INTERACTION

SPECTRUM

Static content

Infographics

Books

Dynamic content

1. Animated content

   “Auto-play”, user is not in control

2. **Interactive content**

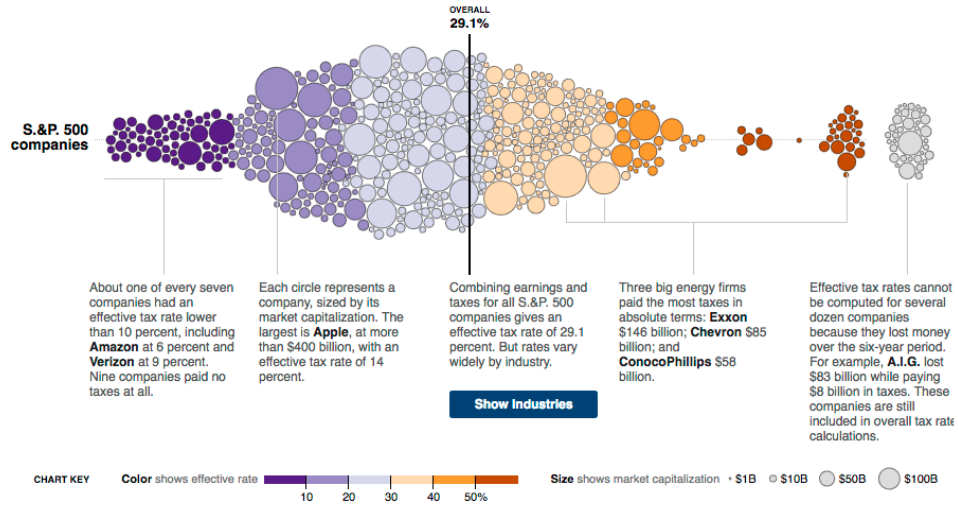
   Changes are a result of user actions

WHY INTERACT WITH VISUALIZATION?

Need to explore data that is big/complex

Too much data

Too many ways to show it

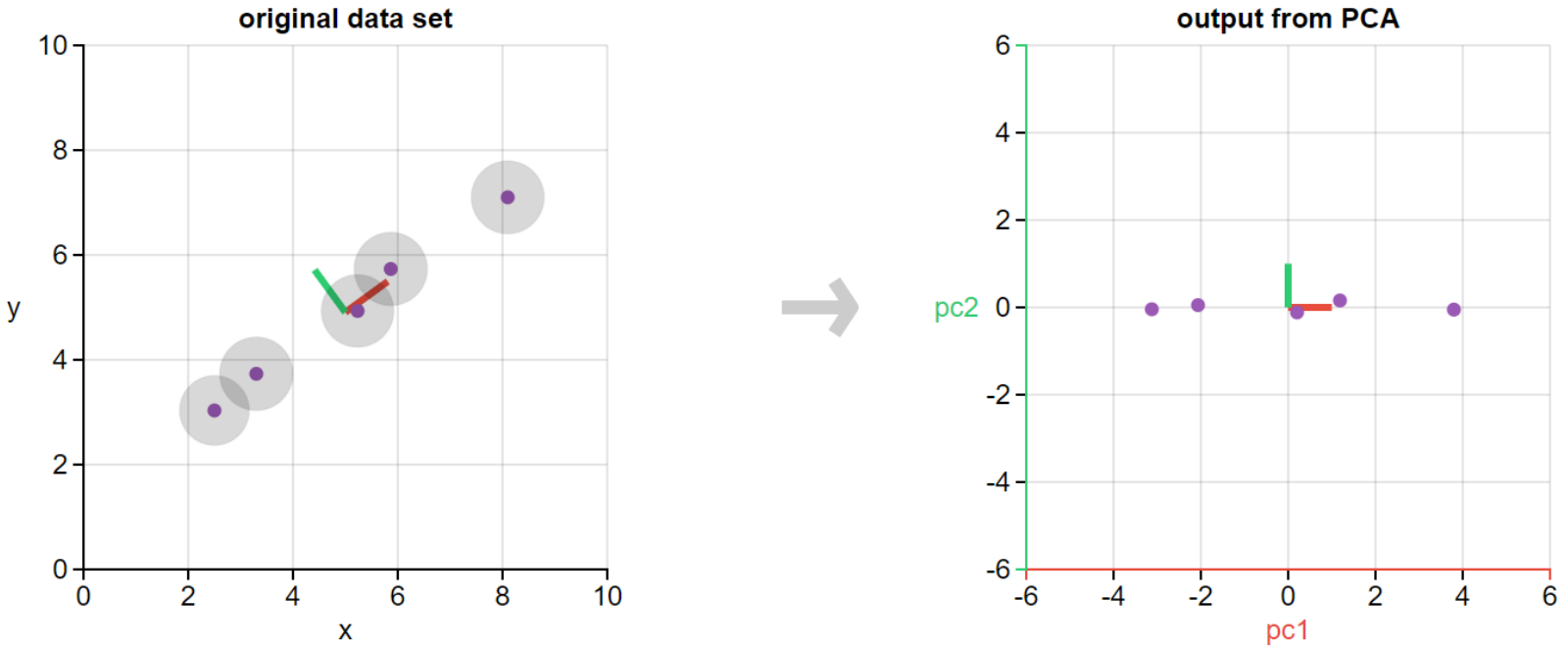


WHY INTERACTION WITH VIS?

Interaction amplifies cognition

Understand things better if we can touch them

When we can observe cause and effect



https://setosa.io/ev/principal-component-analysis/

INTERACTION METHODS

What do you design for?

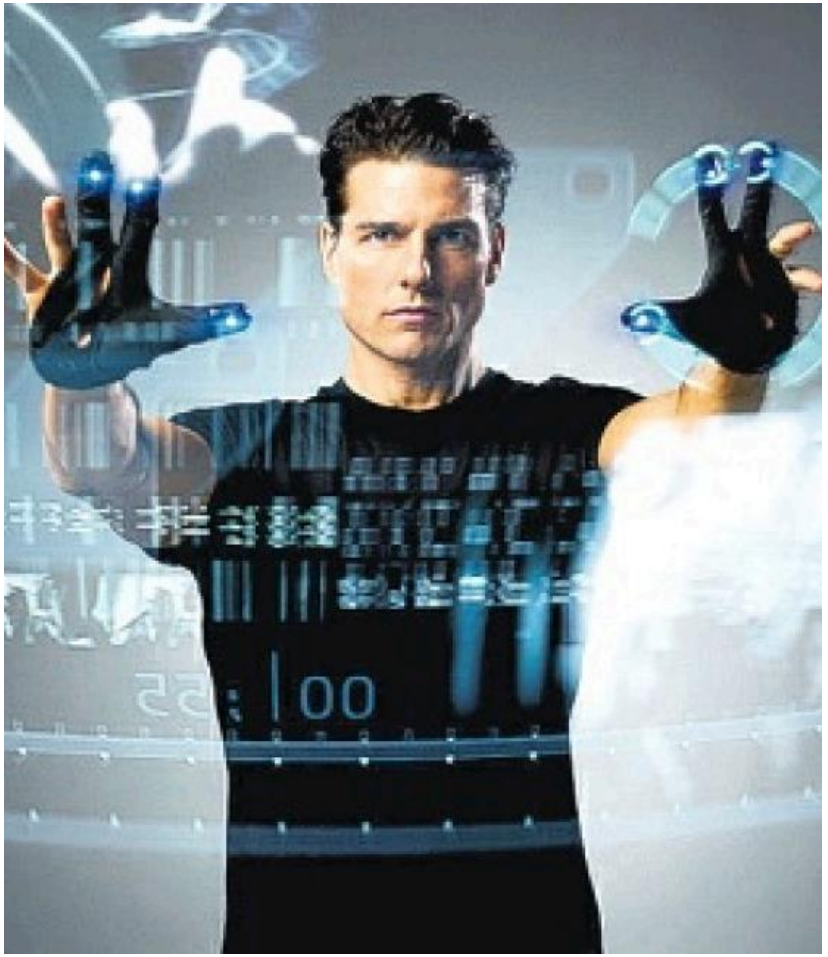
Mouse, keyboard?

Touch interaction / mobile?

Gestures?

Eye movement?

Speech?

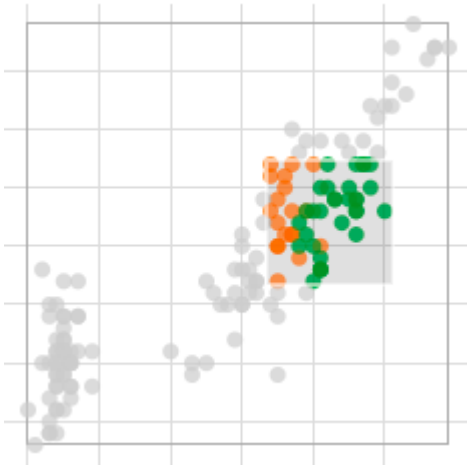


https://www.youtube.com/watch?v=QXLfT9sFcbc

DIRECT MANIPULATION

Interact directly with objects

Continuous feedback/updates



Indirect interact

Using a query, a slides, etc.

https://observablehq.com/@d3/brushable-scatterplot-matrix

TYPES OF INTERACTION

Single view

Change over time

Navigation

Semantic zooming

Filtering and Querying

Focus + Context

Multiple views

Selection (Details on demand)

Linking & brushing

Adapting representation

PURPOSES OF INTERACTION

DOI:10.1145/2133806.2133821

Article development led by acmqueue
queue.acm.org

A taxonomy of tools that support the fluent and flexible use of visualizations.

BY JEFFREY HEER AND BEN SHNEIDERMAN

Interactive Dynamics for Visual Analysis

TABLE 1: Taxonomy of interactive dynamics for visual analysis

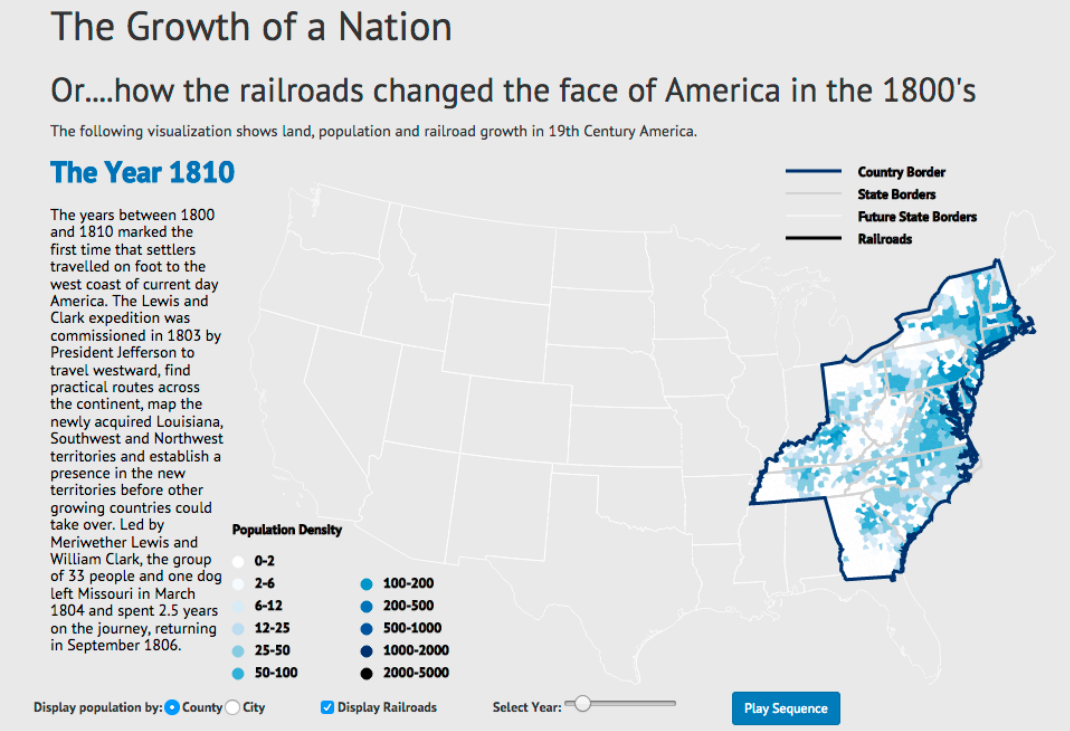
Data & View Specification	**Visualize** data by choosing visual encodings. **Filter** out data to focus on relevant items. **Sort** items to expose patterns. **Derive** values or models from source data.
View Manipulation	**Select** items to highlight, filter, or manipulate them. **Navigate** to examine high-level patterns and low-level detail. **Coordinate** views for linked, multi-dimensional exploration. **Organize** multiple windows and workspaces.
Process & Provenance	**Record** analysis histories for revisitation, review and sharing. **Annotate** patterns to document findings. **Share** views and annotations to enable collaboration. **Guide** users through analysis tasks or stories.

