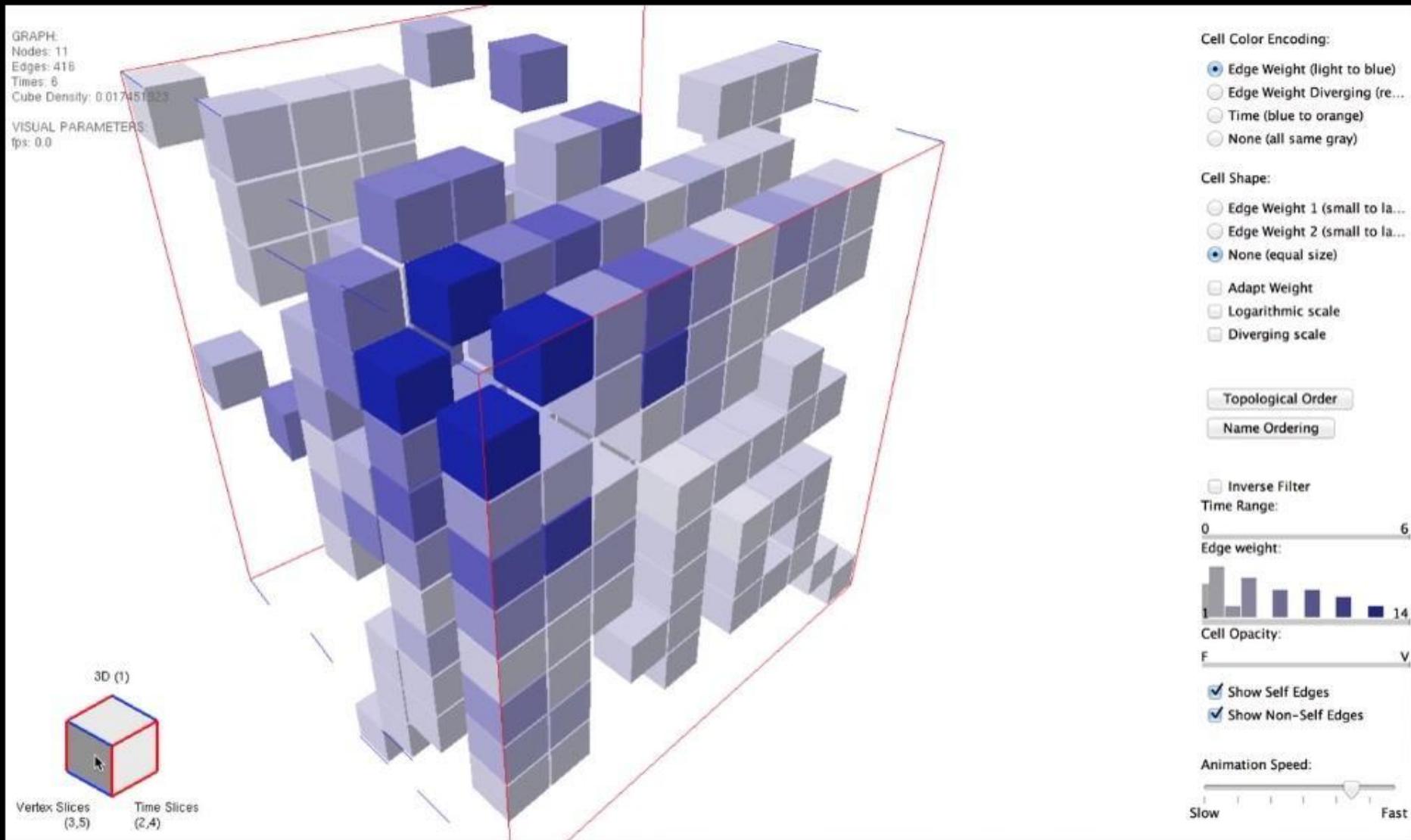


Weighted eulerian with correlation guide

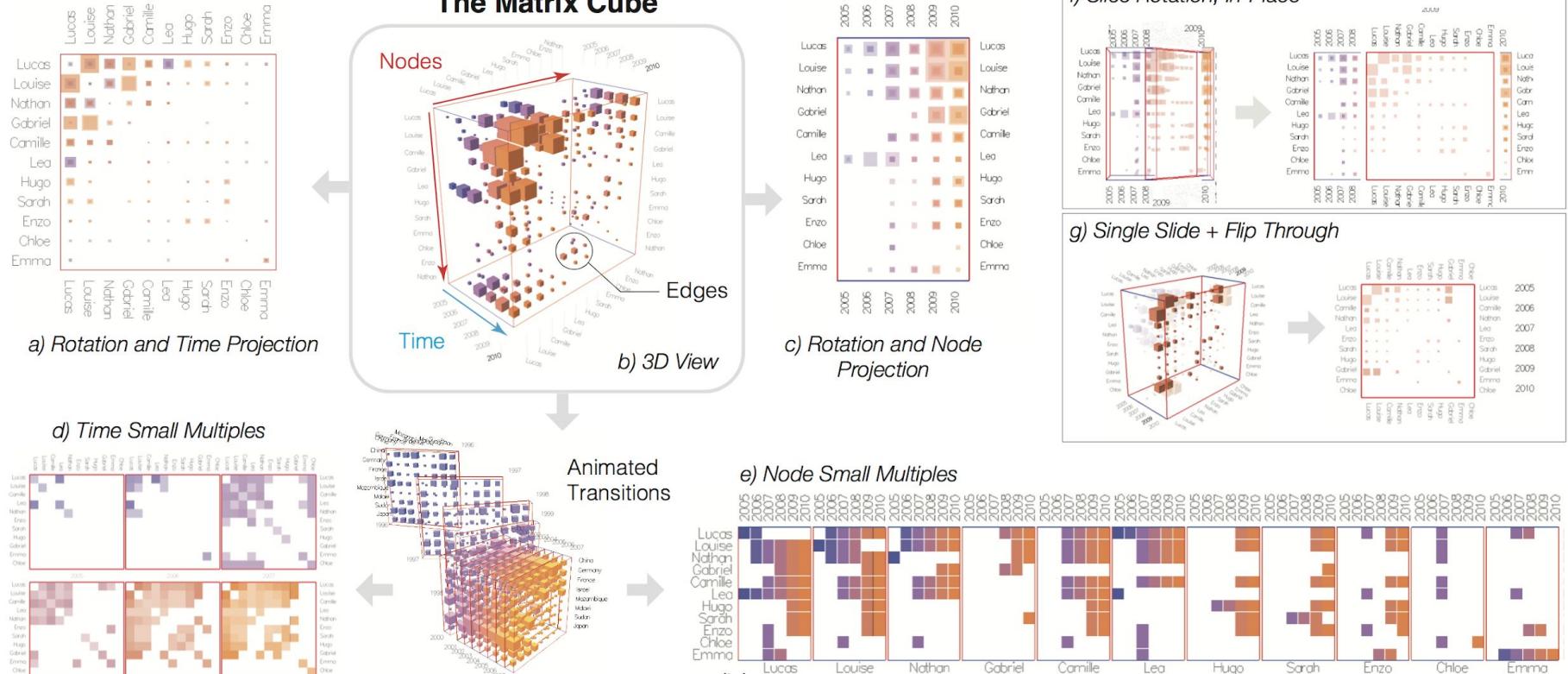


Reconfigure: 3D visualizations

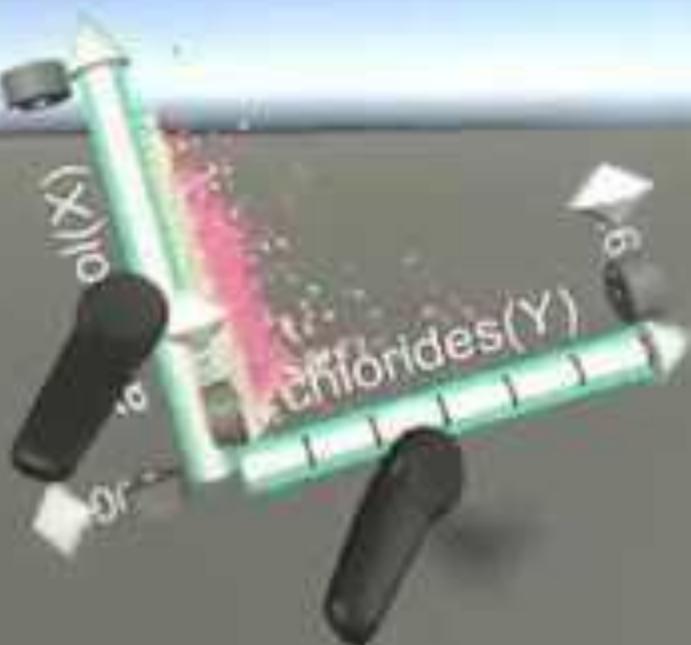
Bach, Benjamin, Emmanuel Pietriga, and Jean-Daniel Fekete. "Visualizing dynamic networks with matrix cubes." *Proceedings of the SIGCHI conference on Human Factors in Computing Systems*. 2014.



Reconfigure: 3D visualizations



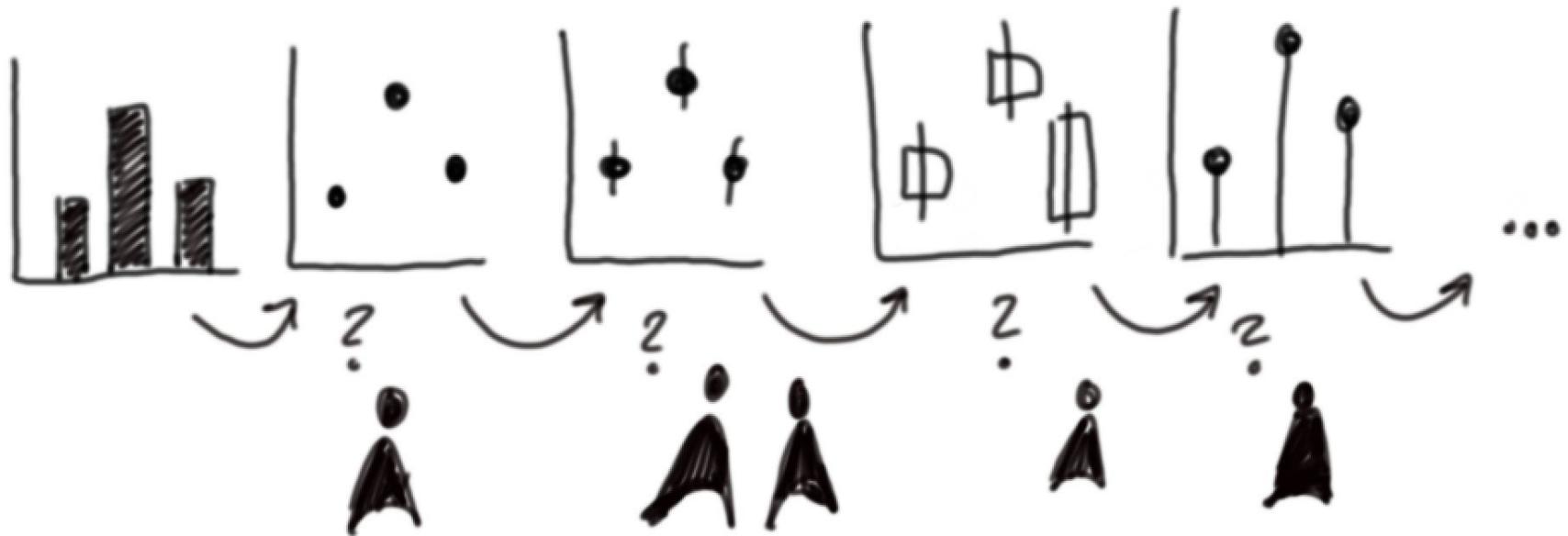
Reconfigure: Imaxis



<https://www.youtube.com/watch?v=hxqJJ934Reg&feature=youtu.be>

Cordeil, Maxime, et al. "ImAxes: Immersive axes as embodied affordances for interactive multivariate data visualisation." *Proceedings of the 30th Annual ACM Symposium on User Interface Software and Technology*. 2017.

Encode: "*Show me a different representation*"



Encode: Visualization Tools

- Select visualization technique
- Select visual encodings

1 Upload Data ✓ 2 Check & Describe ✓ 3 Visualize

Chart type

- Bar Chart
- Split Bars
- Stacked Bars
- Bullet Bars
- Dot Plot
- Range Plot
- Arrow Plot
- Column Chart
- Grouped Column Chart
- Stacked Column Chart
- Lines
- Area Chart
- Scatter Plot
- Pie chart
- Donut chart
- Election Donut
- Short Table
- Long Table

Archived chart types:

Hint: In case the visualization doesn't look like you expected, you should try to transpose the data.

The screenshot shows the Datawrapper interface. Step 1: 'Upload Data' is completed. Step 2: 'Check & Describe' is completed. Step 3: 'Visualize' is active, showing a scatter plot titled 'Income vs. Life Expectancy'. The plot shows a positive correlation between GDP per capita (X-axis, ranging from -20k to 100k) and life expectancy (Y-axis, ranging from 50 to 80). Data points include Luxembourg, Kuwait, United Arab Emirates, North Korea, Equatorial Guinea, Botswana, Swaziland, Lesotho, and Nicaragua. The plot has a light gray background with a grid. The Datawrapper logo is visible at the bottom right.

