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# Visualization for Data Science

## DS-4630 / CS-5630 / CS-6630

SINGLE VIEW, MULTIVIEW, &  
FOCUS+CONTEXT

# Single vs Multiple views

- eyes over memory—trade-off of display space and working memory
- similar situation with partitioning vs layering

# A variety of options...

## ➔ Juxtapose and Coordinate Multiple Side-by-Side Views

### ➔ Share Encoding: Same/Different

#### ➔ *Linked Highlighting*



### ➔ Share Data: All/Subset/None



### ➔ Share Navigation

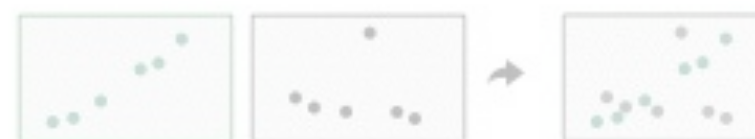


		Data		
		All	Subset	None
Encoding	Same	Redundant	Overview/ Detail	Small Multiples
	Different	Multiform	Multiform, Overview/ Detail	No Linkage

## ➔ 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

- What to show
  - **encoding:** same or multiform
  - **dataset:** share all, subset, or none
- How to interact
  - **highlighting:** to link, or not
  - **navigation:** to share, or not

# MULTIFORM

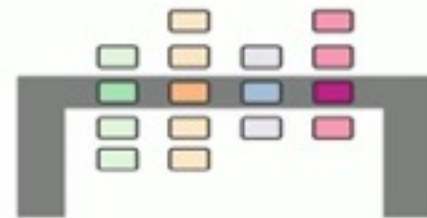
- different visual encodings are used between the views
  - rational: single, monolithic view has strong limits on the number of attributes that can be shown simultaneously

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# VisBricks: Multiform Visualization of Large, Inhomogeneous Data

caleydotugraz [+ Subscribe](#) 12 videos

## VisBricks: Multiform Visualization of Large, Inhomogeneous Data



Alexander Lex, Hans-Jörg Schulz, Marc Streit, Christian Partl and Dieter Schmalstieg



Like [+ Add to](#) [Share](#)

143 views

Uploaded by [caleydotugraz](#) on Jul 12, 2011

Large volumes of real-world data often exhibit inhomogeneities: vertically in the form of correlated or independent dimensions, horizontally in the form of clustered or scattered data items. In essence, these inhomogeneities form

1 likes, 0 dislikes

Put Text Into Usable Data by SASsoftware 5,776 views Ad

Will Hunsinger shows off Evri by TechFlashVideos 158 views

Information Visualization by UTHHealthSBMI 183 views

code\_swarm - A Design Study in Organic by michaelogawa 190 views

Caleydo Matchmaker Commercial by caleydotugraz 172 views

Model-Driven Design for the Visual Analysis of ... by caleydotugraz 109 views

The Caleydo Jukebox



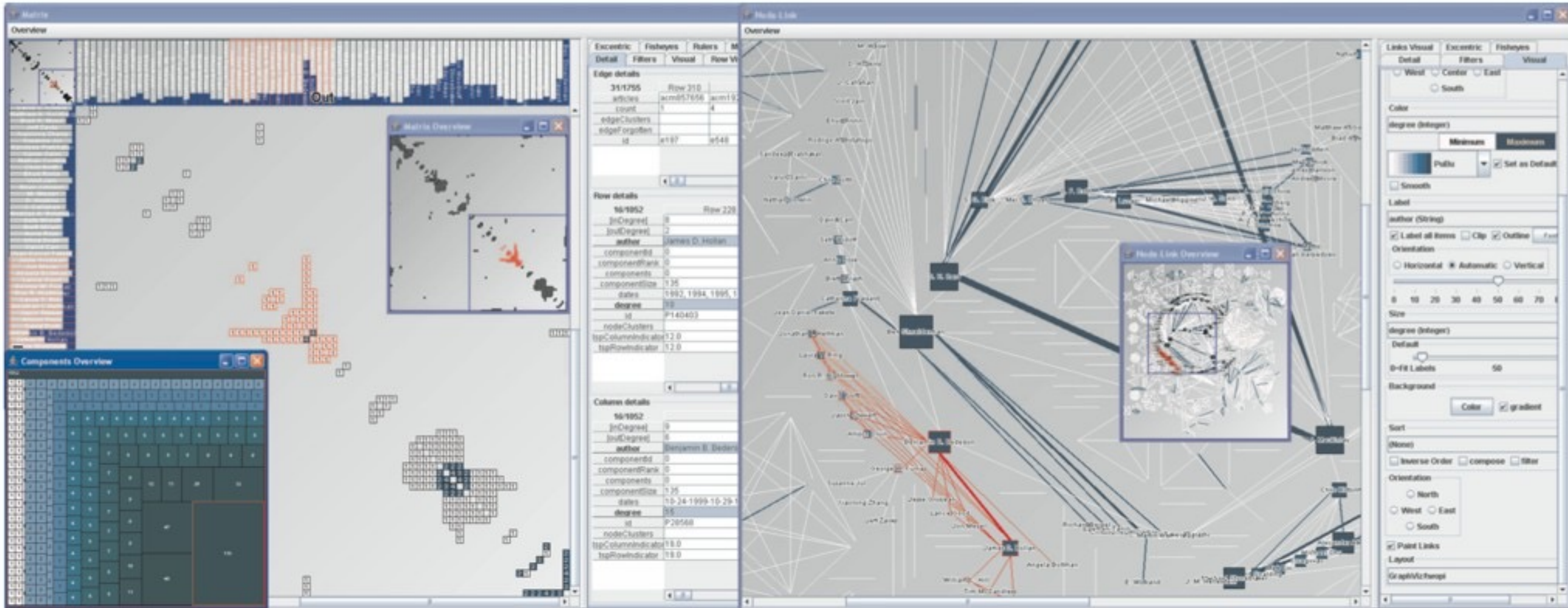
- What to show
  - **encoding**: same or multiform
  - **dataset**: share all, subset, or none
- How to interact
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  - **navigation**: to share, or not



# SHARED DATA

- showing all data in each view, but with different encoding schemes
  - rational: different views support different tasks