CHANGE OVER TIME/TRANSITIONS

CHANGE OVER TIME

Use slides to see view with data at different times

Sometimes better to show difference explicitly



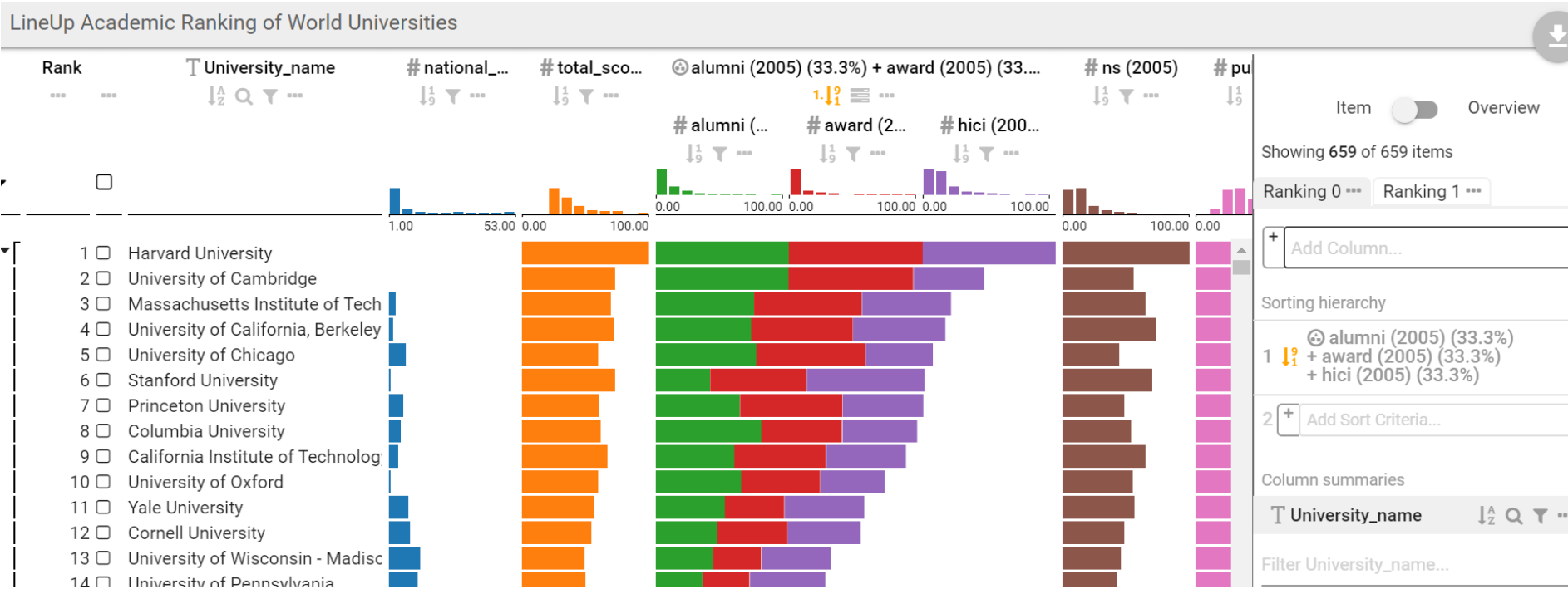
http://laurenwood.github.io/

CHANGE OVER TIME

Doesn't have to be literal time:

change as you go

as part of an analysis process



https://lineup.js.org/app/#shanghai

https://caleydo.org/tools/lineup/

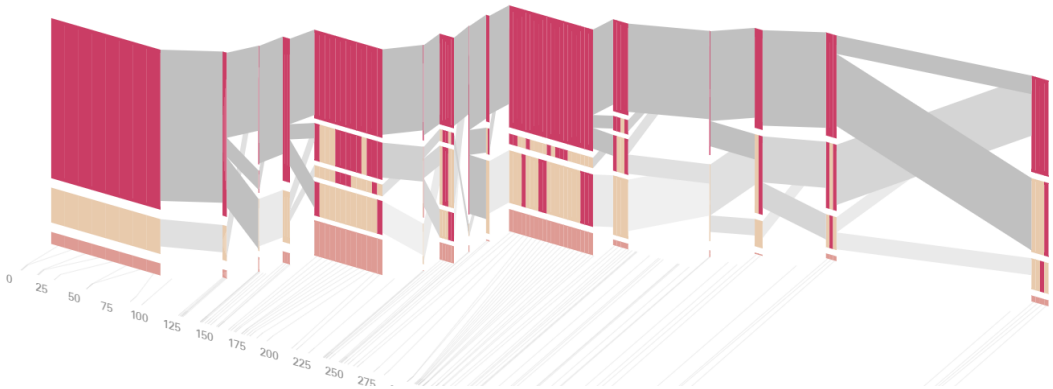
WHY TRANSITION?

Different representations support different tasks

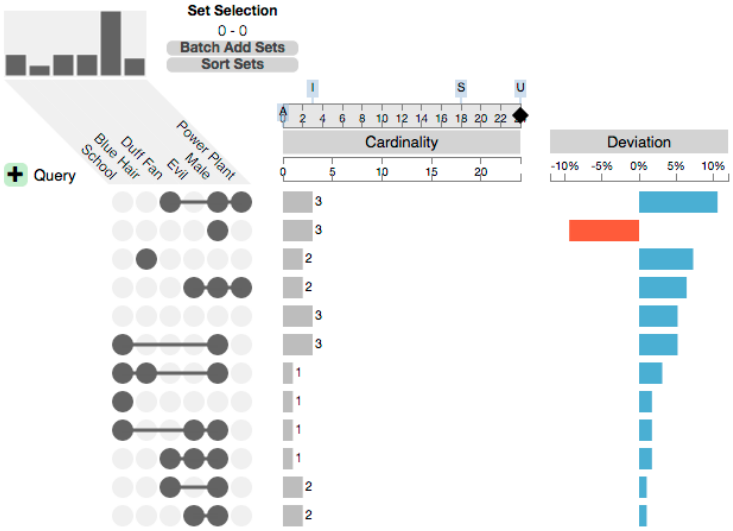
Bar chart vs stacked bar chart

Change ordering

Transition make it possible for users to track what is going on



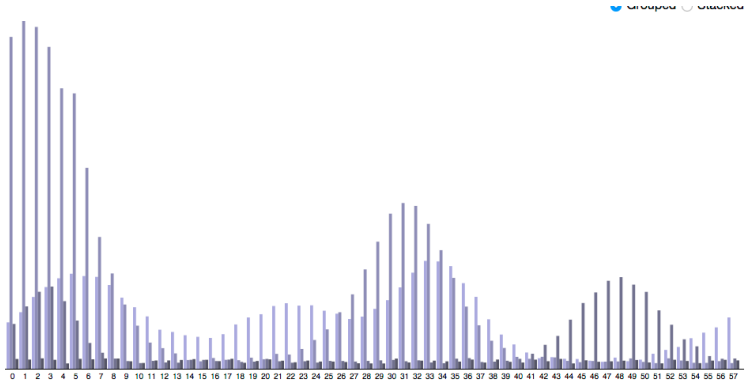
https://benfry.com/isometricblocks/



http://vcg.github.io/upset/

ANIMATED TRANSITIONS

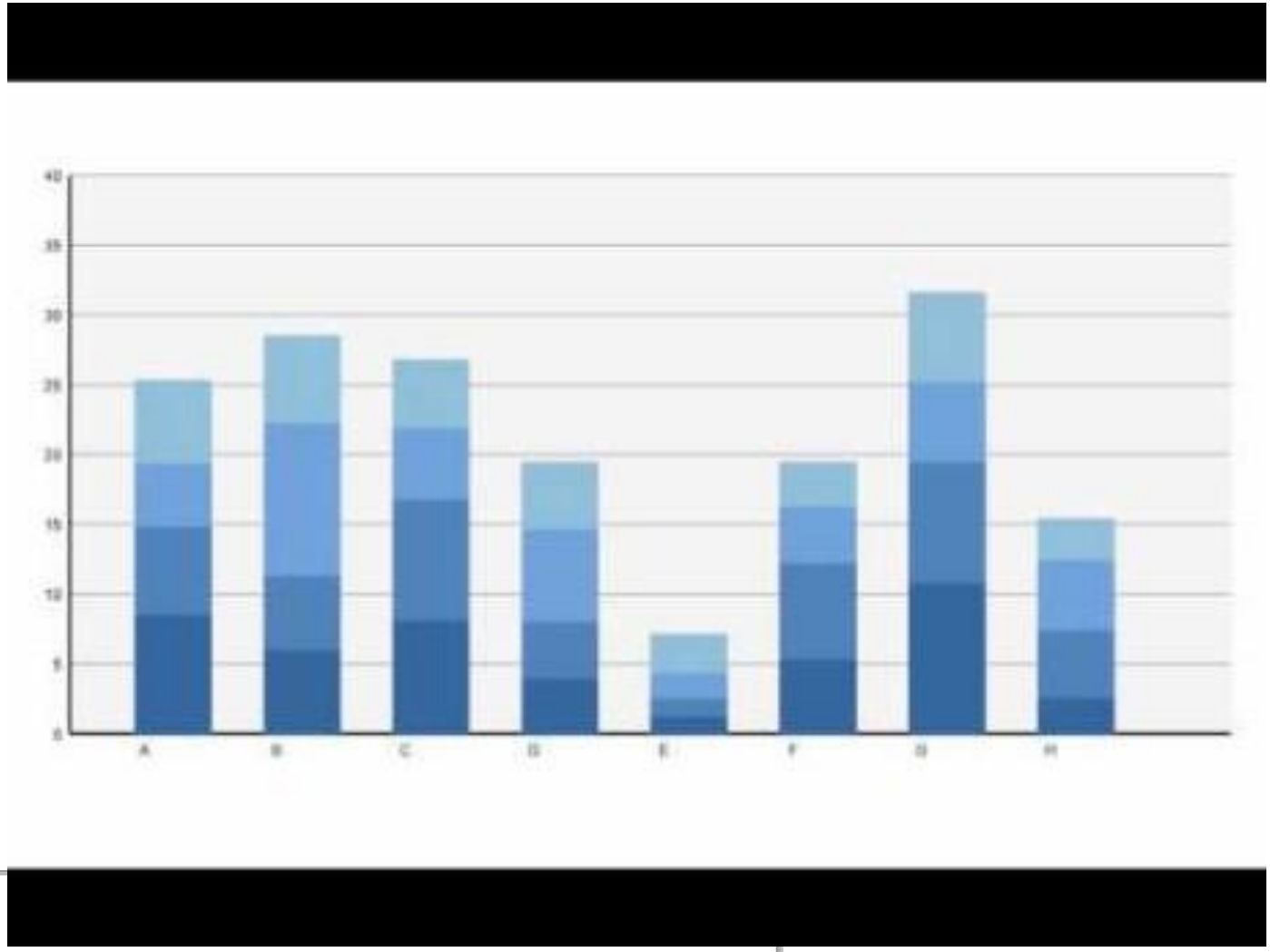
Smooth interpolation between states or visualization techniques



http://bl.ocks.org/mbostock/3943967

https://observablehq.com/@d3/zoomable-sunburst

WHY ANIMATED TRANSITION?



