Visualization in HCI

05-499/05-899 Section C

Carnegie Mellon University Human-Computer Interaction Institute

Interaction + Views

March 20, 2017

Project Proposals Due Wednesday

Written Proposal (Uploaded to github):

- Motivation: Why you chose this topic?
- Objectives: what questions you will try to answer?
- Data: What and where? Processing?
- Visualization: Sketches of how it might look
- Features: Must-haves and optional
- Schedule: Weekly deadlines

Informal In-class Presentation:

In **5 minutes,** summarize:

•Motivation

•Objectives

•Data Source + Processing Req.

Do not include visualization design/feature list.

https://cmu-vis-course.github.io/2017/project/

Announce team members + topic in Slack #general

Focus + Context

synthesis of **visual encoding and interaction**

user selects region of interest (focus)
through navigation or selection

provide context through

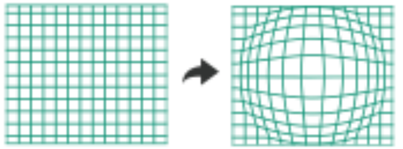
- aggregation
- reduction
- layering

Embed

- Elide Data

- Superimpose Layer

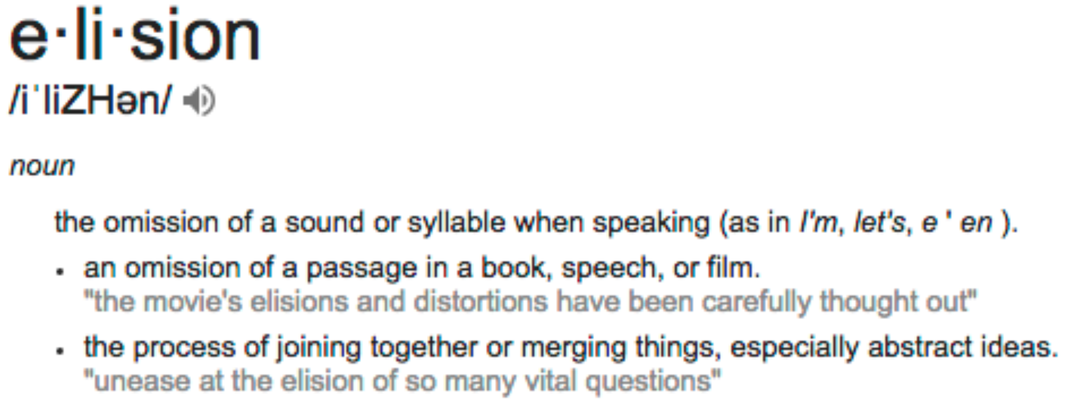
- Distort Geometry



Elision

focus items shown in detail,

other items summarized for context



e·li·sion

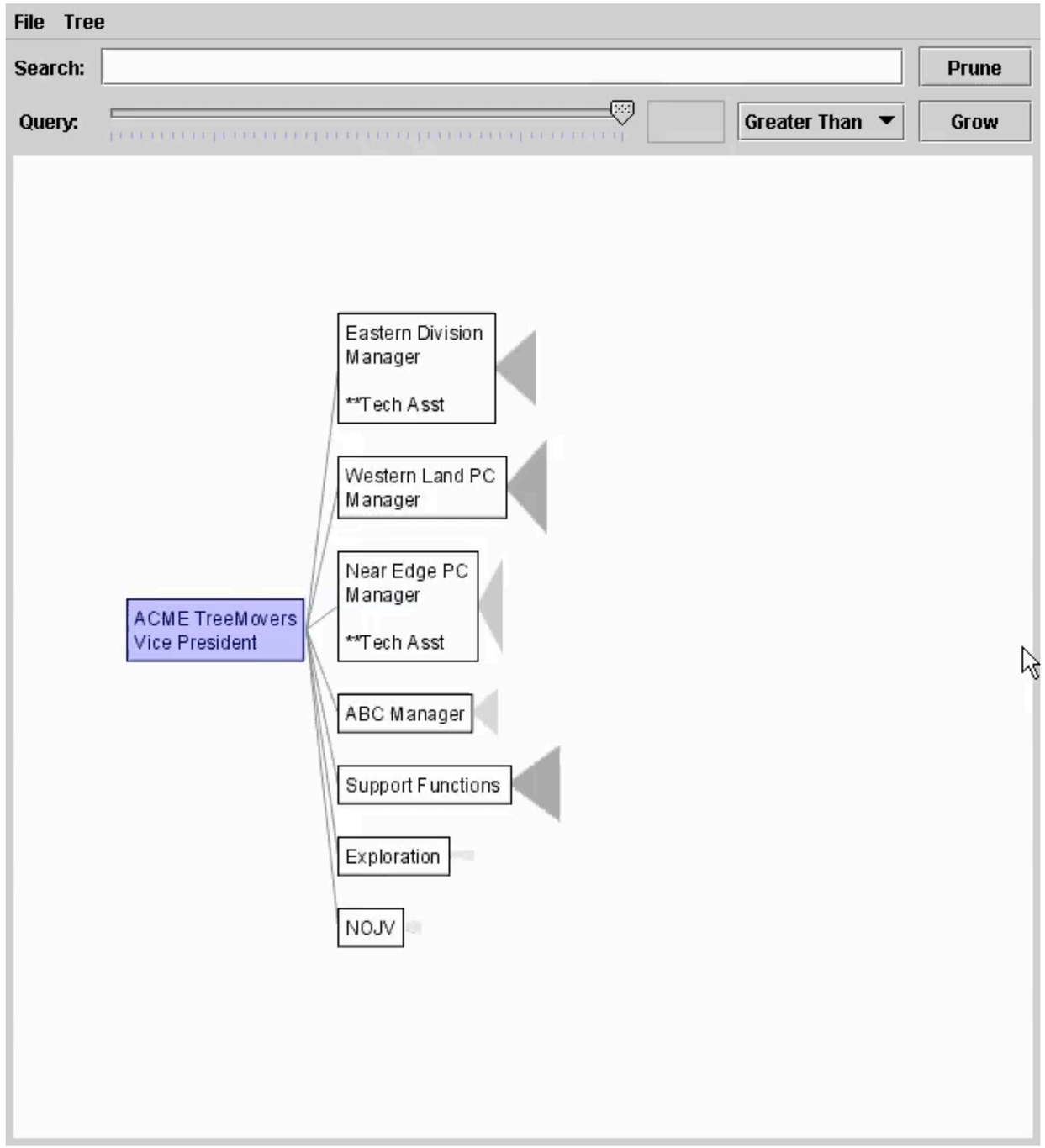
/iˈliZHən/

noun

the omission of a sound or syllable when speaking (as in *I'm*, *let's*, *e ' en*).

- an omission of a passage in a book, speech, or film.
  "the movie's elisions and distortions have been carefully thought out"
- the process of joining together or merging things, especially abstract ideas.
  "unease at the elision of so many vital questions"

SpaceTree



Grosjean 2002

Degree of Interest (DOI)

Based on observation that humans often represent their own neighborhood in detail, yet only major landmarks far away

Goal is balance between local detail and global context

$$DOI(x) = I(x) - D(x,y)$$

I - interest function
D - a distance function, either semantic or spatial

x- the location of an item

y - current focus point

Furnas 1986

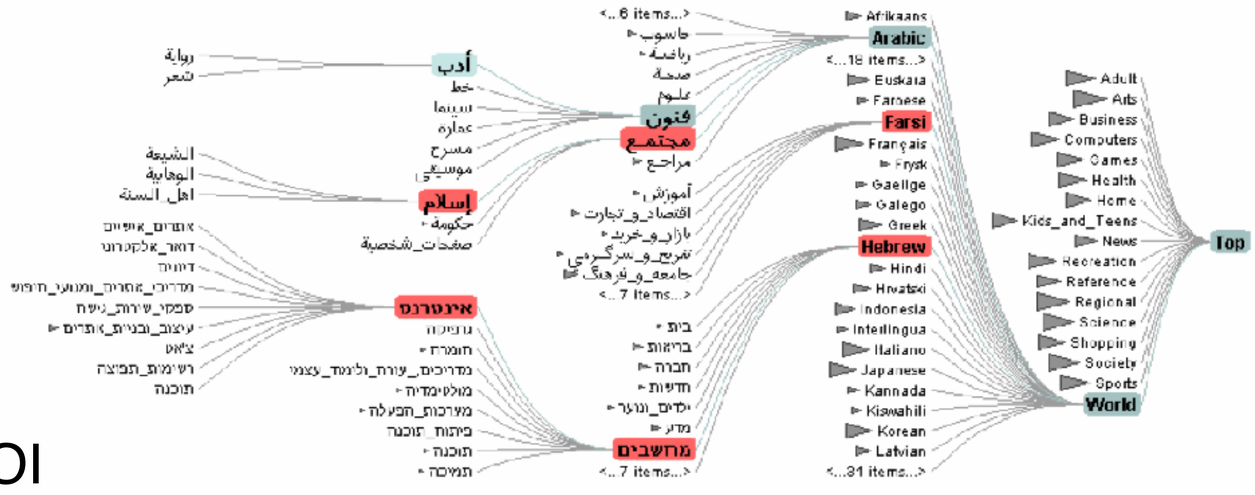
DOI Tree

interactive trees with animated transitions that fit within a bounded region of space

layout depends on the user's estimated DOI

uses:

- 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



[Heer 2004]

Superimpose

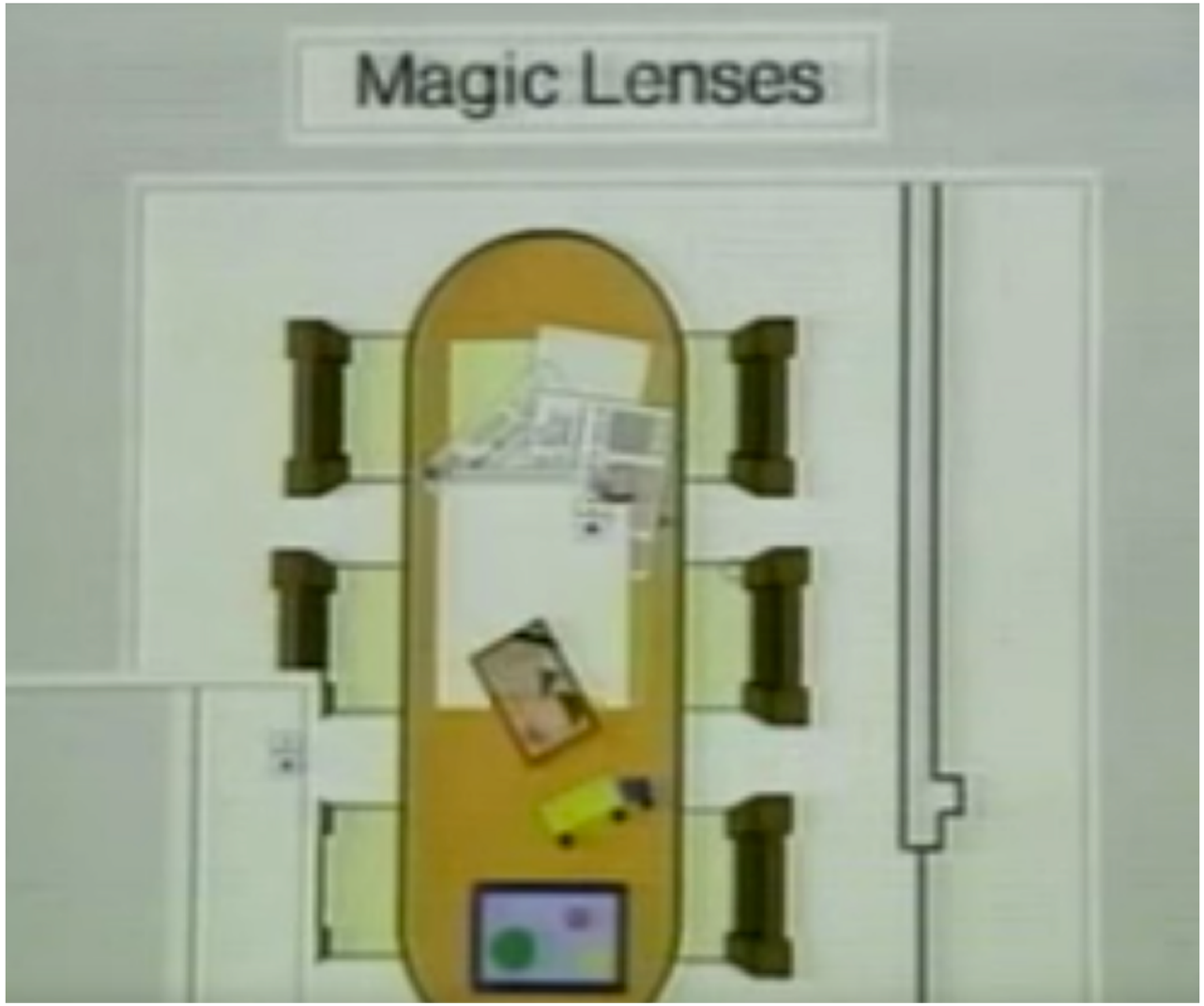
focus layer limited to a local region of view,