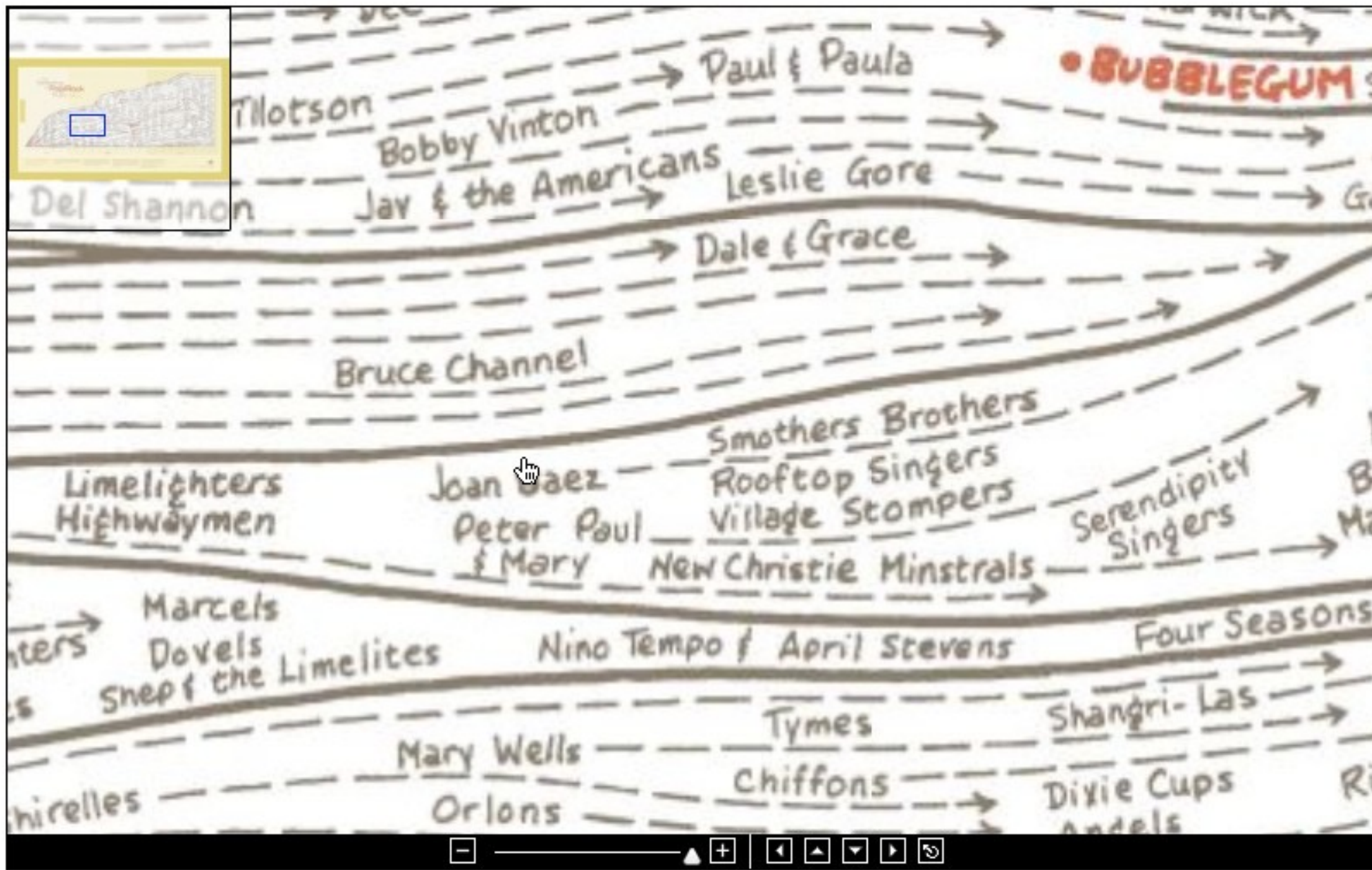
# MatrixExplorer



# OVERVIEW + DETAIL

- one view shows (often summarized) information about the entire dataset, while additional view(s) shows more detailed information about a subset of the data
  - rational: for large or complex data, a single view of the entire dataset cannot capture fine details

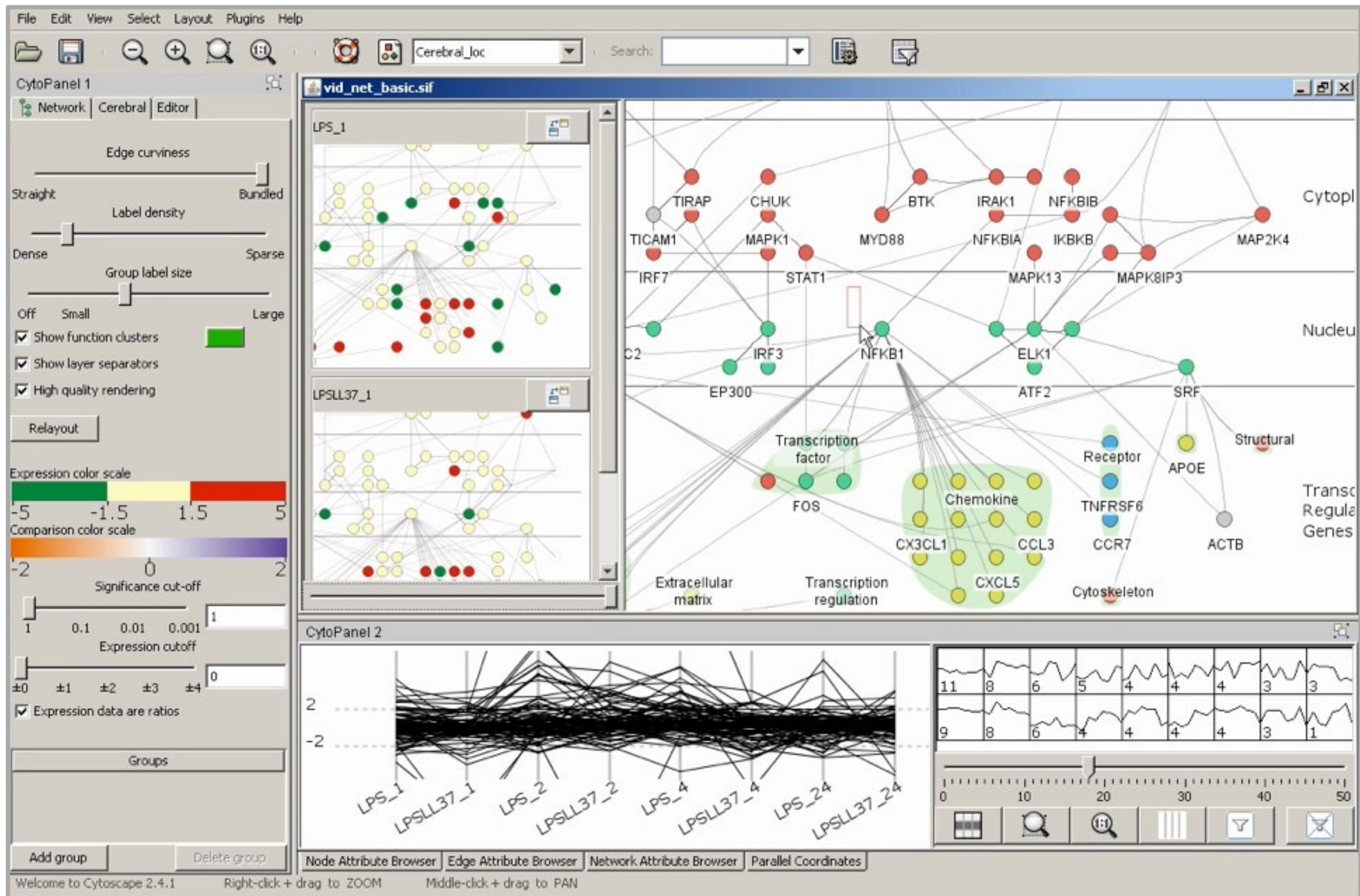










# SMALL MULTIPLES

- each view uses the same visual encoding but shows a different subset of the data
  - rational: quickly compare different parts of a data set, relying on eyes instead of memory



