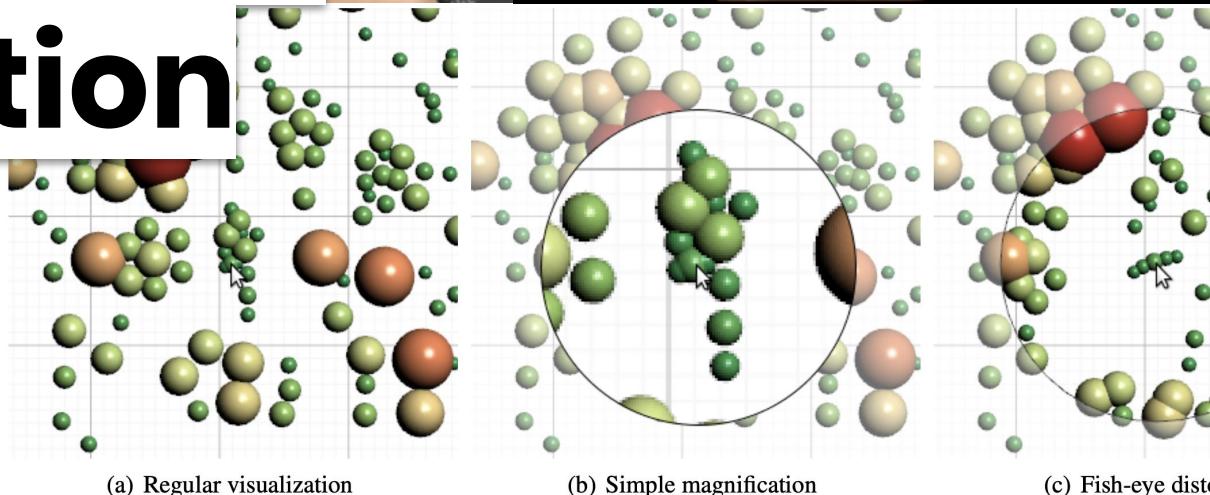




Interaction for Visualization



Online Course
**Data Visualization
for Professionals**



THE UNIVERSITY
of EDINBURGH

Benjamin Bach

June 2020

<http://benjbach.me>
<https://datavis-online.github.io>

-- Not for external use --

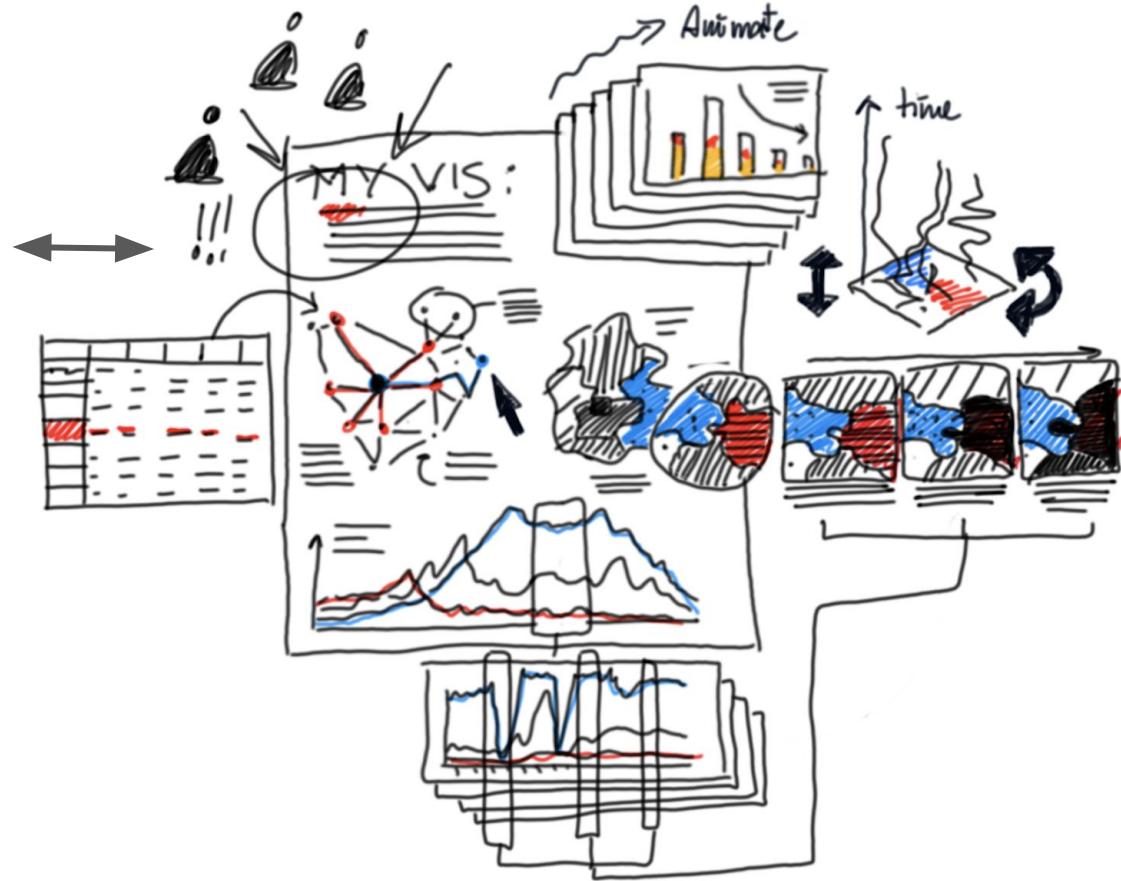
Interaction



Static Visualization

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

Interaction



Static Visualization

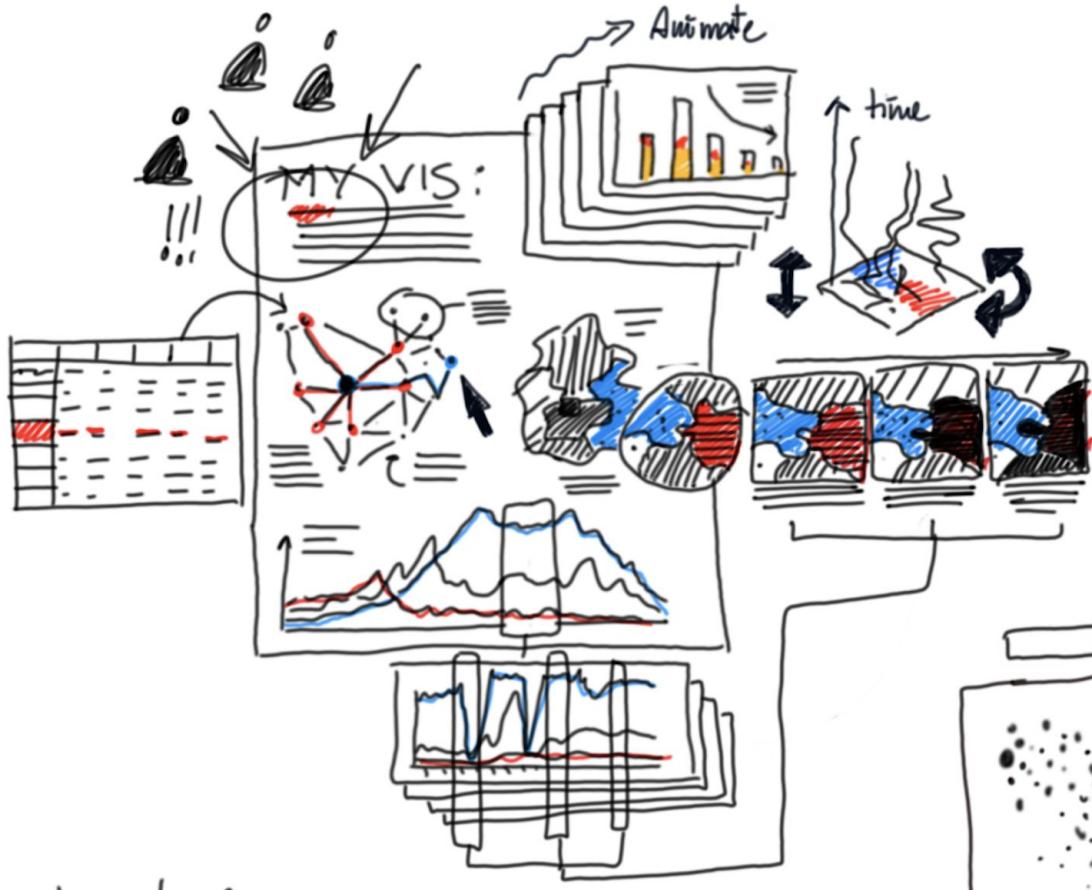
- Single perspective
- **Interaction:** Ask, Move, Search, Annotate, ... a

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 ...

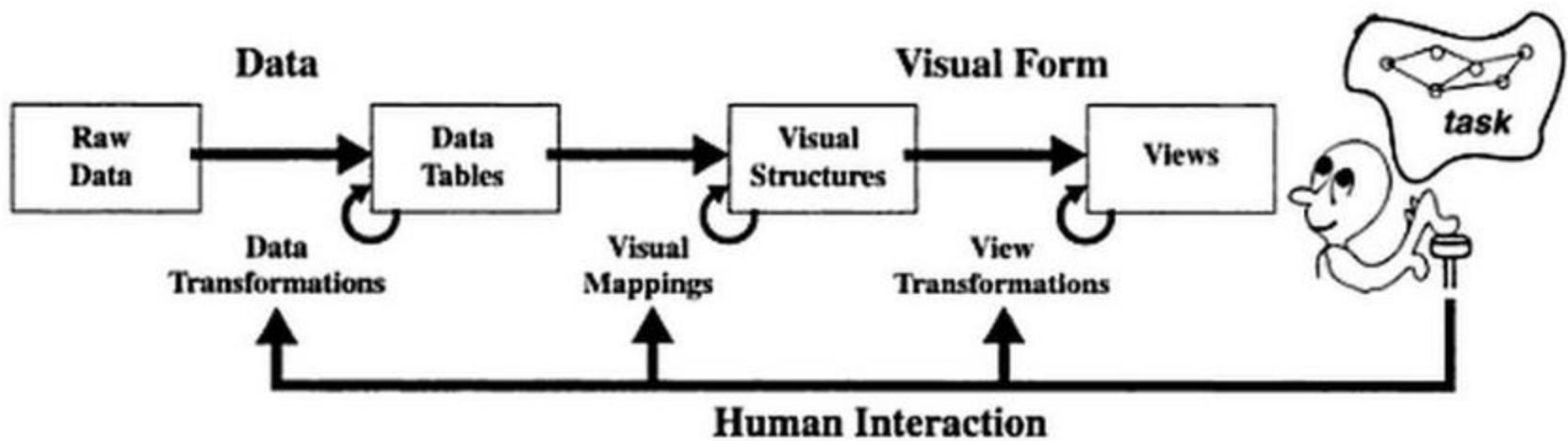
Visualization:

"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:

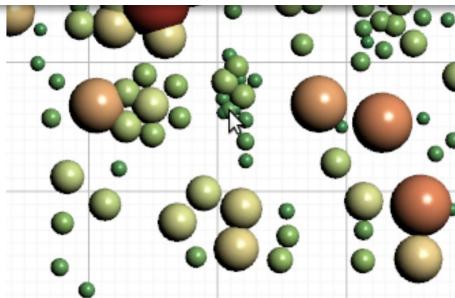
(A technical view on interaction)