Data

World Bank Indicators

Dimensions

- Date (year)
- Location
- Abc Region
- Abc Subregion
- Country / Region
- Measure Names

Filters

YEAR(Date (year)): 201...

Marks

- Automatic
- Color
- Size
- Label
- Detail
- Tooltip

Measures

- # % of world average
- # F: Deposit interest rate (%)
- # F: GDP (curr \$)
- # F: GDP per capita (curr \$)
- # F: Lending interest rate (%)
- *# GDP per capita (weighted)
- # H: Health exp (% GDP)
- # H: Health exp/cap (curr \$)
- # H: Life exp (years)
- # P: Population (count)
- *# Rate spread (difference)
- @ Latitude (generated)
- @ Longitude (generated)
- # Number of Records
- # Measure Values

Region

- Europe
- Middle East
- The Americas
- Oceania
- Asia
- Africa

Pages

Columns: AVG(F: GDP per capita (curr \$))

Rows: Country / Region

Title

Softpedia

Country	GDP per capita (curr \$)
Luxembourg	\$104.5K
Bermuda	\$85.7K
Norway	\$85.4K
Qatar	\$72.4K
Switzerland	\$67.6K
Denmark	\$56.3K
Macao SAR, China	\$52.0K
Australia	\$50.7K
Sweden	\$49.3K
United States	\$46.7K
Netherlands	\$46.6K
Canada	\$46.2K
Ireland	\$45.9K
Kuwait	\$45.4K
Austria	\$44.9K
Finland	\$44.1K
Japan	\$43.1K
Belgium	\$42.8K
Singapore	\$42.0K
Germany	\$39.9K
United Arab Emirates	\$39.6K
Iceland	\$39.5K

Legend: F: GDP per capita (curr \$)

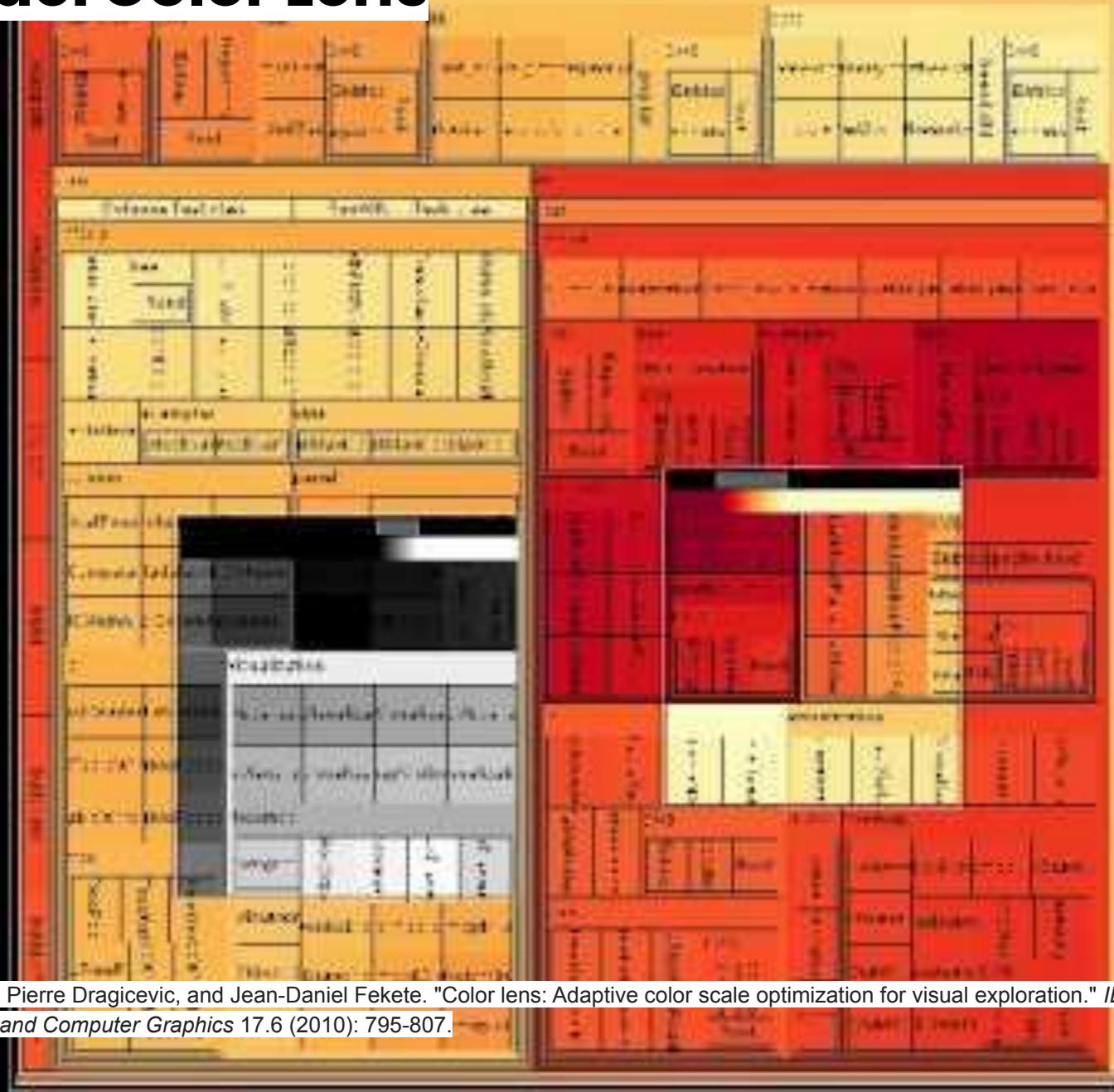
Navigation: GDP per capita, GDP per capita map, GDP per capita by region, GPD per Capita Dashboard, Health spending vs life expecta...

Right sidebar: For symbol maps try 1 geo @ dimension, 0 or more dimensions, 0 to 2 measures.