Animated Transitions in Statistical Data Graphics

Jeffrey Heer, George G. Robertson

Abstract—In this paper we investigate the effectiveness of animated transitions between common statistical data graphics such as bar charts, pie charts, and scatter plots. We extend theoretical models of data graphics to include such transitions, introducing a taxonomy of transition types. We then propose design principles for creating effective transitions and illustrate the application of

https://youtu.be/vLk7mlAtEXI

ANIMATION CAVEATS (WARNING)

Changes can be hard to track

Eyes over memory

Show all states in multiple views

NAVIGATION

NAVIGATION

Pan

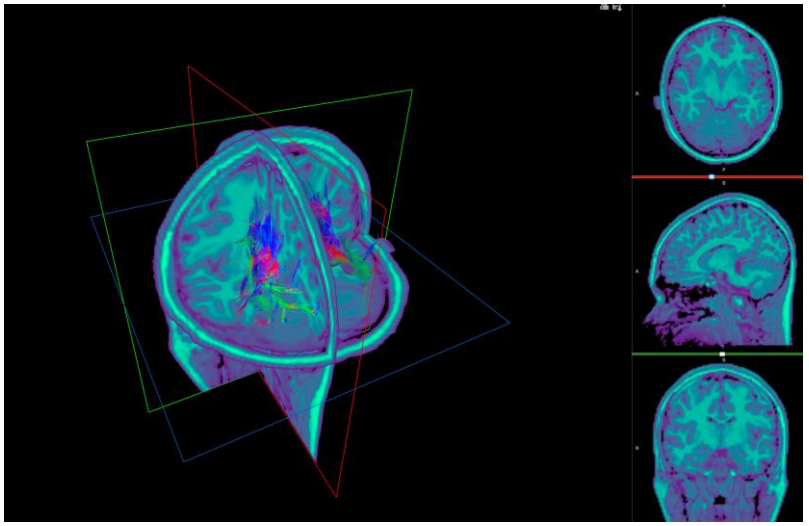
Move around

Zoom

Enlarge/make smaller

Rotate

https://www.google.com/maps/@40.5388417,19.7863469,14278660m/data=!3m1!1e3



http://x.babymri.org/example1/?scene=http://x.babymri.org/example1/scene.json

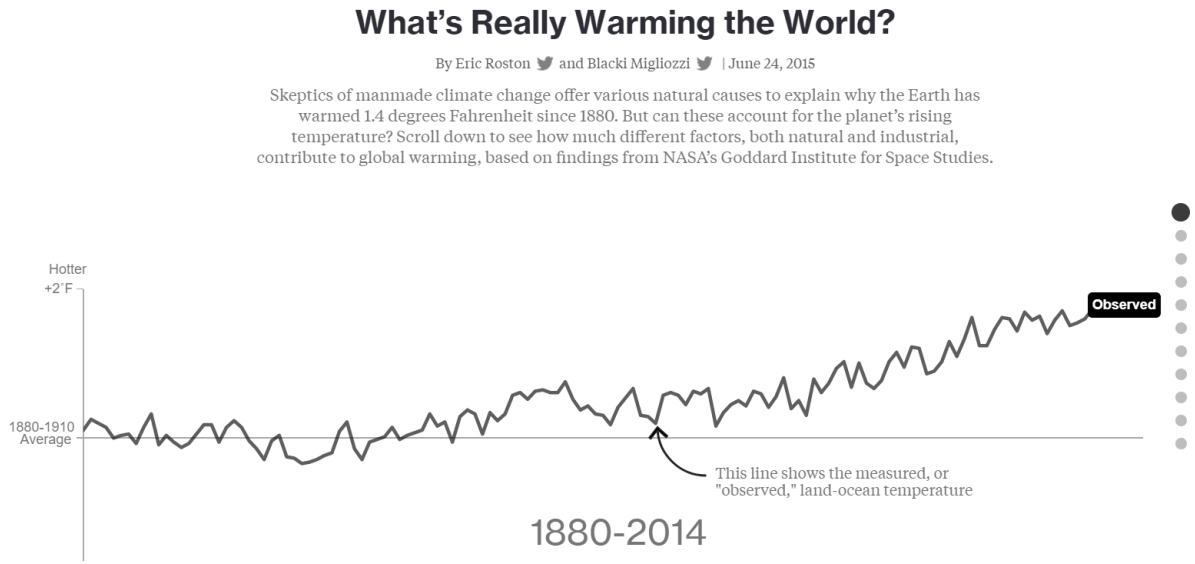
SCROLLTELLING

Telling an interactive story

Interaction by scrolling

Nice but

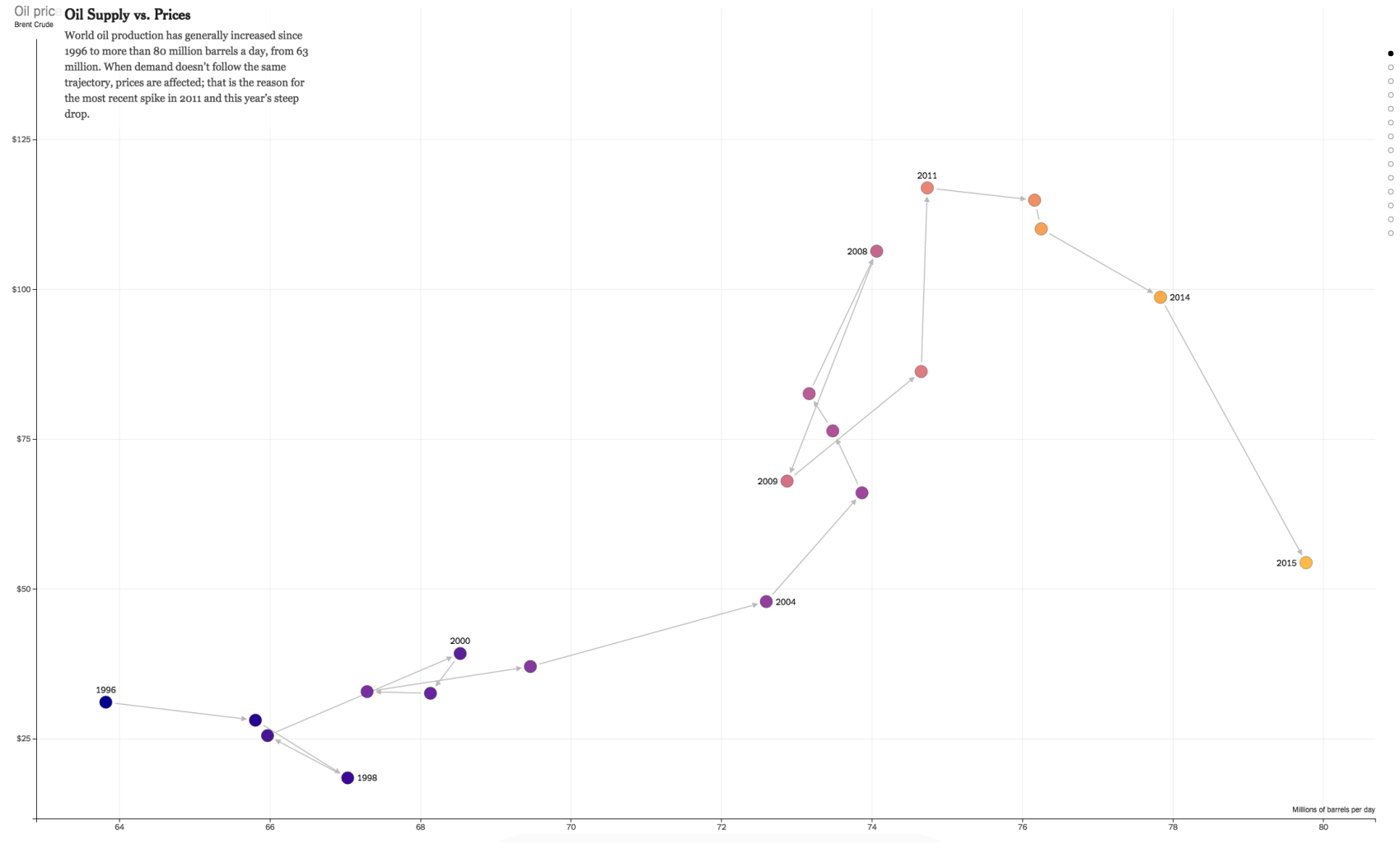
- Continuous scrolling vs discrete states
- Direct access
- Unexpected behavior



https://www.bloomberg.com/graphics/2015-whats-warming-the-world/

https://eagereyes.org/blog/2016/the-scrollytelling-scourge

SCROLLTELLING: OIL PRICES

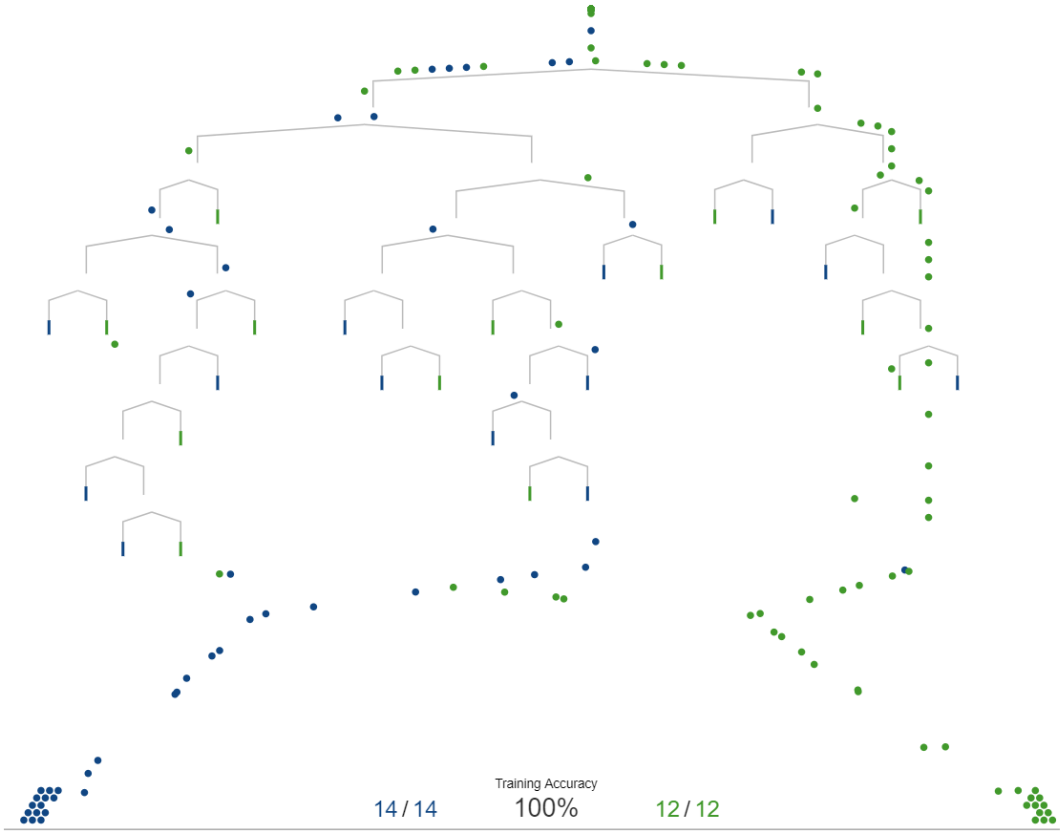


http://www.nytimes.com/interactive/2015/09/30/business/how-the-us-and-opec-drive-oil-prices.html?_r=0

SCROLLTELLING: INTRO TO ML

Making predictions

The newly-trained decision tree model determines whether a home is in San Francisco or New York by running each data point through the branches.