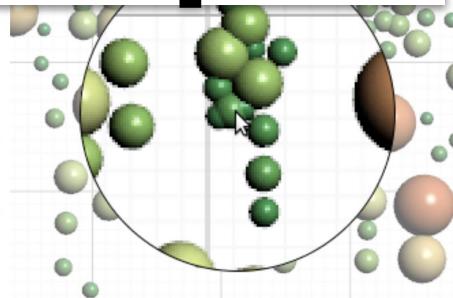


Interaction for Visualization

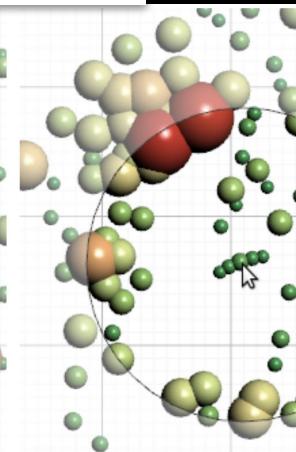
Interaction Techniques



(a) Regular visualization



(b) Simple magnification



(c) Fish-eye disto



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Benjamin Bach

June 2020

<http://benjbach.me>
<https://datavis-online.github.io>

-- Not for external use --

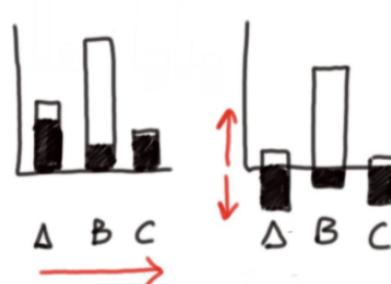
Interaction



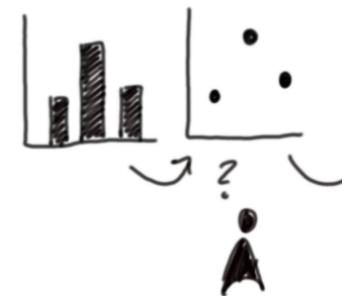
Select



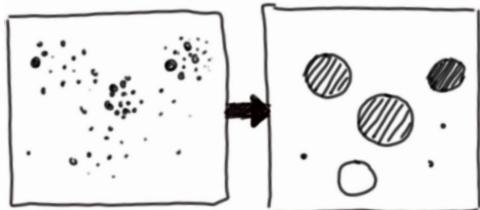
Explore



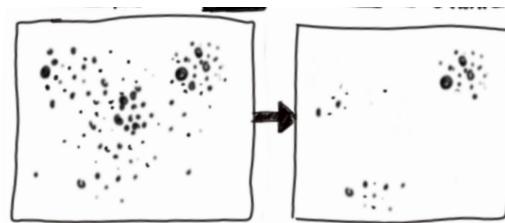
Reconfigure



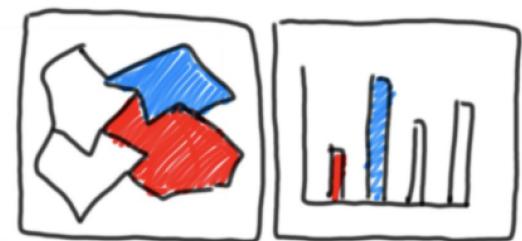
Encode



Abstract



Filter



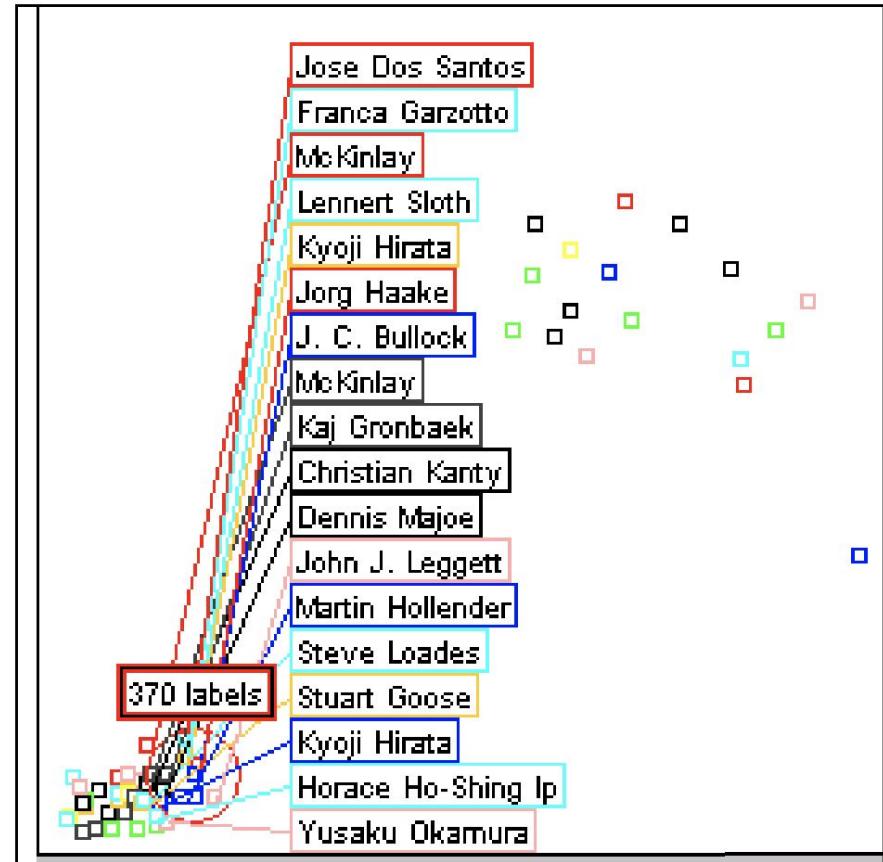
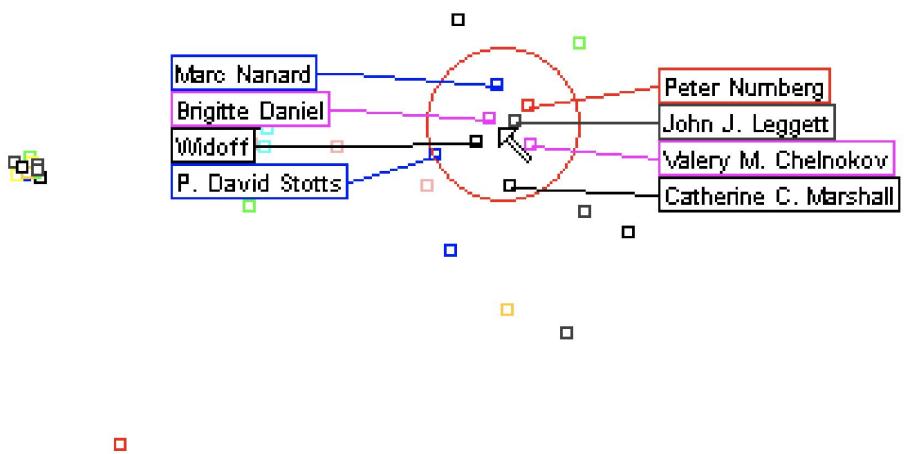
Connect

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.

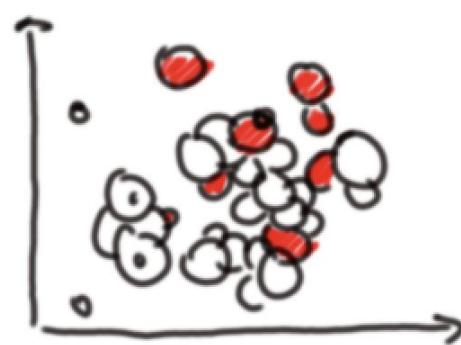
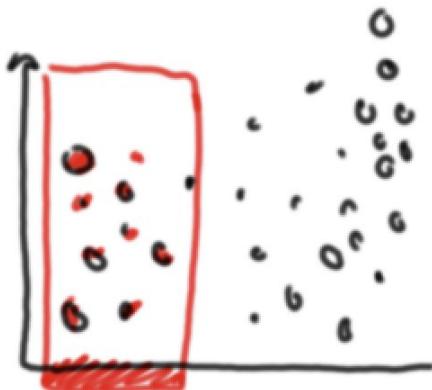
Select: "Mark data items"



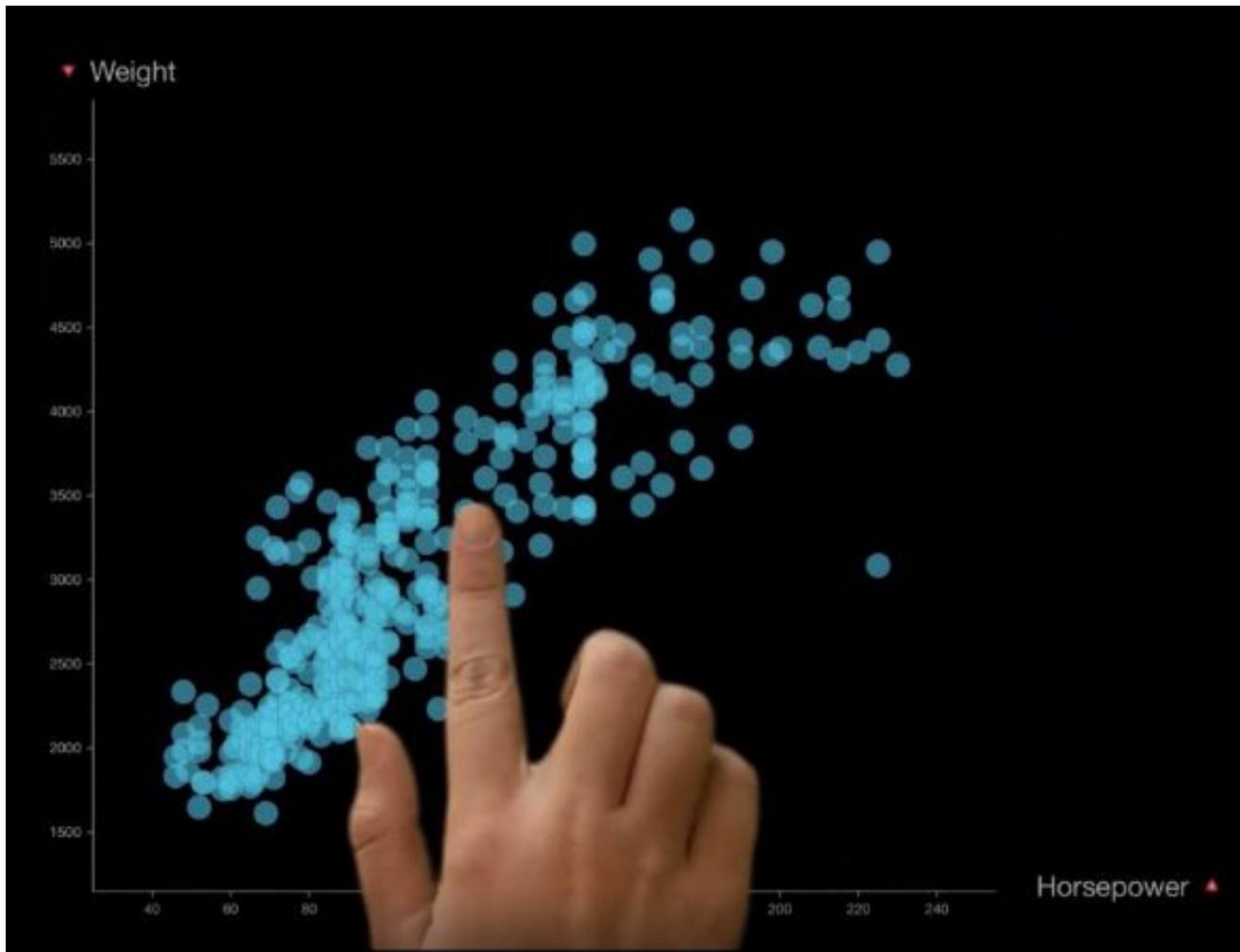
Select: Excentric labeling



Select: "Mark data items"

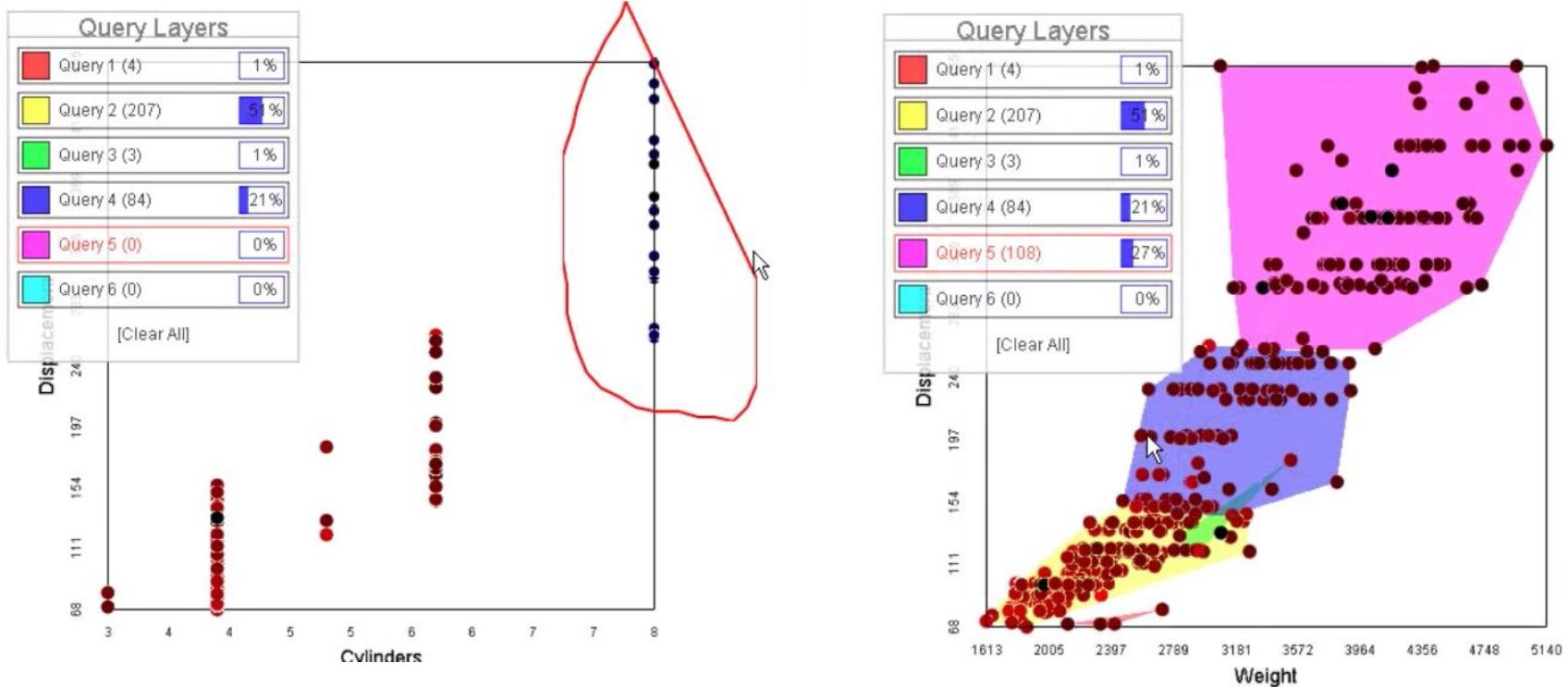


Select: "Mark data items"



<https://ramiksadana.com/video/tangere/select.webm>

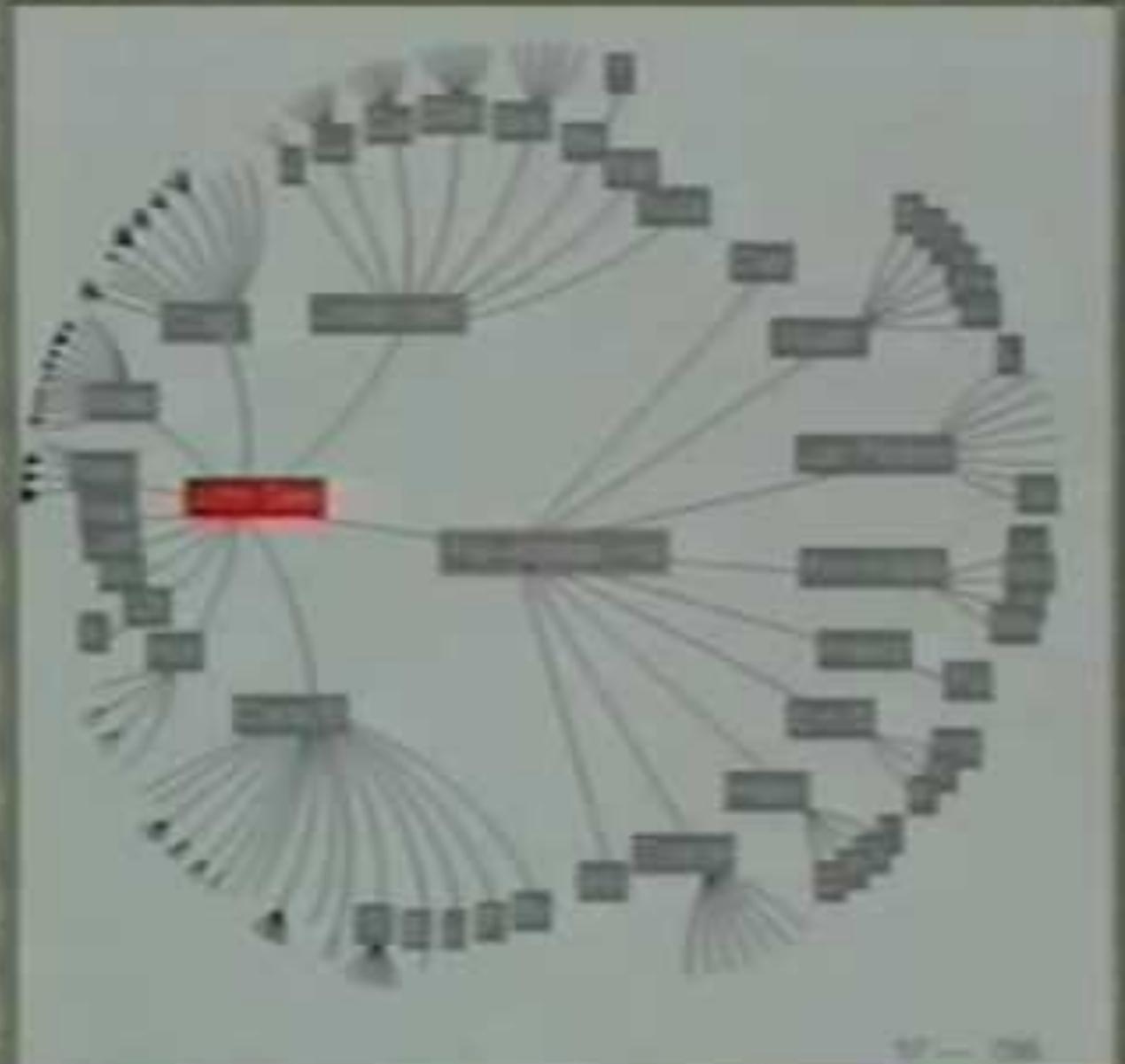
Select: Lasso+highlight (Scatterdice)