Data Wrapper

Tableau

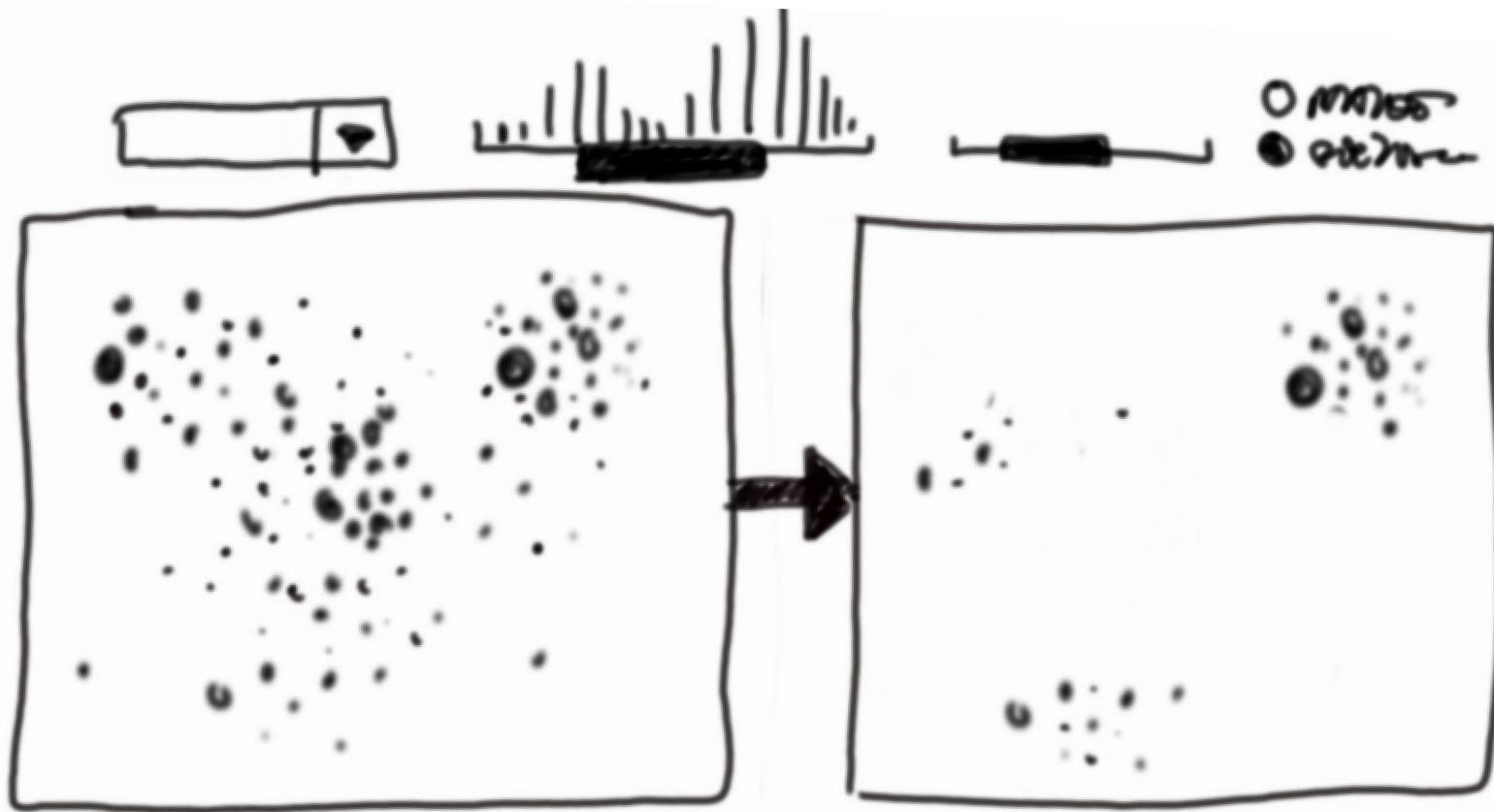
Encode: Color Lens



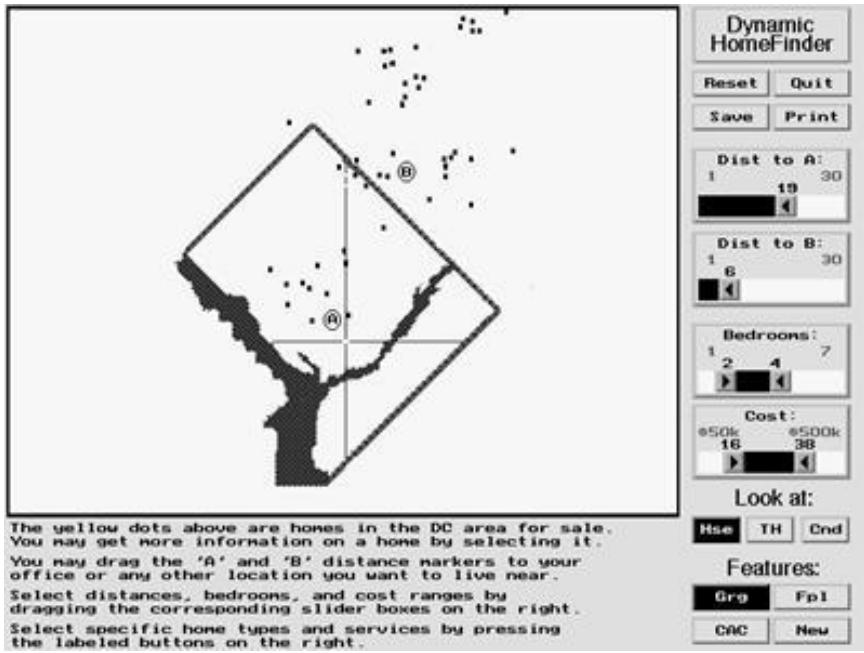
Elmqvist, Niklas, Pierre Dragicevic, and Jean-Daniel Fekete. "Color lens: Adaptive color scale optimization for visual exploration." *IEEE Transactions on Visualization and Computer Graphics* 17.6 (2010): 795-807.

Filter: "*show me something conditionally*"

- Select elements of specific properties
- Hide rest
- Filter in real-time



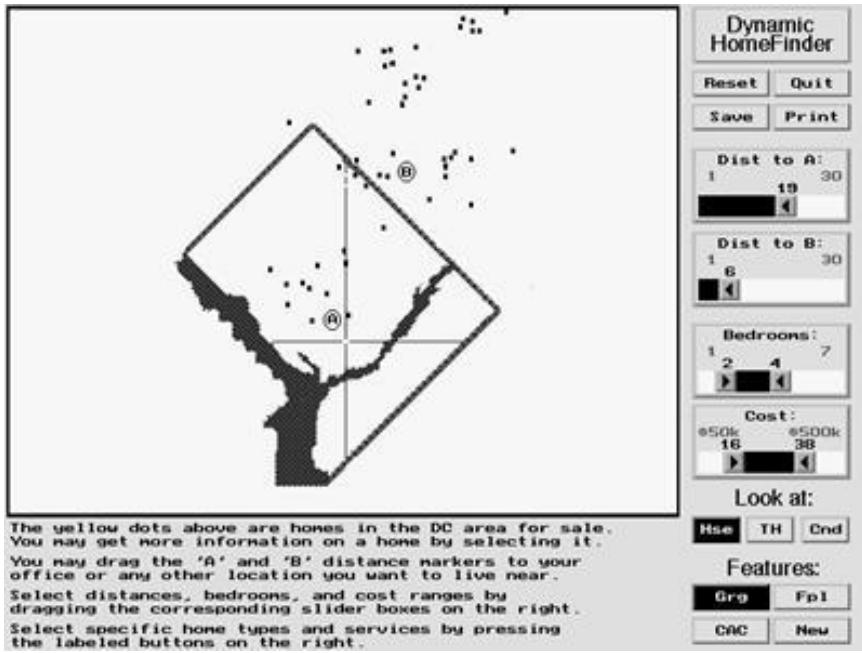
Filter: Dynamic Queries



Multiple aRnge sliders

Shneiderman, Ben. "Dynamic queries for visual information seeking." *IEEE software* 11.6 (1994): 70-77.