instead of stretching across the entire view

Toolglass & Magic Lenses

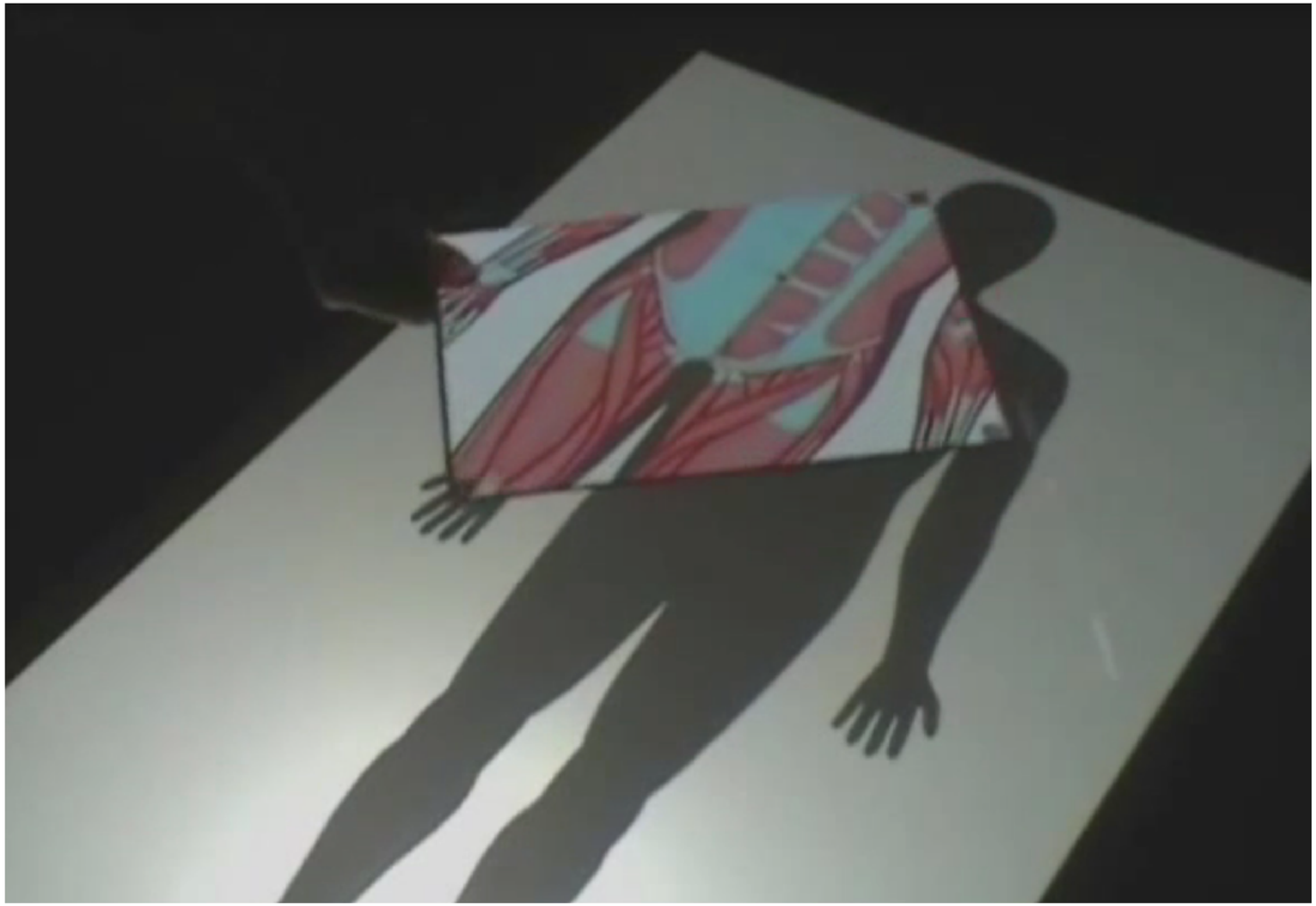
Magic Lenses:

details/different data is shown
when moving a lens
over a scene



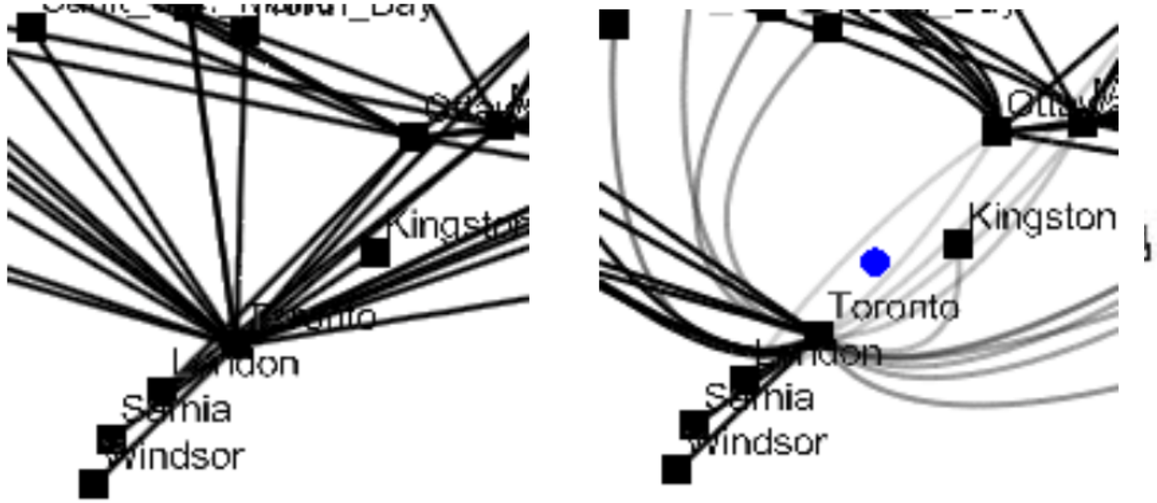
[Bier, Siggraph 1993]

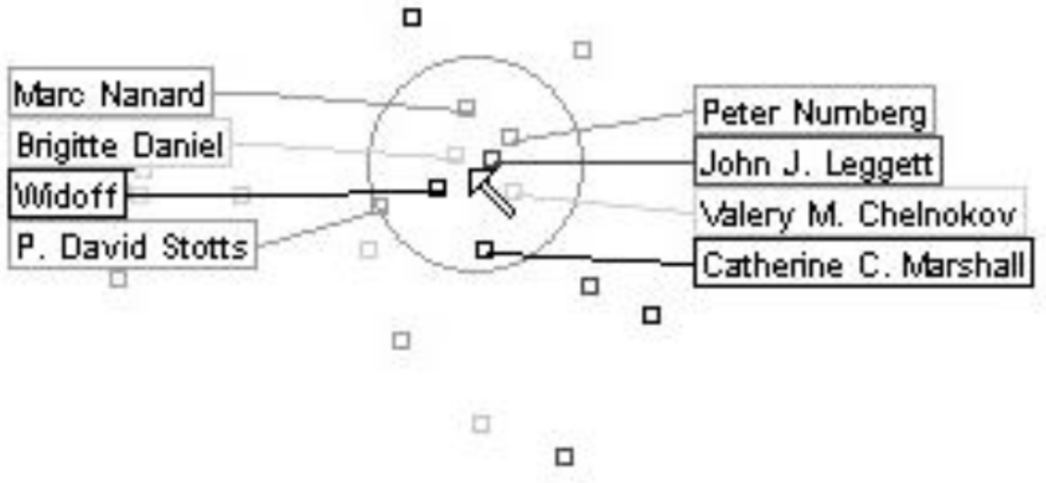
Magic Lenses with Tangible Interface



[Spindler, CHI 2010]

Magic Lense: Edges & Labeling



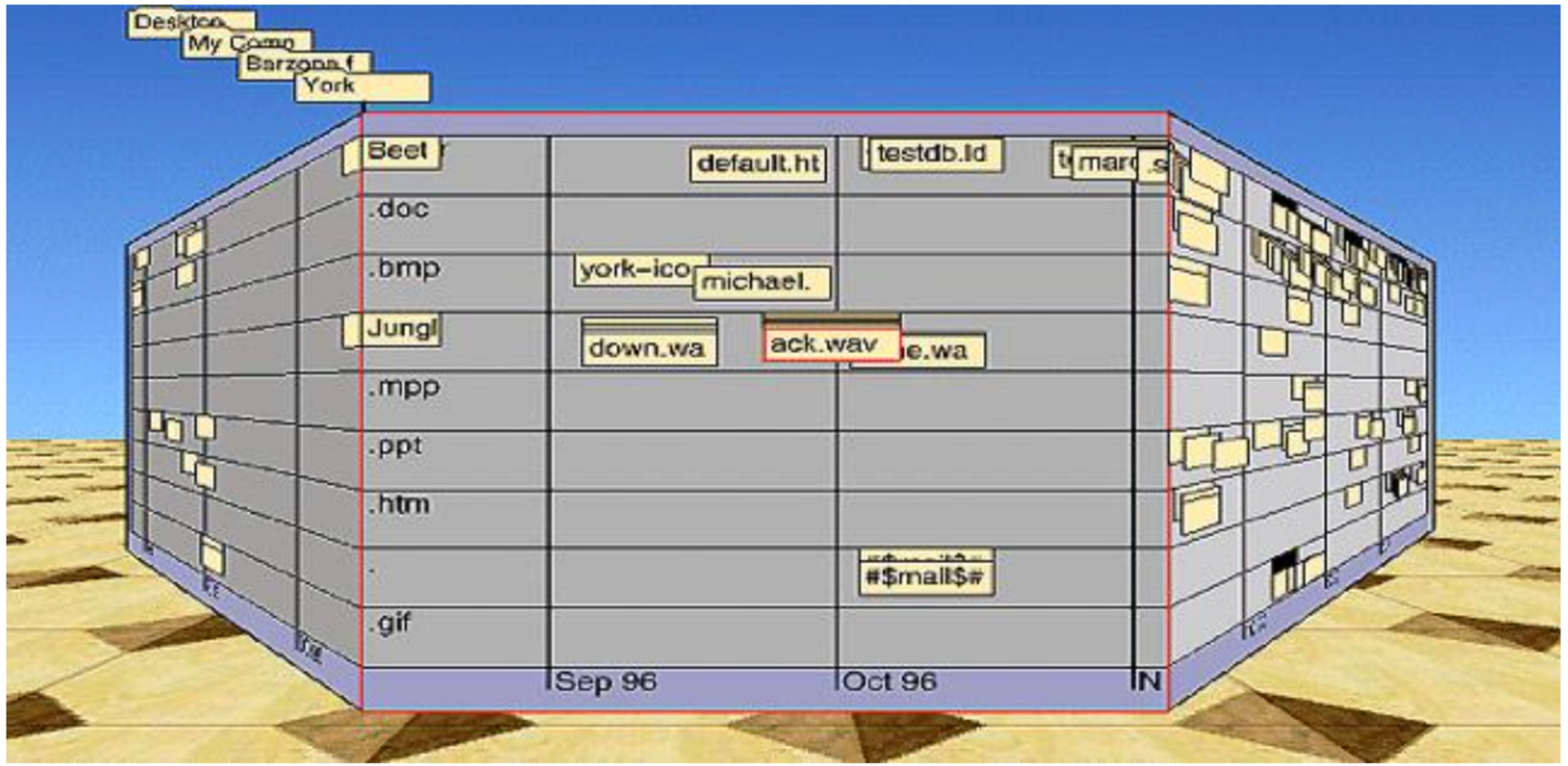


[Fekete and Plaisant, 1999]

Distortion

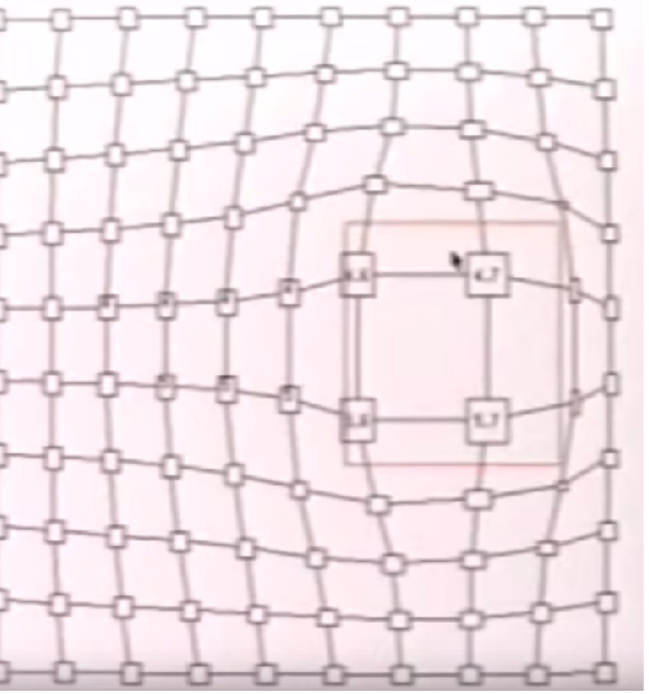
use geometric distortion of the contextual regions to make room for the details in the focus region(s)

Perspective Wall

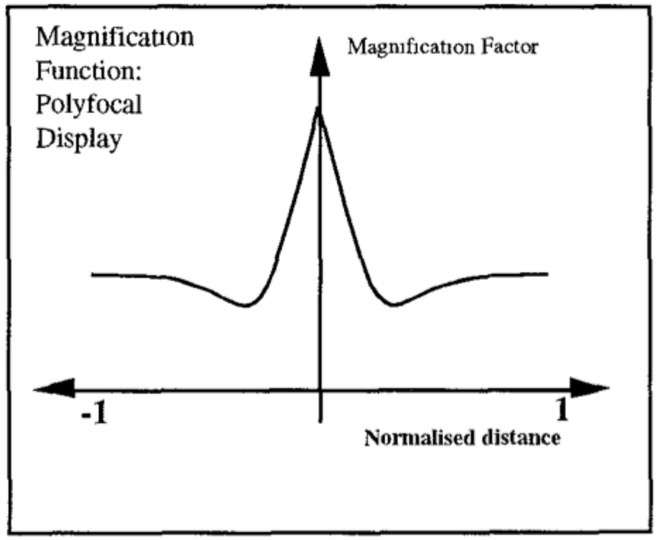


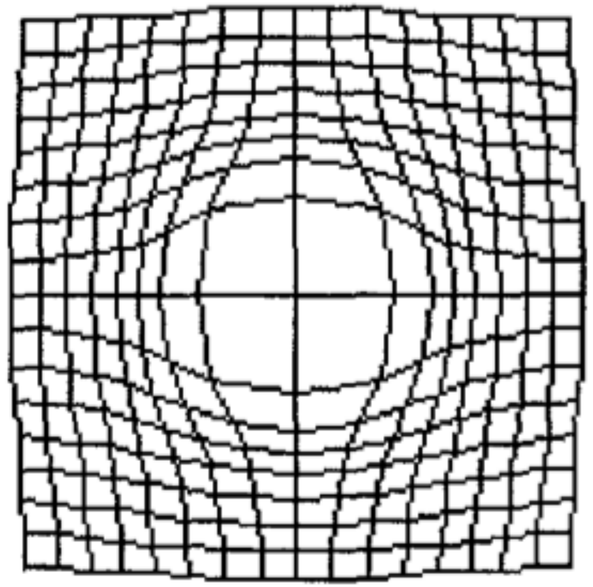
[Mackinlay, 1991]

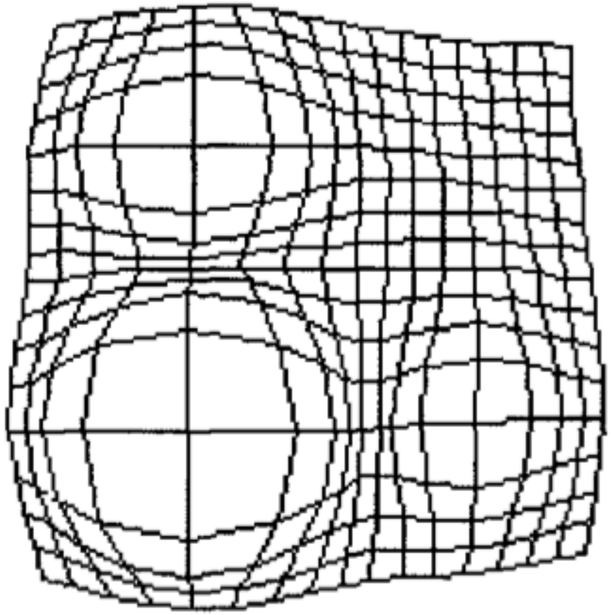
Fisheye



[Sarkar, 1993]