Explore: "Show me something else"

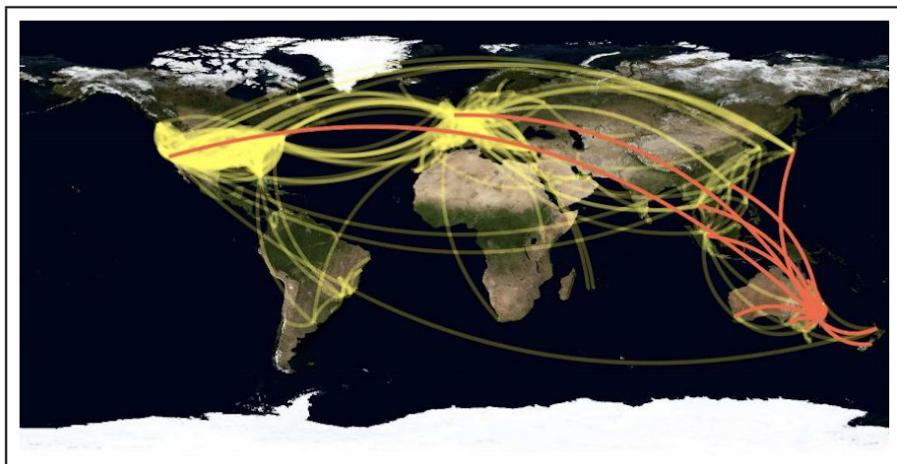


Explore: Hyperbolic trees

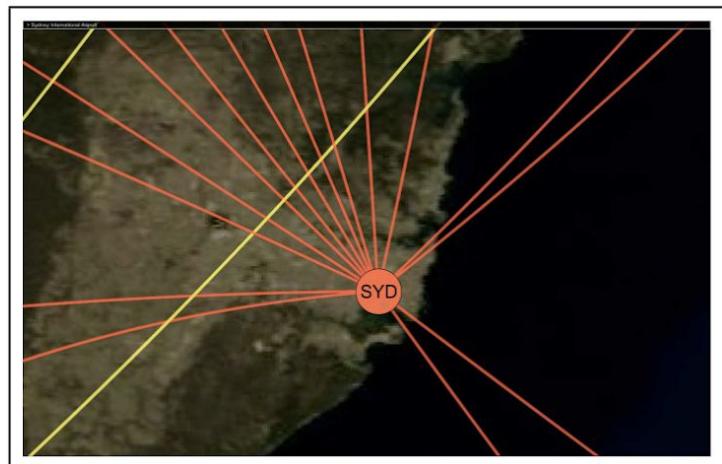


Lamping, John, and Ramana Rao. "Laying out and visualizing large trees using a hyperbolic space." *Proceedings of the 7th annual ACM symposium on User interface software and technology*. 1994.

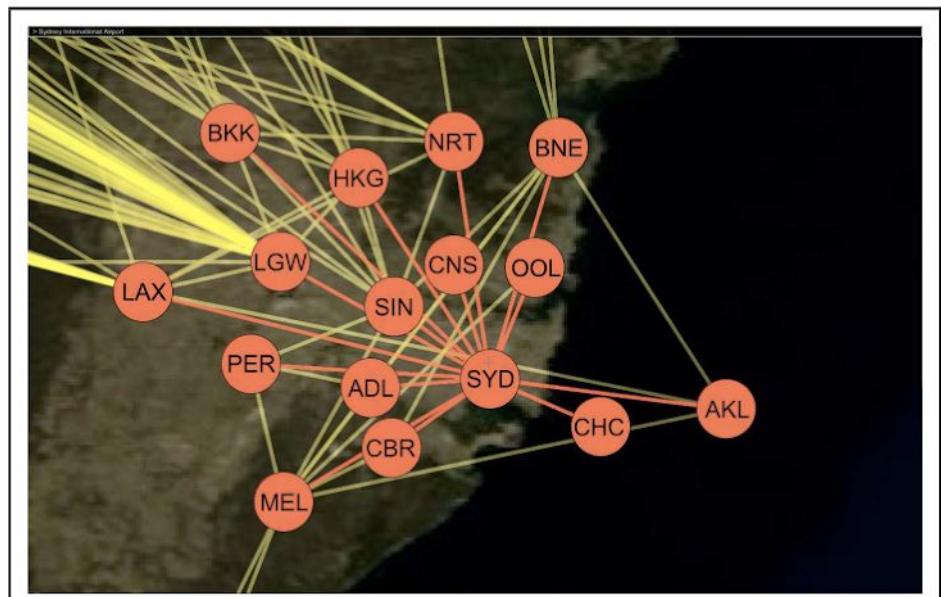
Bring and go (for networks)



(a)



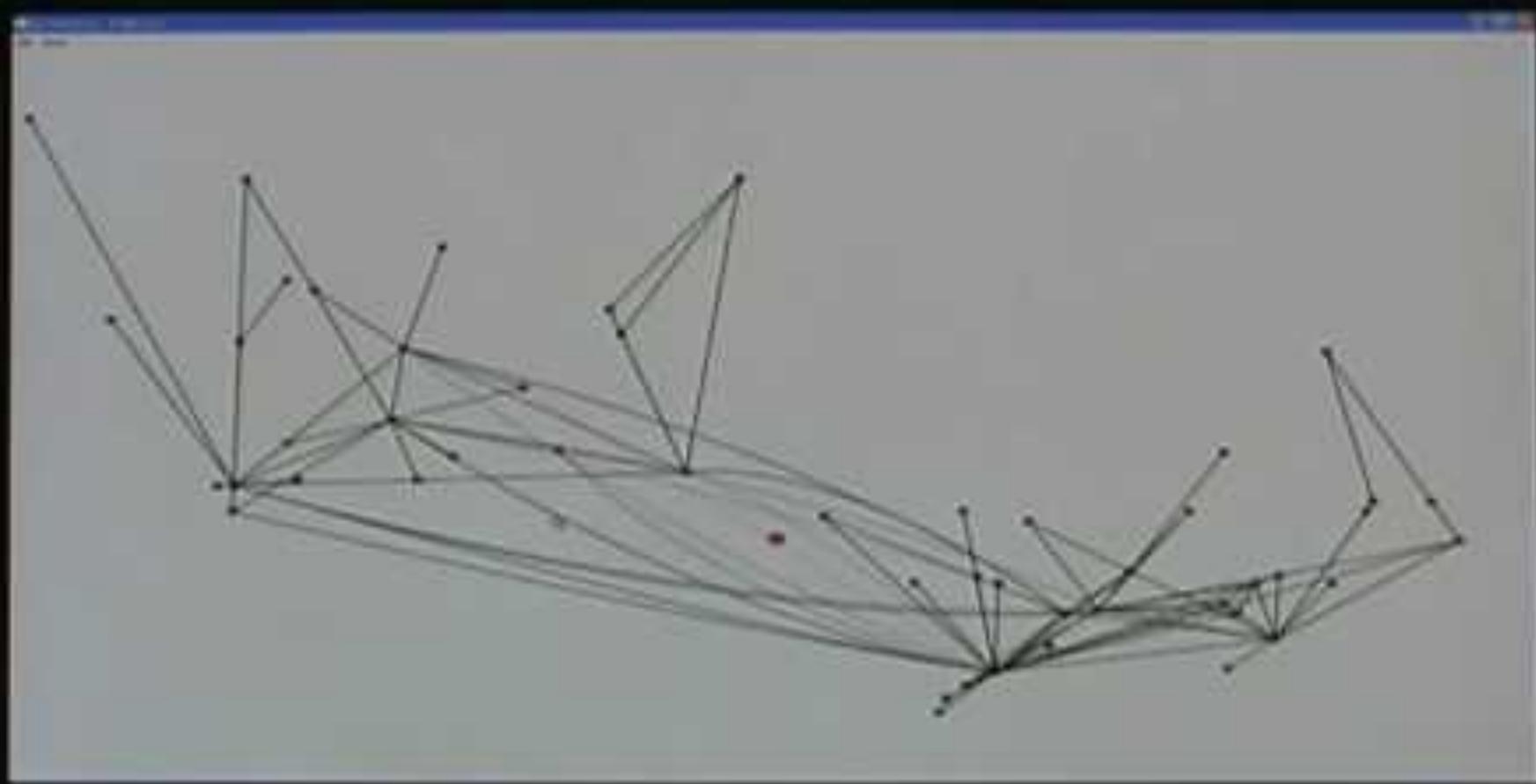
(b)



(c)

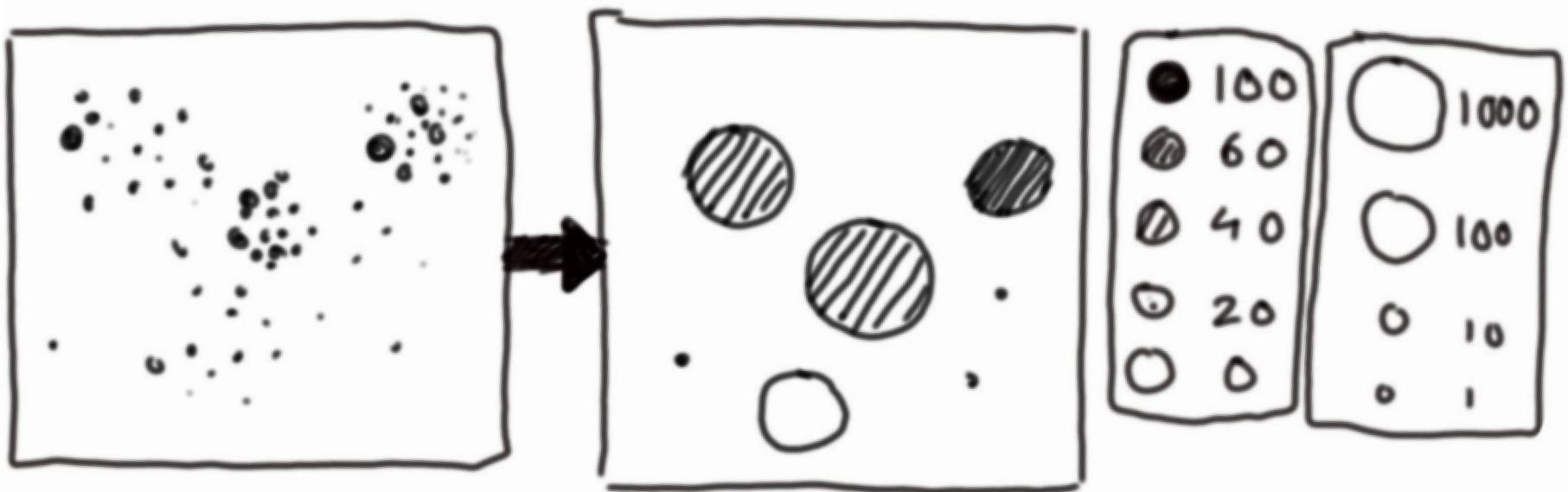
Moscovich, Tomer, et al. "Topology-aware navigation in large networks." *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 2009.