Filter: Dynamic Queries



Multiple range sliders

Shneiderman, Ben. "Dynamic queries for visual information seeking." *IEEE software* 11.6 (1994): 70-77.

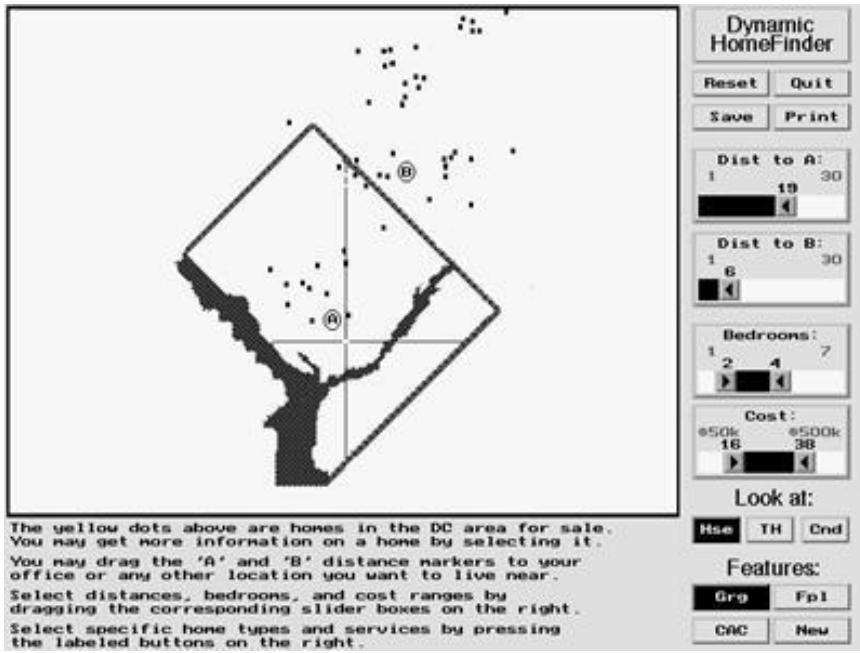
Range slider + Histogram:

€9 - €562

The average price per night for New York is €125.



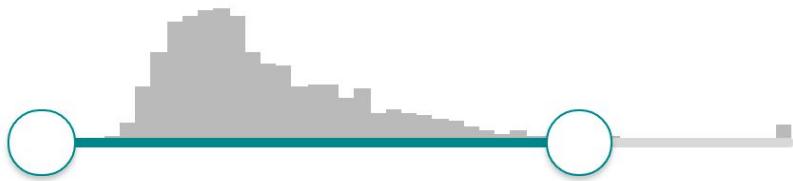
Filter: Dynamic Queries



Range slider + Histogram:

€9 - €562

The average price per night for New York is €125.



Cancel

Apply

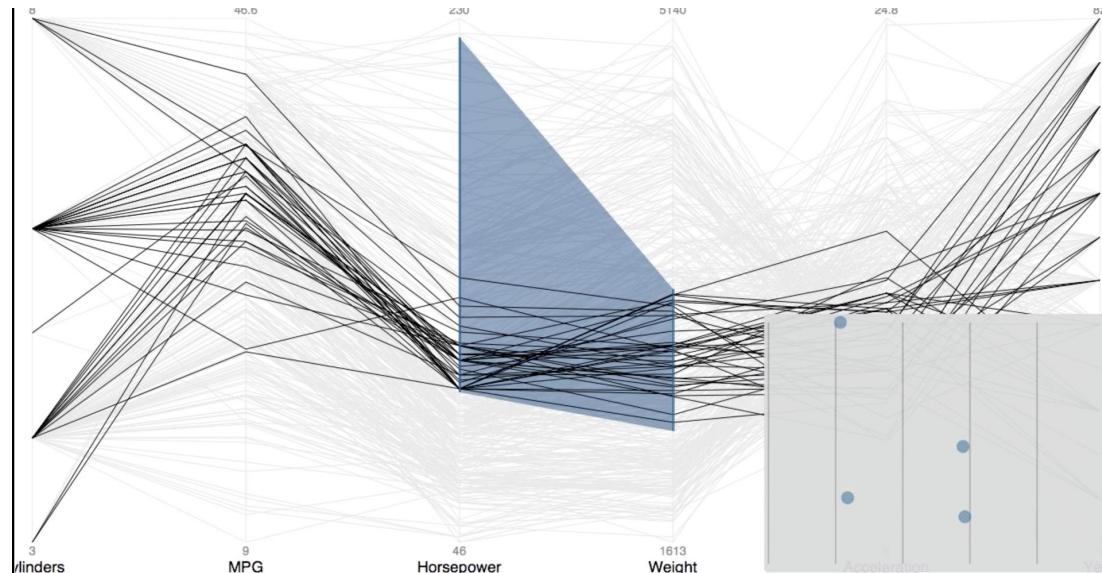
Multiple aRnge sliders

Shneiderman, Ben. "Dynamic queries for visual information seeking." *IEEE software* 11.6 (1994): 70-77.

Google Suggest:

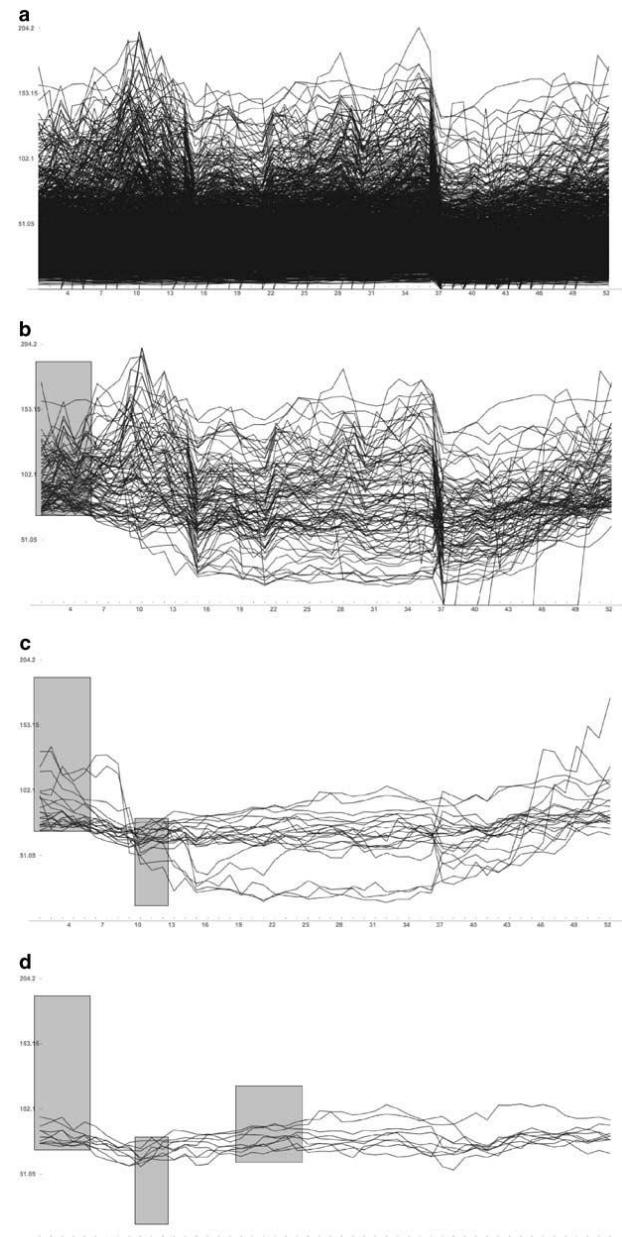
- why are german|
- why are germans so
- why are german words so long
- why are german cars so good
- why are german cars limited to 155mph
- why are german kitchens the best
- why are german shepherds so protective
- why are german shepherds aggressive
- why are german football fans protesting
- why are german bonds negative
- why are german toilets flat

Filter: PCP + Time series



Kosara, Robert. "Indirect multi-touch interaction for brushing in parallel coordinates." *Visualization and Data Analysis* 2011. Vol. 7868. International Society for Optics and Photonics, 2011.

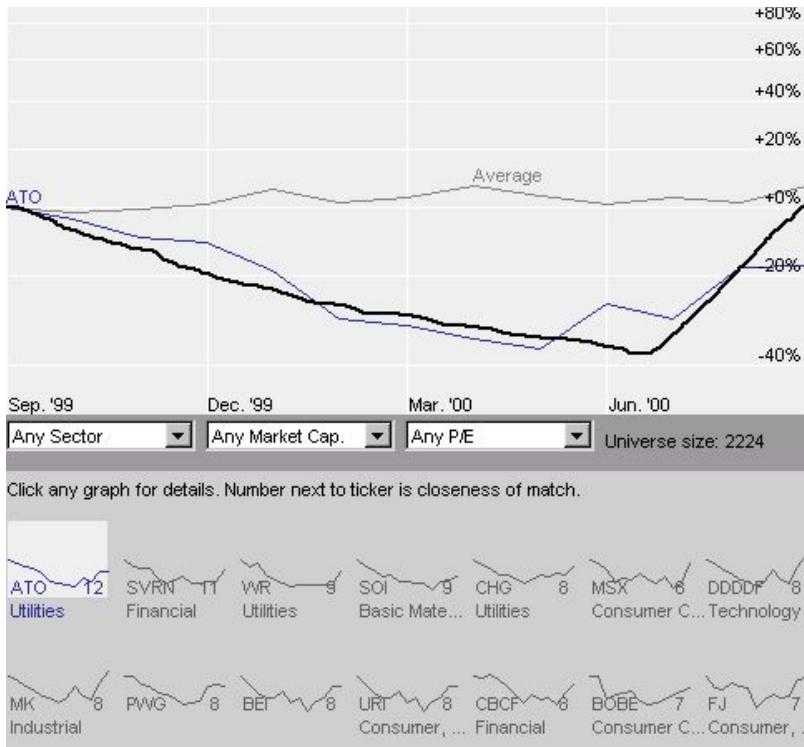
<https://vimeo.com/13437693>



Hochheiser, Harry, and Ben Shneiderman. "Dynamic query tools for time series data sets: timebox widgets for interactive exploration." *Information Visualization* 3.1 (2004): 1-18.