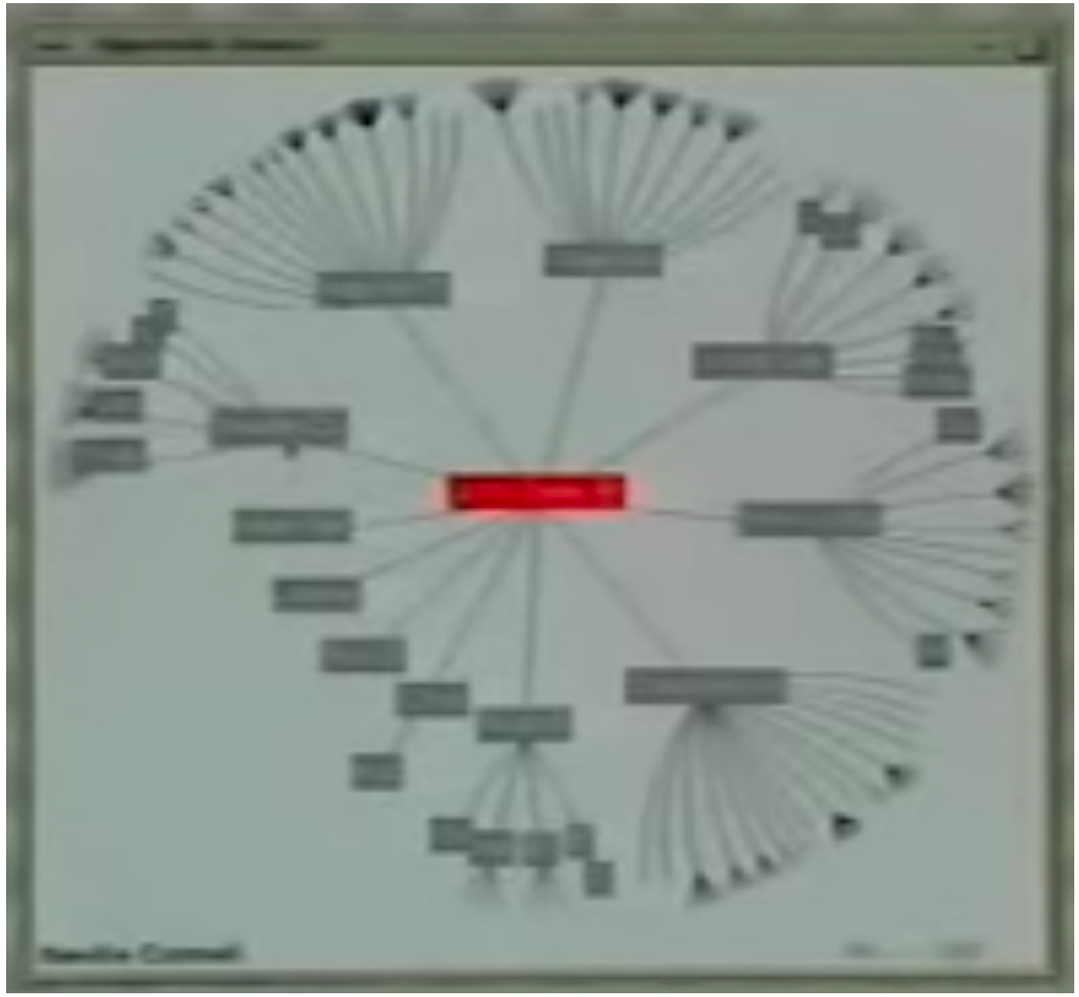






Leung 1994

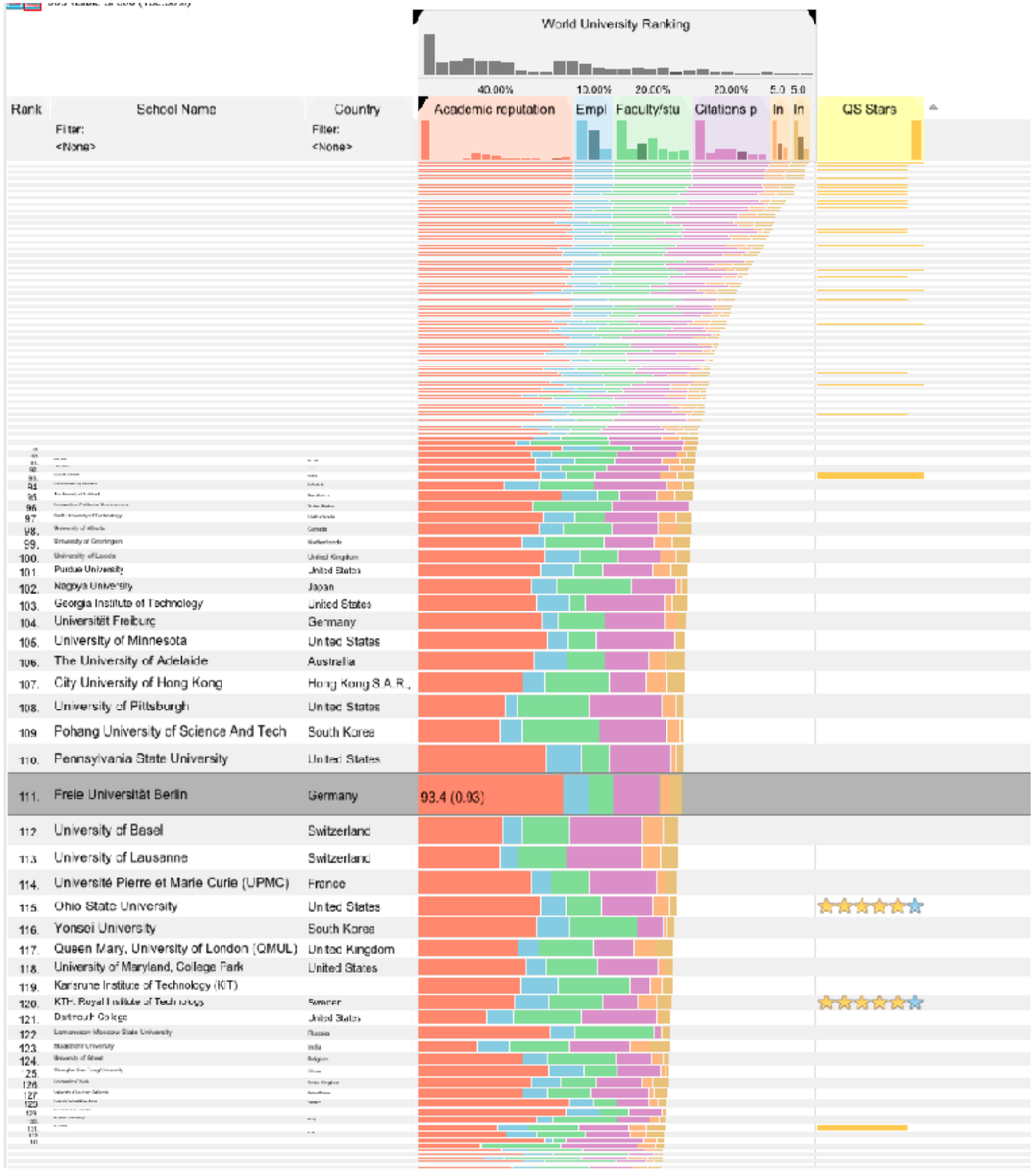
Hyperbolic Geometry



[Lamping, 1995]


Edmonton
Saskatchewan
Ontario
Quebec
Calgary
Winnipeg
Vancouver
Seattle
Spokane
Washington
Montana
North Dakota
Minnesota
Portland
Minneapolis
Wisconsin
Michigan
South Dakota
Oregon
Idaho
Wyoming
Madison
Milwaukee
Detroit
Toledo
Chicago
Iowa
Nebraska
Omaha
Lincoln
Illinois
Salt Lake City
Kansas City
Indiana
Ohio
Nevada
Utah
Colorado
United States
St. Louis
Missouri
Kansas
Sacramento
Stockton
California
Las Vegas
Bakersfield
Wichita
Tulsa
Oklahoma
Arkansas
Kentucky
West Virginia
Virginia
Tennessee
Albuquerque
Arizona
New Mexico
Los Angeles
Riverside
Mexicali
Phoenix
Tijuana
Ensenada
Tucson
Memphis
Mississippi
Atlanta
North Carolina
South Carolina
Dallas
Texas
Alabama
Georgia
Ciudad Juarez
San Antonio
Houston
Louisiana
Mobile
Hermosillo
Chihuahua
Nuevo Laredo
Corpus Christi
Gulf of California
Ciudad Obregón
Monclova
Matamoros
Los Mochis
Saltillo
Monterrey
Jacksonville
Orlando
Florida
Miami
La Paz
Culiacan
México
Mazatlan
Ciudad Victoria
Gulf of Mexico
Aguascalientes
San Luis
Ottawa
Montreal
Toronto
Buffalo
New York
Cleveland
Pennsylvania
Philadelphia
Columbus
Cincinnati
Maine
Rhode
Connecticut
New Jersey
Delaware
Maryland
District of Columbia

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



Fisheye Tree View

ctominski

Subscribe 2

100 views

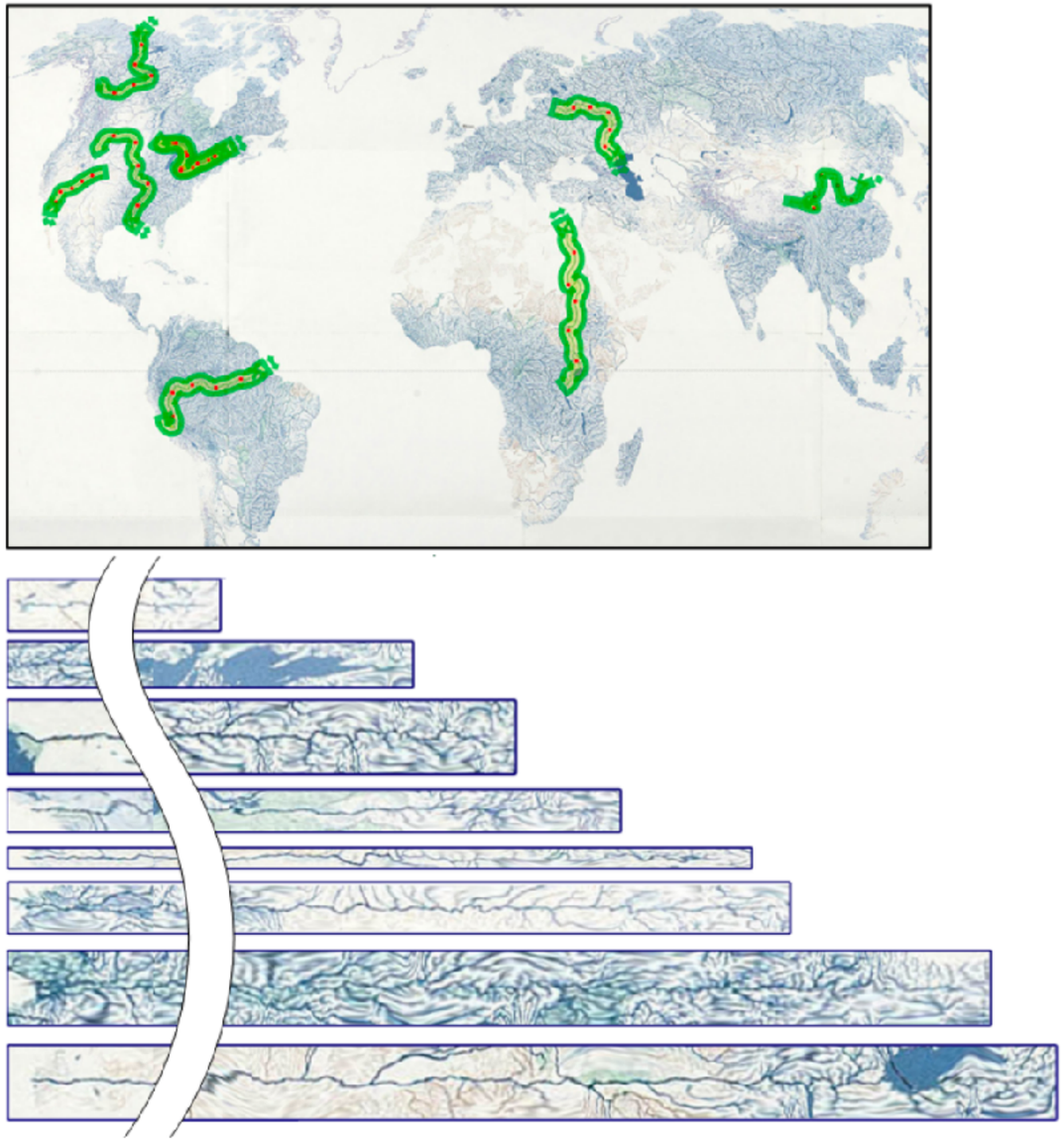
Add to Share More

0 0

Transmorgification

Idea: straighten complex shapes in image space

Can be spatial data,
but also other vis techniques



[Brosz, 13]

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 results compared to separate views and temporal navigation

filtering

aka brushing, aka selecting

& dynamic querying

The MANTRA

Visual Information Seeking Mantra (Shneiderman, 1996)