Explore: EdgeLens

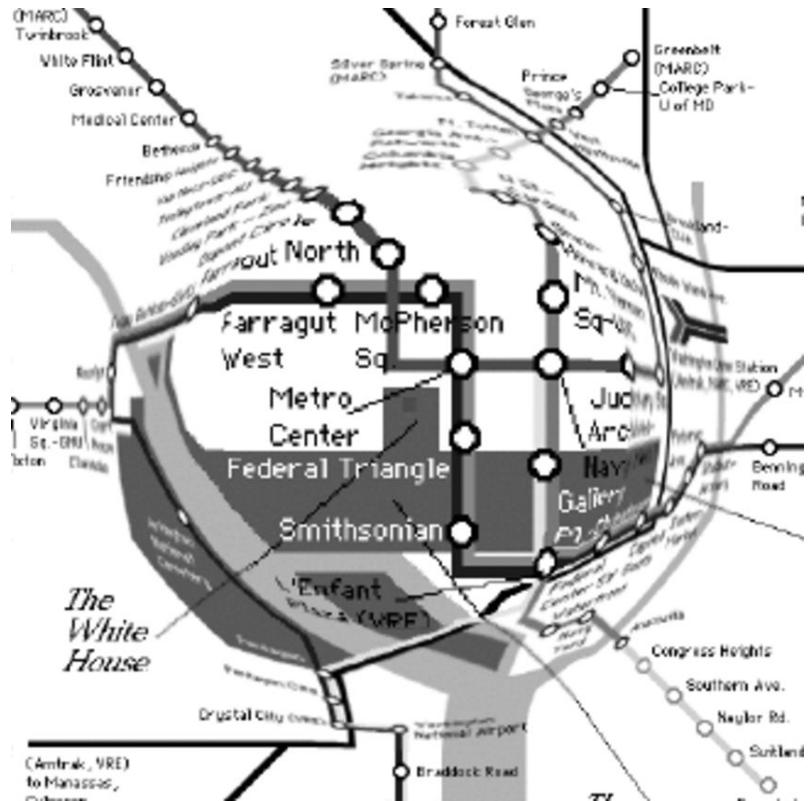
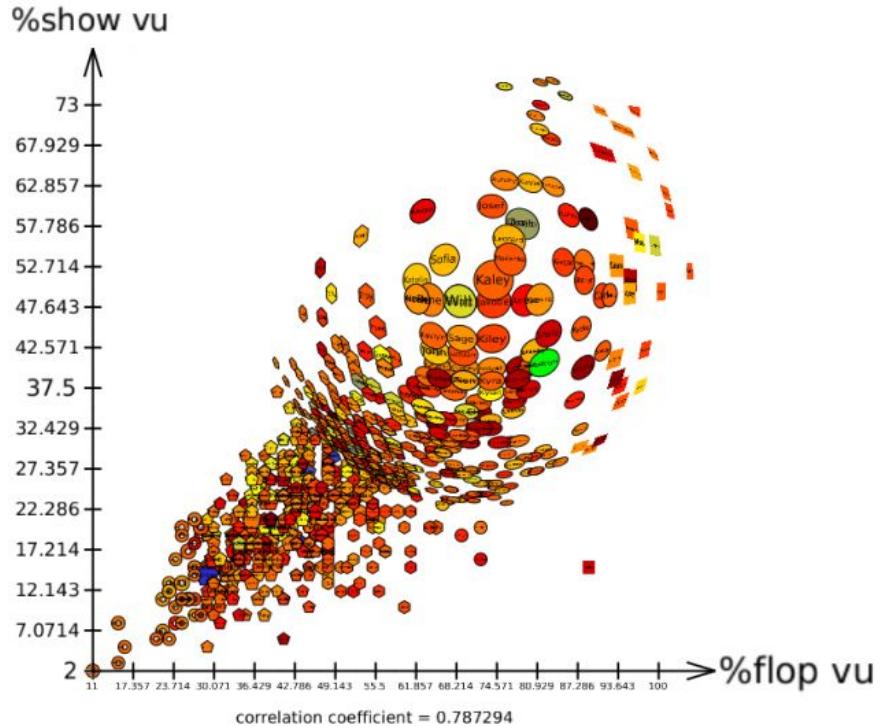


Wong, Nelson, Sheelagh Carpendale, and Saul Greenberg. "Edgelens: An interactive method for managing edge congestion in graphs." *IEEE Symposium on Information Visualization 2003 (IEEE Cat. No. 03TH8714)*. IEEE, 2003.

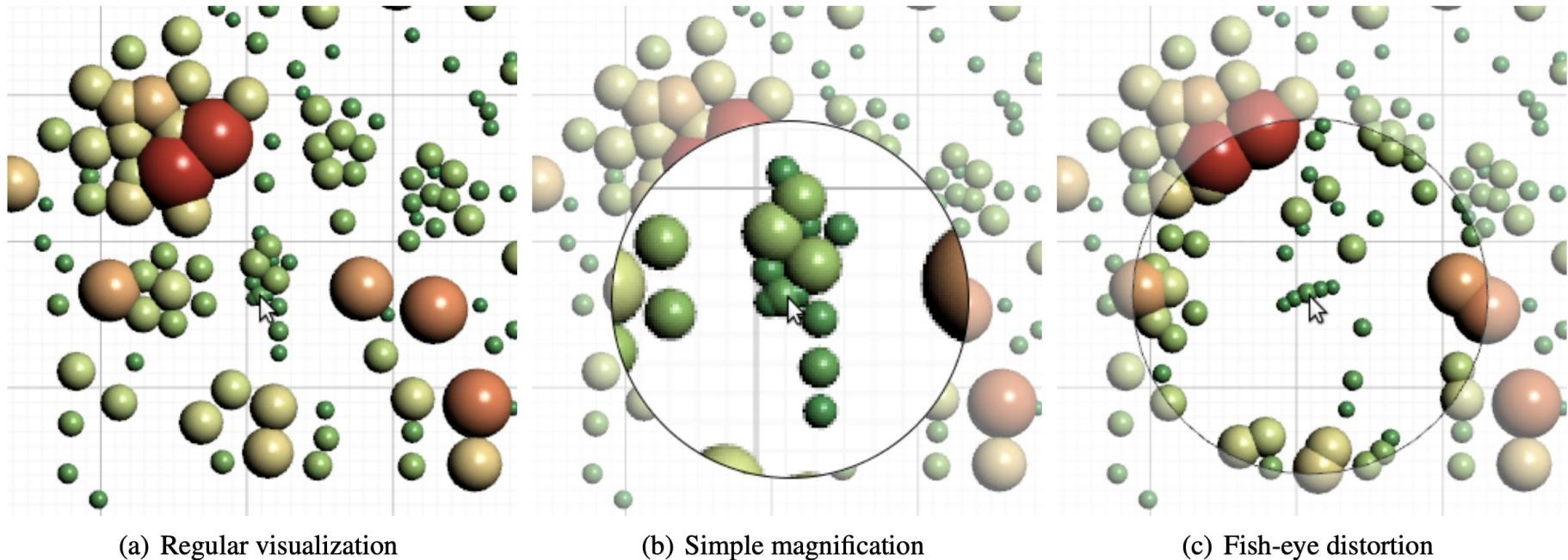
Abstract/Elaborate: **"Show me more or less detail"**



Abstract/Elaborate: Fisheye lenses



Explore: Lenses

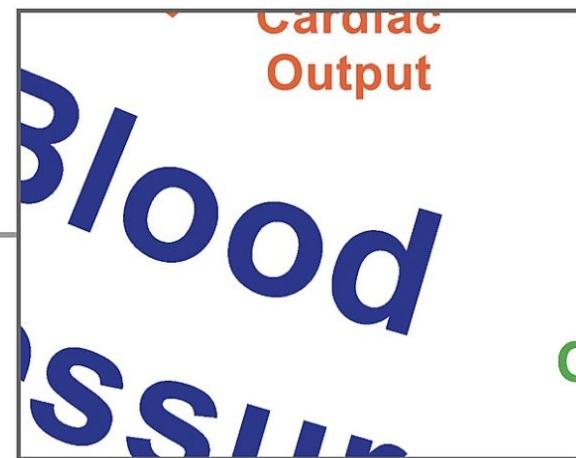
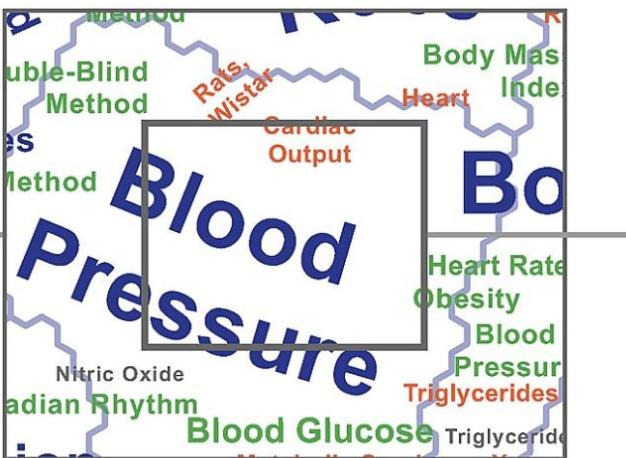
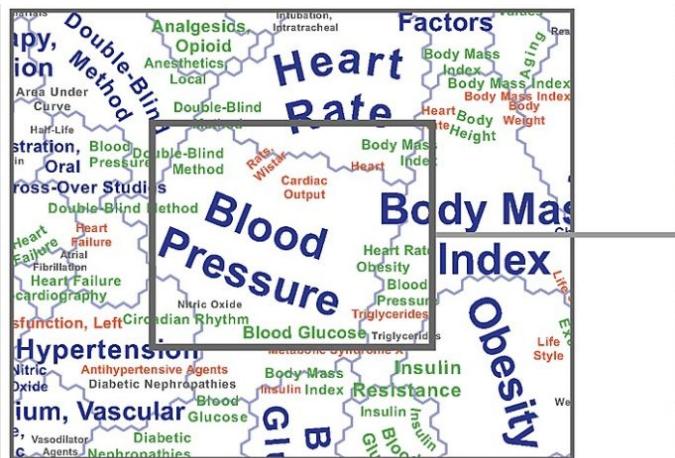


(a) Regular visualization

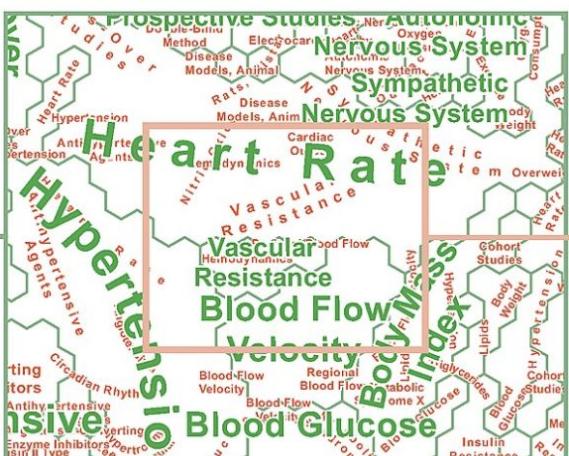
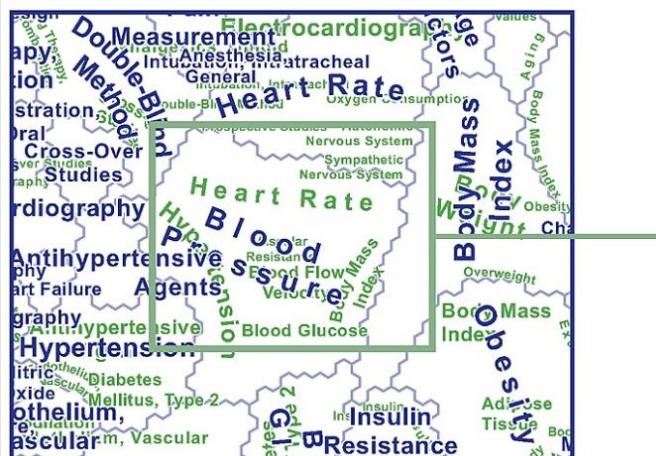
(b) Simple magnification

(c) Fish-eye distortion

Geometric Zoom ..



vs. Semantic Zoom:

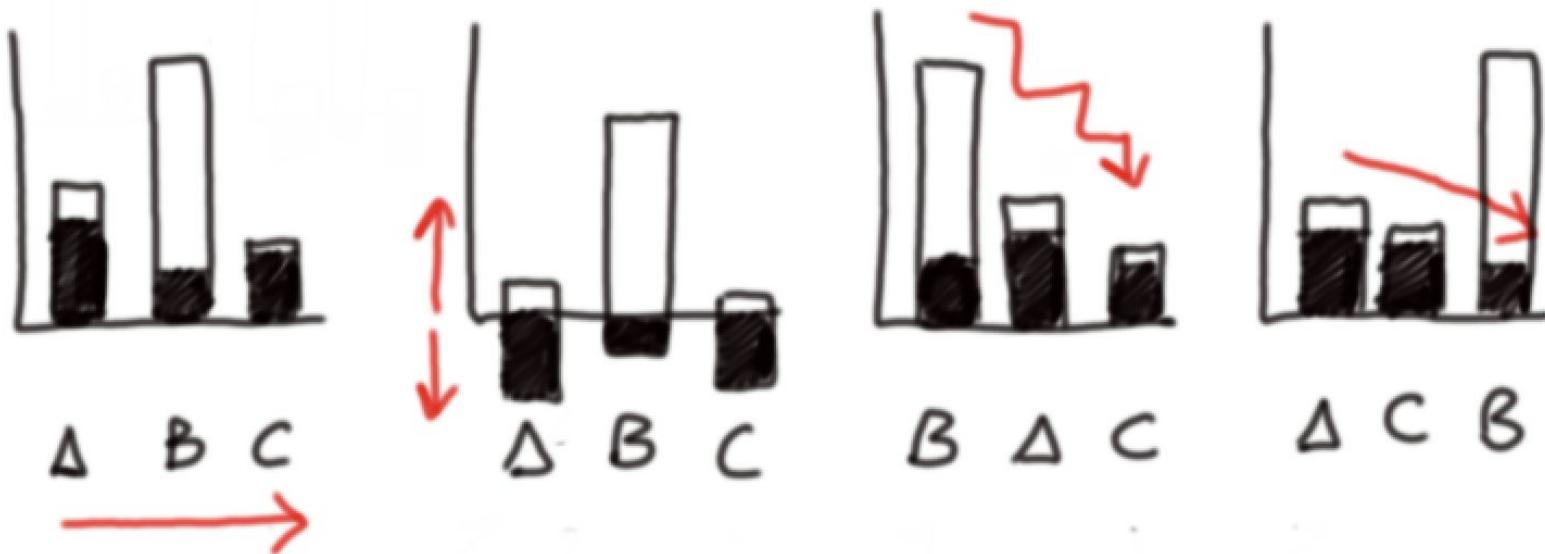


https://www.researchgate.net/figure/Juxtaposed-are-examples-of-geometric-zooming-into-the-static-display-of-multiple-levels_fig8_236105790

Explore: Zoom

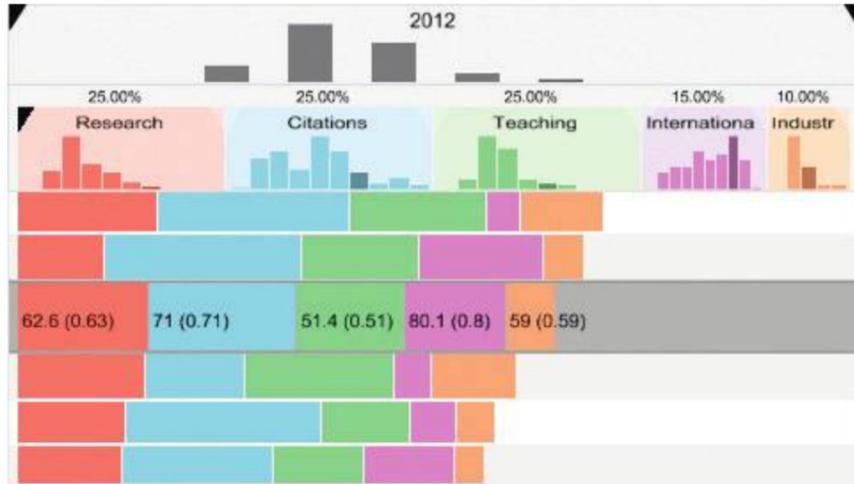


Reconfigure: "Show me a different arrangement"