http://www.r2d3.us/visual-intro-to-machine-learning-part-1/

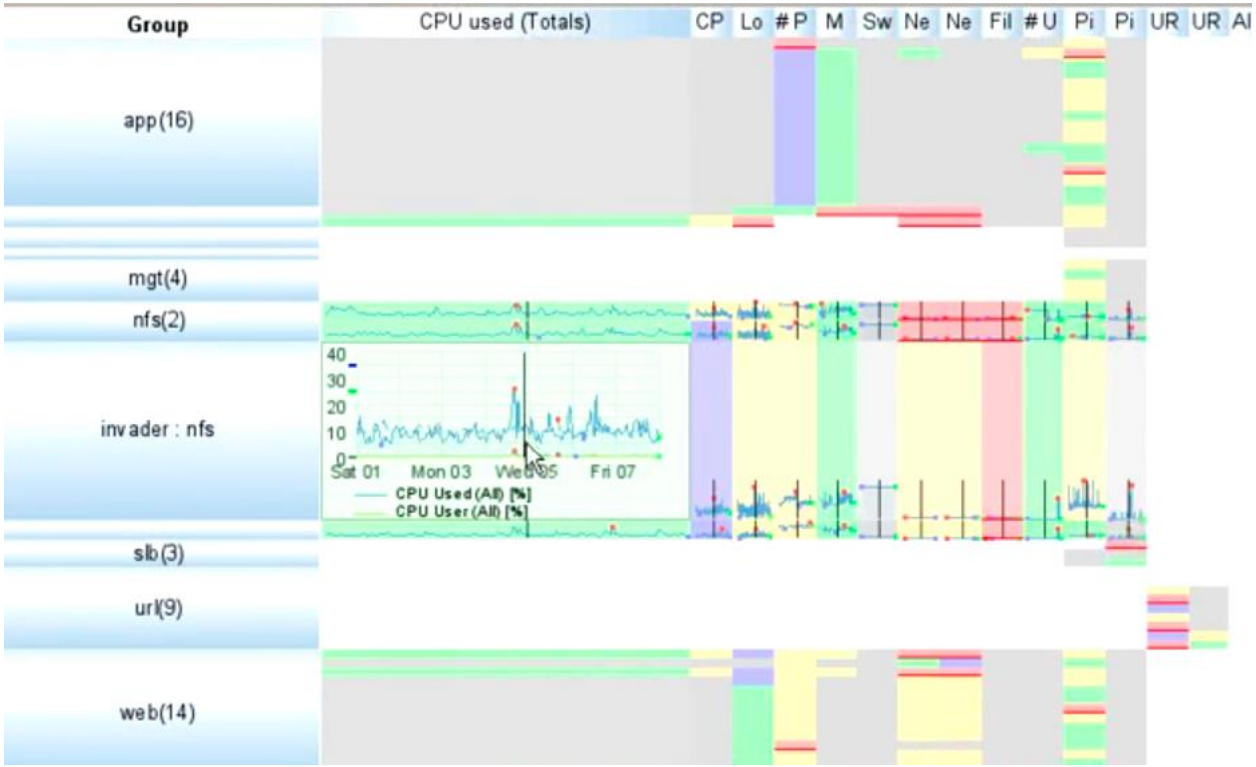
SEMANTIC ZOOMING

SEMANTIC ZOOMING

Update content on zooming

More detail as more space becomes available

Ideally readable at multiple resolutions



https://youtu.be/ld0c3H0VSkw

FOCUS + CONTEXT

FOCUS + CONTEXT

Carefully pick what to show

Hint at what you are not showing

FOCUS + CONTEXT

Synthesis of **visual encoding and interaction**

User selects regions of interest (focus) through navigation or selection

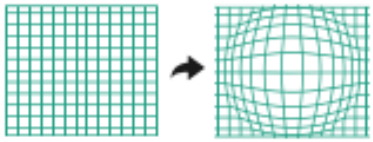
Provide context through

- aggregation
- reduction
- layering

- **Embed**
  - Elide Data

  - Superimpose Layer

  - Distort Geometry

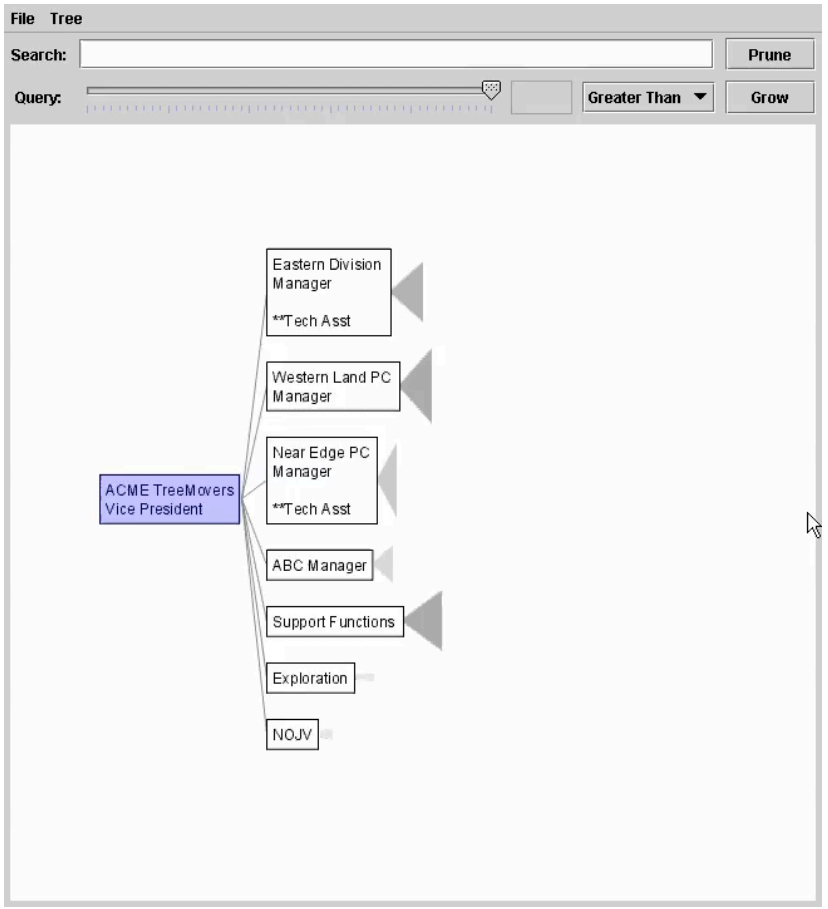


ELISION

Focus item shown in detail

Other items summarized for context

Example: SpaceTree



https://www.cs.umd.edu/hcil/spacetree/

https://youtu.be/F7-vJBsFBWw

DEGREE OF INTEREST (DOI)

Represent objects in the neighborhood in detail, and only major landmarks far away

Balance between local detail and global context

$$DOI(x) = I(x) – D(x,y)$$

I(x): interest in object x

D – a distance function to the current focus y of x

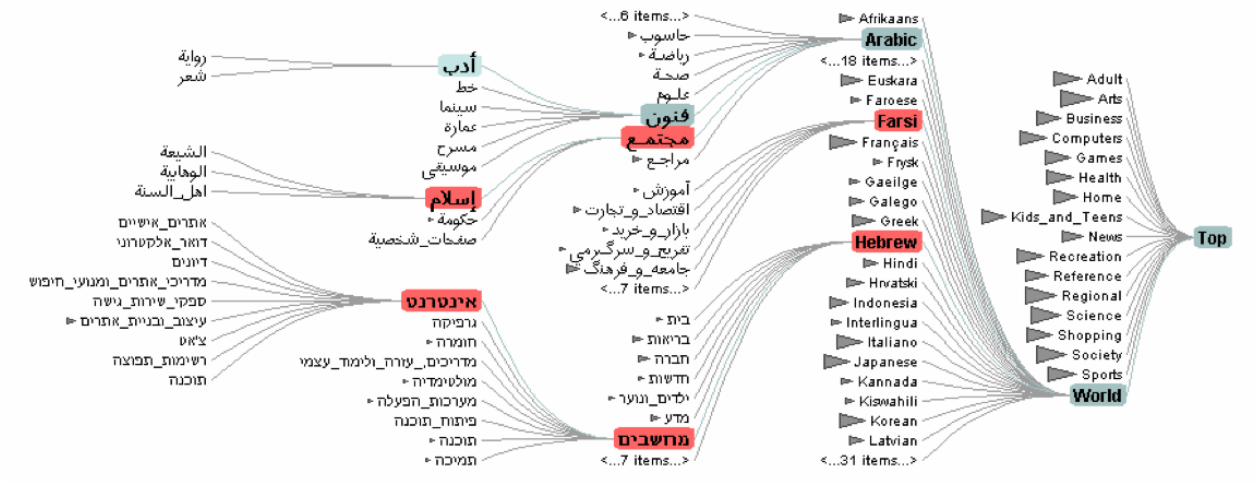
There may have many foci

DOI TREE

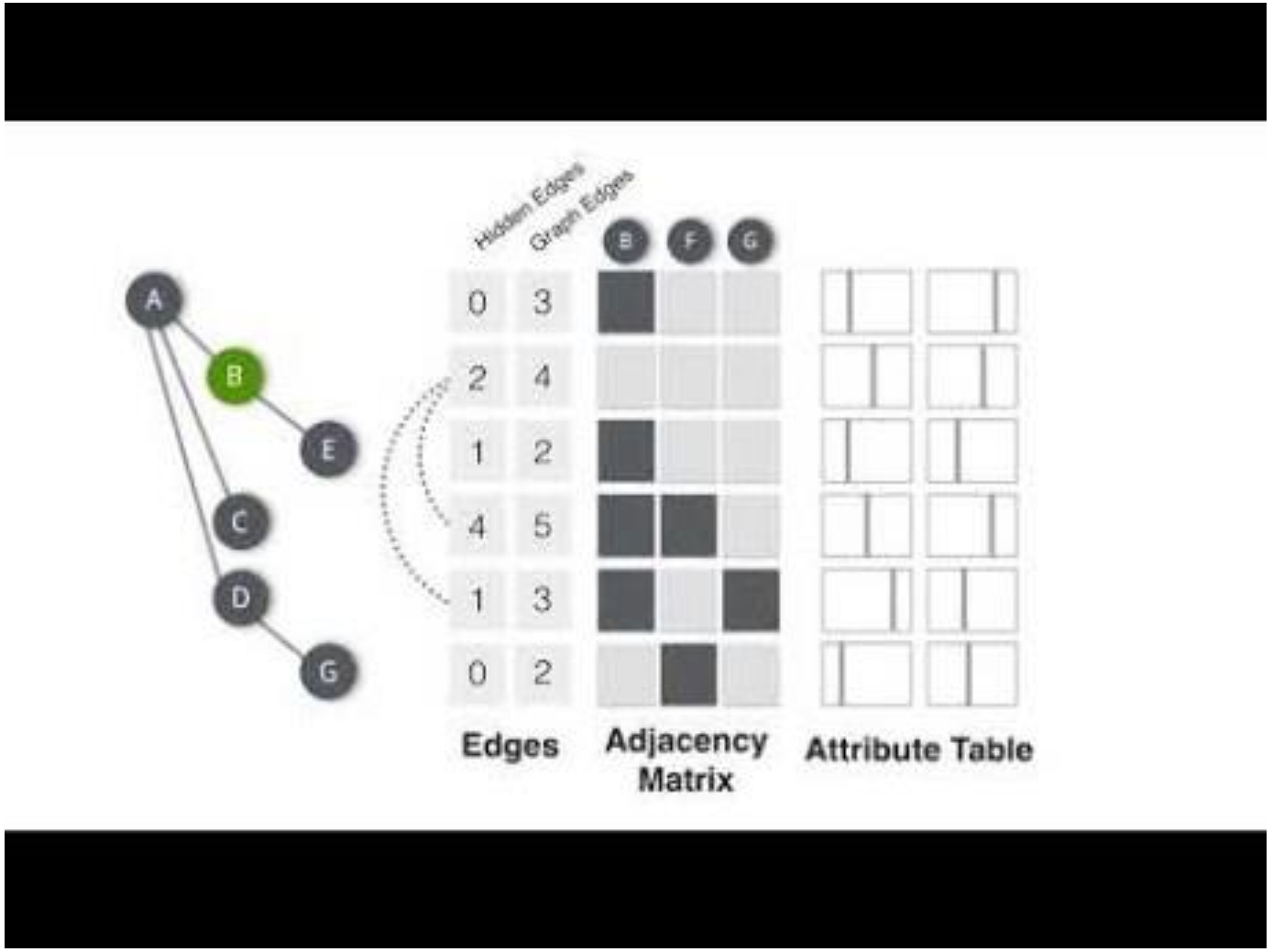
Interactive tree with animated transitions that fit within a bounded region of space layout depends on the user's estimated DOI

USE:

- logical filtering based on DOI
- Geometric distortion of node size based on DOI
- Semantic zooming on content based on node size
- Aggregate representations of elided subtrees



DOI: JUNIPER EXAMPLE



https://youtu.be/EAjNxFgsJ58

SUPERIMPOSE

Focus layer limited to a local region of view

Instead of stretching across the entire view

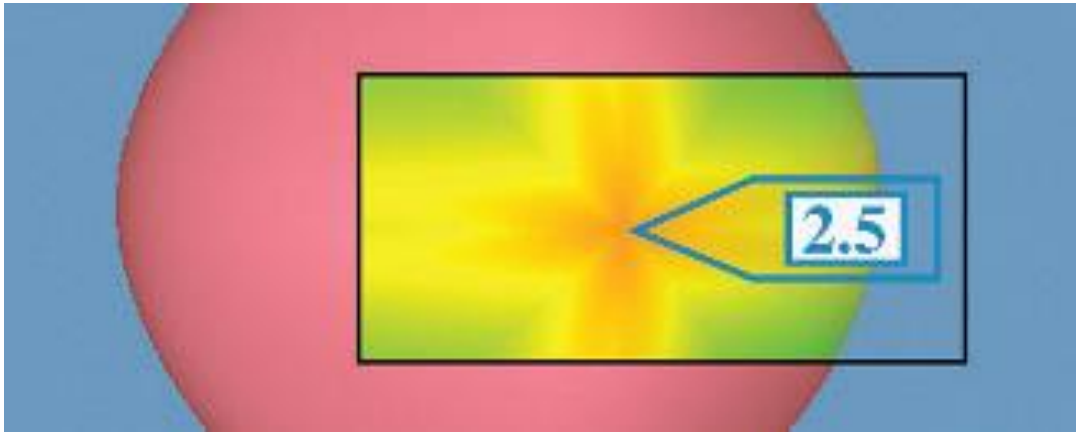
TOOLGLASS & MAGIC LENSES

Magic lense:

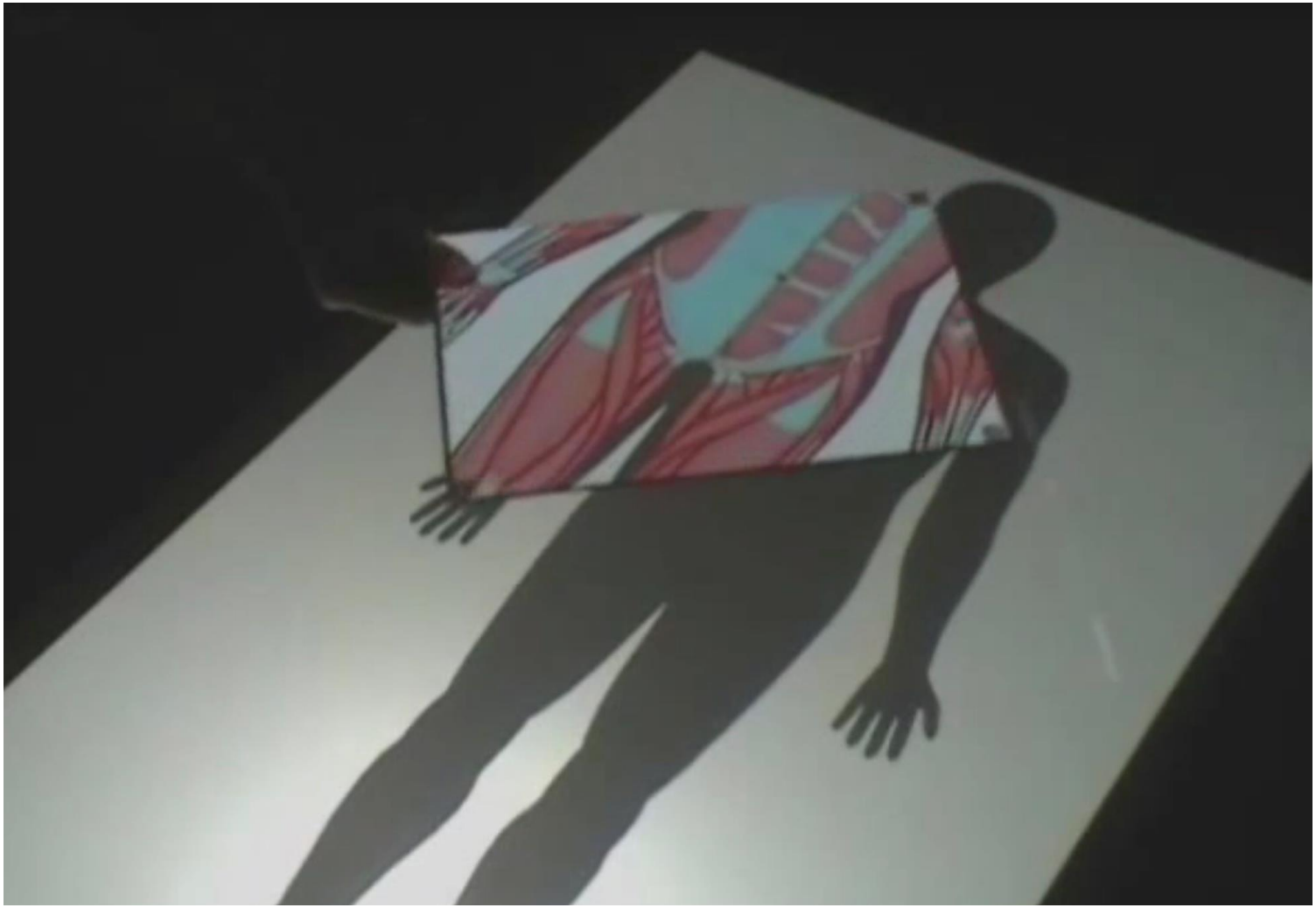
details/different data is shown

when moving a lens

over a scene

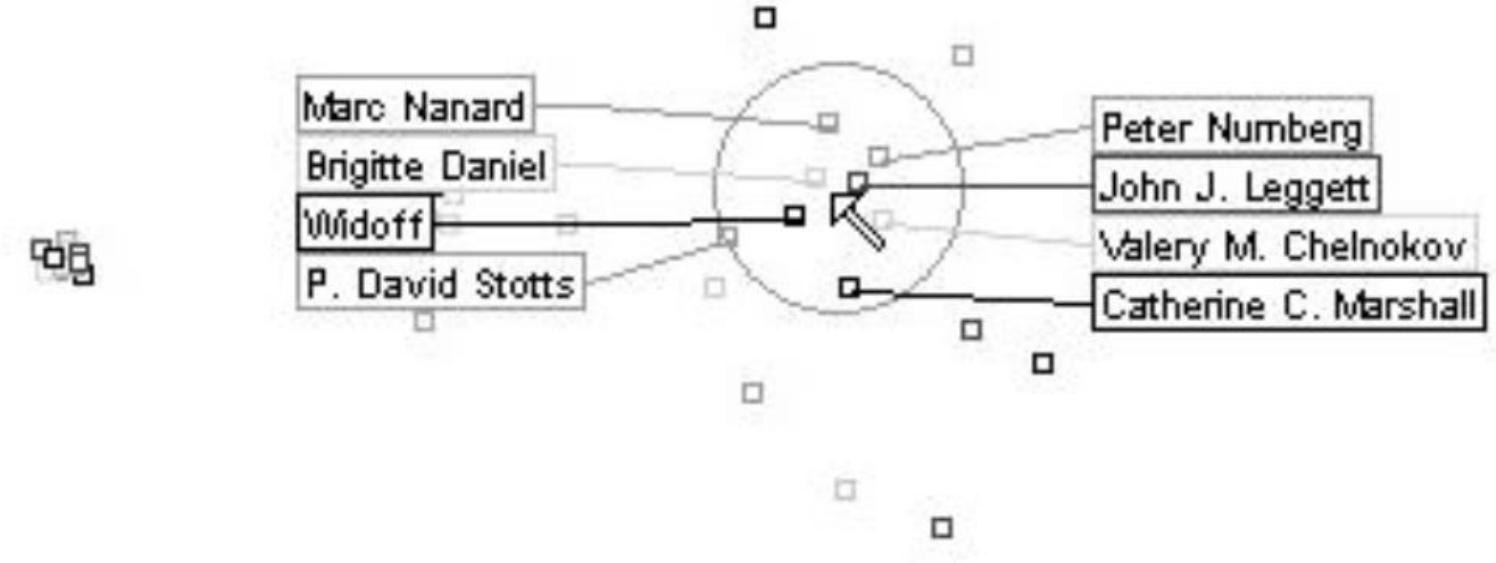


MAGIC LENSE



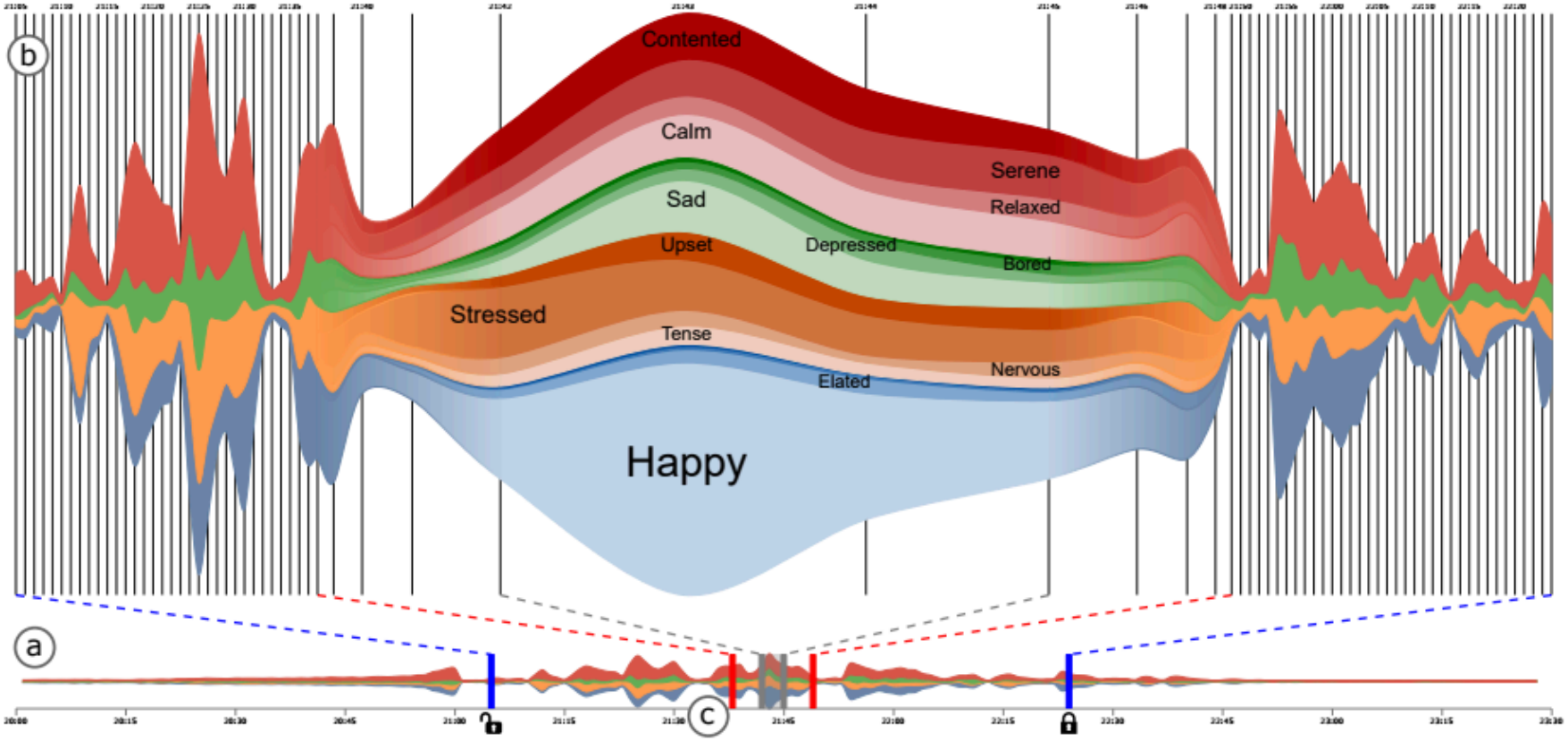
https://www.youtube.com/watch?v=h-mF4_OAhU0