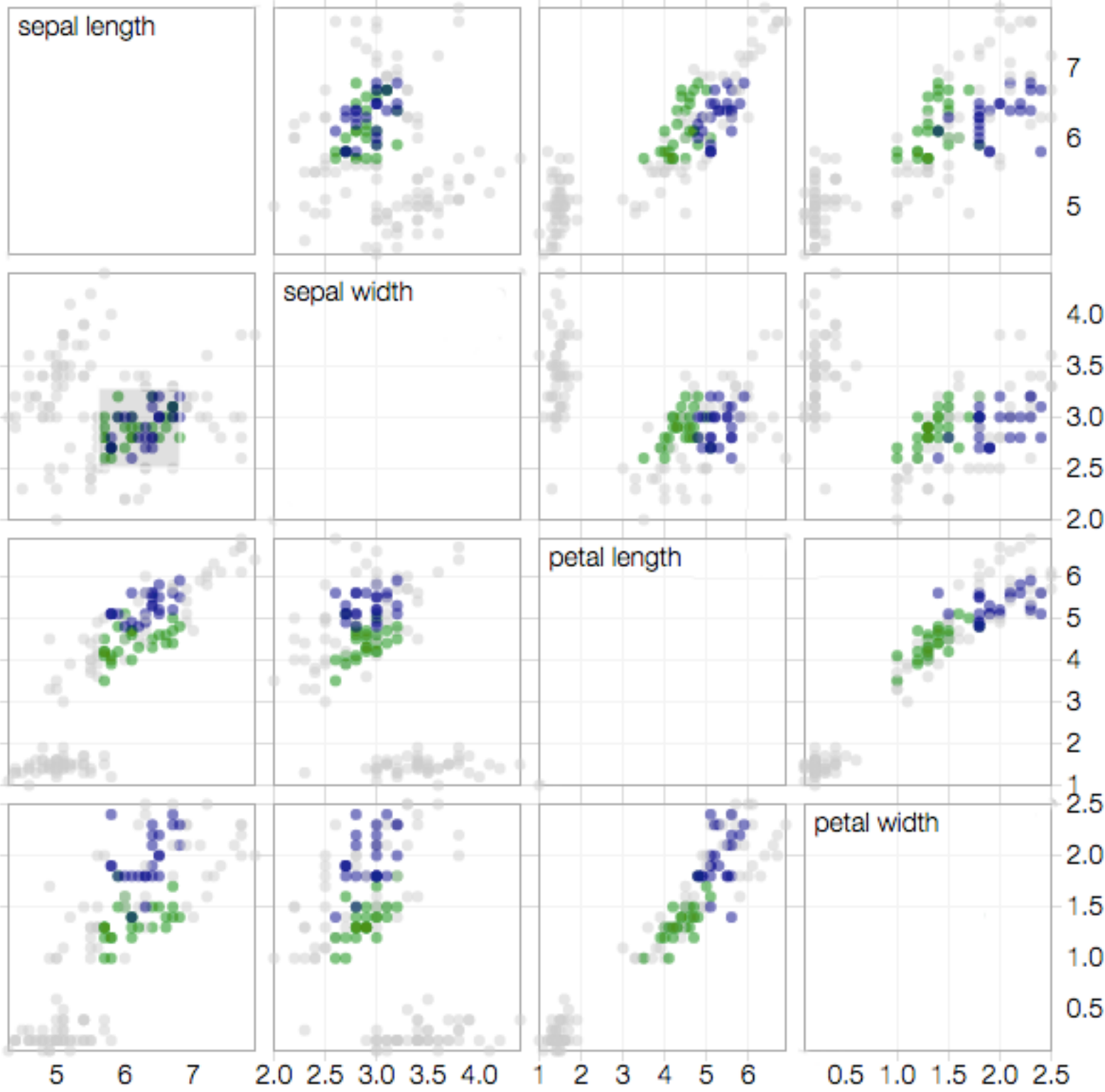


		Shared Data		
		All	Subset	None
Shared Encoding	Same	 <p>Redundant</p>	 <p>Overview/ Detail</p>	 <p>Small Multiples</p>
	Different	 <p>Multiform</p>	 <p>Multiform, Overview/ Detail</p>	 <p>No Linkage</p>



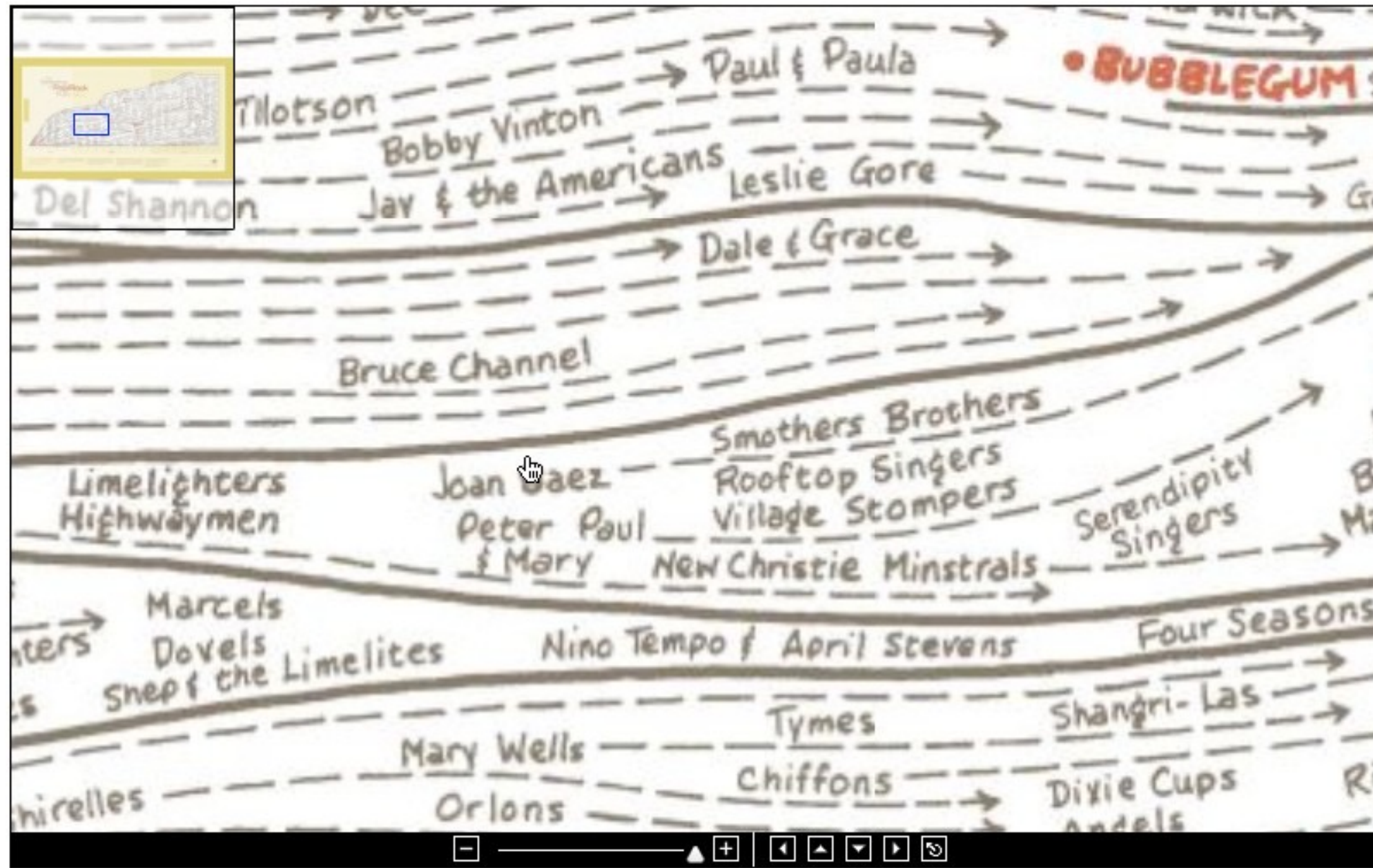
- What to show
  - **encoding**: same or multiform
  - **dataset**: share all, subset, or none
- How to interact
  - **highlighting**: to link, or not
  - **navigation**: to share, or not

# LINKED HIGHLIGHTING



- What to show
  - **encoding:** same or multiform
  - **dataset:** share all, subset, or none
- How to interact
  - **highlighting:** to link, or not
  - **navigation:** to share, or not

# LINKED NAVIGATION



# A variety of options...

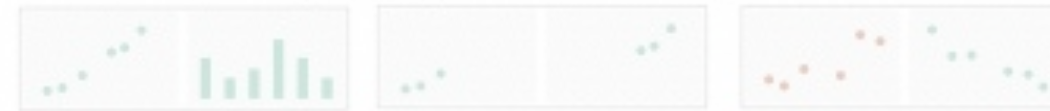
## ➔ Juxtapose and Coordinate Multiple Side-by-Side Views