Overview first,

zoom and filter,

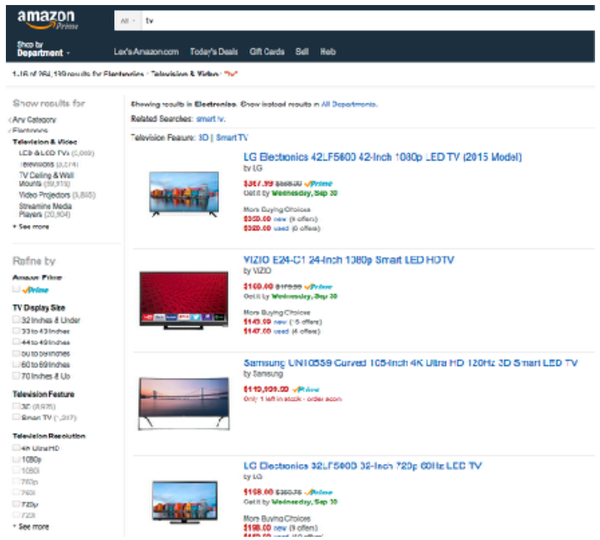
then details on demand

relate, history, extract

Dynamic Queries

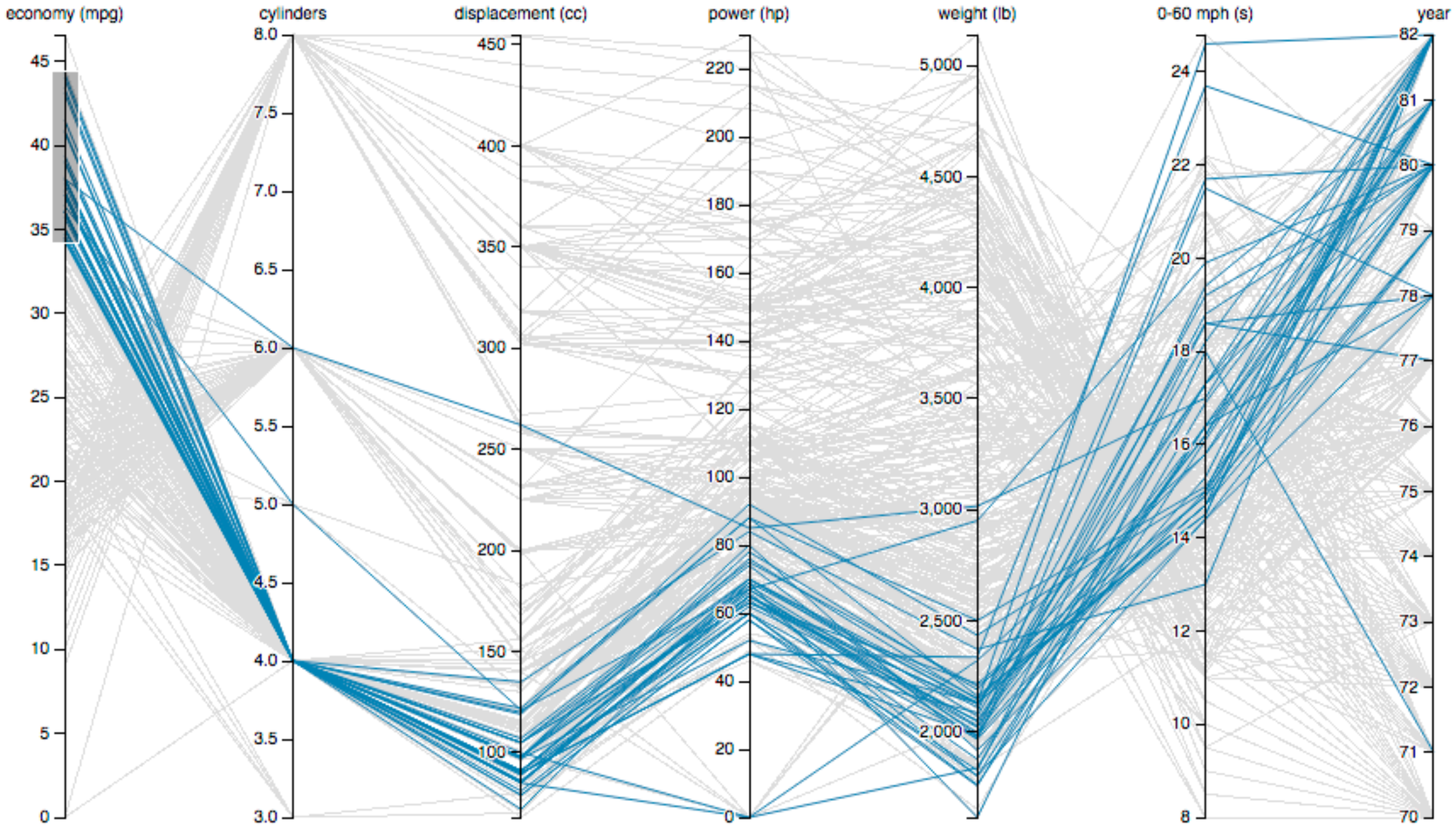
Define criteria for inclusion/ exclusion

“Faceted Search”

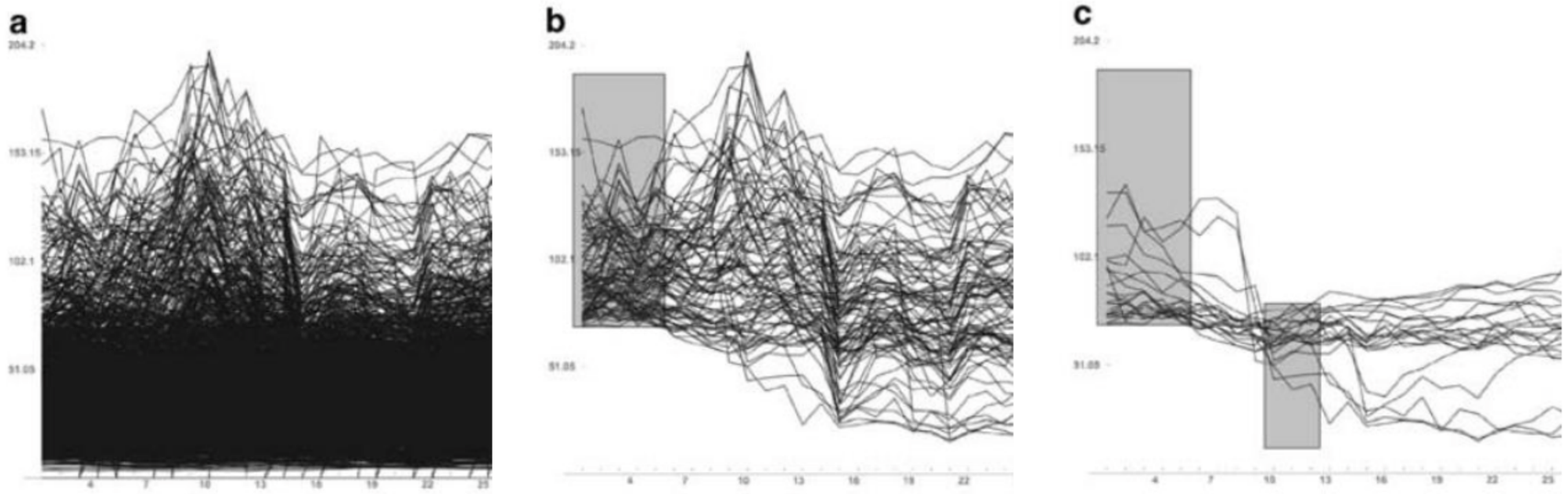


[Ahlberg & Shneiderman, 1994]

Visual Queries

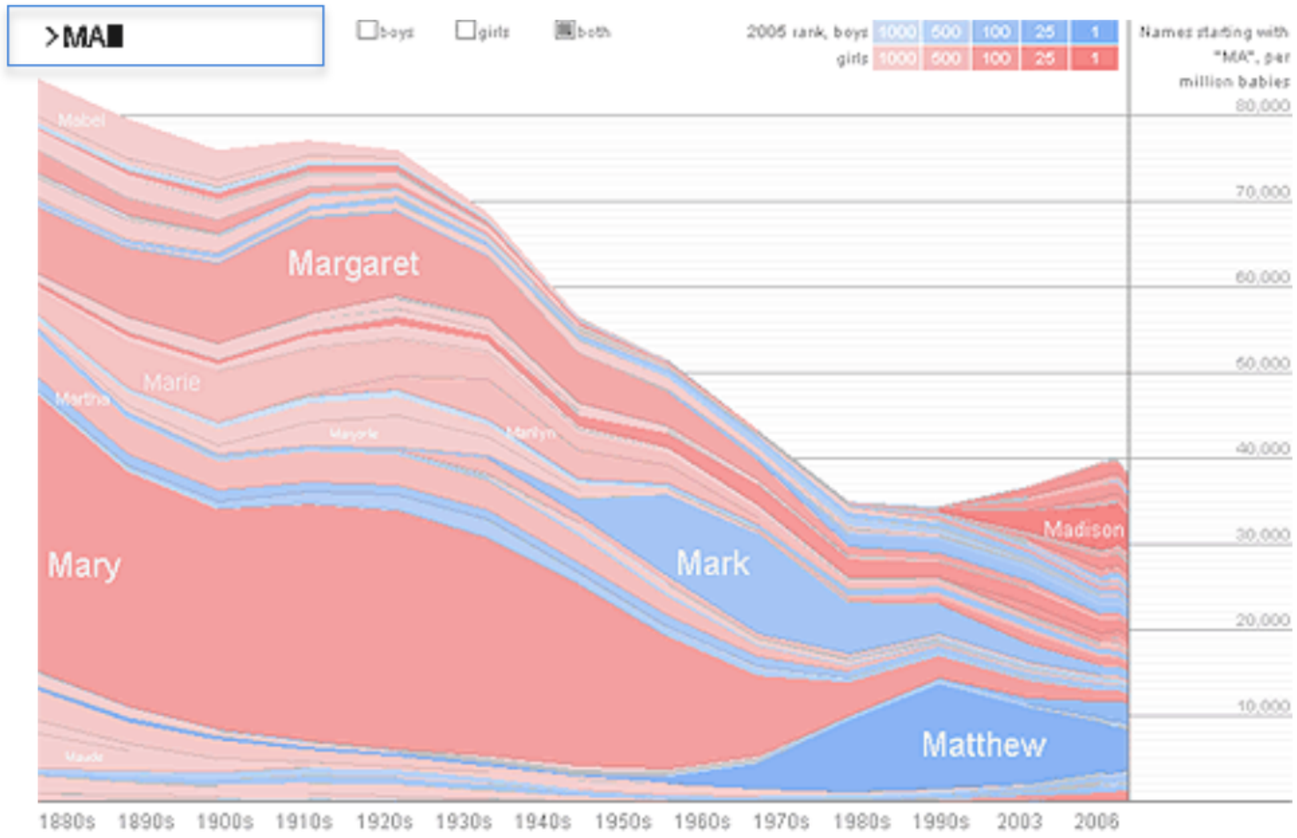


Visual Queries

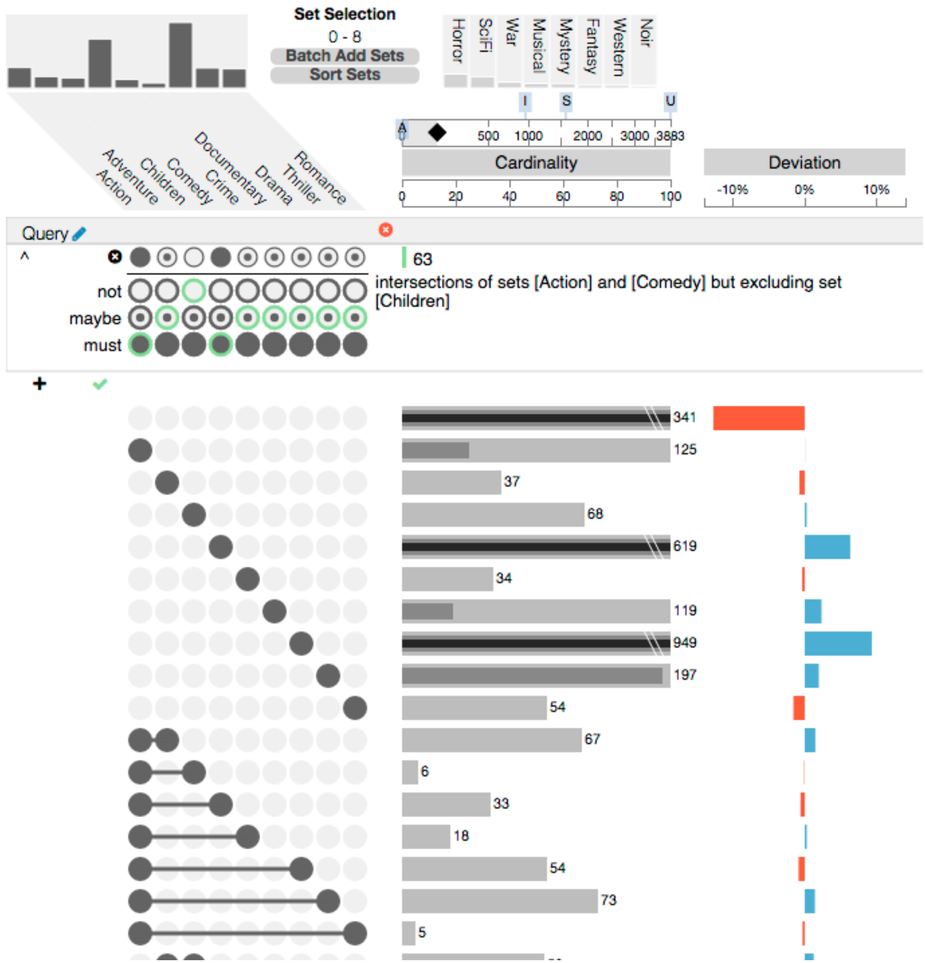


Time Searcher (Hocheiser, 2003)

Incremental Text Search



Query Interfaces



https://www.youtube.com/watch?v=-IfF2wGw7Qk&feature=youtu.be

Views

Multiple Views

Eyes over Memory:

Trade-off of display space and working memory

Juxtapose and Coordinate Multiple Side-by-Side Views

- Share Encoding: Same/Different
  - *Linked Highlighting*

- Share Data: All/Subset/None

- Share Navigation

		Data		
		All	Subset	None
Encoding	Same	Redundant	Overview/ Detail	Small Multiples
	Different	Multiform	Multiform, Overview/ Detail	No Linkage

Partition into Side-by-Side Views

Superimpose Layers

Linked Views

Multiple Views that are simultaneously visible and linked together such that actions in one view affect the others.