MAGIC LENSE: LABELING



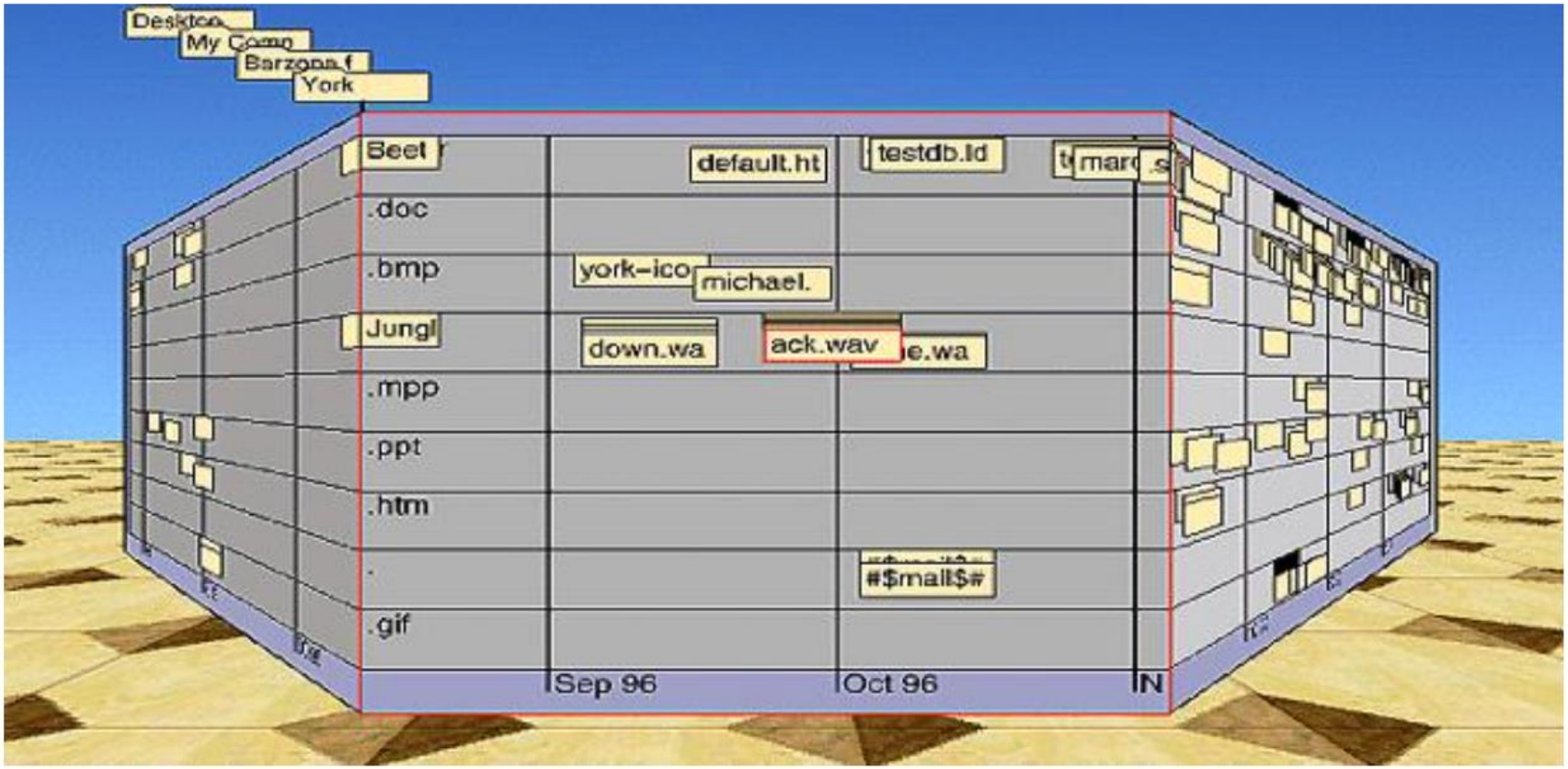
DISTORTION

Use geometric distortion of the contextual regions to make room for the details in the focus regions(s)



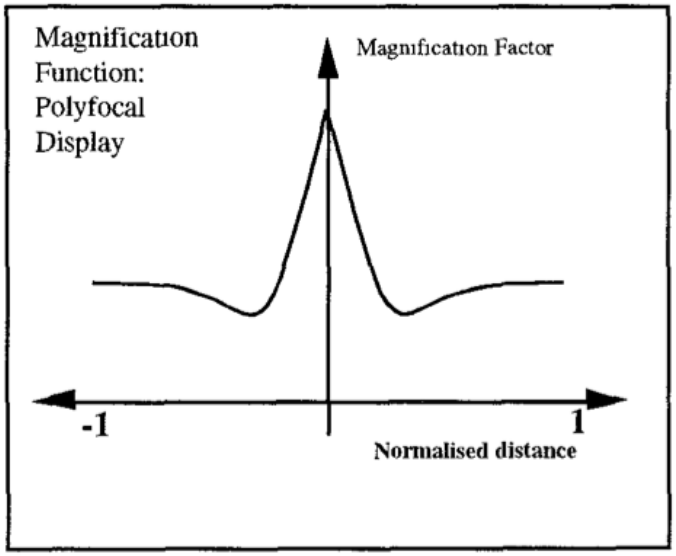
http://advanse.lirmm.fr/multistream/

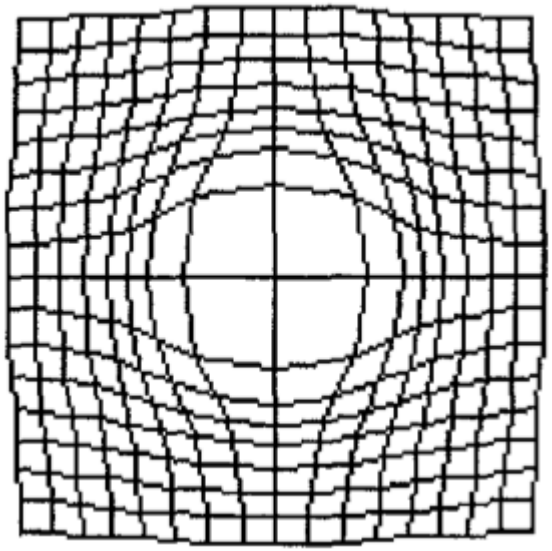
PERSPECTIVE WALL

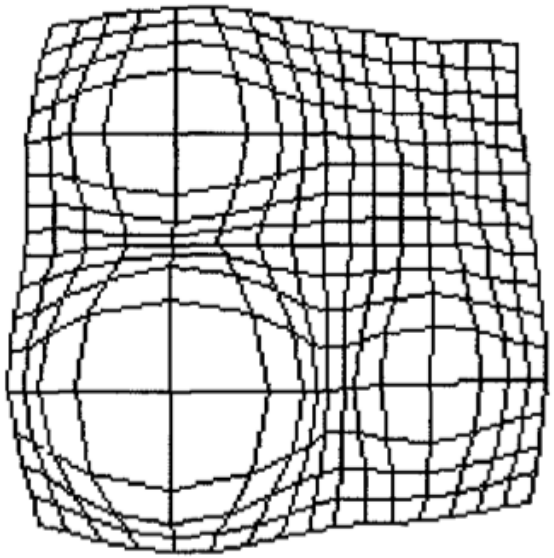


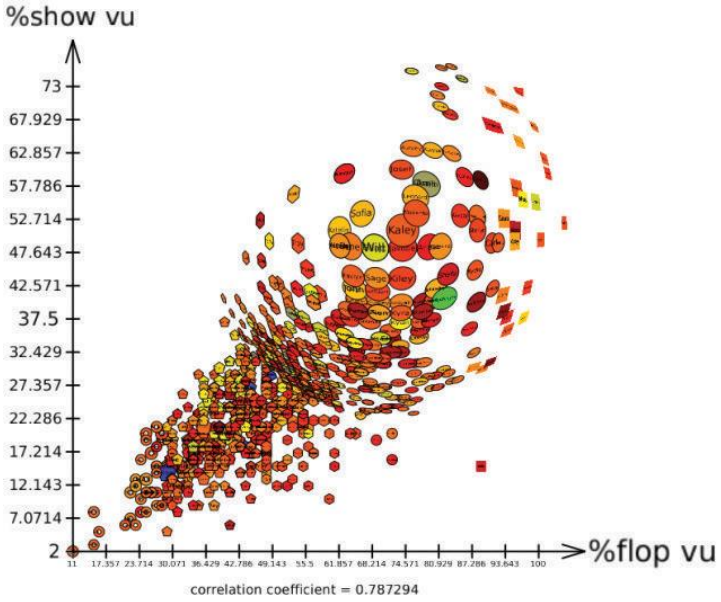
https://www.youtube.com/watch?v=hYUZbrWtCZg

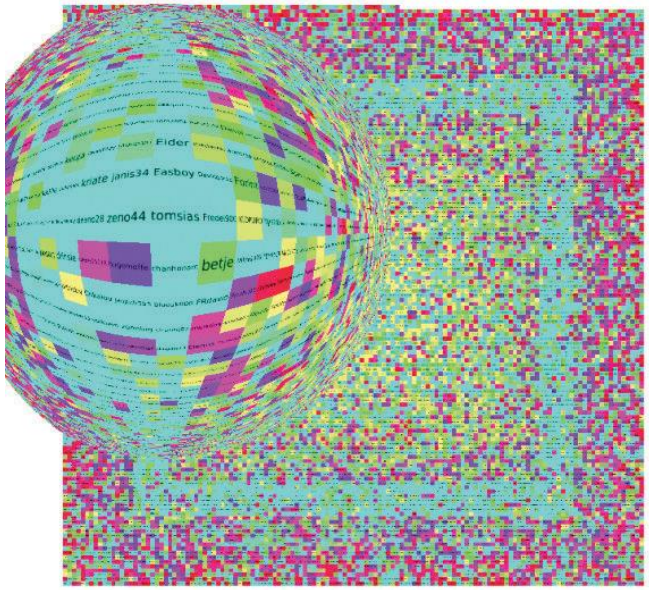
FISHEYE


Magnification Function: Polyfocal Display
Magnification Factor
-1
1
Normalised distance

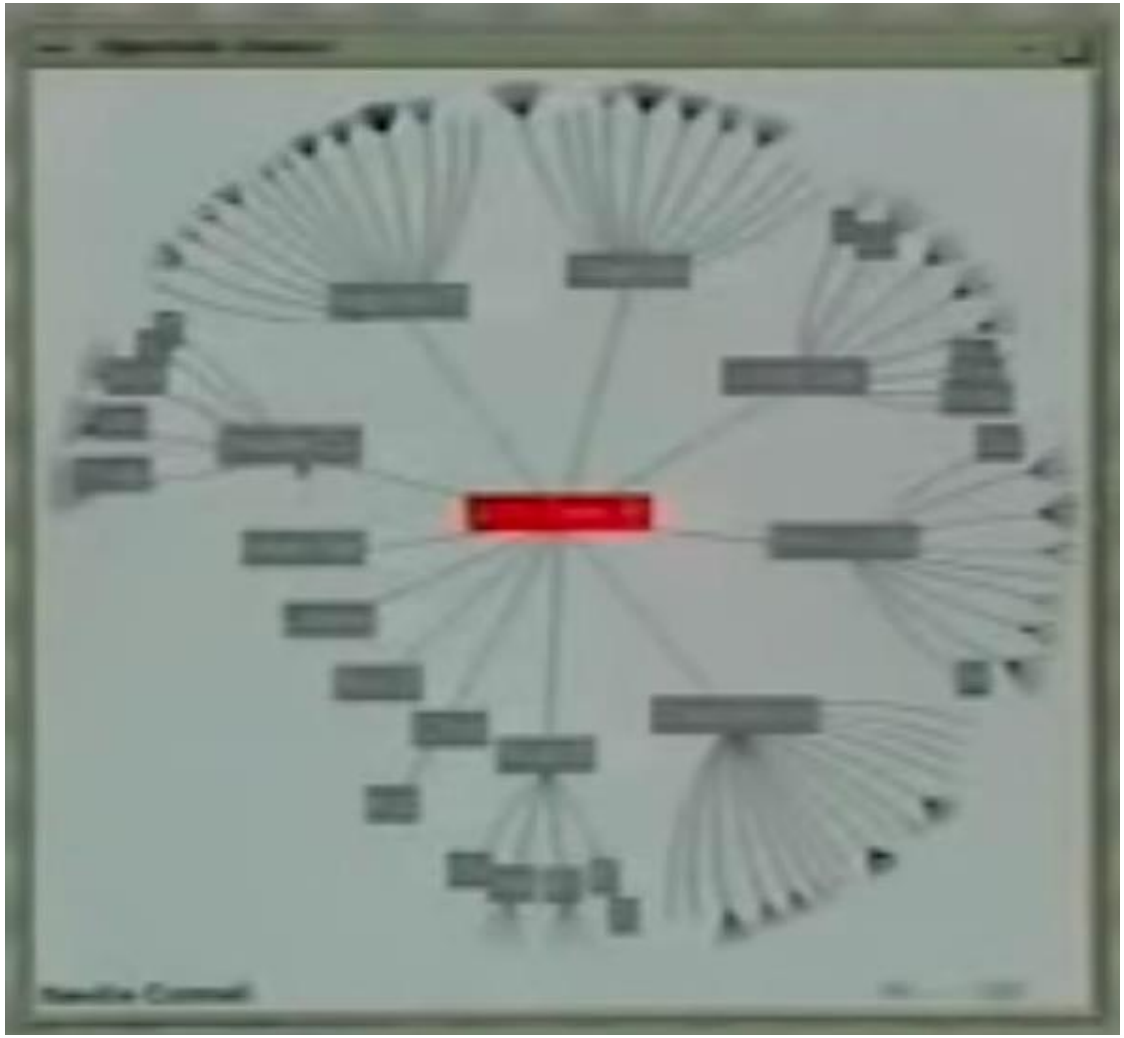





%show vu
73
67.929
62.857
57.786
52.714
47.643
42.571
37.5
32.429
27.357
22.286
17.214
12.143
7.0714
2
%flop vu
correlation coefficient = 0.787294