➔ 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



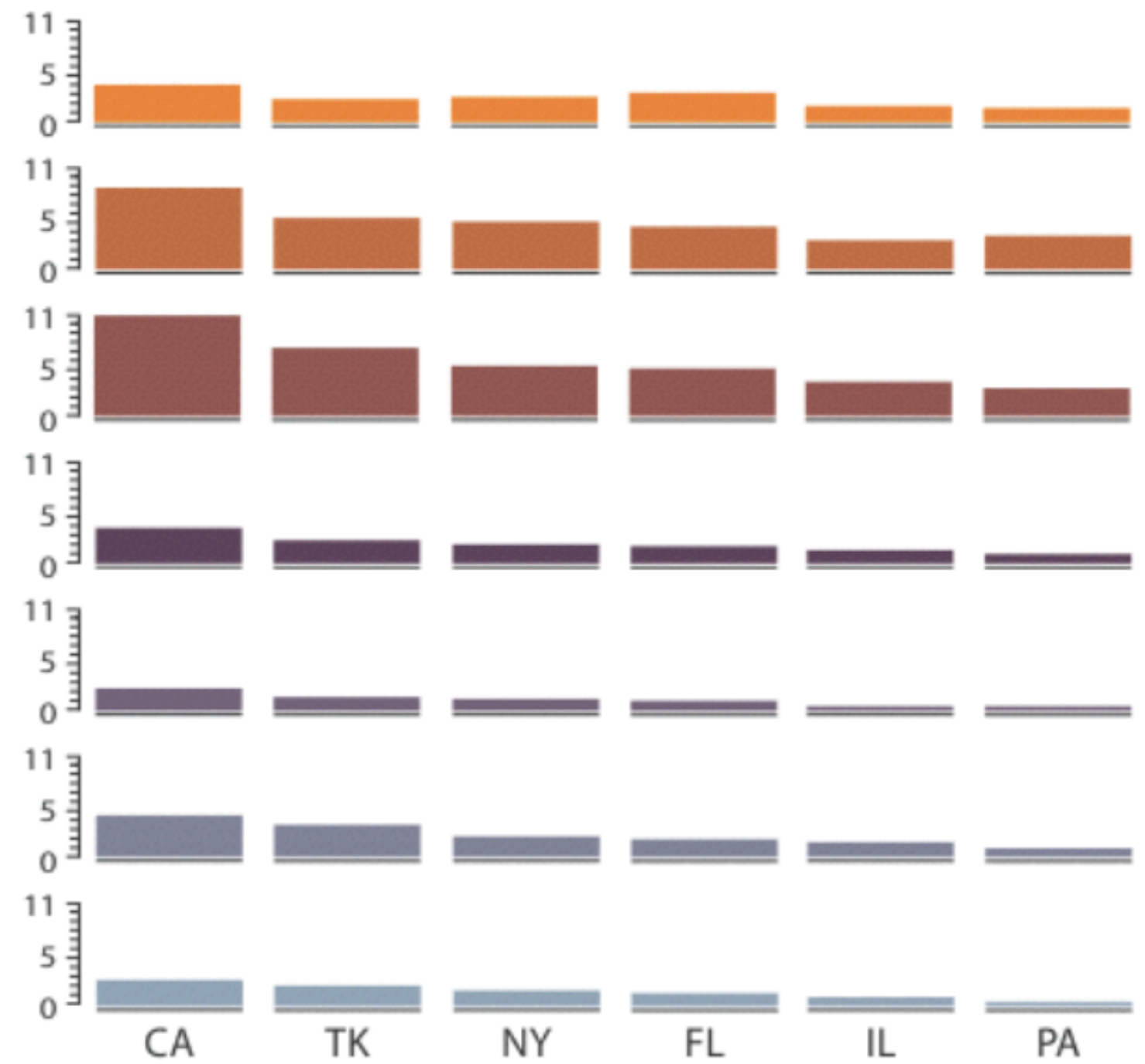
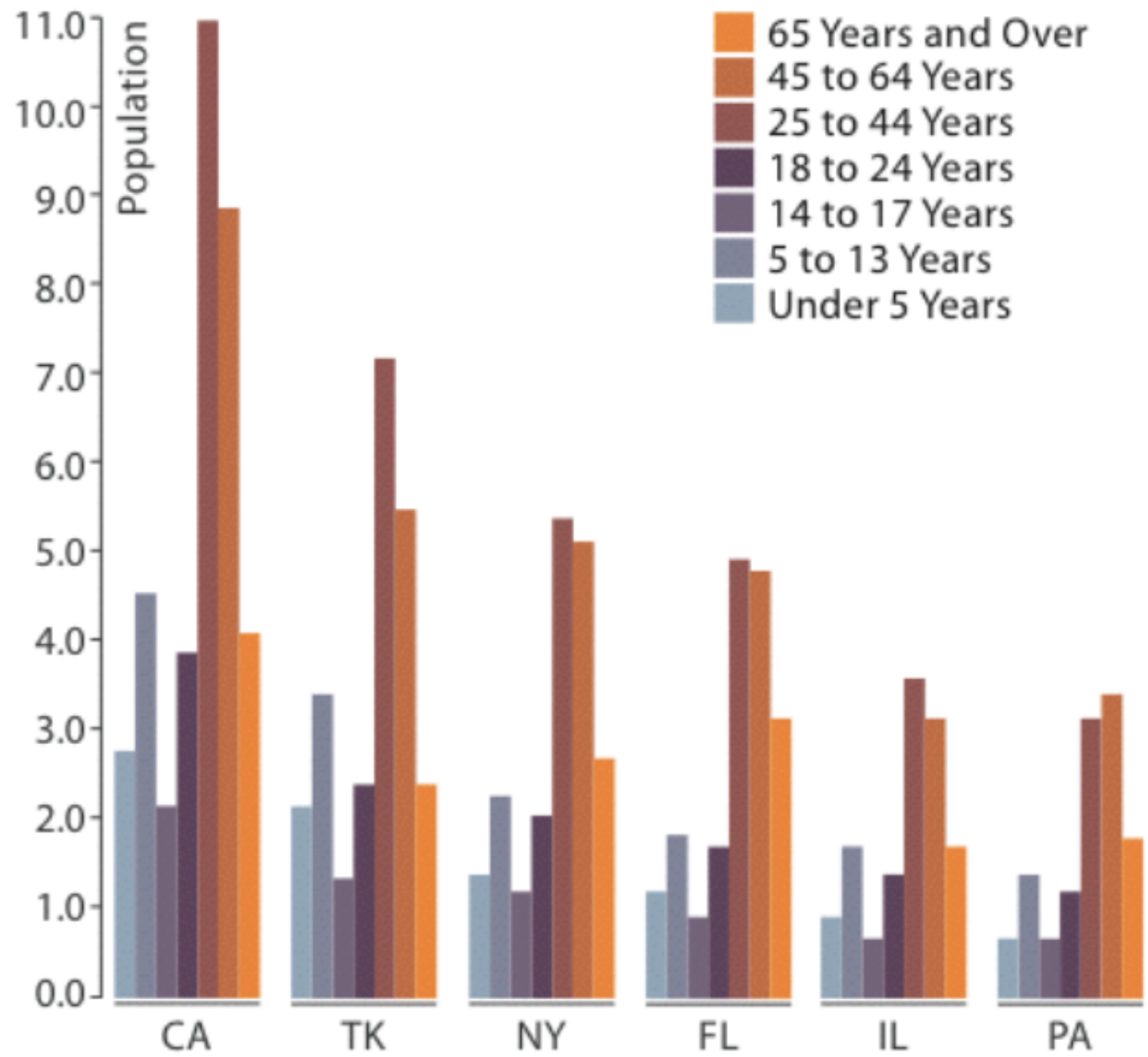
## ➔ Superimpose Layers