Linked Views Options

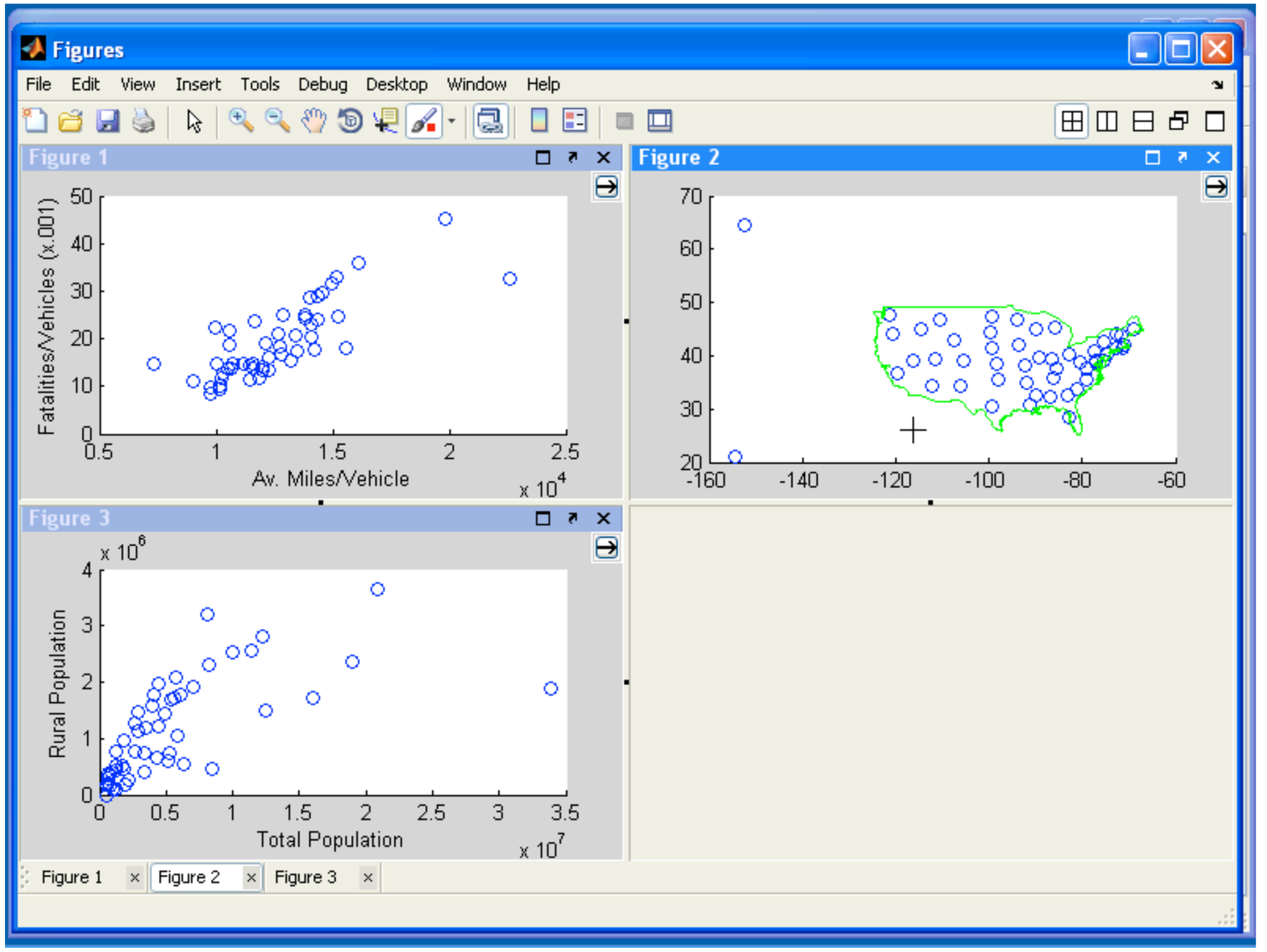
encoding: same or multiform

dataset: share all, subset, or none

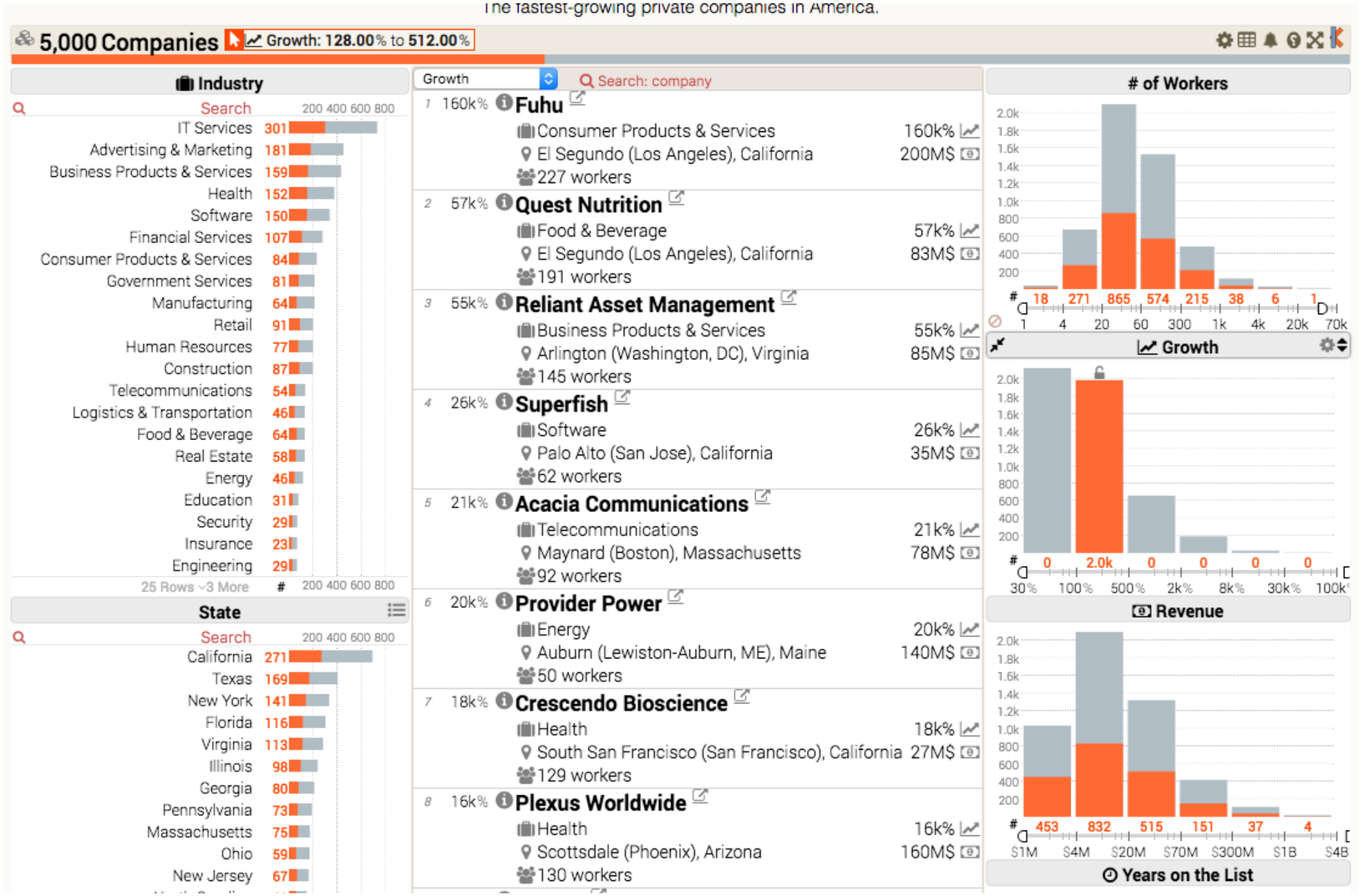
highlighting: to link, or not

navigation: to share, or not

Linked Highlighting



Linked Highlighting

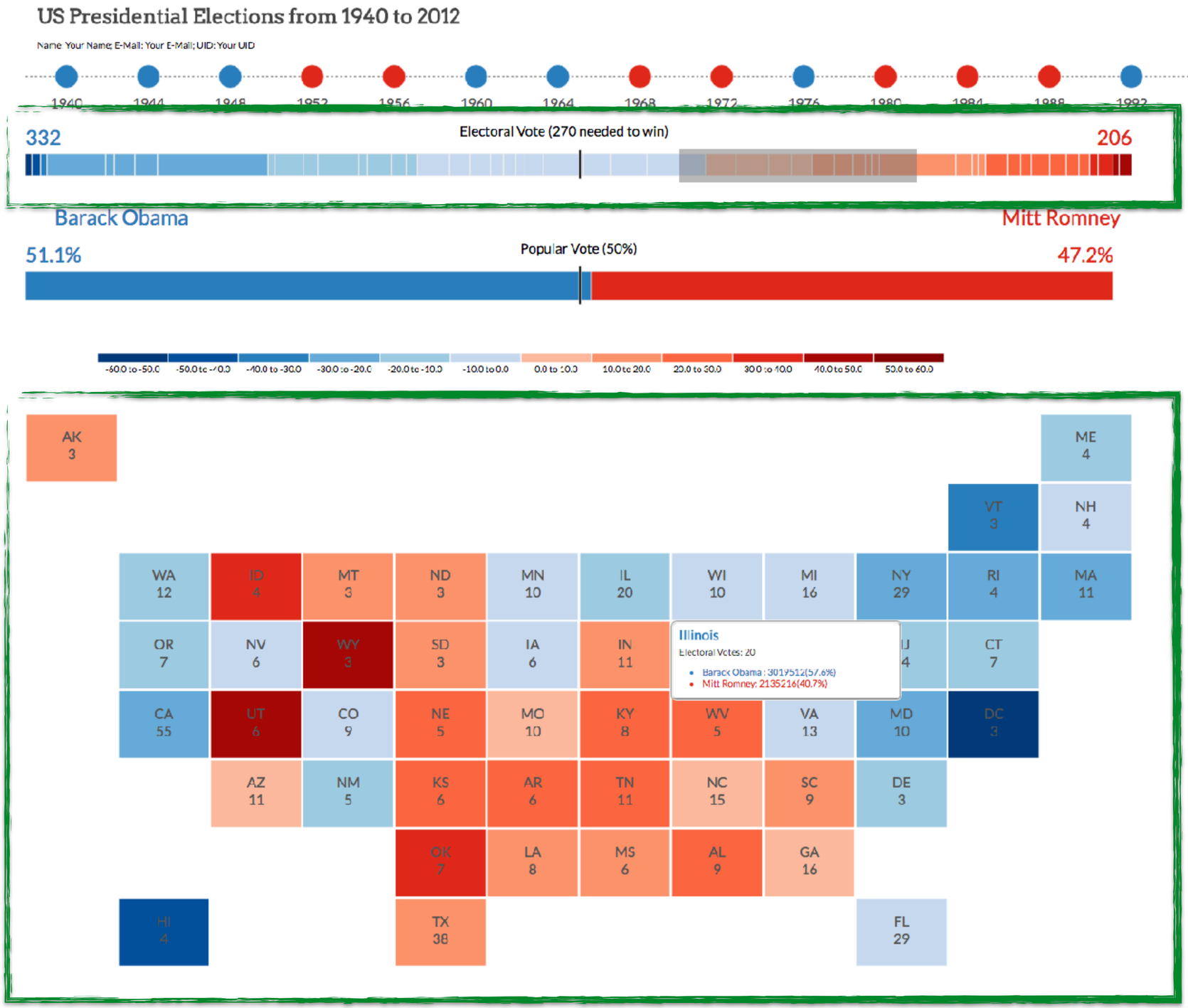


Multiform

difference visual encodings are used between the views

- implies shared data
- either all data
- or subset of data (overview + detail)

rationale:
single, monolithic view has strong limits on the number of attributes that can be shown simultaneously



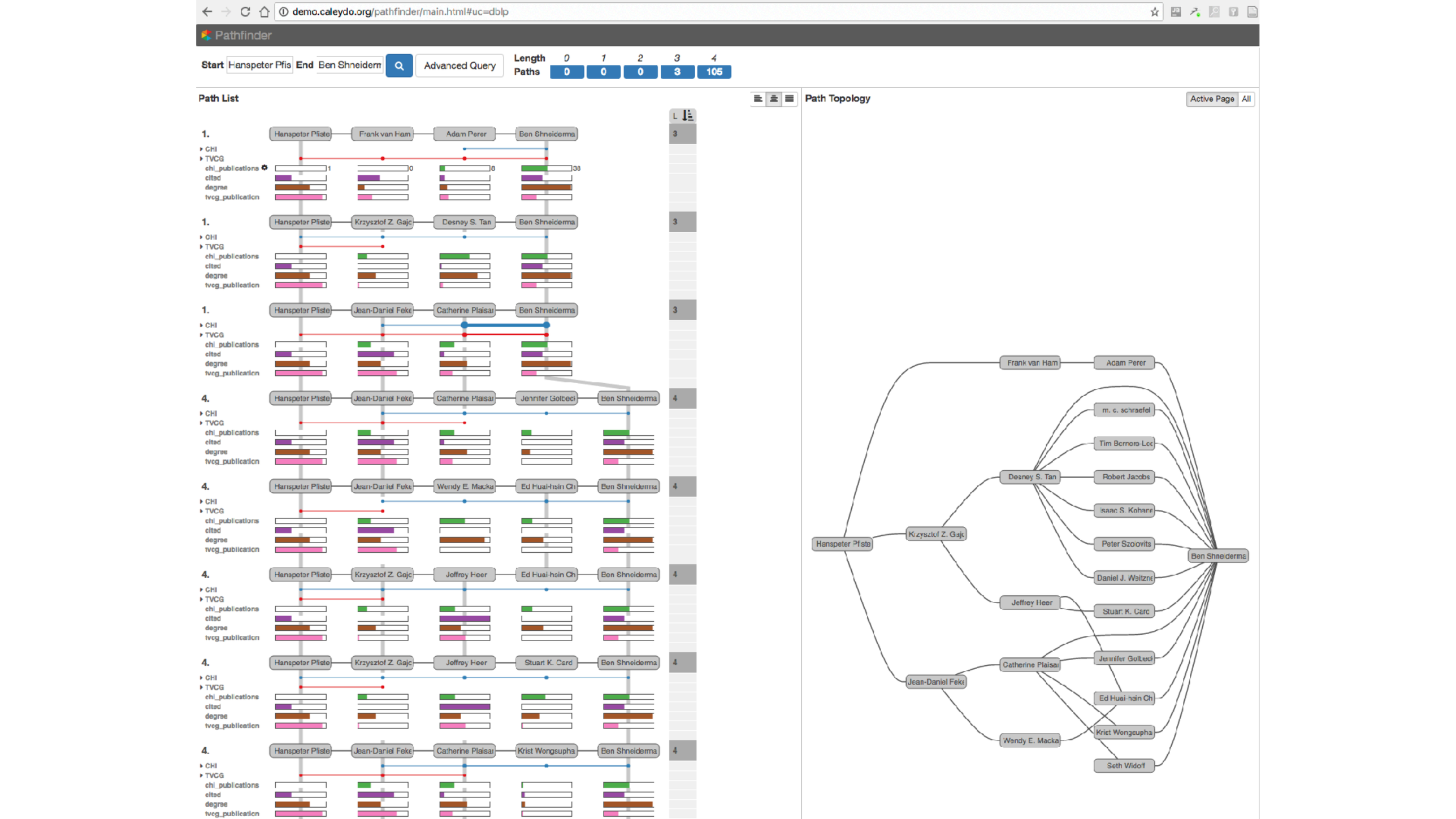
Multiform
Different Views
here also same data

SHARED-DATA

showing all data in each view, but with different encoding schemes

rationale:

different views support different tasks


demo.caleydo.org/pathfinder/main.html#uc=dblp
Pathfinder
Start Hanspeter Pfis End Ben Shneiderm
Advanced Query
Length 0 1 2 3 4
Paths 0 0 0 3 105
Path List
Path Topology
Active Page All
1.
Hanspeter Pfiste
Frank van Ham
Adam Perer
Ben Shneiderma
3
1.
Hanspeter Pfiste
Krzysztof Z. Gajc
Desney S. Tan
Ben Shneiderma
3
1.
Hanspeter Pfiste
Jean-Daniel Feke
Catherine Plaisar
Ben Shneiderma
3
4.
Hanspeter Pfiste
Jean-Daniel Feke
Catherine Plaisar
Jennifer Golbeck
Ben Shneiderma
4
4.
Hanspeter Pfiste
Jean-Daniel Feke
Wendy E. Macka
Ed Huai-hsin Ch
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Jeffrey Heer
Stuart K. Card
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Jean-Daniel Feke
Catherine Plaisar
Krist Wongsupha
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Frank van Ham
Adam Perer
m. c. schraefel
Tim Berners-Lee
Desney S. Tan
Robert Jacobs
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Peter Szolovits
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Hanspeter Pfiste
Krzysztof Z. Gajc
Ben Shneiderma
Jeffrey Heer
Stuart K. Card
Jennifer Golbeck
Catherine Plaisar
Jean-Daniel Feke
Ed Huai-hsin Ch
Krist Wongsupha
Wendy E. Macka
Seth Widoff