Filter: Sketch

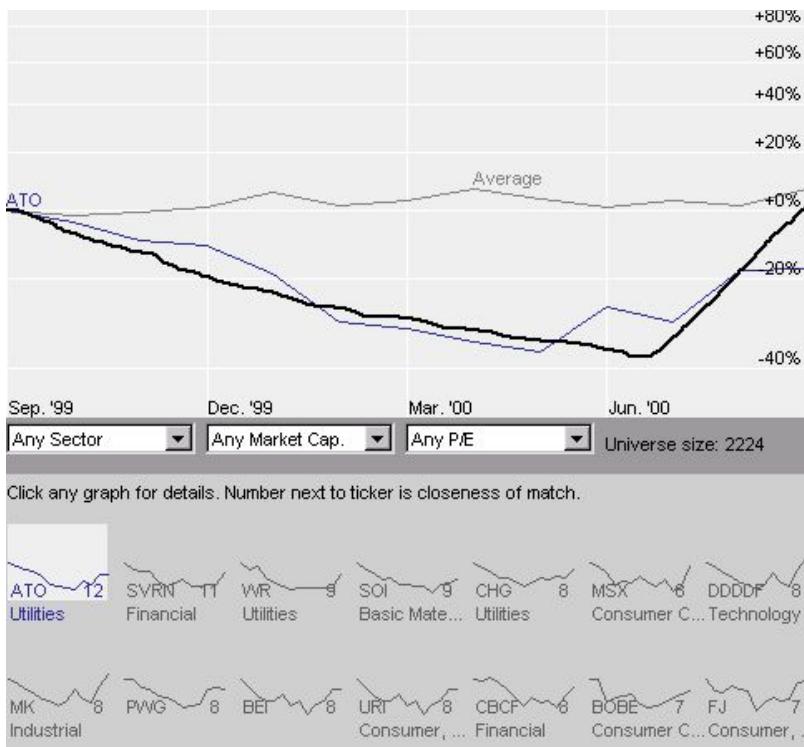
QuerySketch: sketch paths



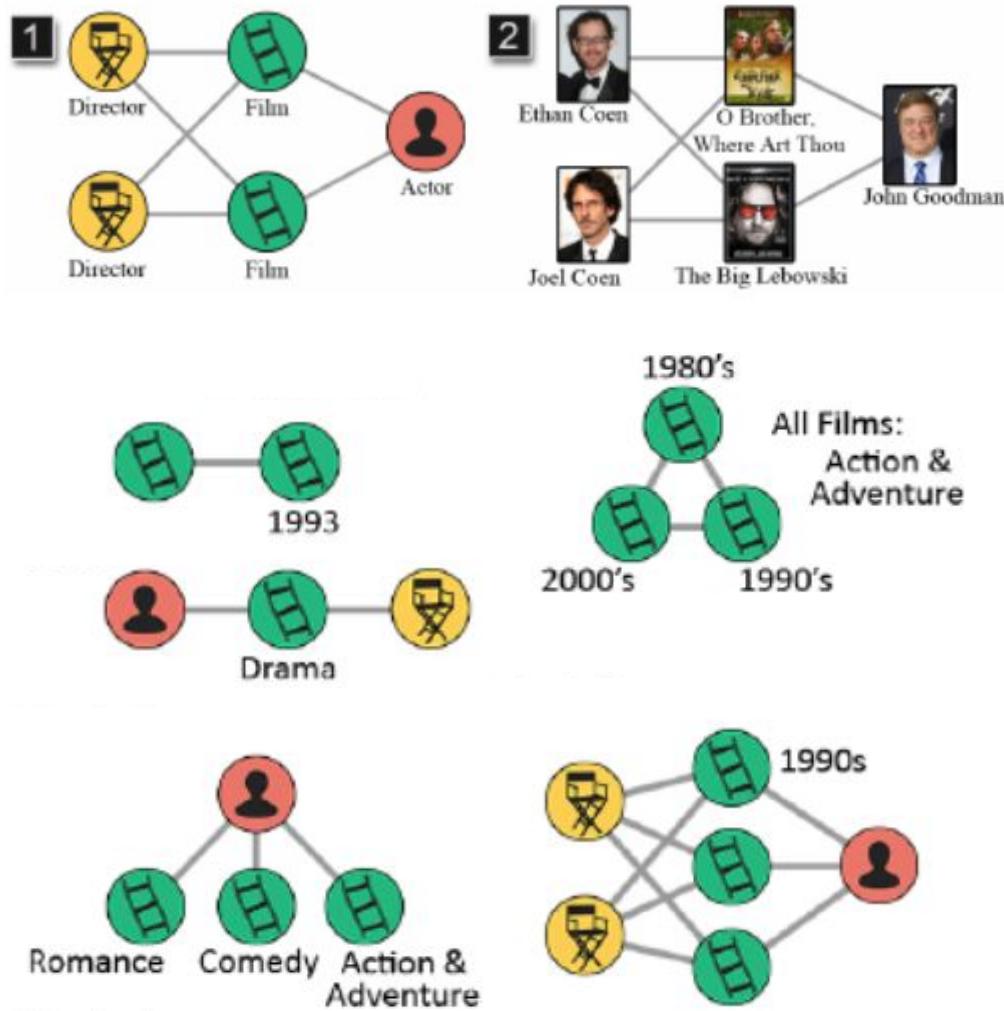
Wattenberg, Martin. "Sketching a graph to query a time-series database." *CHI'01 Extended Abstracts on Human factors in Computing Systems*. 2001.

Filter: Sketch

QuerySketch: sketch paths



Build (Graph) Query

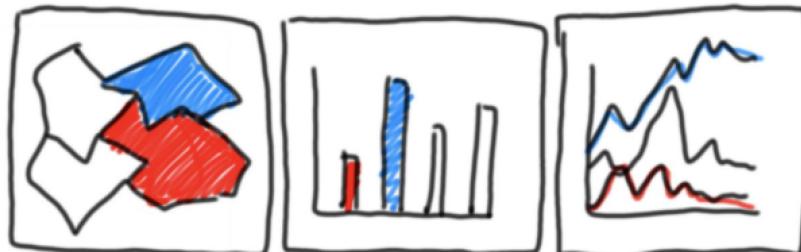


Wattenberg, Martin. "Sketching a graph to query a time-series database." *CHI'01 Extended Abstracts on Human factors in Computing Systems*. 2001.

Pienta, Robert, et al. "Visage: Interactive visual graph querying." *Proceedings of the International Working Conference on Advanced Visual Interfaces*. 2016.

Connect: "Show me related Items"