# PARTITIONING

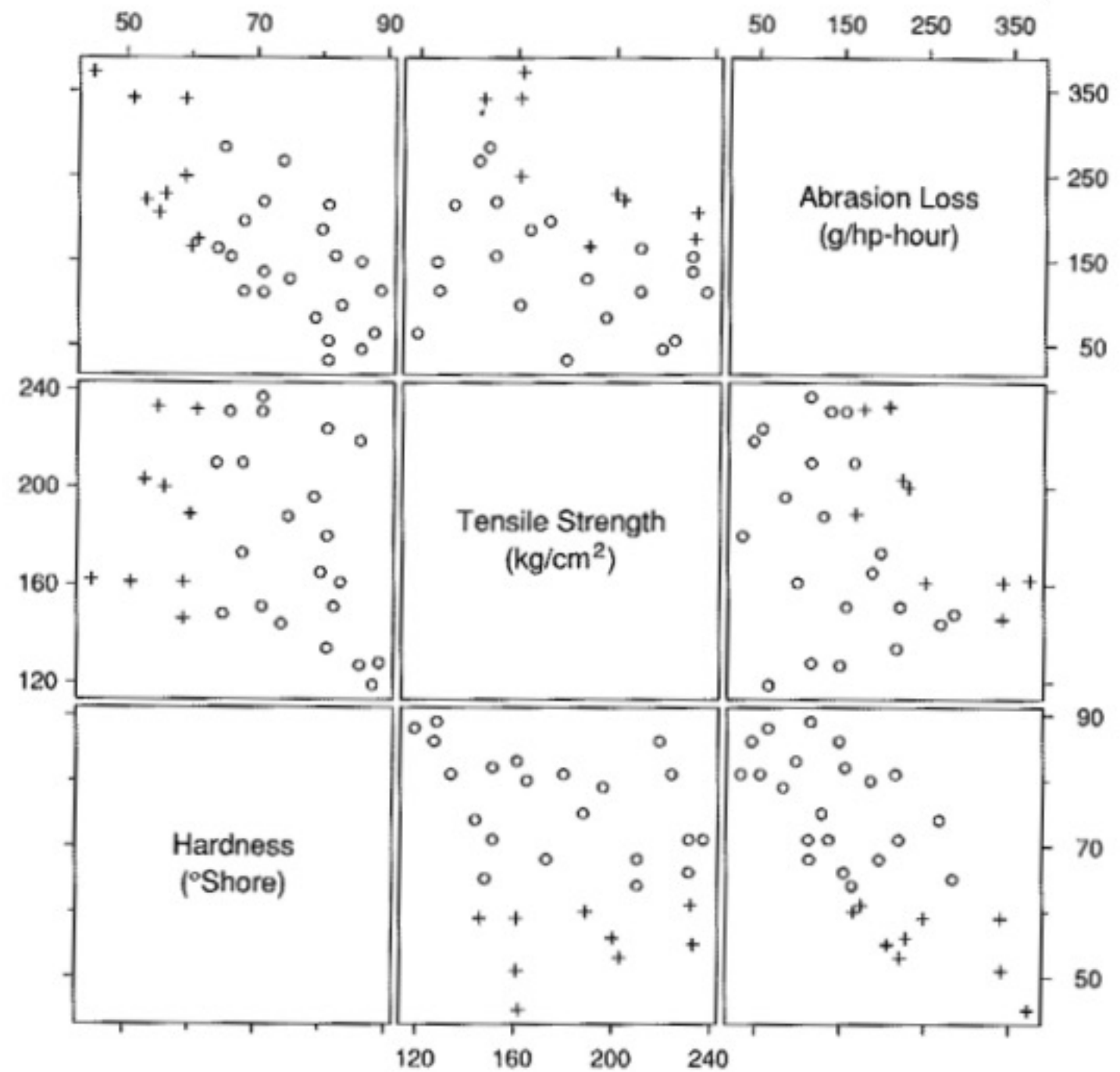
- action on the dataset that separates the data into groups
- main design choices
  - how to divide data up between views, given a hierarchy of attributes
  - how many splits, and order of splits how many views (usually data driven)
- partition attribute(s)
  - typically categorical







# SCATTERPLOT MATRIX (SPLOM)

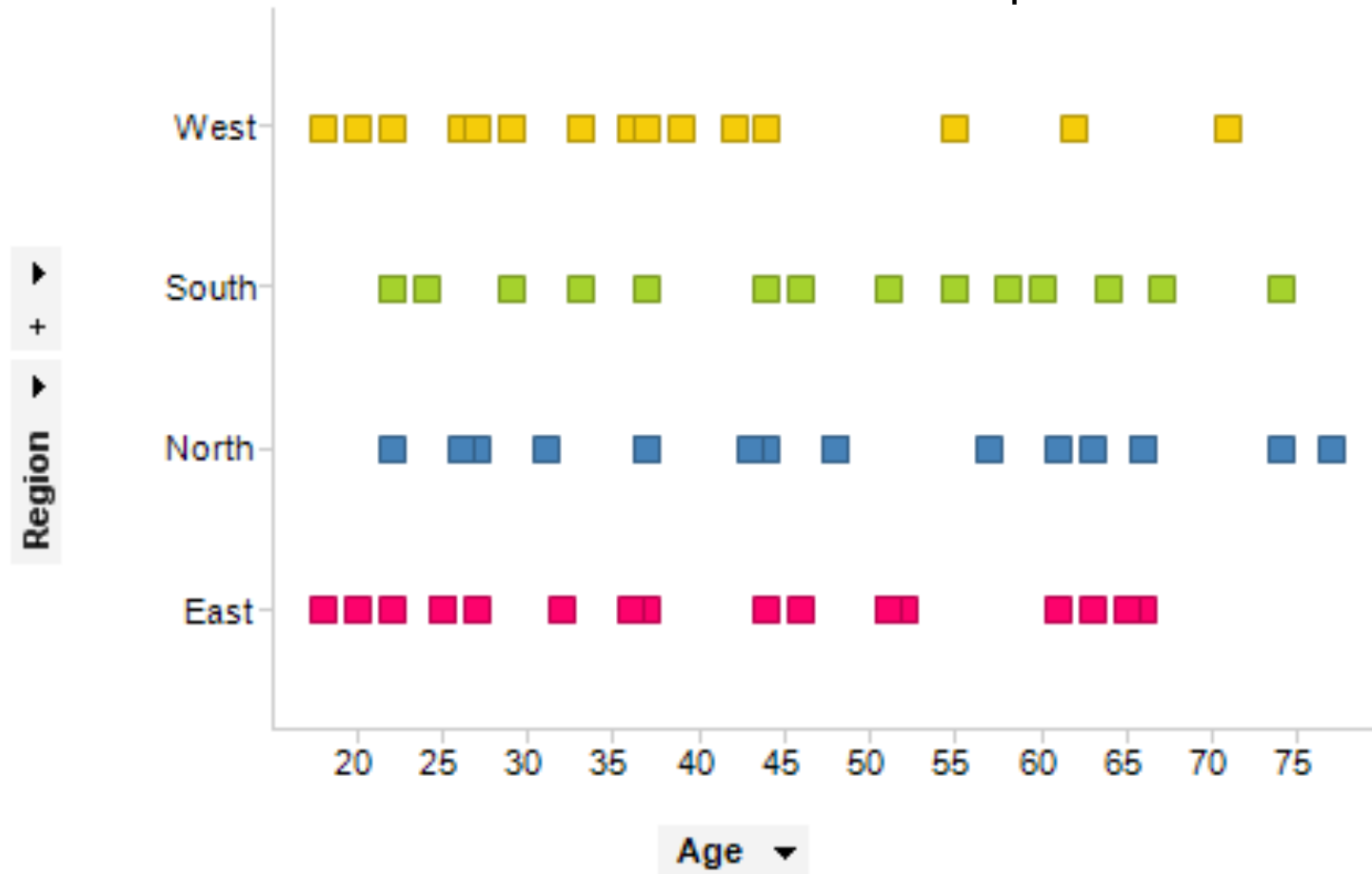


3.65 CONDITIONING. A scatterplot matrix displays trivariate data: measurements of abrasion loss, hardness, and tensile strength for 30 rubber specimens. The "+" plotting symbols encode the data for those specimens with hardness less than 62 °Shore.