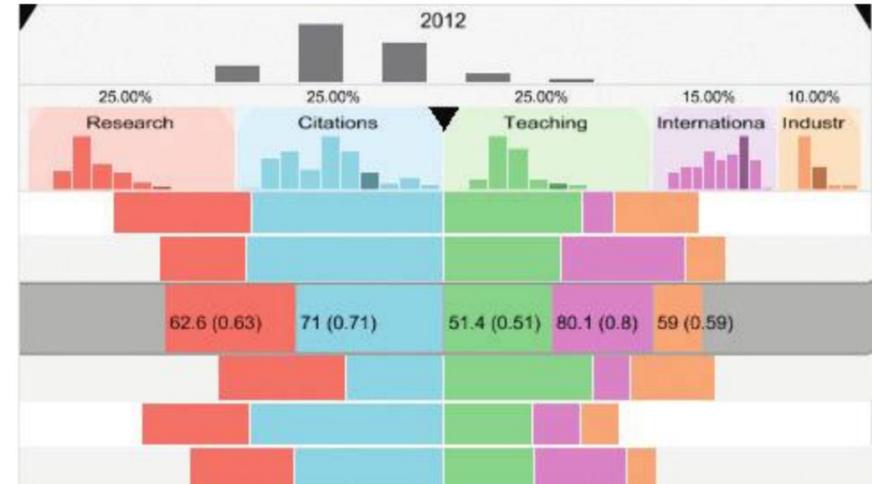


Stacked Bar Charts

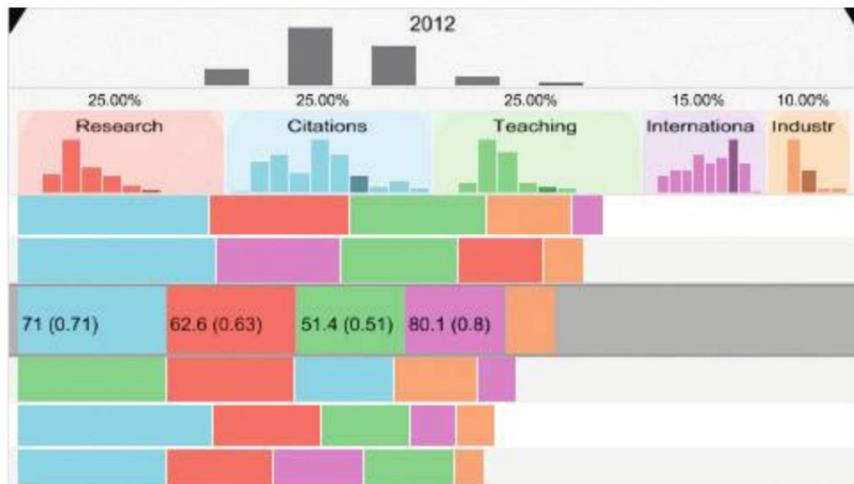
Gratzl, Samuel, et al. "Lineup: Visual analysis of multi-attribute rankings." *IEEE transactions on visualization and computer graphics* 19.12 (2013): 2277-2286.



(a)



(b)



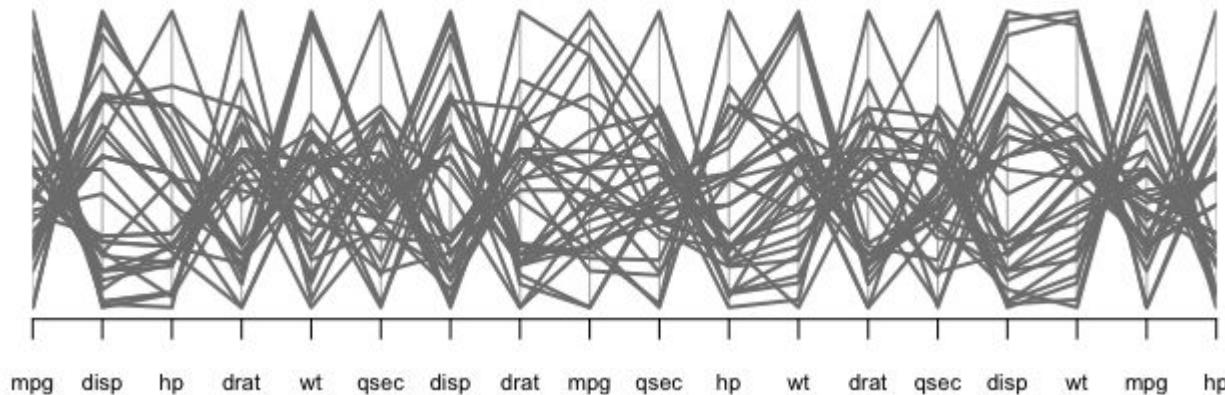
(c)



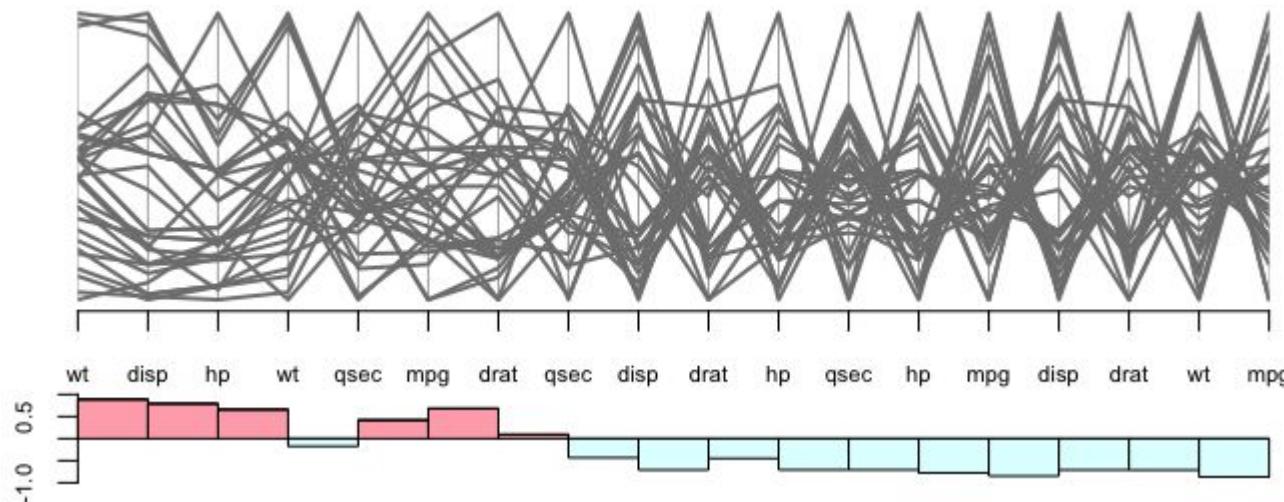
(d)

Reconfigure: Axes in PCP

Hamiltonian decomposition

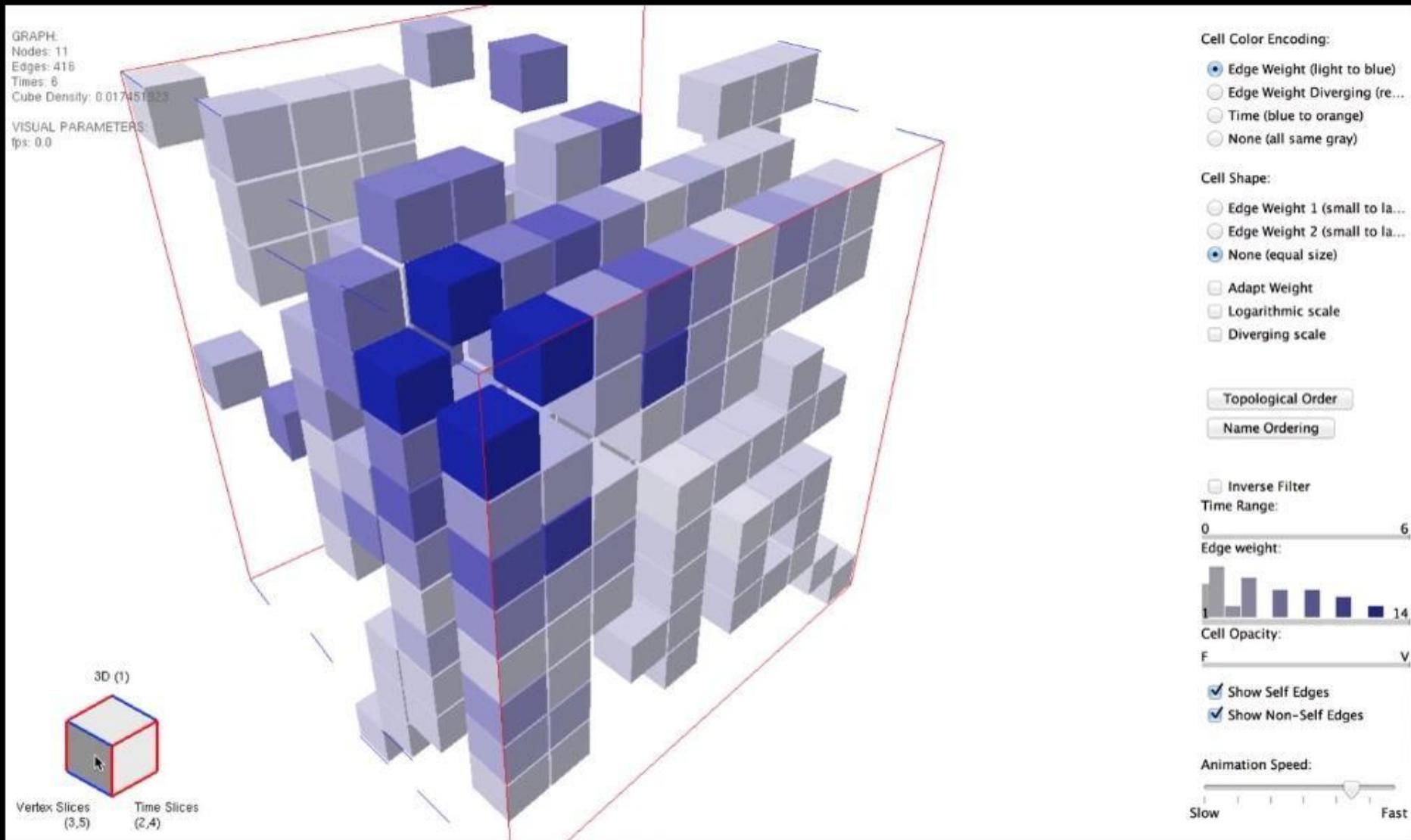


Weighted eulerian with correlation guide

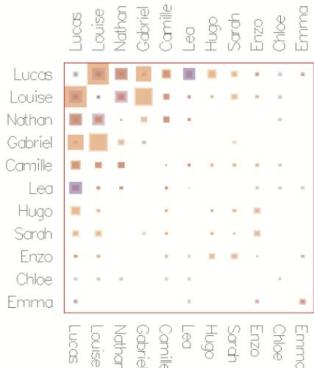


Reconfigure: 3D visualizations

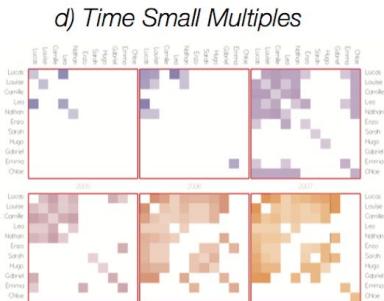
Bach, Benjamin, Emmanuel Pietriga, and Jean-Daniel Fekete. "Visualizing dynamic networks with matrix cubes." *Proceedings of the SIGCHI conference on Human Factors in Computing Systems*. 2014.