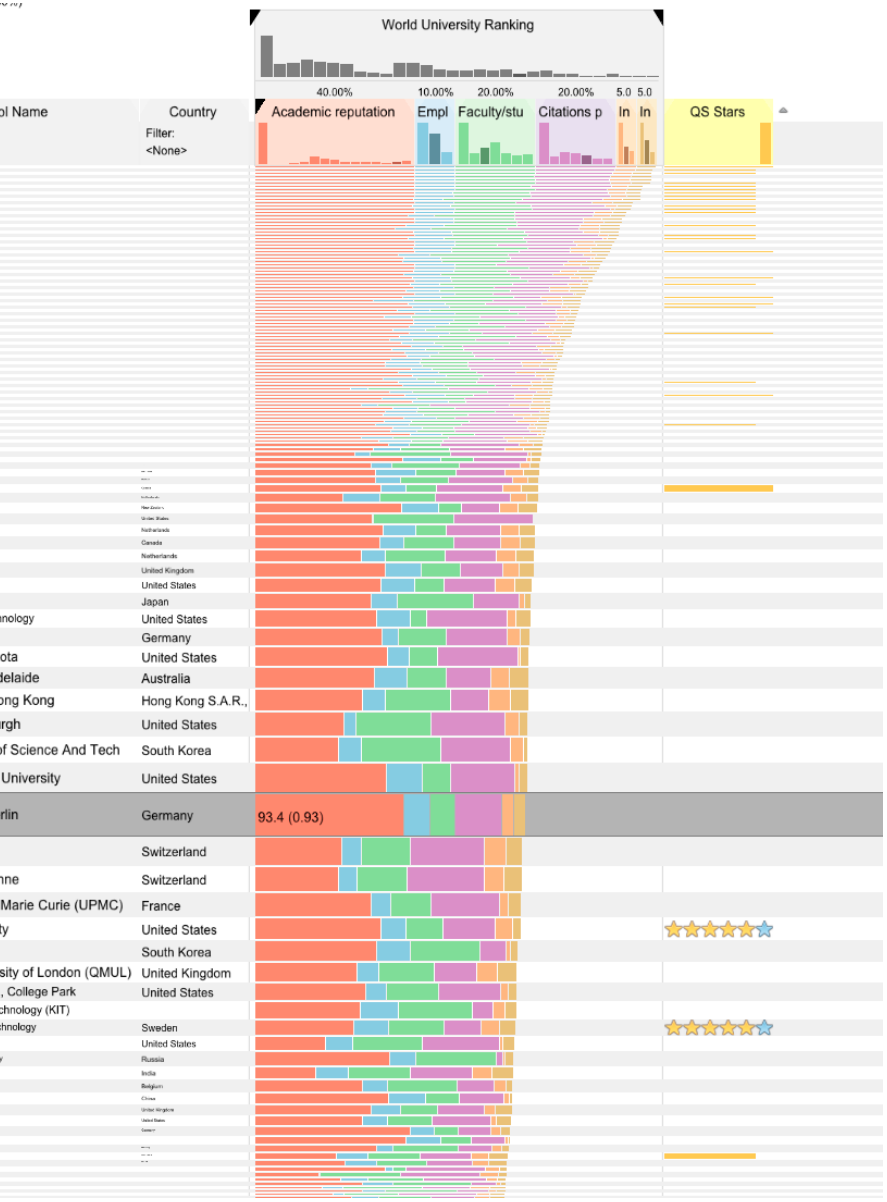

Fider
janis34
Fasboy
zeno44
tomsias
betje

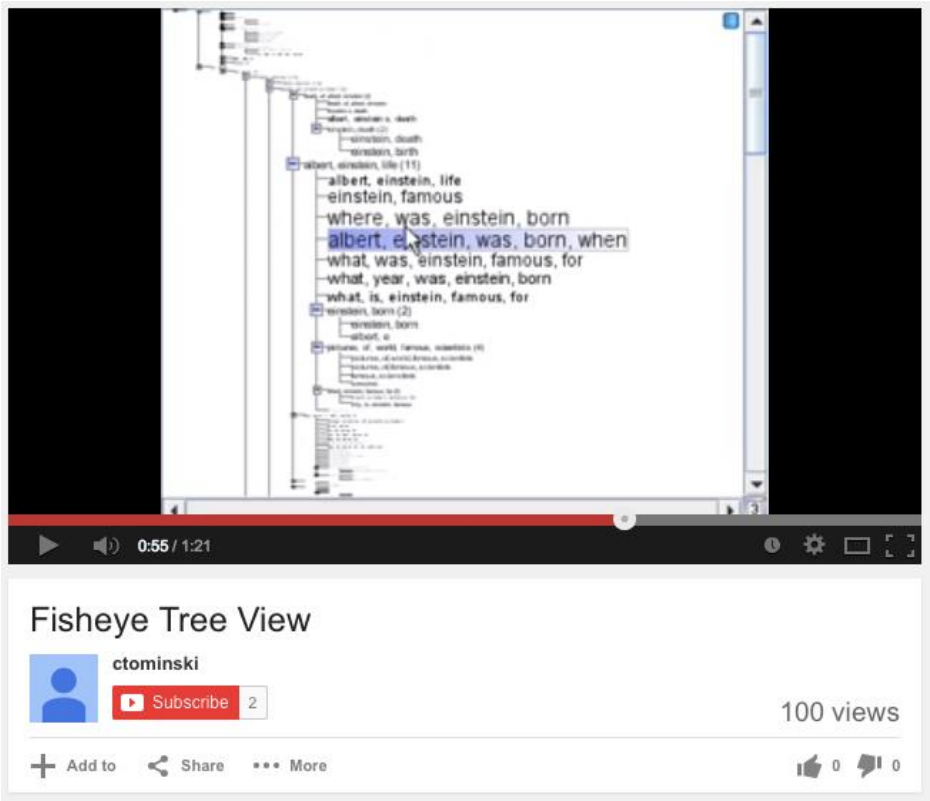
HYPERBOLIC GEOMETRY



https://www.youtube.com/watch?v=pwpze3RF55o

http://pmcruz.com/information-visualization/data-lenses





https://www.youtube.com/watch?v=mTf7bPvdeJo

DISTORTION CONCERNS

Unsuitable for relative spatial judgements

Overhead of tracking distortion

Visual communication of distortion

  gridlines, shading

Target acquisition problem

  lens displacing items away from screen location

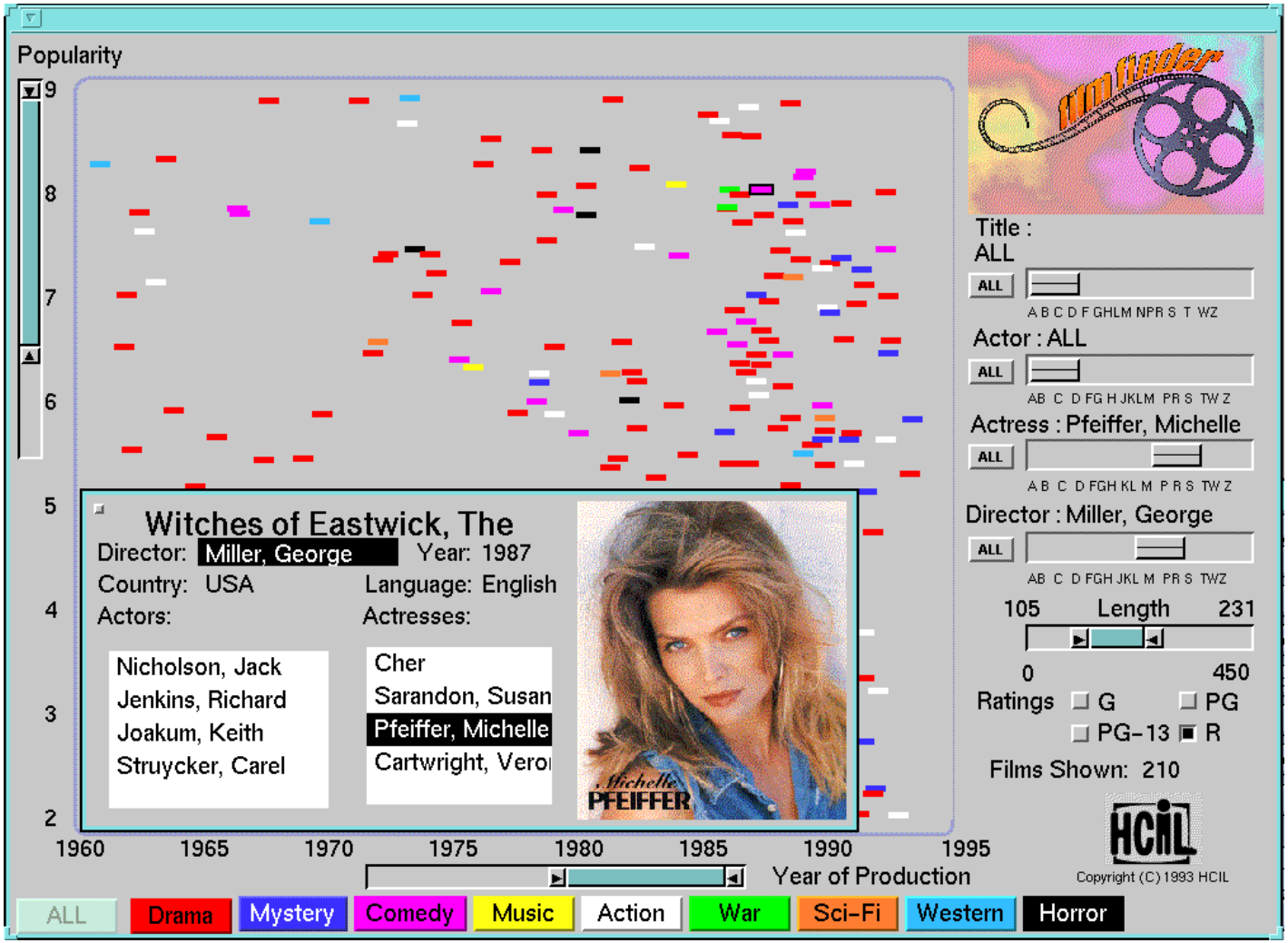
Mixed result compared to separate views and temporal naviation

OVERVIEW + DETAIL

OVERVIEW AND DETAIL

One view shows overview

Other show detail



[FilmFinder, Ahlberg & Shneiderman, 1994]

FILTERING & DYNAMIC QUERYING

MANTRA

Visual information seeking matra (Shneiderman, 1996)