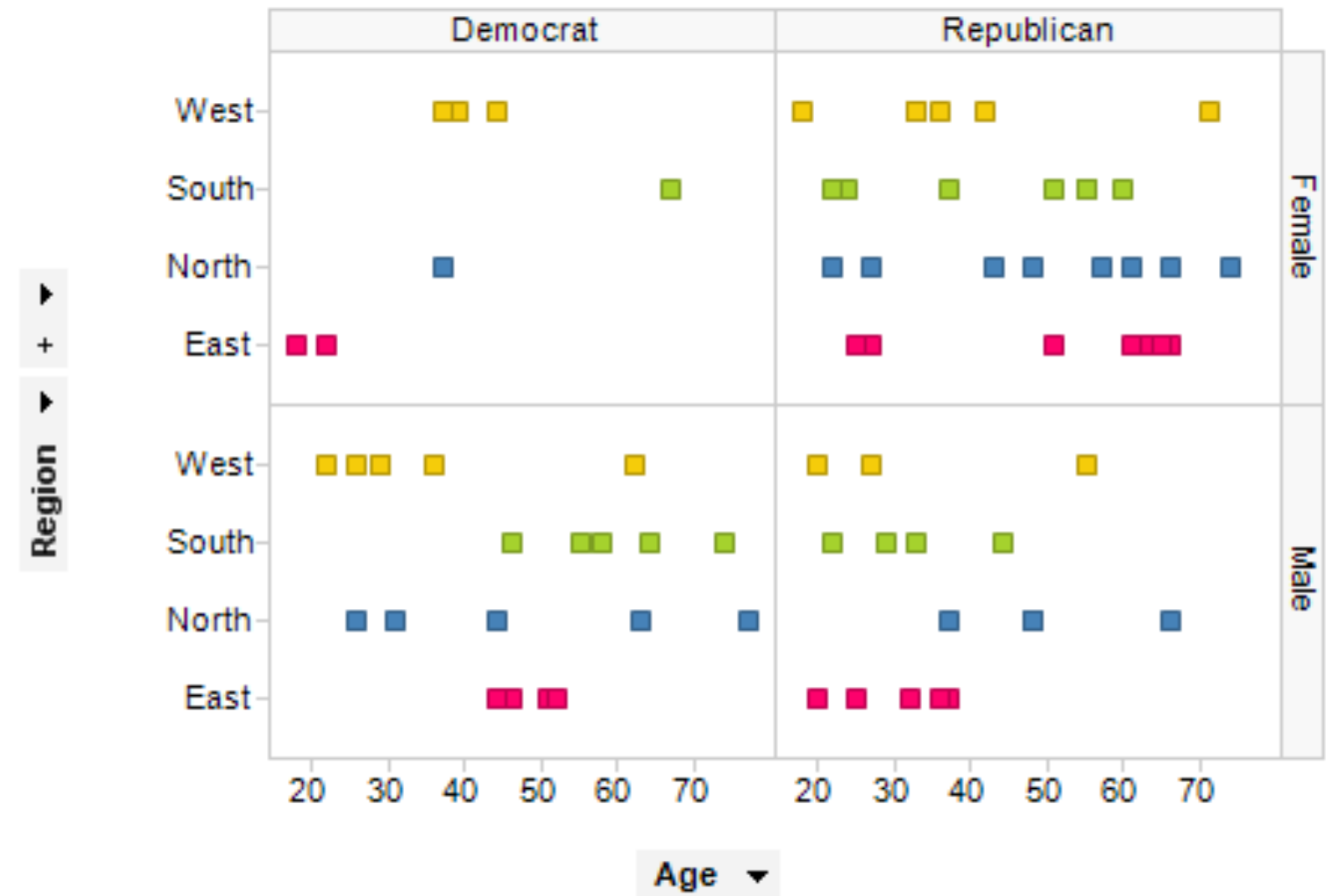
# TRELLISED VIEWS

- panel variables: attributes encoded in individual views
- partitioning variables: partitioning attributes assigned to columns, rows, and pages

non-trellised scatter plot



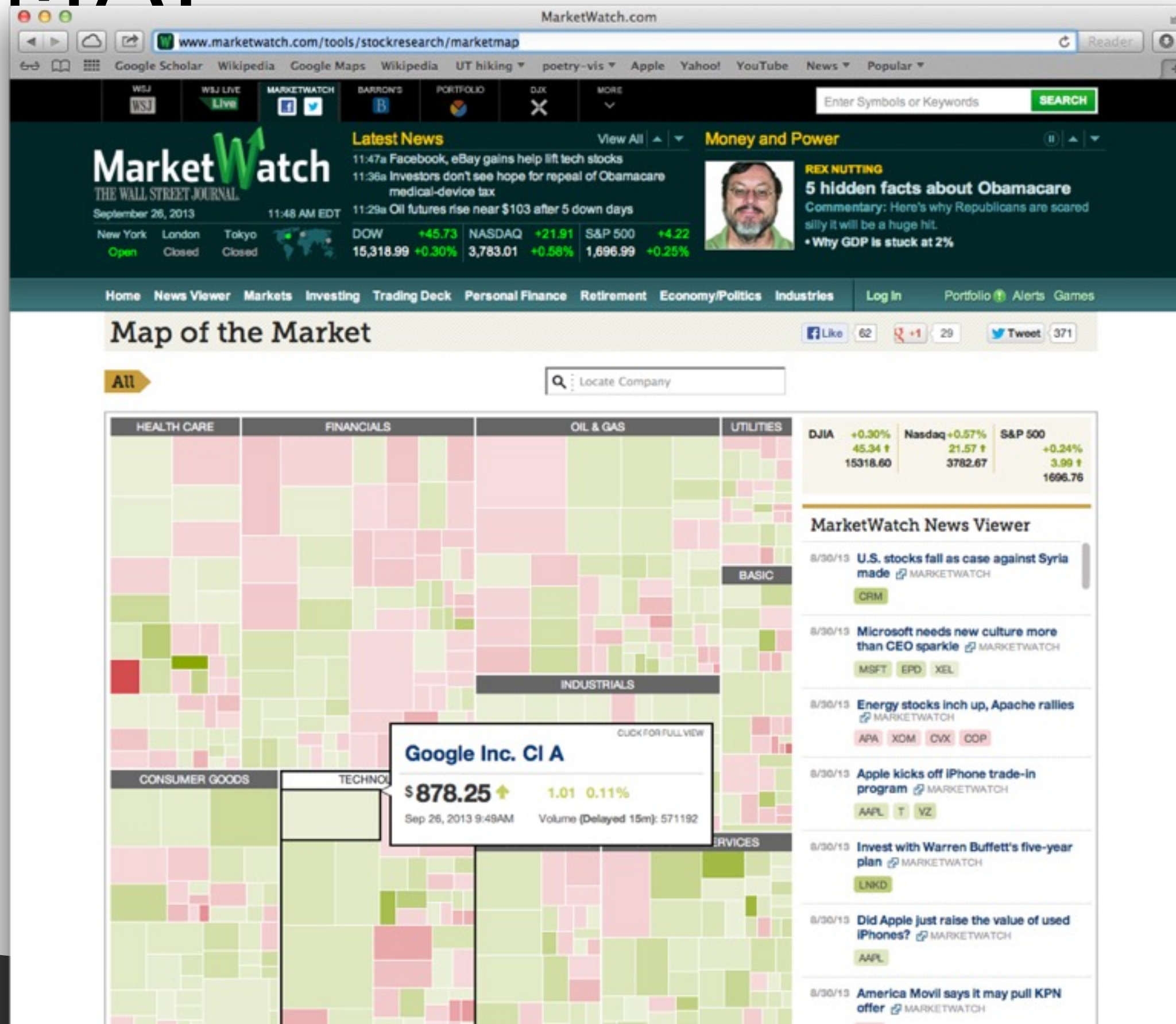
trellising this visualization based on Gender and Political affiliation