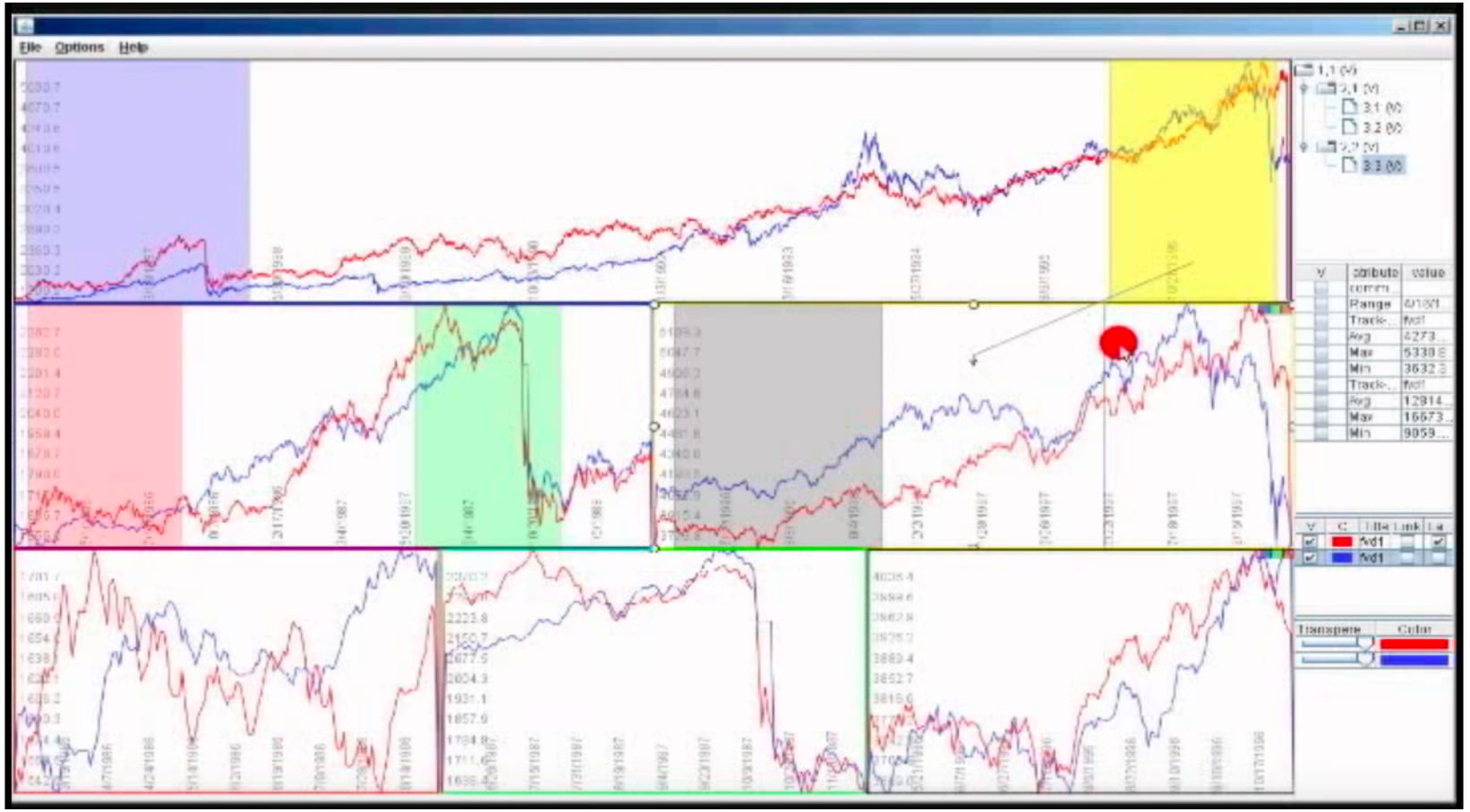
OVERVIEW + DETAIL

one view shows (often summarized) information about entire dataset, while additional view(s) shows more detailed information about a subset of the data

rationale:

for large or complex data, a single view of the entire dataset cannot capture fine details

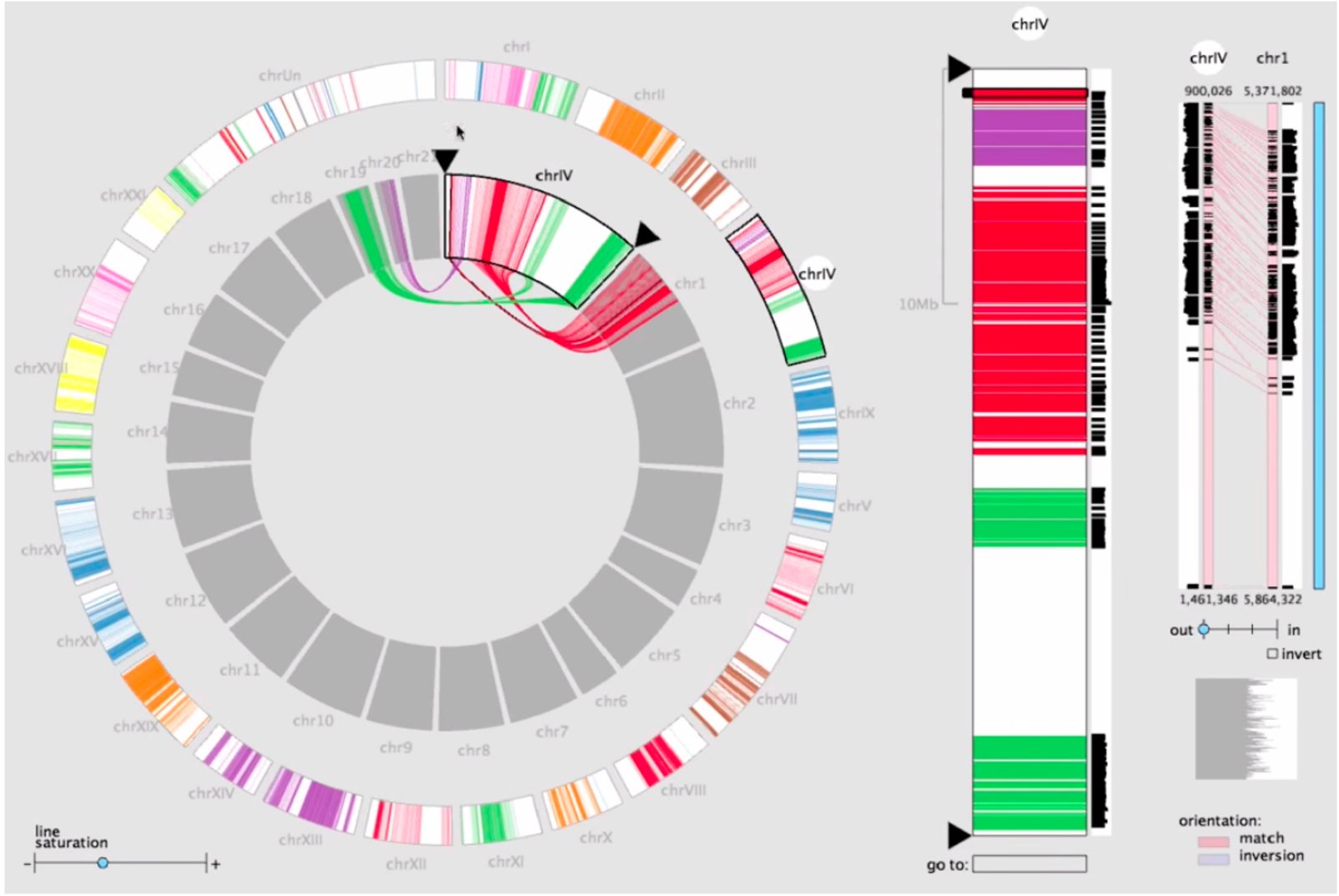
Stack Zooming



Same Data - Same Encoding, Different Resolution

[Javed & Emlqvist, PacificVis, 2010]

MizBee



Multiform Overview & Detail

[Meyer 2009]

SMALL MULTIPLES

each view uses the same visual encoding, but shows a different subset of the data

rationale:

quickly compare different parts of a data set, relying on eyes instead of memory

Small Multiples for Graph Attributes

[Barsky, InfoVis 2008]

Partitioning

PARTITIONING

action on the dataset that **separates the data into groups**

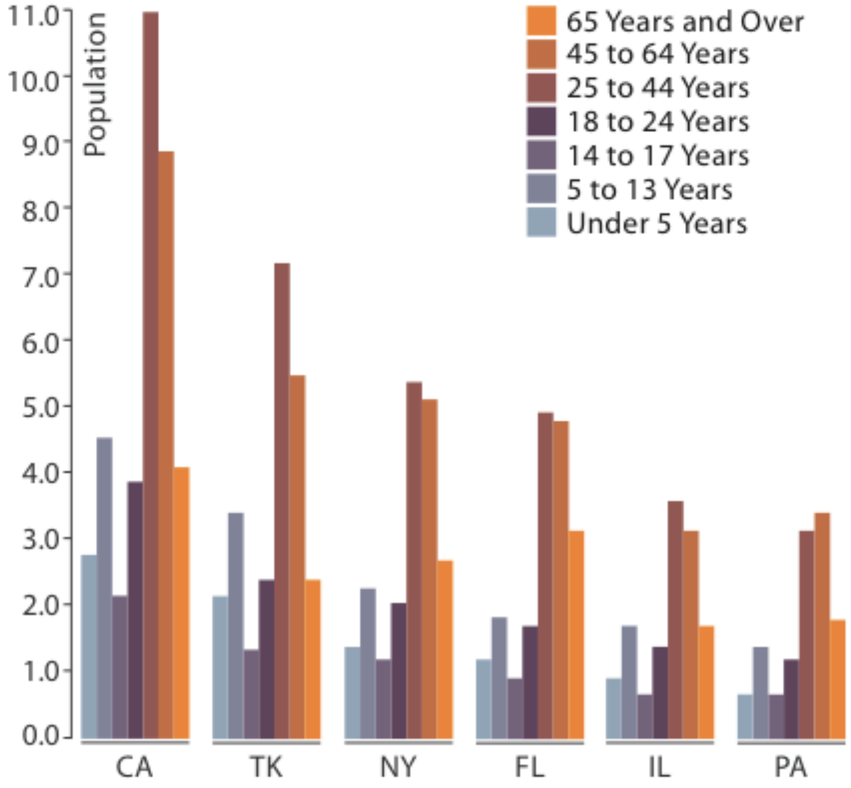
design choices

- how to divide data up between views, given a hierarchy of attributes
- how many splits, and order of splits
- how many views (usually data driven)

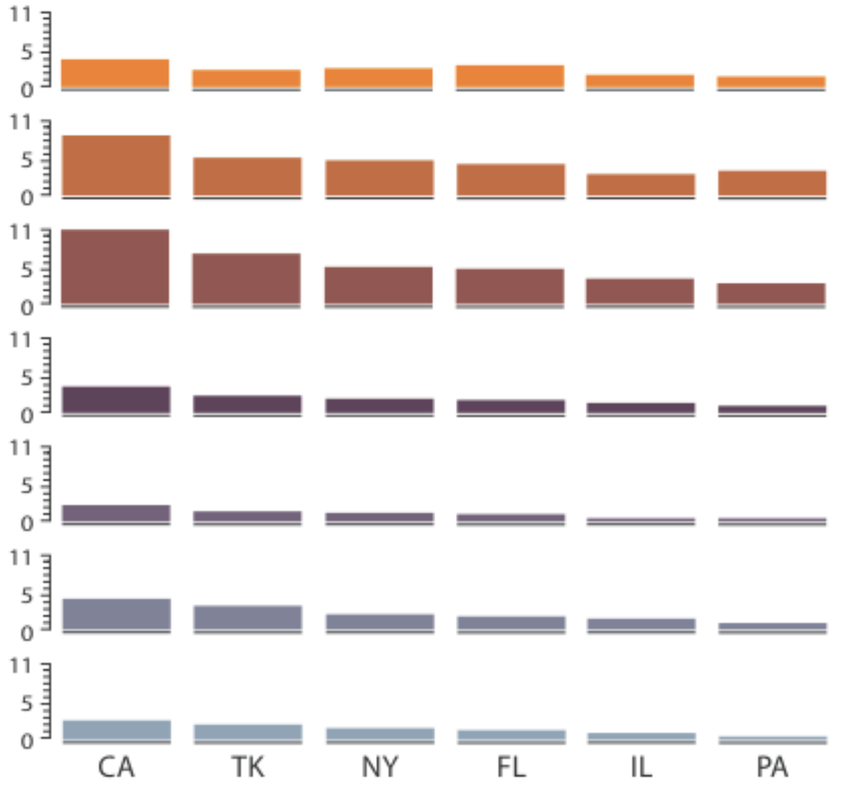
partition attribute(s)