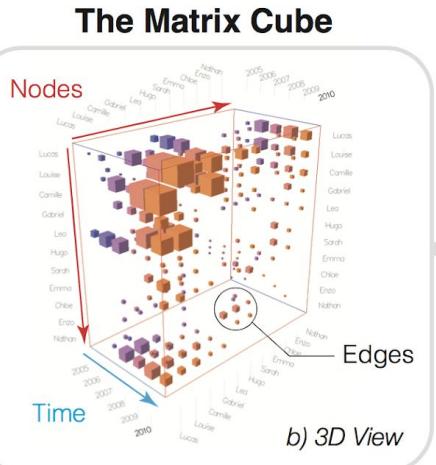
Reconfigure: 3D visualizations



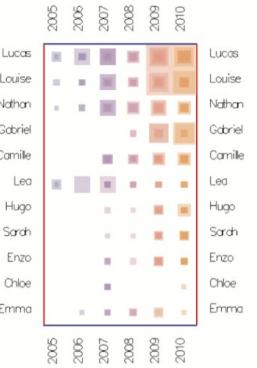
a) Rotation and Time Projection



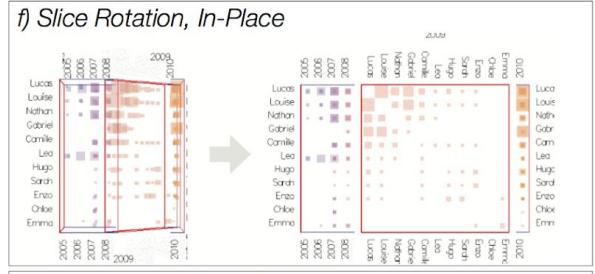
d) Time Small Multiples



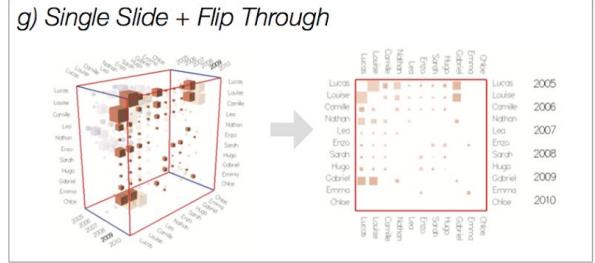
b) 3D View



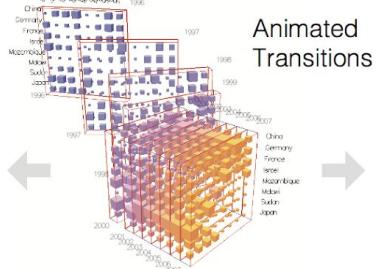
c) Rotation and Node Projection



f) Slice Rotation, In-Place



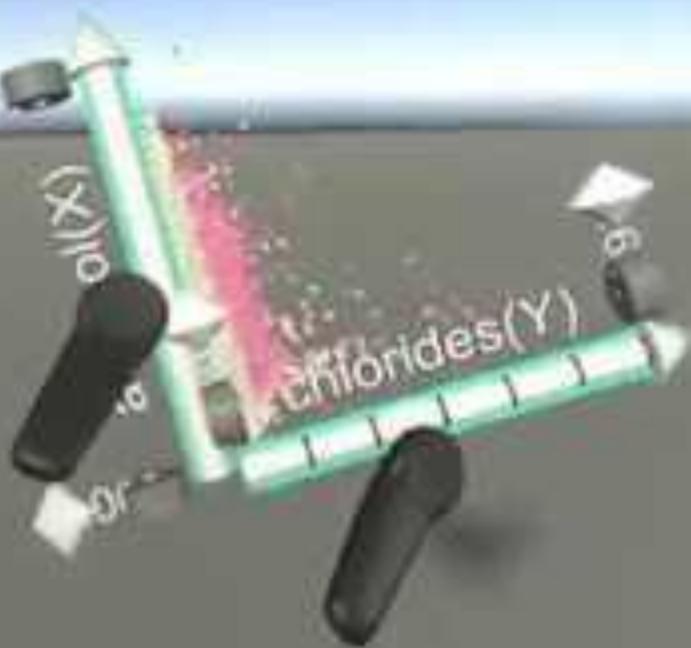
g) Single Slide + Flip Through



Animated Transitions

e) Node Small Multiples

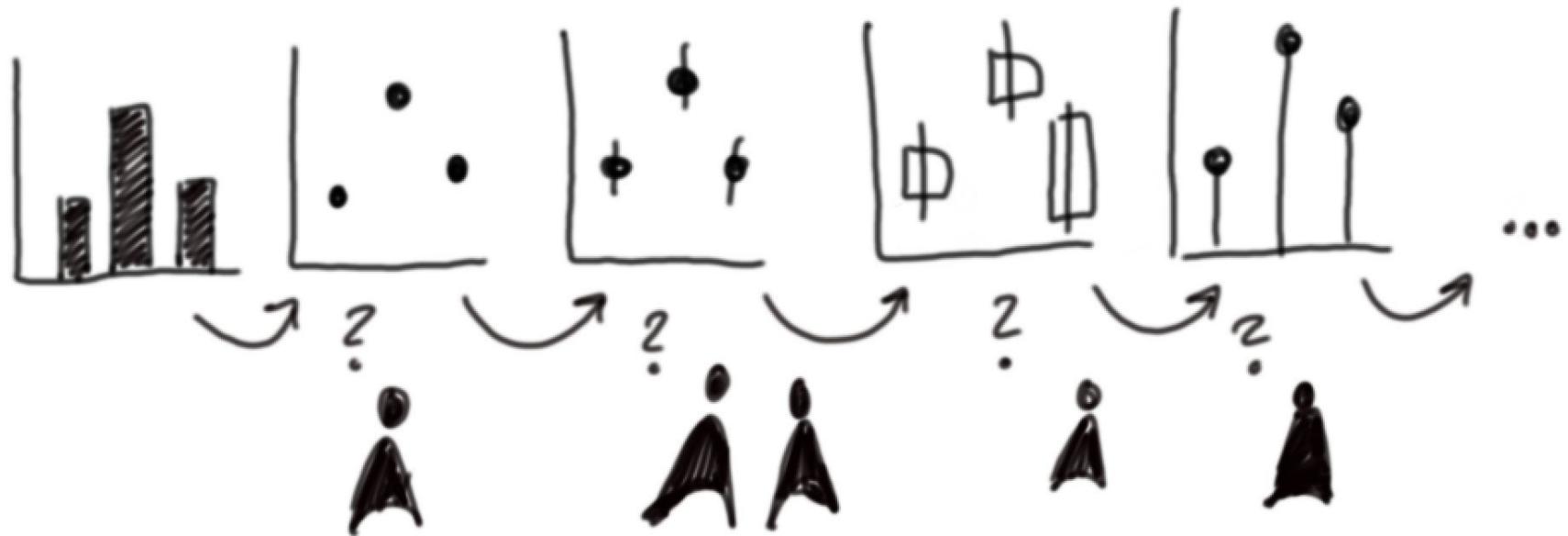
Reconfigure: Imaxis



<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, displaying 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, Norway, Switzerland, Denmark, Macao SAR, China, Australia, Sweden, United States, Netherlands, Canada, Ireland, Kuwait, Austria, Finland, Japan, Belgium, Singapore, Germany, United Arab Emirates, Iceland, and France. The plot includes a legend for 'Country / Region' and a note from Gaptminder.

File Data Worksheet Dashboard Analysis Map Format Server Window Help

Data

World Bank Indicators

Dimensions

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

Filters

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

Region

Avg(F: GDP per capita..)

Marks

- Automatic
- Color
- Size
- Label

Detail

Tooltip

Avg(F: GDP pe..)

Region

% of world .. △

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

Regions

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

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
France	\$39.5K

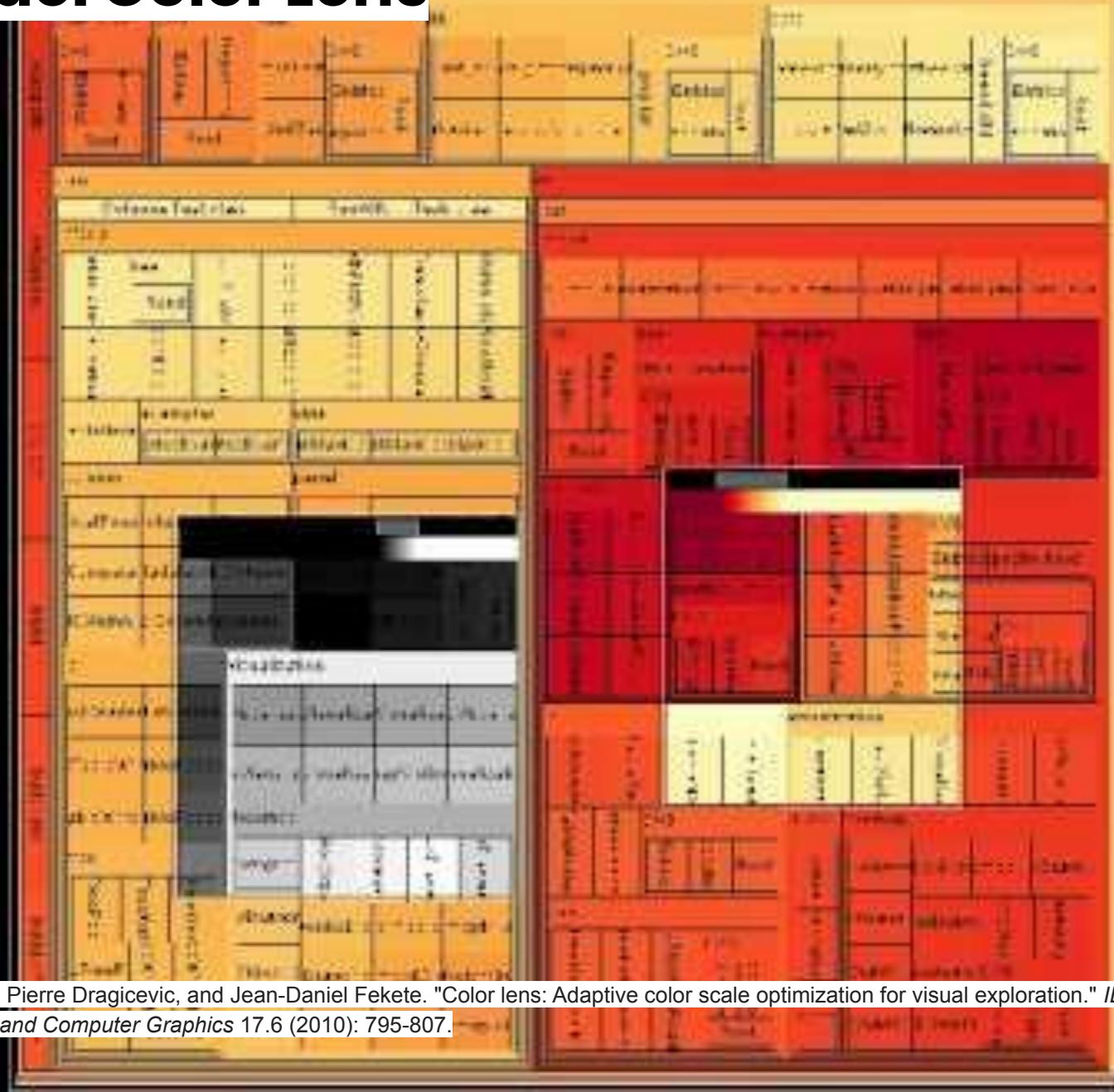
GDP per capita GDP per capita map GDP per capita by region GDP per Capita Dashboard Health spending vs life expecta...

The screenshot shows the Tableau interface. A bar chart displays 'GDP per capita' for various countries, color-coded by region. The Y-axis lists countries: Luxembourg, Bermuda, Norway, Qatar, Switzerland, Denmark, Macao SAR, China, Australia, Sweden, United States, Netherlands, Canada, Ireland, Kuwait, Austria, Finland, Japan, Belgium, Singapore, Germany, United Arab Emirates, Iceland, and France. The X-axis shows GDP values from \$20.0K to \$120.0K. A tooltip for Luxembourg shows a value of \$104.5K. The interface includes a sidebar with various visualization icons and a note about symbol maps.

Data Wrapper

Tableau

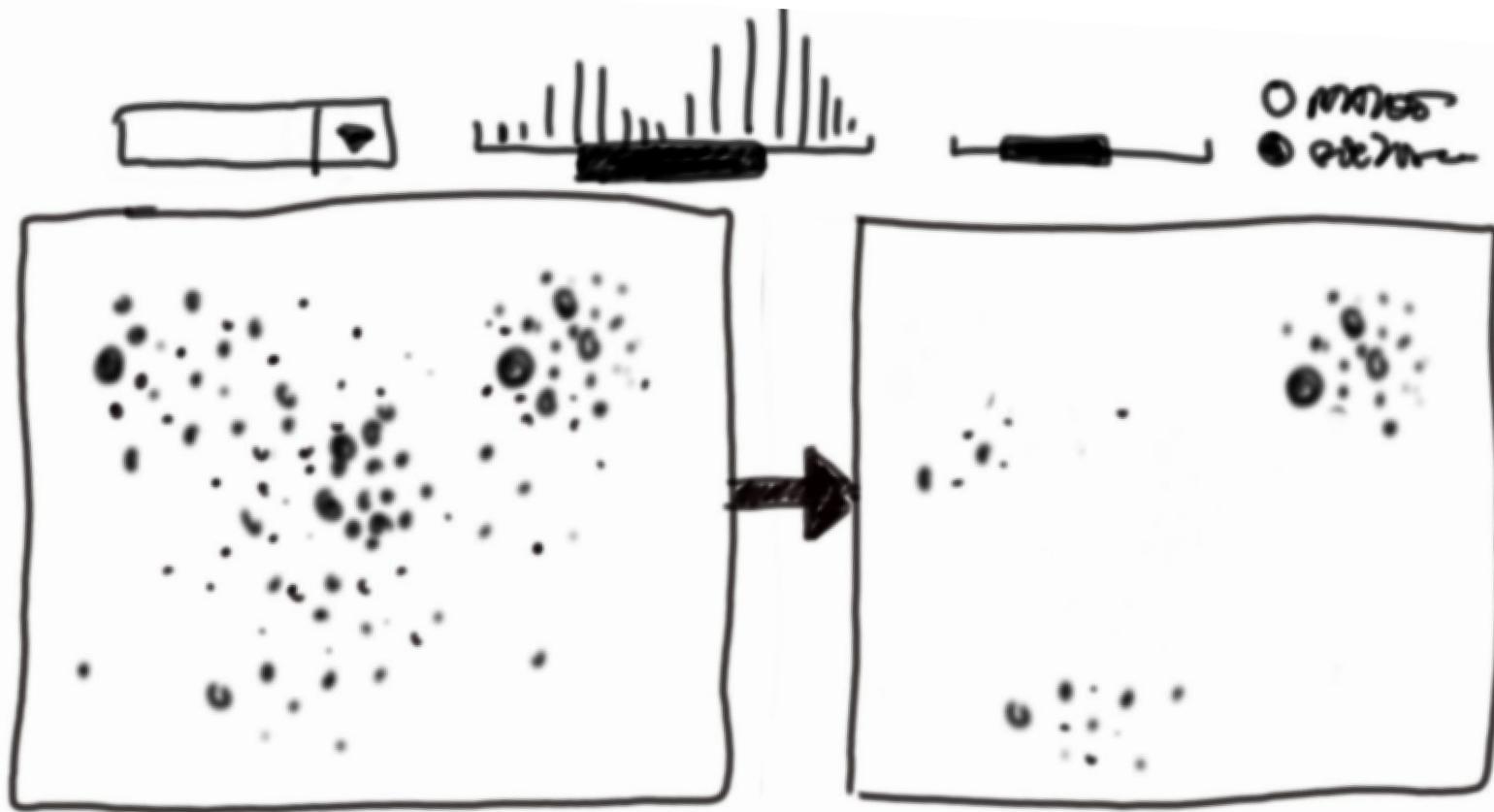
Encode: Color Lens



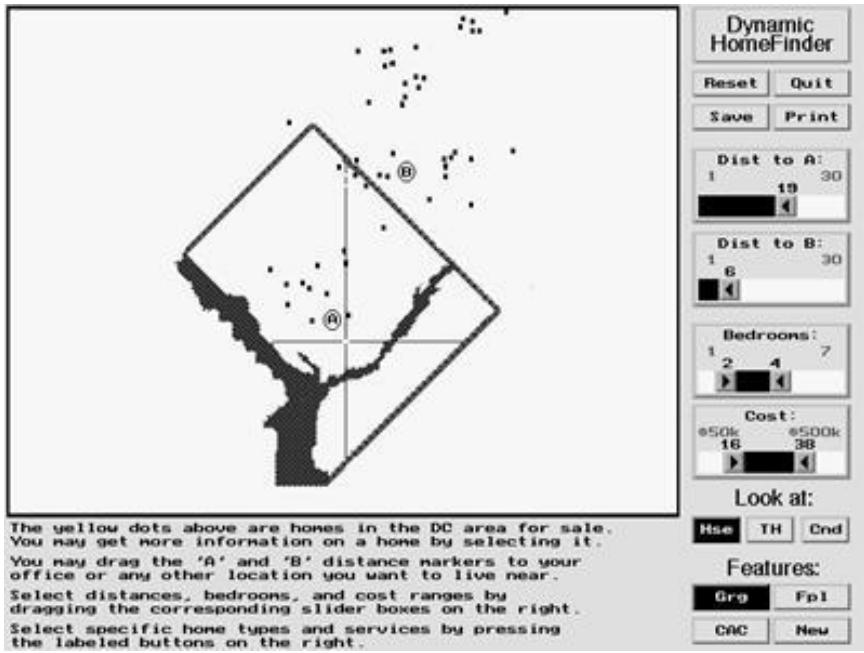
Elmqvist, Niklas, Pierre Dragicevic, and Jean-Daniel Fekete. "Color lens: Adaptive color scale optimization for visual exploration." *IEEE Transactions on Visualization and Computer Graphics* 17.6 (2010): 795-807.