Overview first,

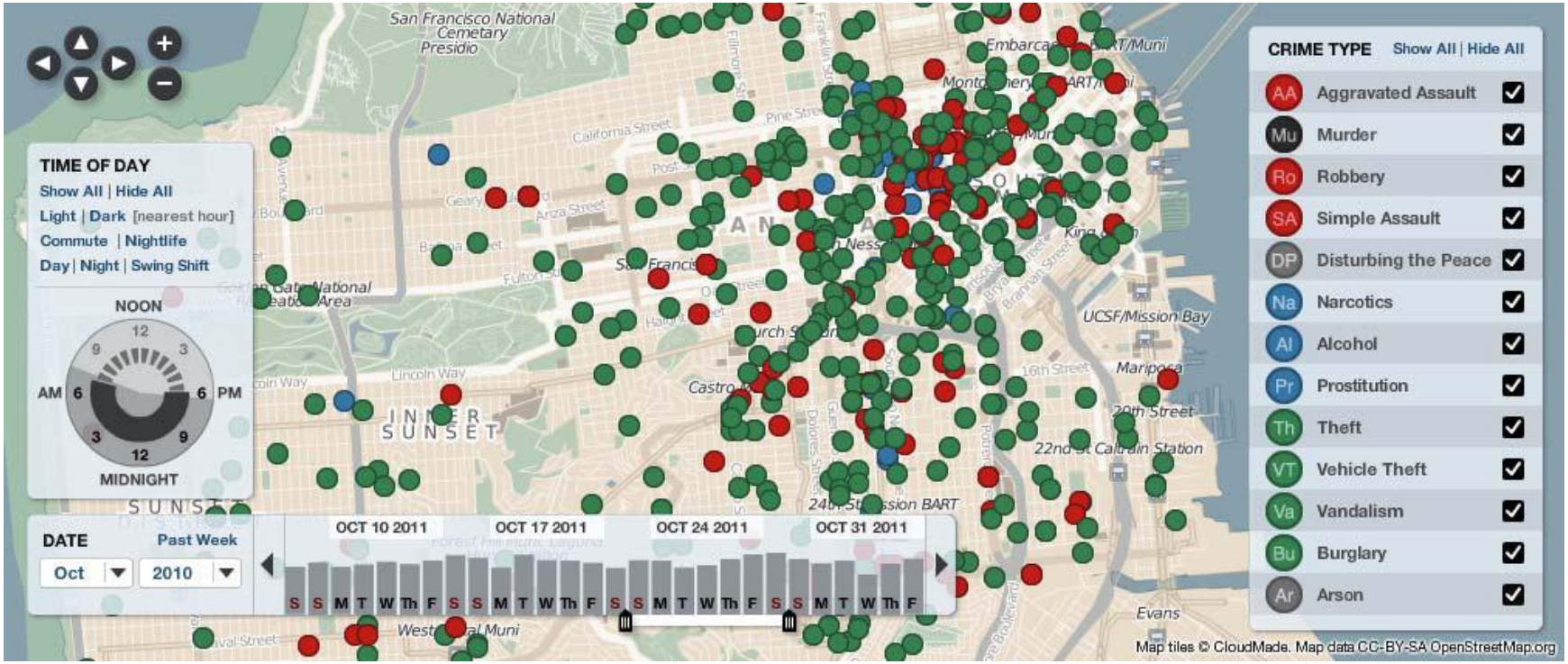
Zoom and filter,

Then details on demand

Related, history, extract

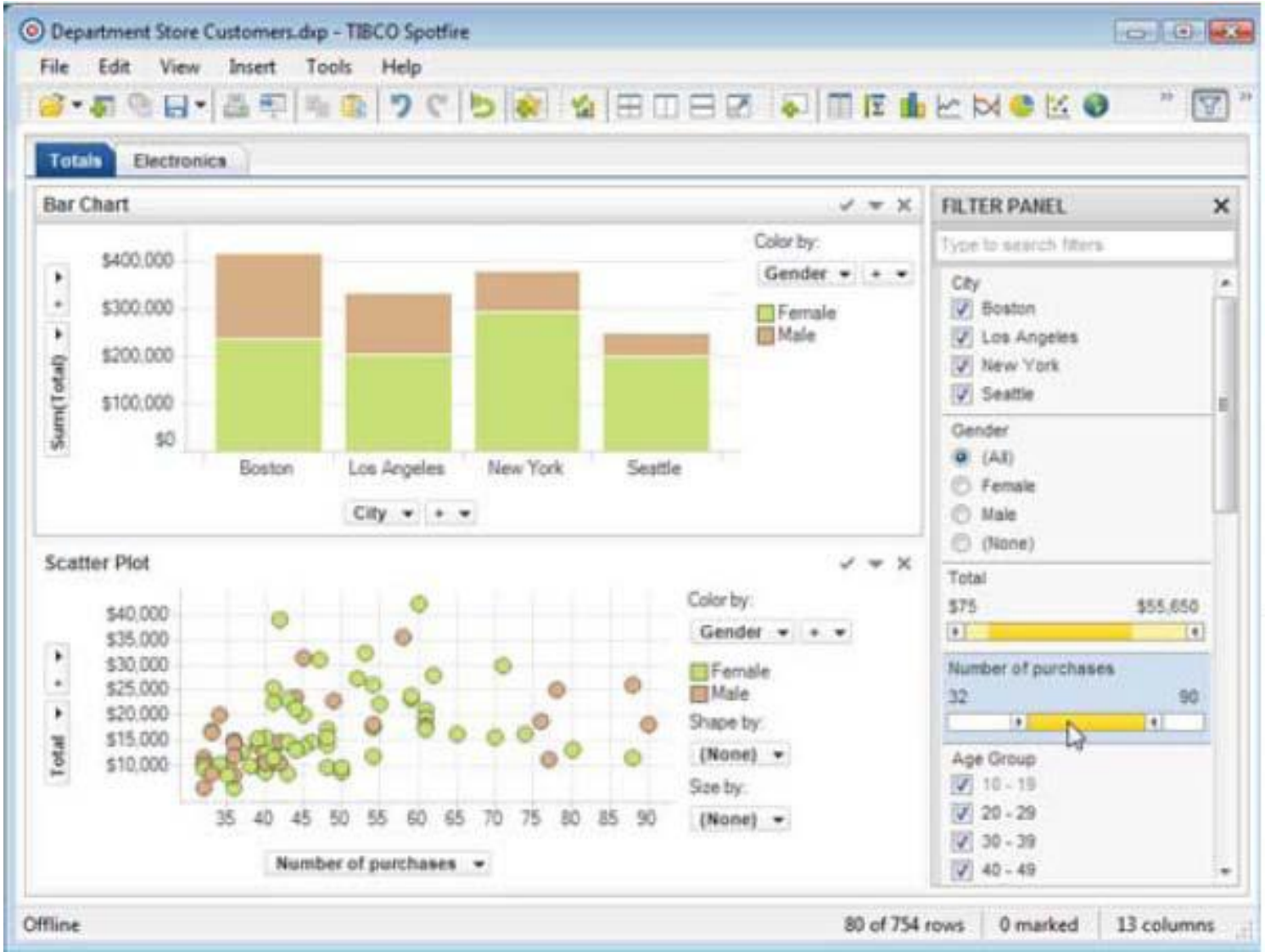
DYNAMIC QUERIES

Define criteria for inclusion/ exclusion

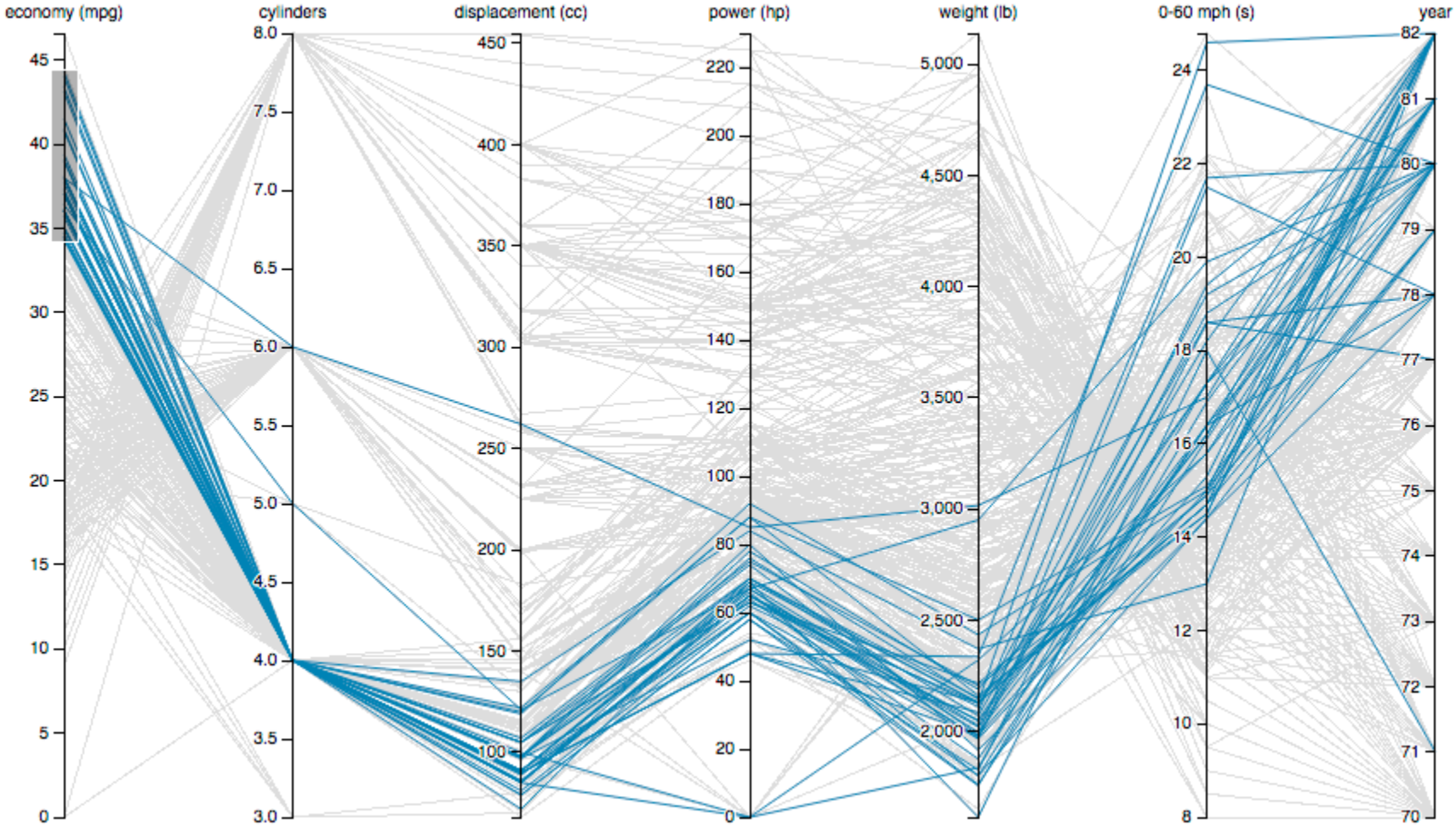


DYNAMIC QUERY WITH FILTER

Spotfire

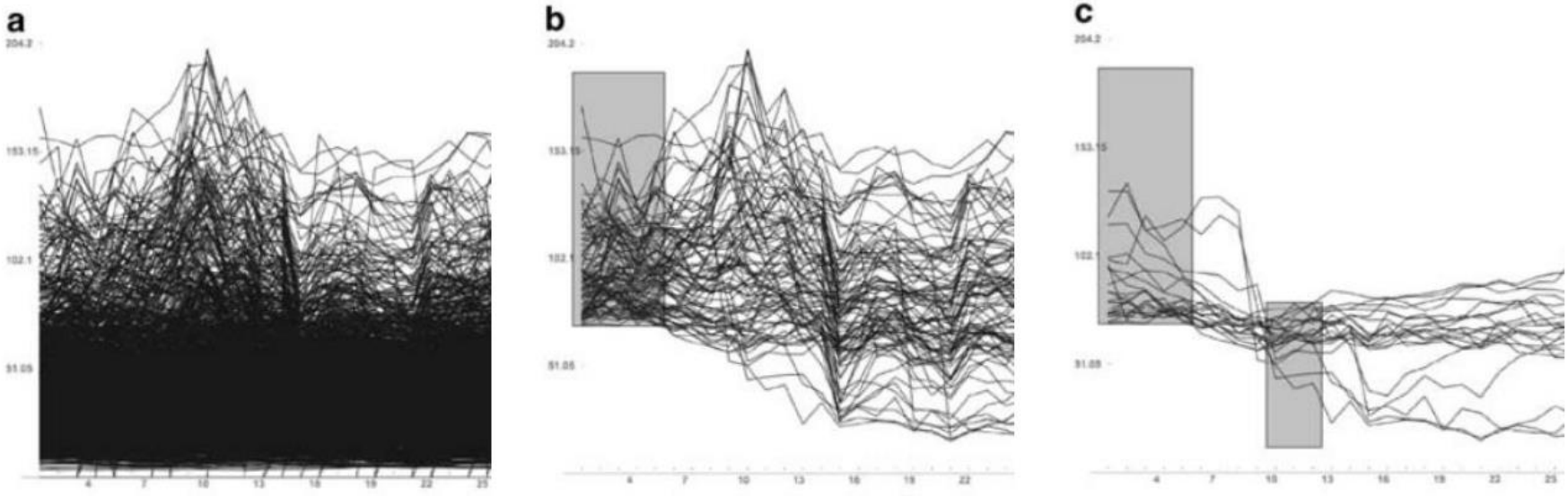


VISUAL QUERIES



http://bl.ocks.org/jasondavies/1341281

VISUAL QUERIES



Time Searcher (Hocheiser, 2003)

QUERY INTERFACES