- typically categorical

Partitioning

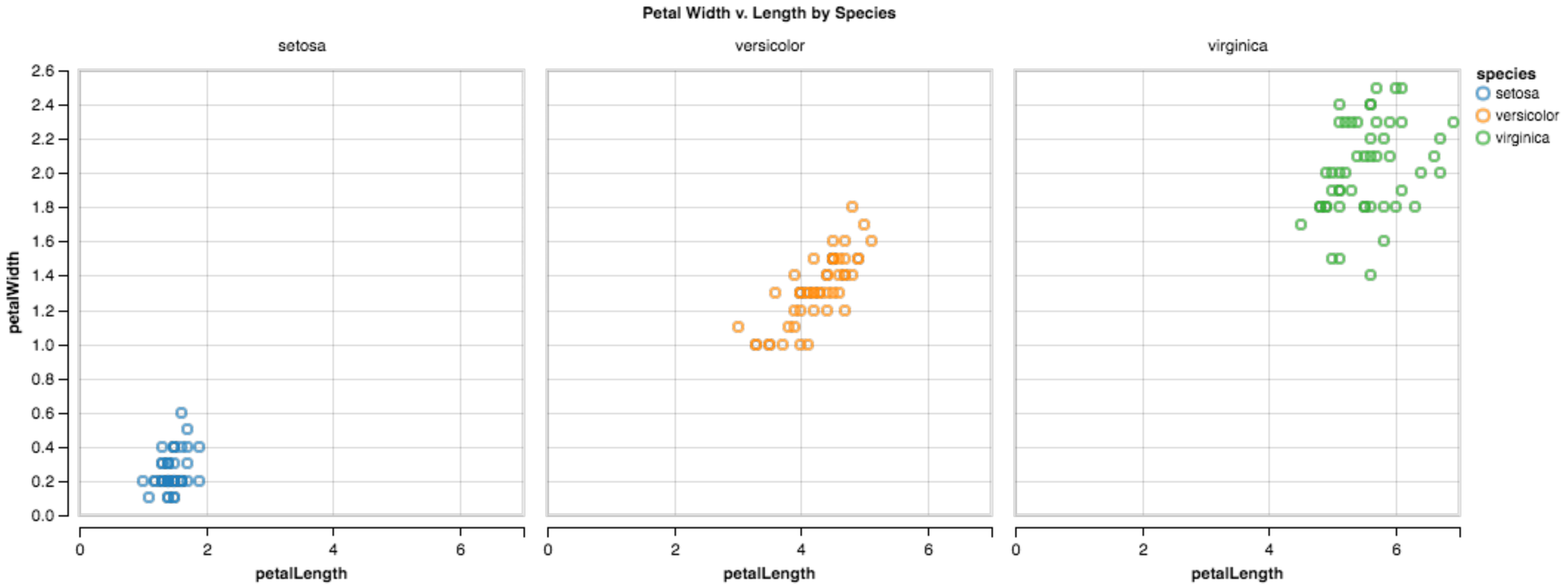


Partitioned by State



Partitioned by Age Group and State

Partition by Category



Trellis Plots

panel variables

attributes encoded in individual views

partitioning variables

partitioning attributes assigned to columns, rows, and pages

main-effects ordering

order partitioning variable levels/states based on derived data

support perception of trends and structure in data

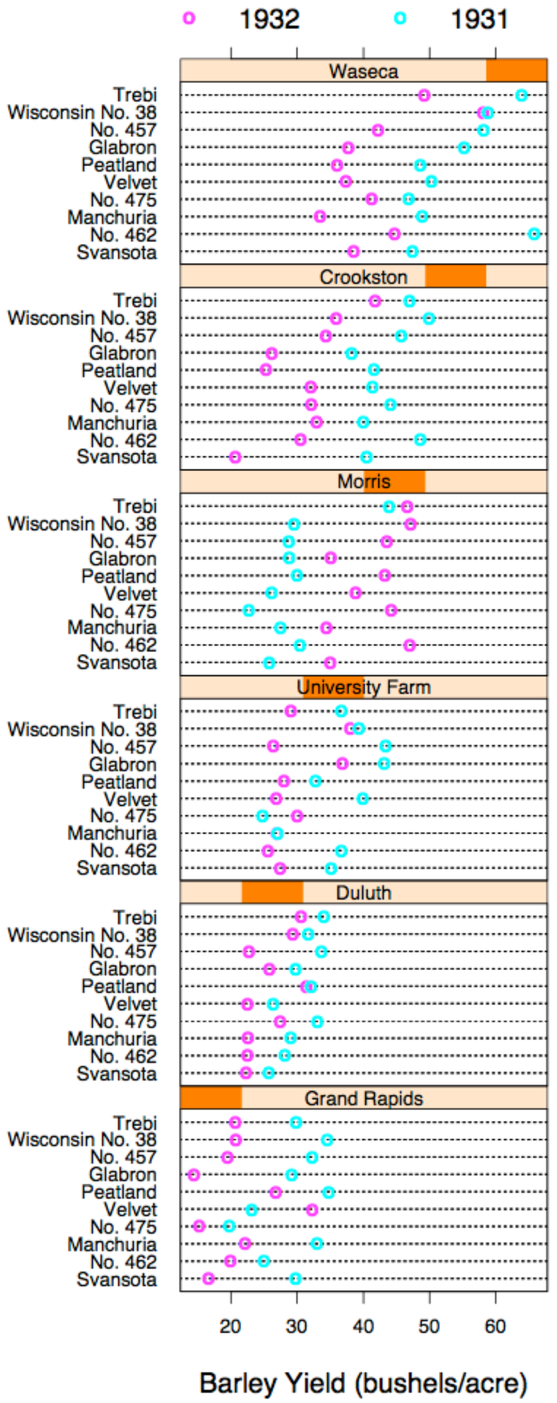
Data

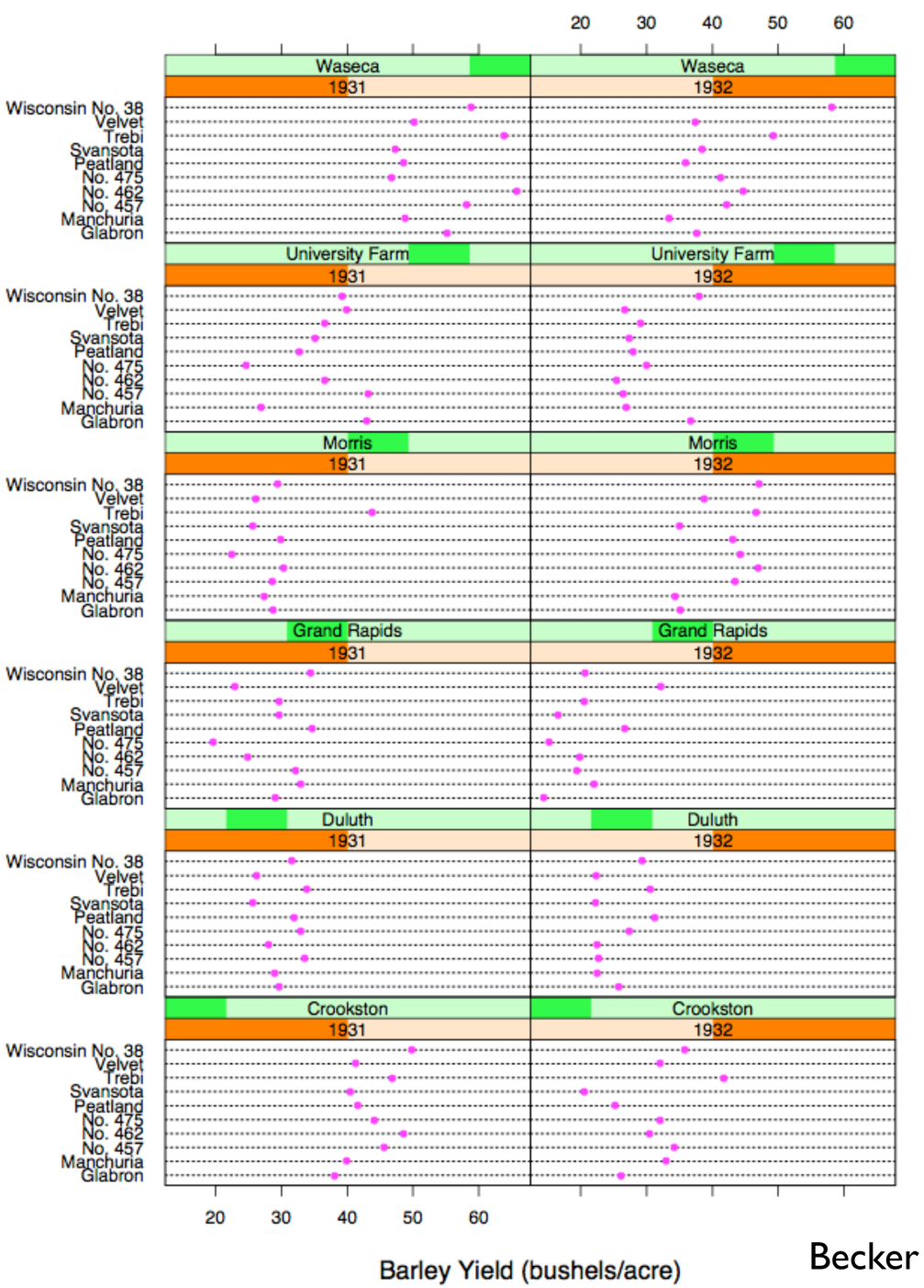
Barley Yields in two years across multiple farms for multiples barley strains

partitioning variables

- Columns partitioned by year
- Rows partitioned by farm

Becker 1996


1932
1931
Waseca
Trebi
Wisconsin No. 38
No. 457
Glabron
Peatland
Velvet
No. 475
Manchuria
No. 462
Svansota
Crookston
Morris
University Farm
Duluth
Grand Rapids
20
30
40
50
60
Barley Yield (bushels/acre)


20
30
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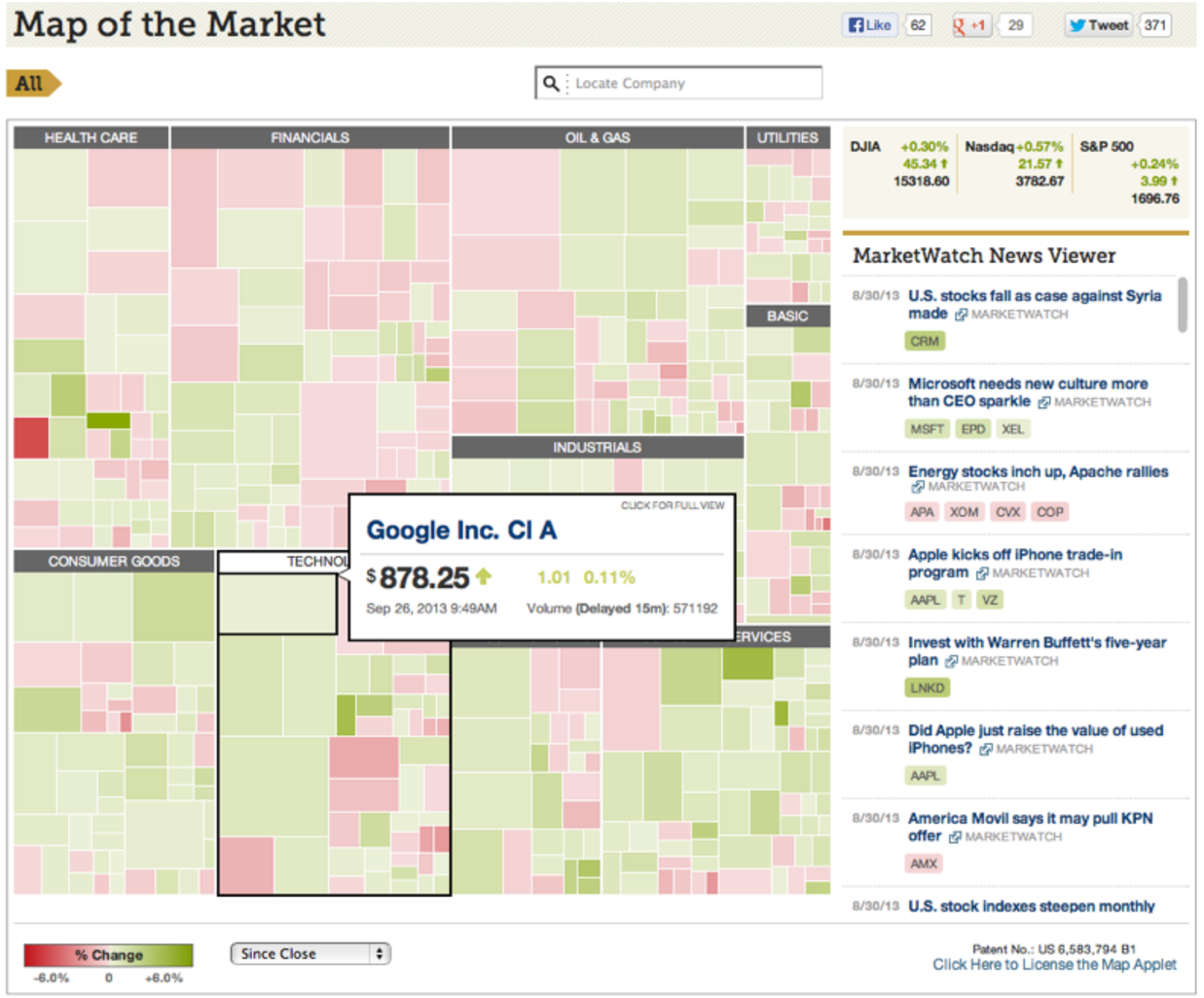
Waseca
1931
1932
Wisconsin No. 38
Velvet
Trebi
Svansota
Peatland
No. 475
No. 462
No. 457
Manchuria
Glabron
University Farm
Morris
Grand Rapids
Duluth
Crookston
Barley Yield (bushels/acre)

Becker 1996

Recursive Subdivision

partitioning: flexibly transform data attributes into a hierarchy

use treemaps as spacefilling rectangular layouts



Treemap

HiVE example: London property

partitioning attributes

house type
neighborhood
sale time

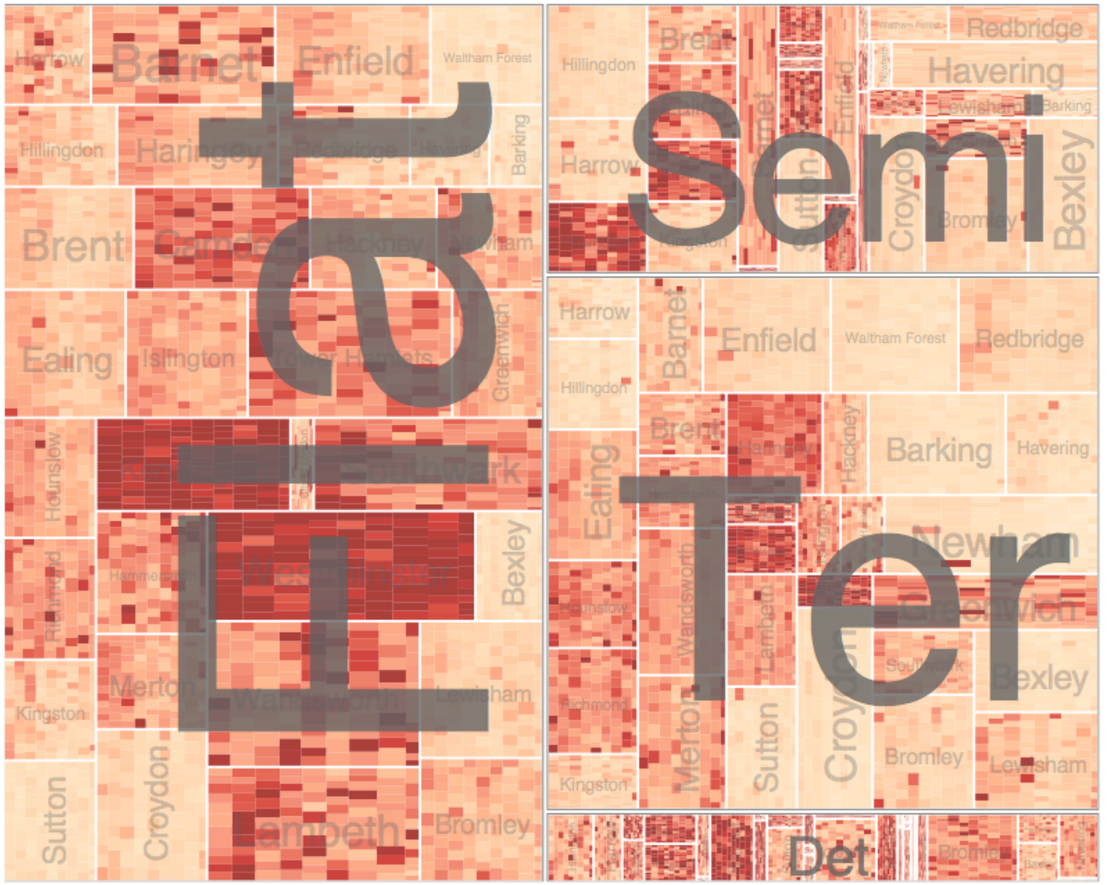
encoding attributes

average price (color)
number of sales (size)