Filter: "*show me something conditionally*"

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



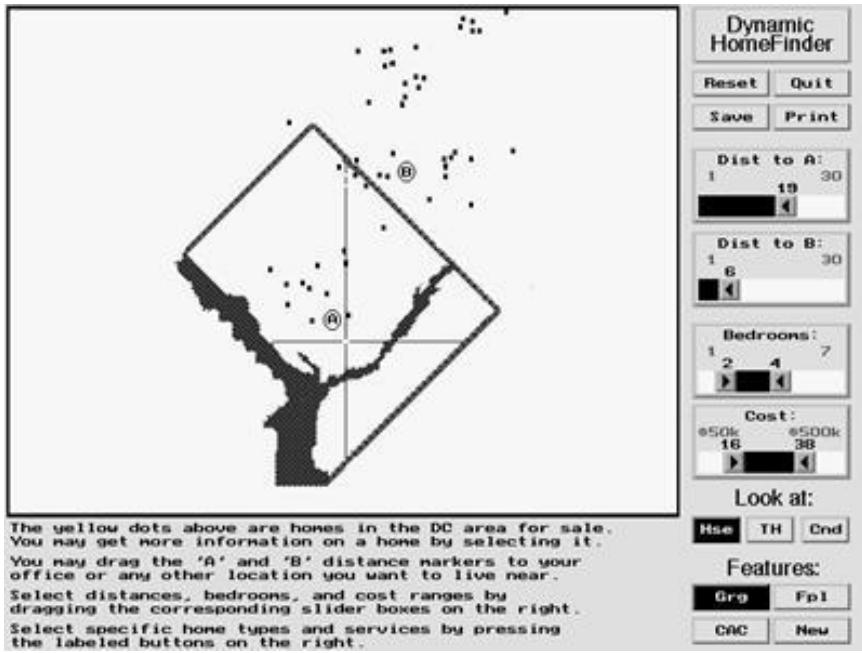
Filter: Dynamic Queries



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.

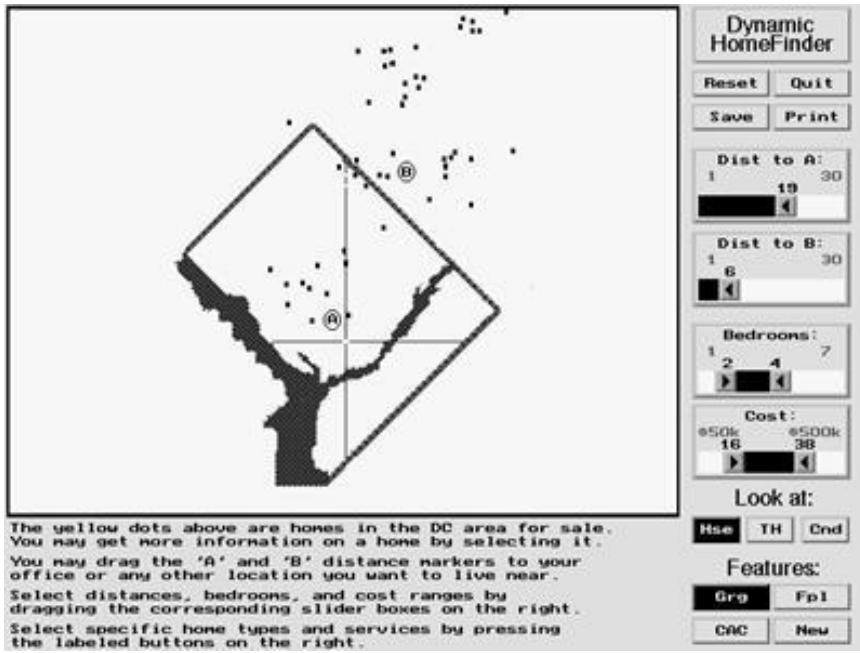
Range slider + Histogram:

€9 - €562

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



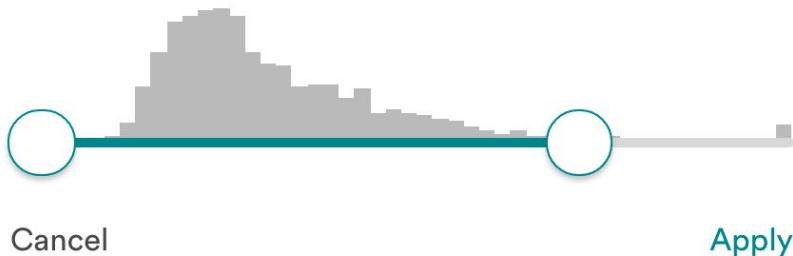
Filter: Dynamic Queries



Range slider + Histogram:

€9 - €562

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



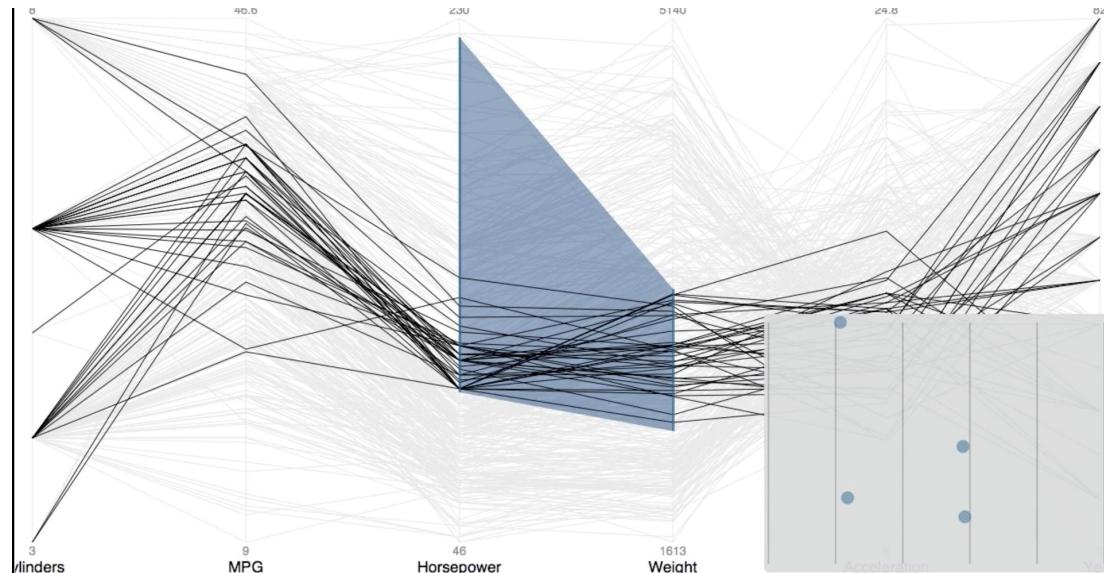
Multiple aRnge sliders

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

Google Suggest:

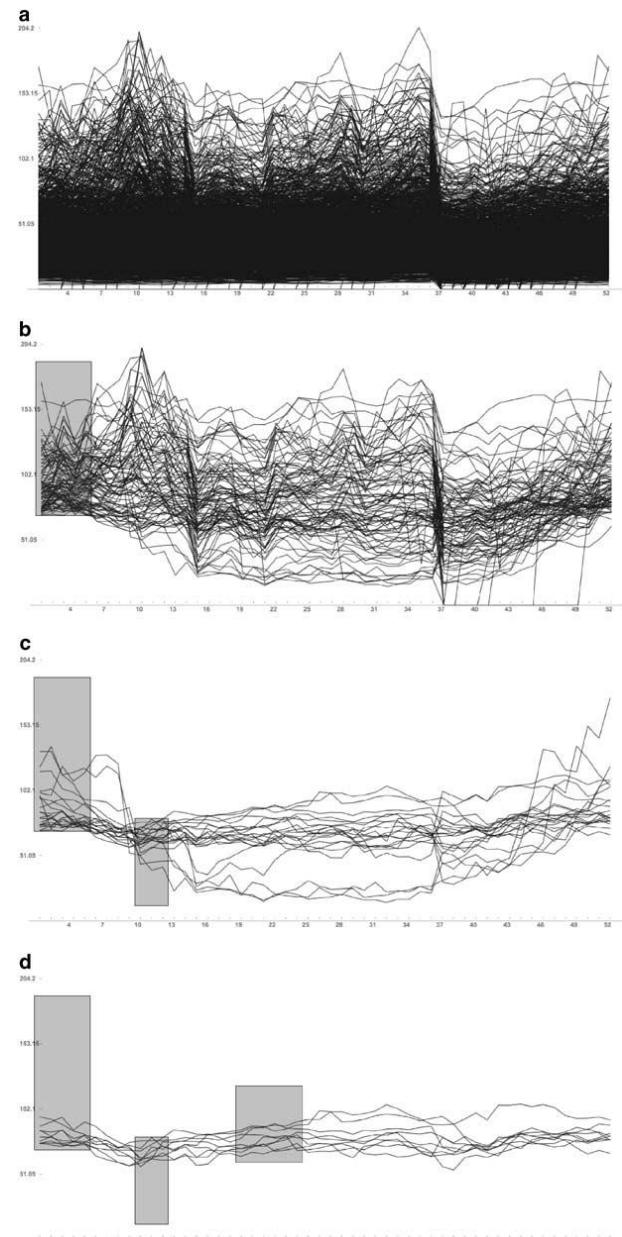
- why are german|
- why are germans so
- why are german words so long
- why are german cars so good
- why are german cars limited to 155mph
- why are german kitchens the best
- why are german shepherds so protective
- why are german shepherds aggressive
- why are german football fans protesting
- why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