- Common in multiple views
- Find related items
- Find hidden items



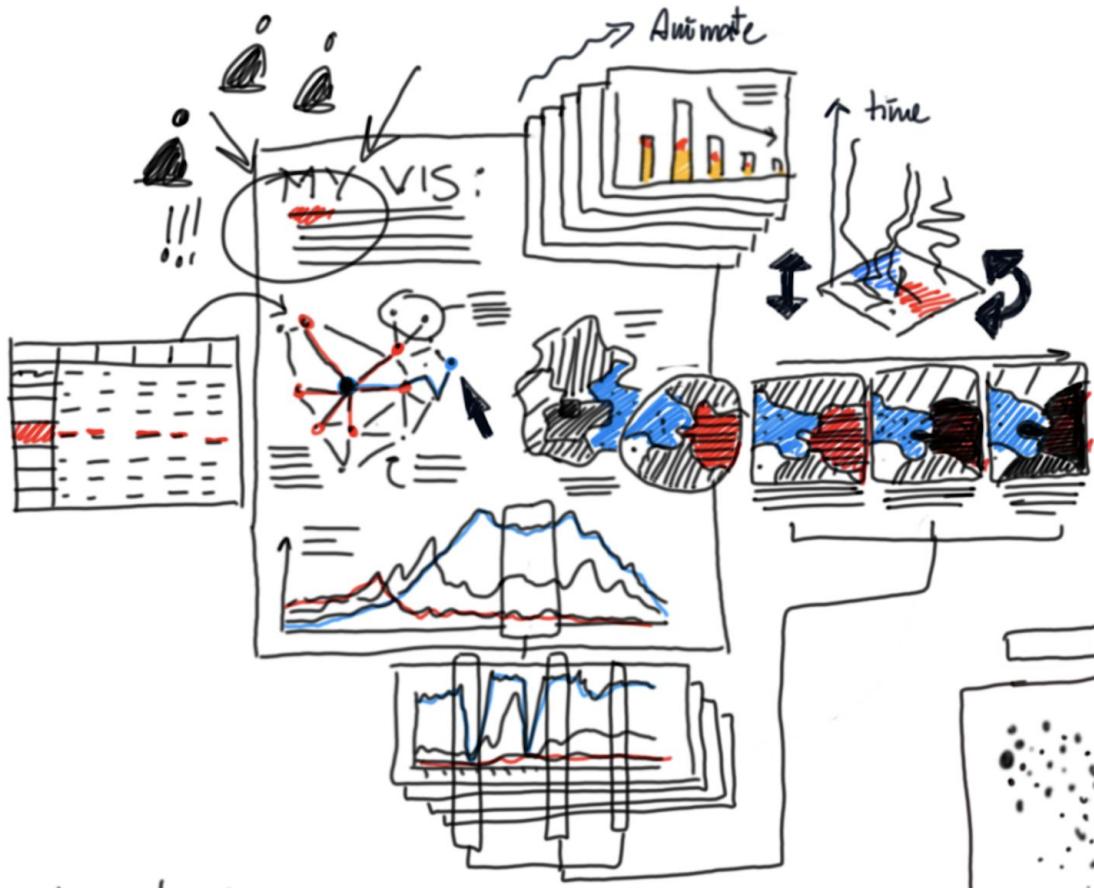
Connect: Brushing and Linking



Guidelines for Interaction

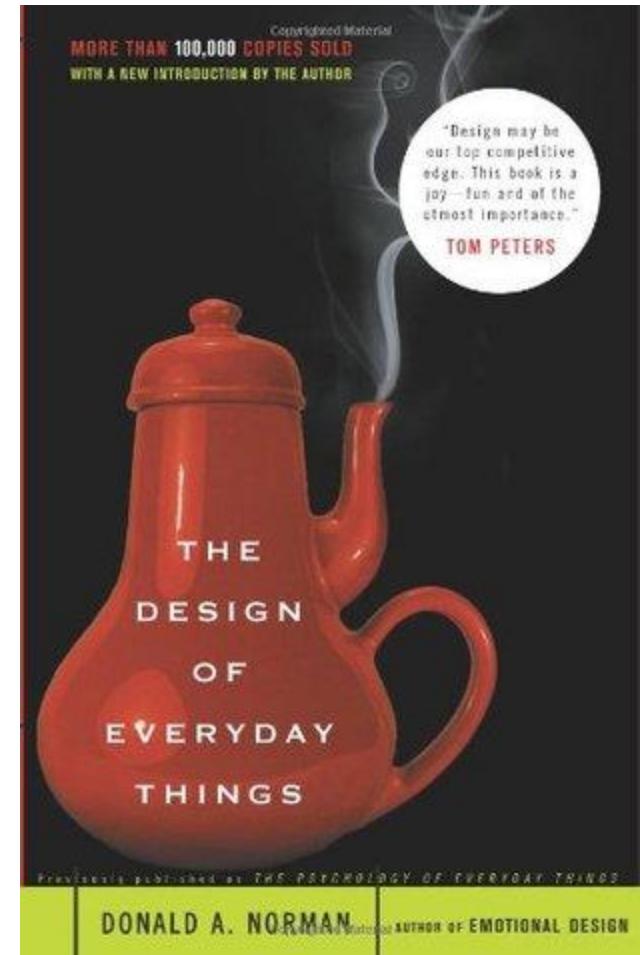
Mental Map

- User's mental representation of a system
- *Where am I?*
- *What can I do?*
- *How do I do that?*



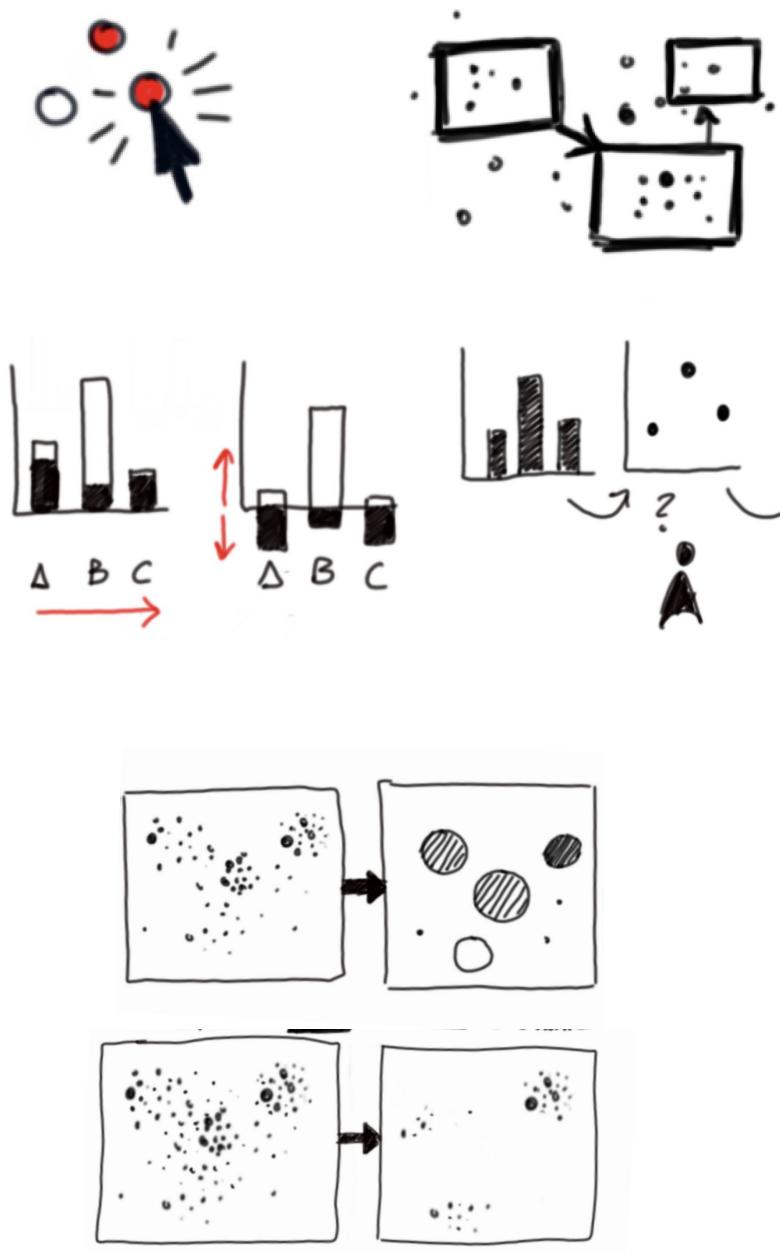
Guidelines for Interaction in Visualization

1. Try a **static visualization first**, add interaction if necessary.
2. Support users **tasks**.
3. **Overview first**, Zoom and Filter, Detail on Demand
4. **Minimize** interaction: e.g., reduce number of clicks
5. **Explain** your interactions
6. Create interaction **affordances** -->
7. Provide for **direct manipulation**
8. Consider people's **devices**.



Strategies

1. Overview first
2. Zoom and filter
3. Select
4. Reconfigure
5. Explore
6. Connect
7. Abstract/Elaborate
8. Details on demand
9. Encode
10.



Further Literature

- Yi, Ji Soo, Youn ah Kang, and John Stasko. "**Toward a deeper understanding of the role of interaction in information visualization.**" *IEEE transactions on visualization and computer graphics* 13.6 (2007): 1224-1231.
- Amar, Robert, James Eagan, and John Stasko. "**Low-level components of analytic activity in information visualization.**" *IEEE Symposium on Information Visualization, 2005. INFOVIS 2005.. IEEE, 2005.*
- Tamara Munzner: **Manipulate View (Chapter 11)** in Tamara Munzner: *Visualization Analysis & Design*.
- Tominski, Christian, et al. "**Interactive lenses for visualization: An extended survey.**" *Computer Graphics Forum*. Vol. 36. No. 6. 2017.