results

between neighborhoods, different housing distributions

within neighborhoods, similar prices



Slingsby 2009

HiVE example: London property

partitioning attributes

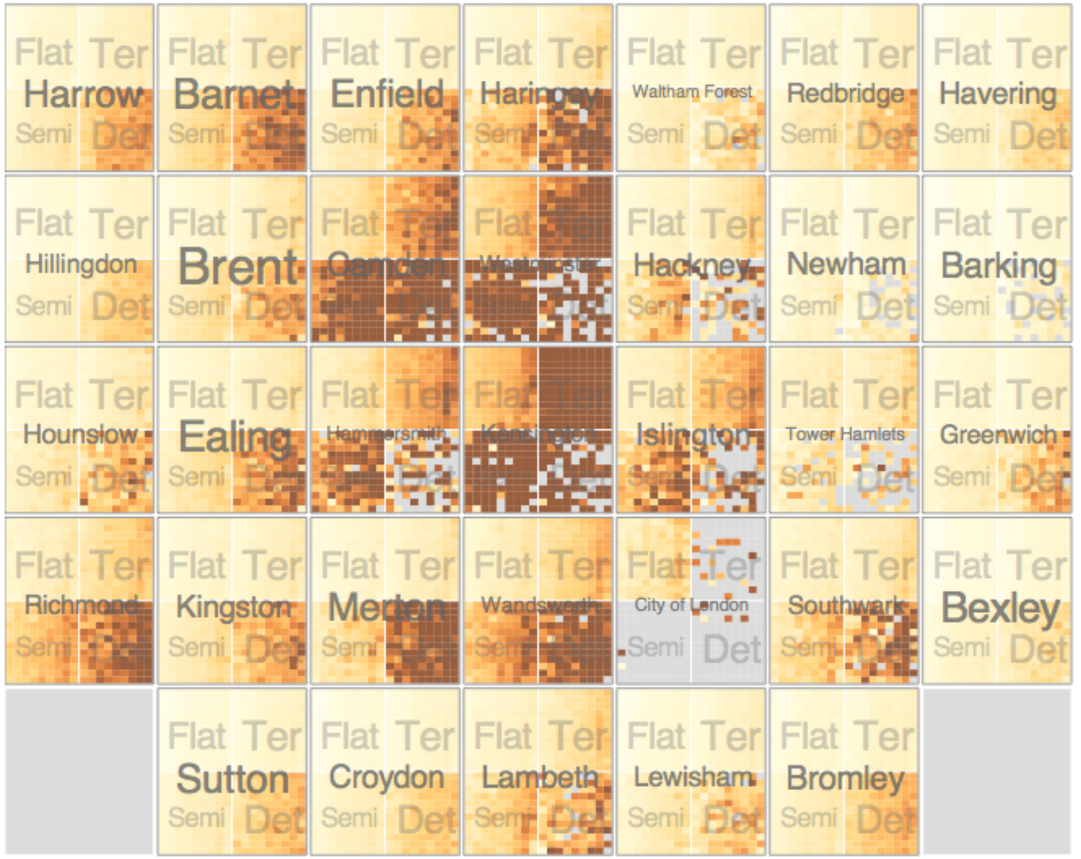
neighborhood location
neighborhood
house type
sale time (year)
sale time (month)

encoding attributes

average price (color)
n/a (size)

results

expensive neighborhoods
near center of city



Slingsby 2009

Configuring Hierarchical Layouts to Address Research Questions

Aidan Slingsby, Jason Dykes and Jo Wood
giCentre, Department of Information Science, City University London
http://www.gicentre.org/hierarchical_layouts/

LAYERING

combining multiple views on top of one another to form a composite view

rationale

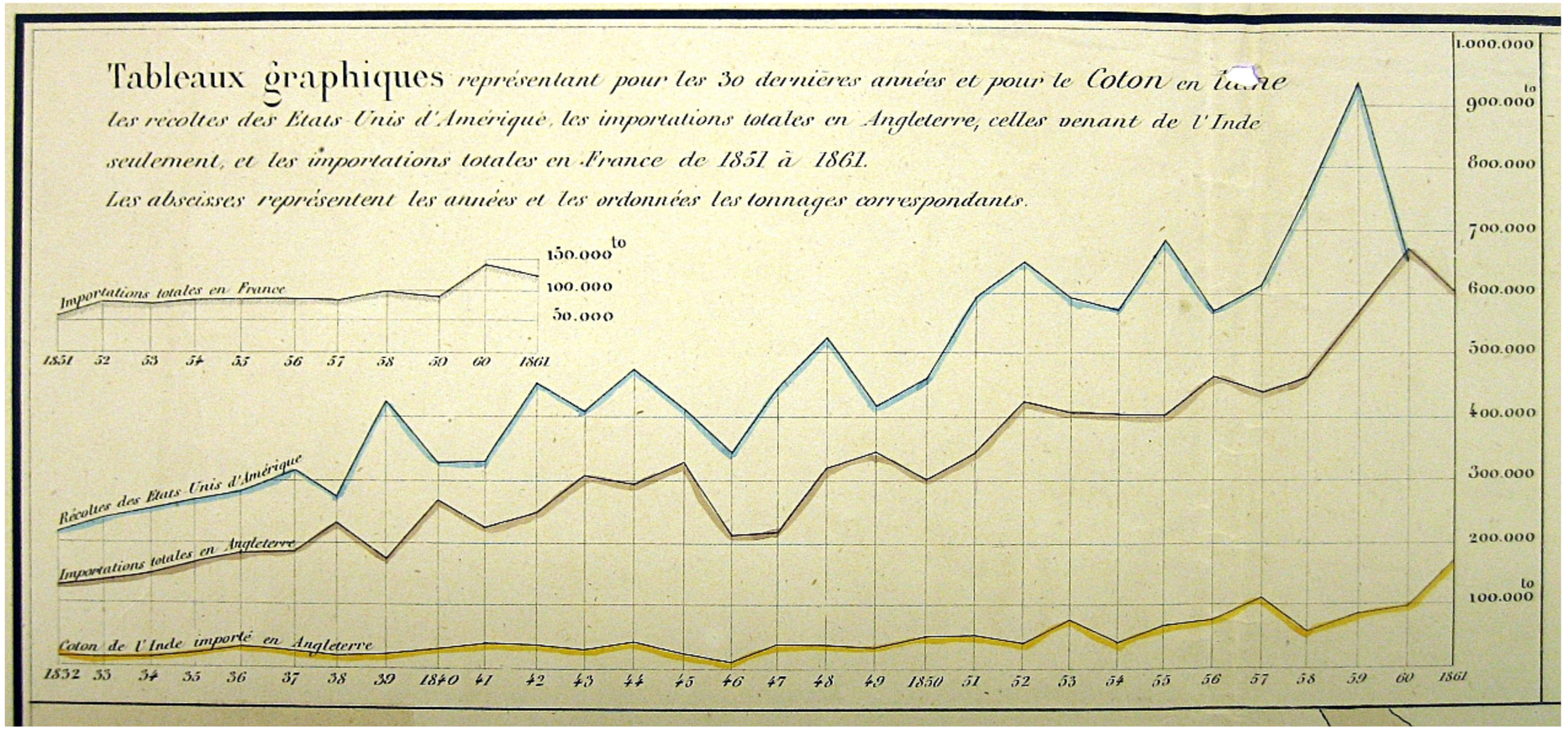
supports a larger, more detailed view than using multiple views

trade-off

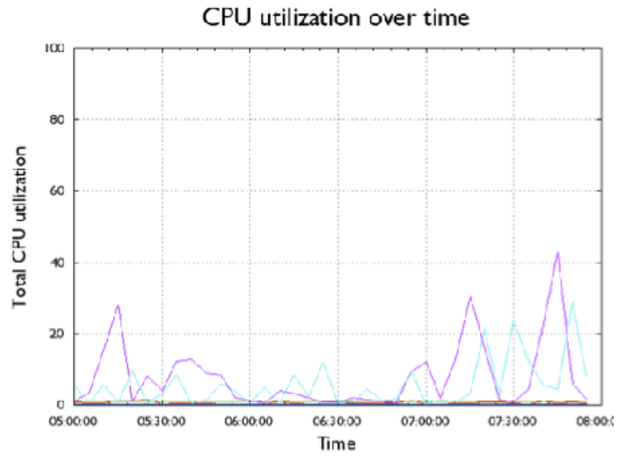
layering imposes constraints on visual encoding choice as well as number of layers that can be shown

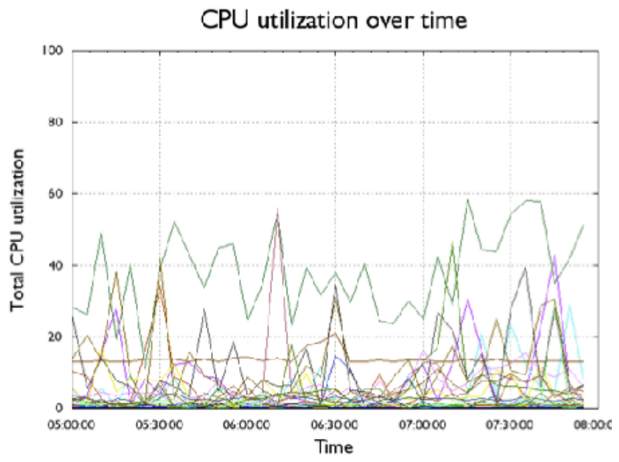
JOSEPH MINARD

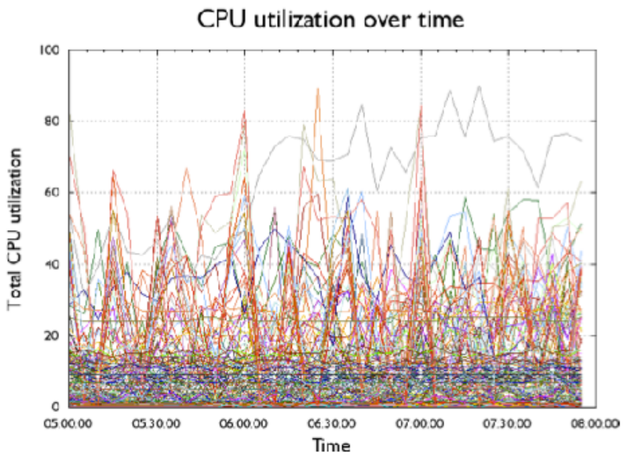
1781-1870



overlays


CPU utilization over time
Total CPU utilization
Time

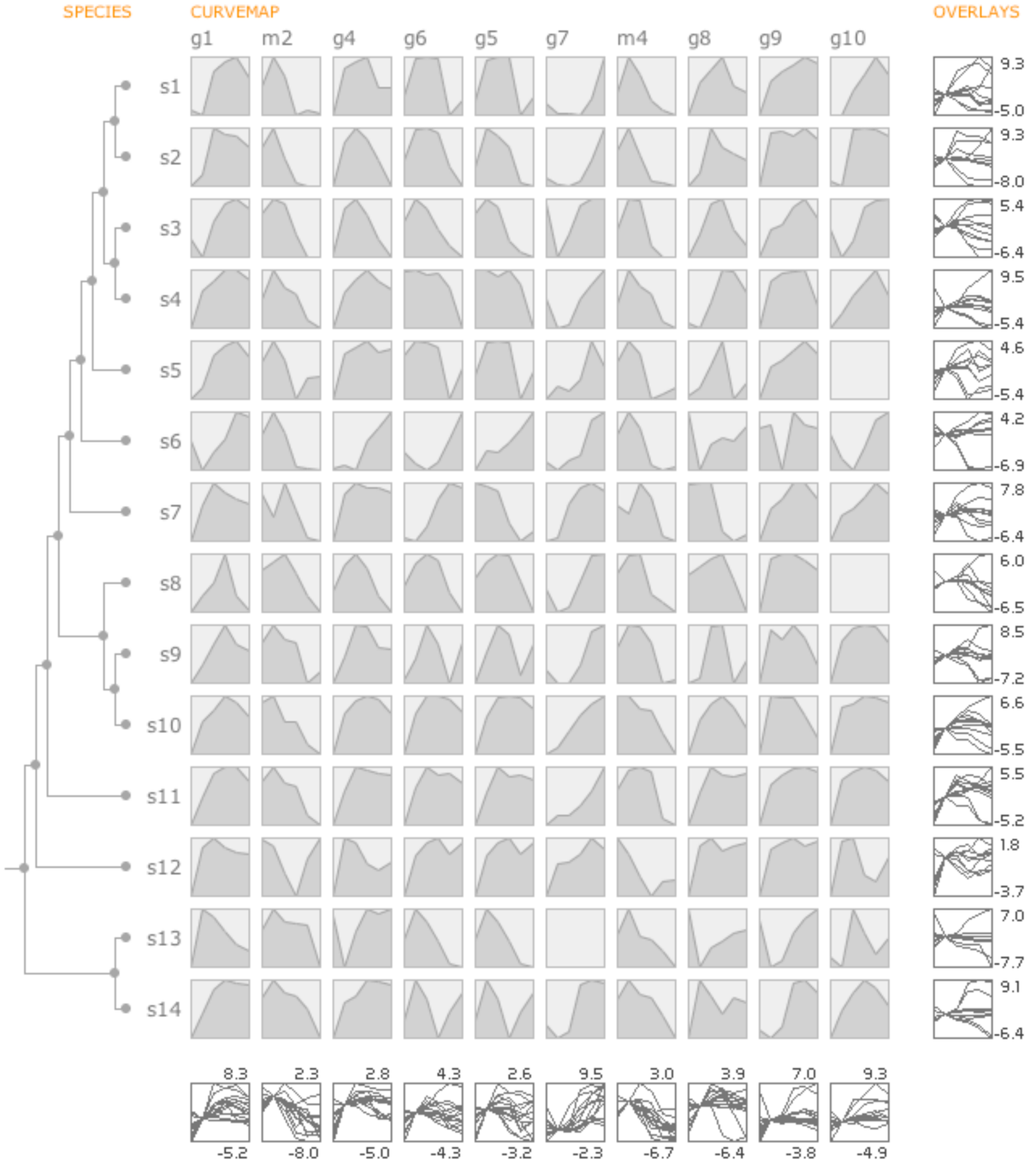

CPU utilization over time
Total CPU utilization
Time


CPU utilization over time
Total CPU utilization
Time

Combined

Partitioned + layered graph

Synchronized through highlighting



MCV to the Max