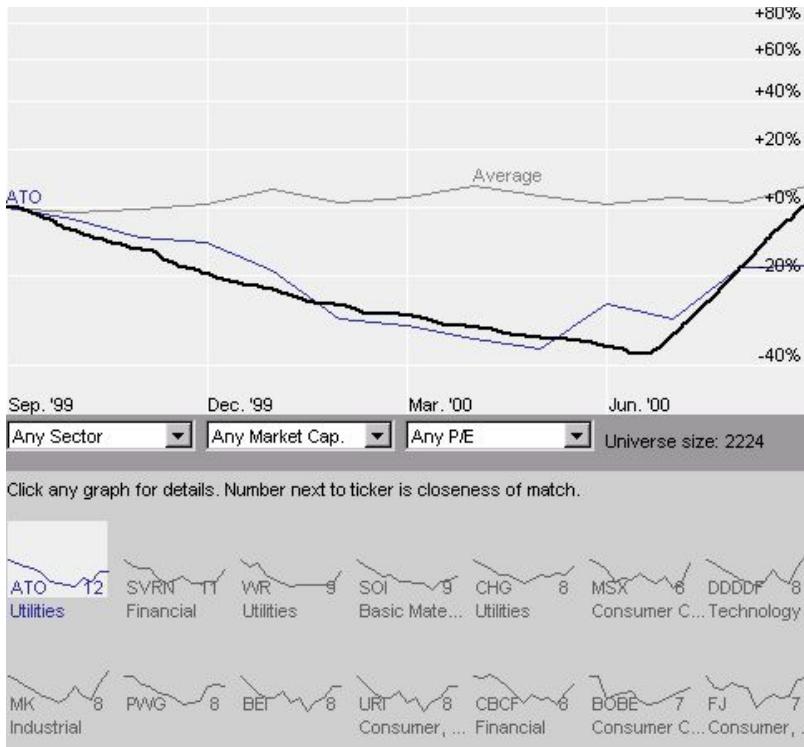
<https://vimeo.com/13437693>



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

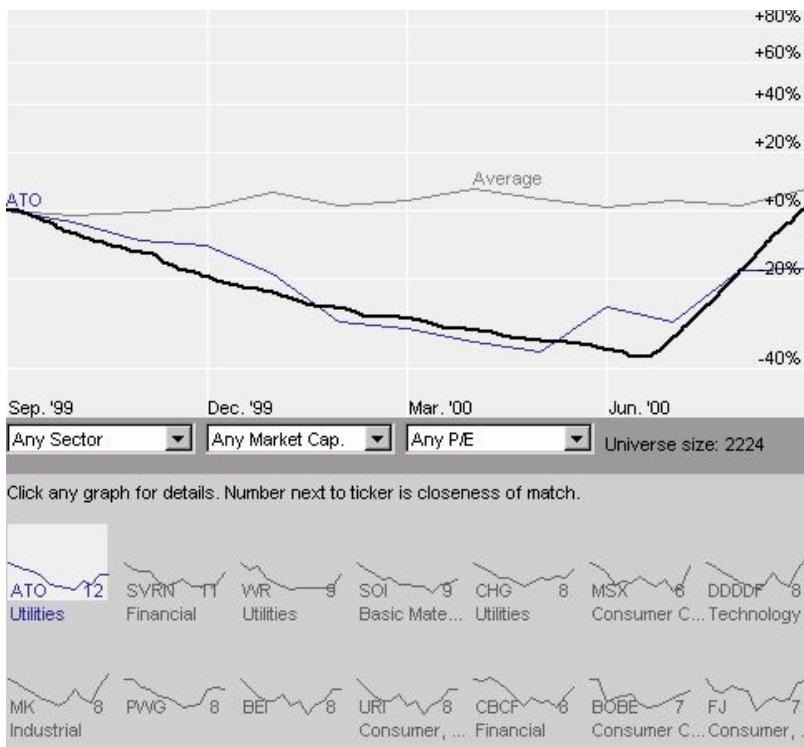
QuerySketch: sketch paths



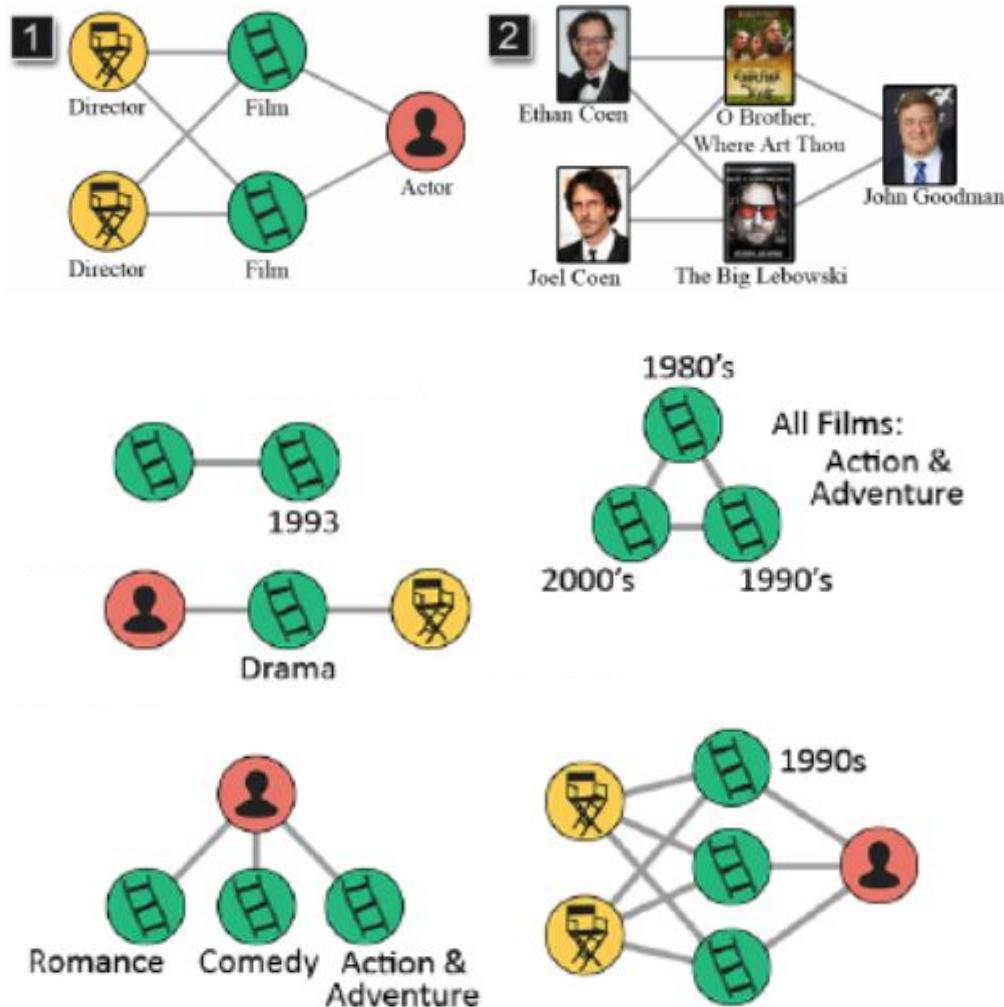
Wattenberg, Martin. "Sketching a graph to query a time-series database." *CHI'01 Extended Abstracts on Human factors in Computing Systems*. 2001.

Filter: Sketch

QuerySketch: sketch paths



Build (Graph) Query

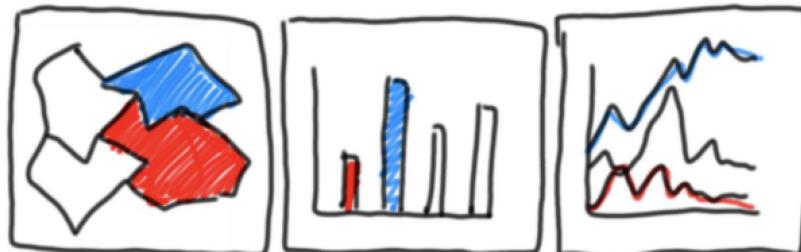


Wattenberg, Martin. "Sketching a graph to query a time-series database." *CHI'01 Extended Abstracts on Human factors in Computing Systems*. 2001.

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



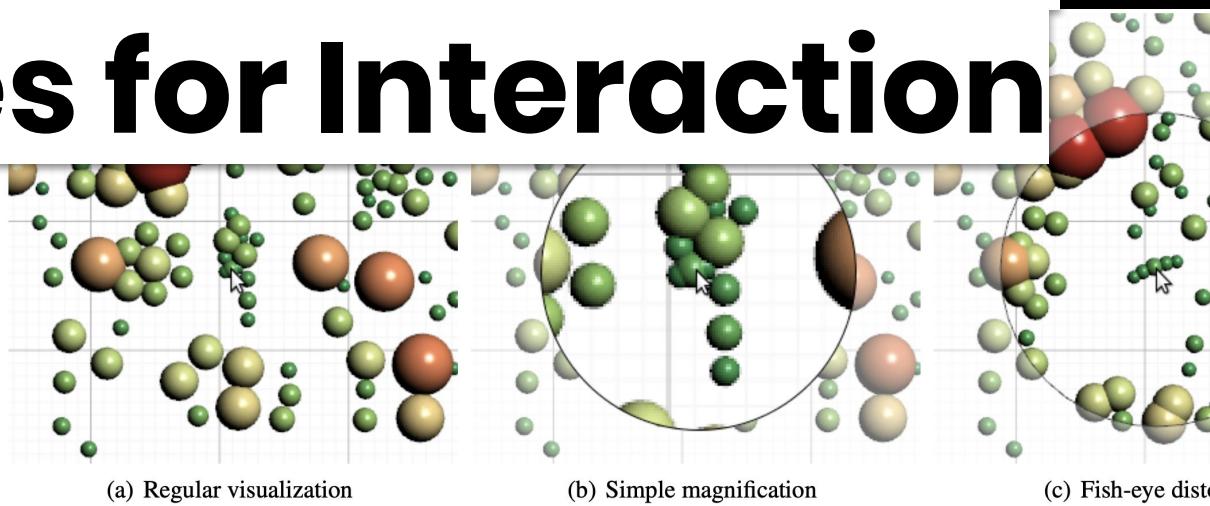
Connect: Brushing and Linking





Interaction for Visualization

Guidelines for Interaction



(a) Regular visualization

(b) Simple magnification

(c) Fish-eye disto



Online Course
**Data Visualization
for Professionals**



THE UNIVERSITY
of EDINBURGH

Benjamin Bach

June 2020

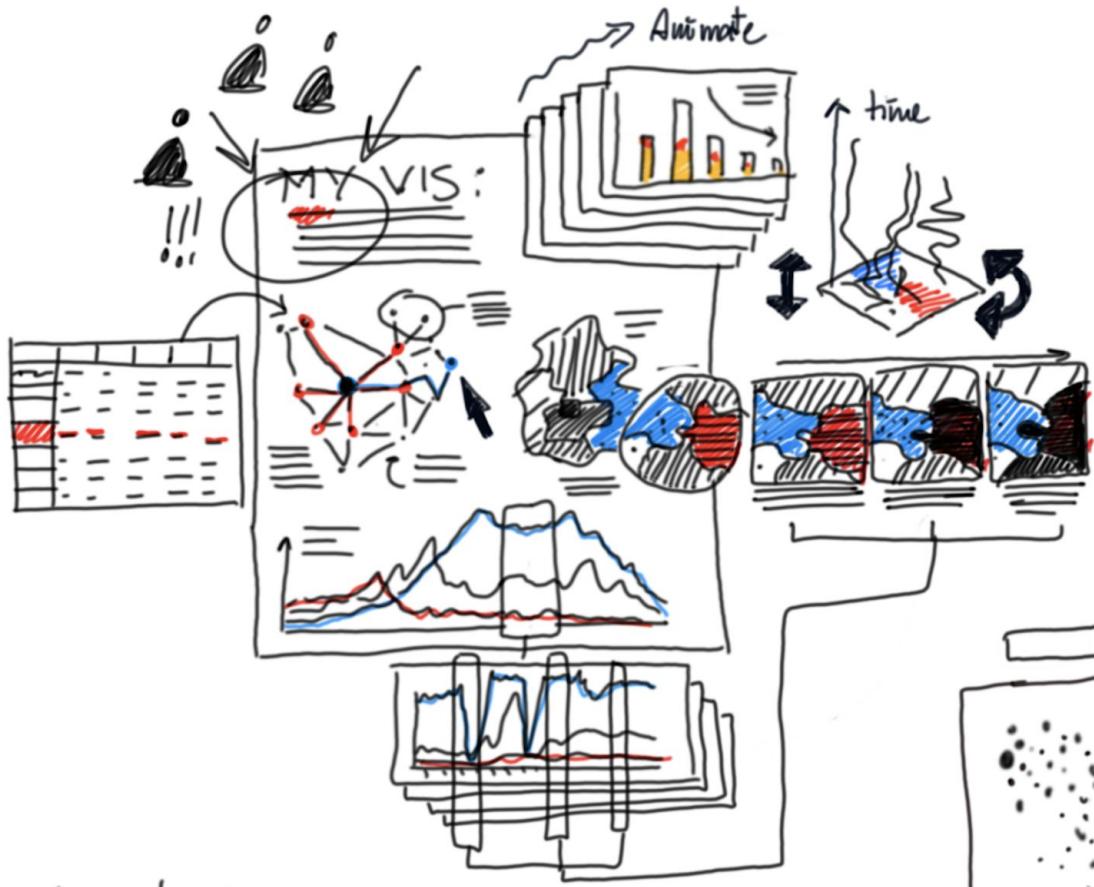
<http://benjbach.me>

<https://datavis-online.github.io>

-- Not for external use --

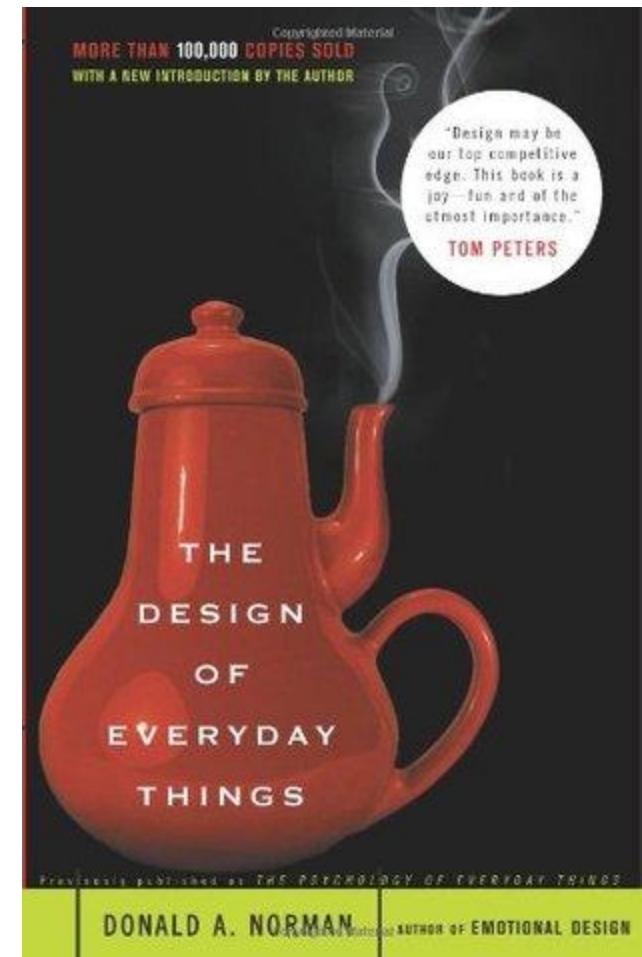
Mental Map

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



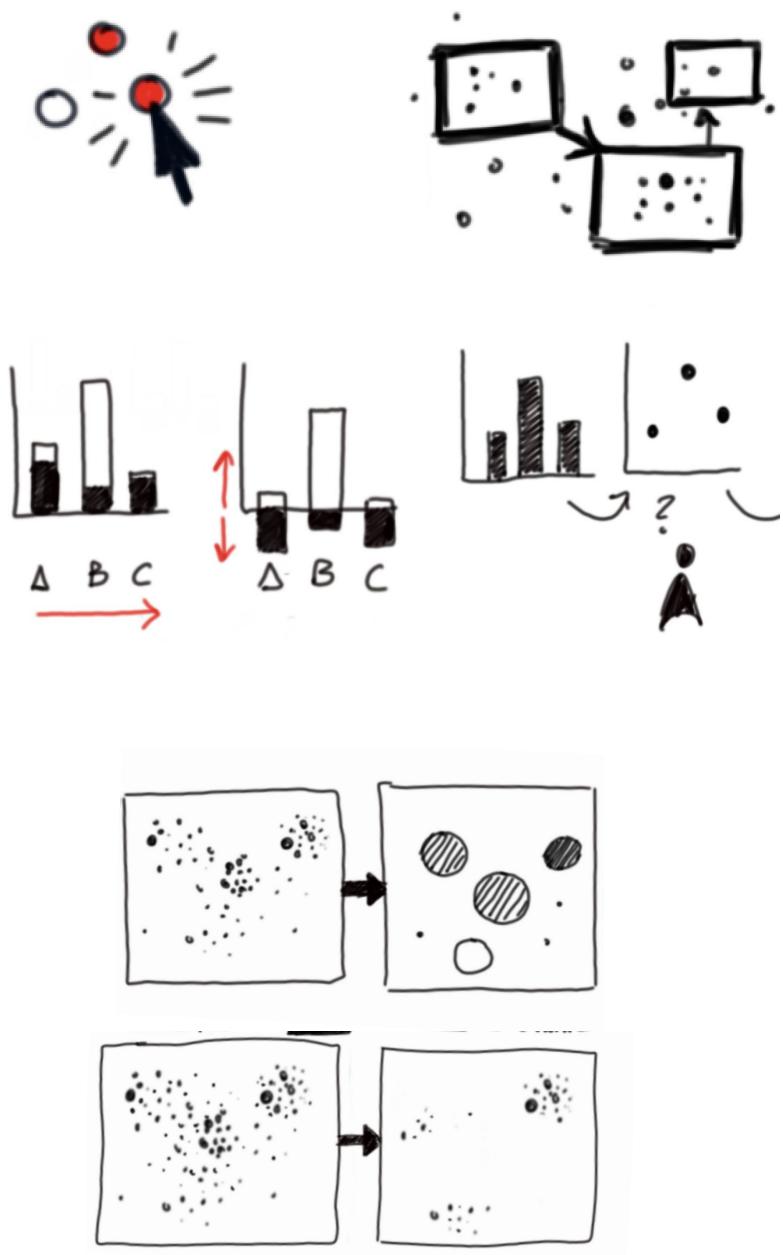
Guidelines for Interaction in Visualization

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 Readings

- 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.