# HiVE: Hierarchical Visual Expression

- partitioning: transform data attributes into a hierarchy
- reconfigure hierarchies to explore data space
- treemaps used as spacefilling layouts

# TREEMAP





# A variety of options...

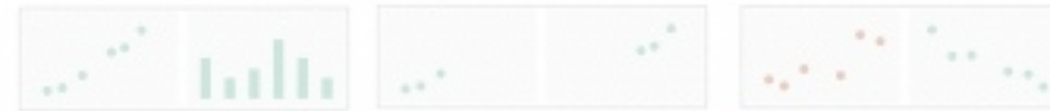
## ④ Juxtapose and Coordinate Multiple Side-by-Side Views

→ 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

## ④ Partition into Side-by-Side Views



## ④ Superimpose Layers

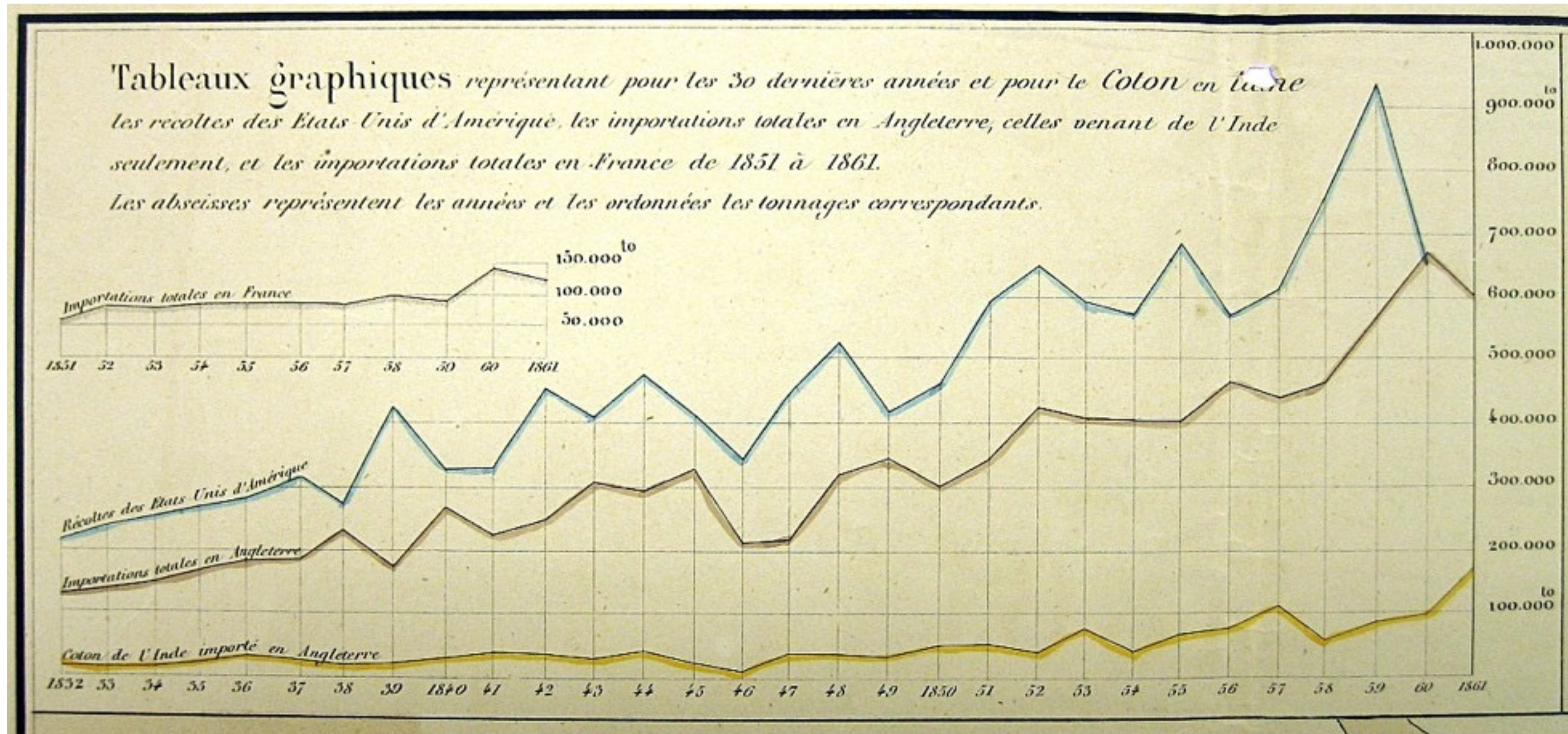


# LAYERING

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

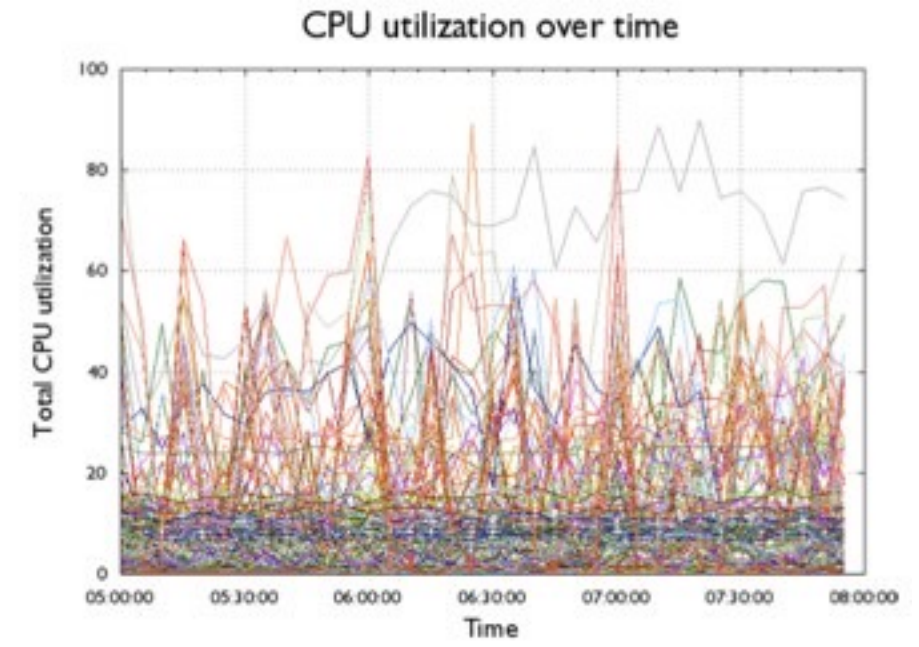
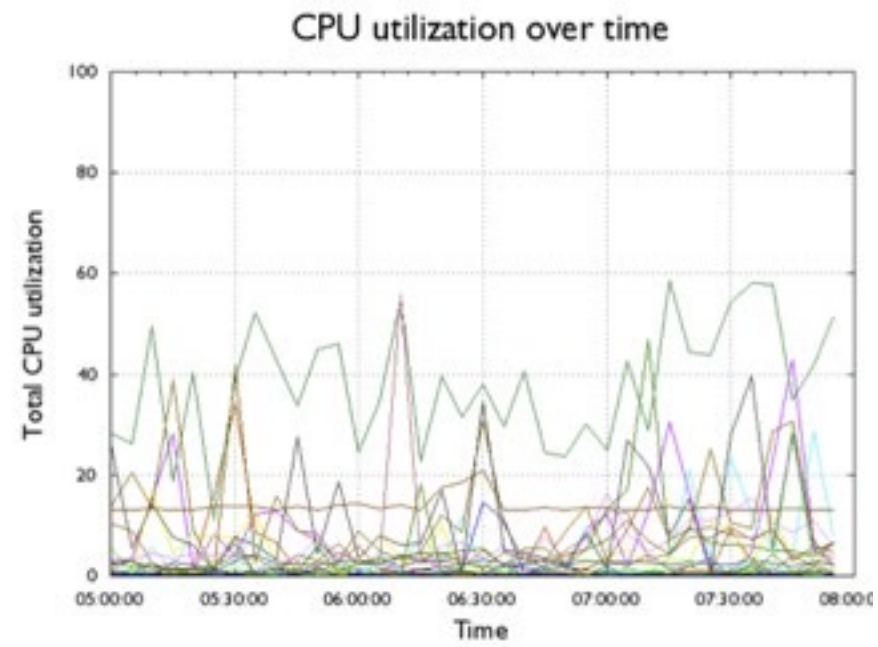
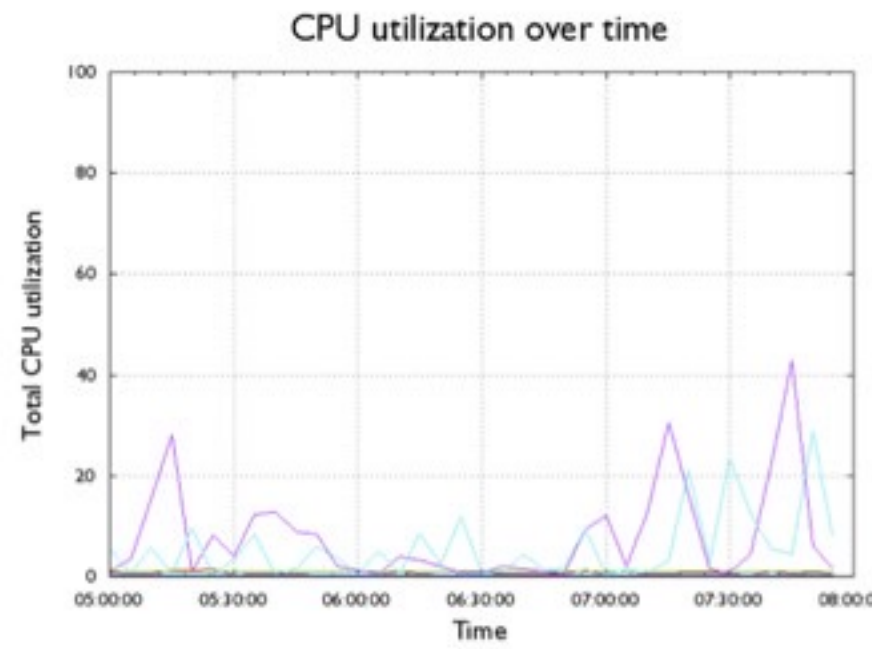


# GLOBAL COMPOSITING

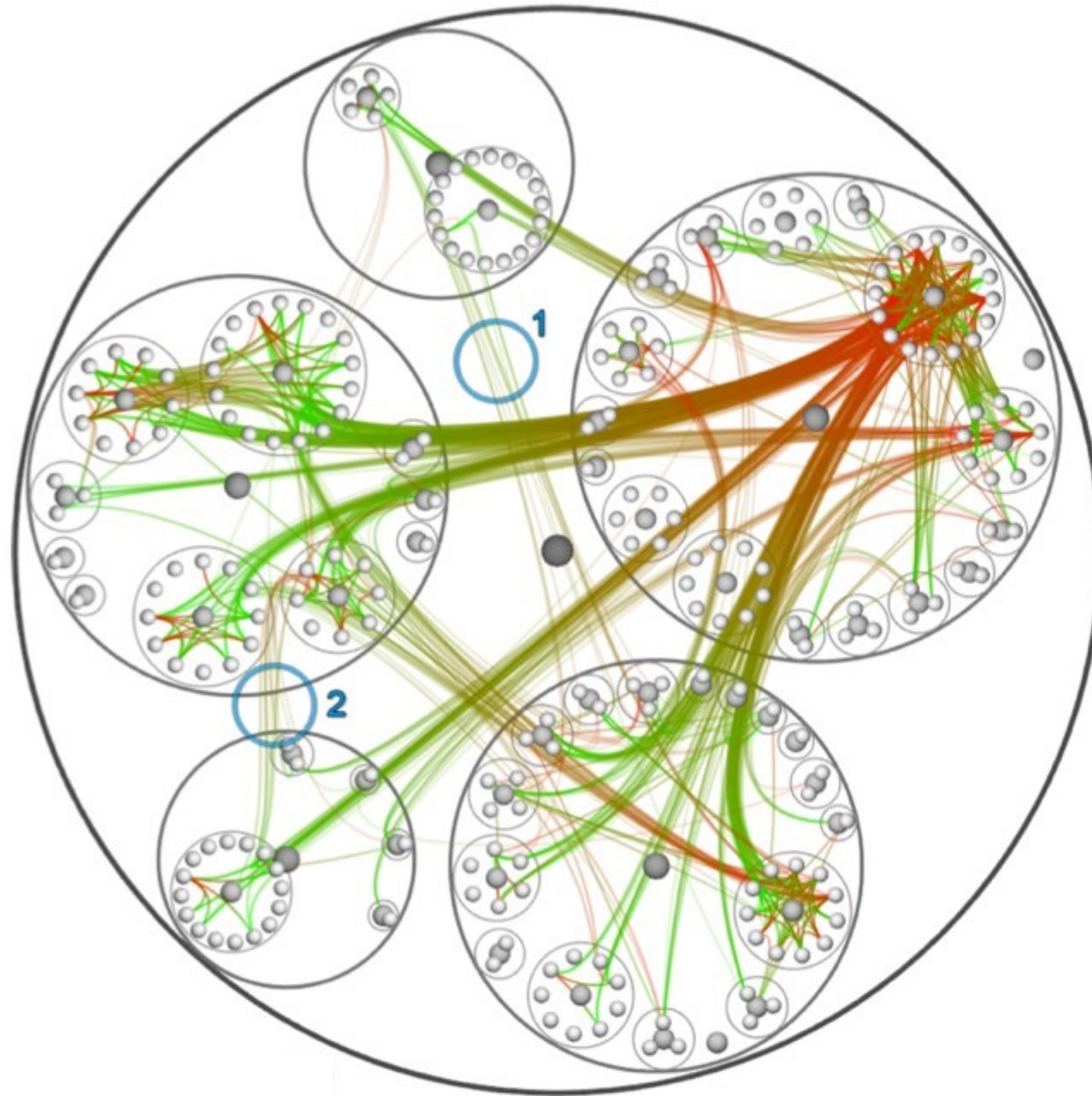




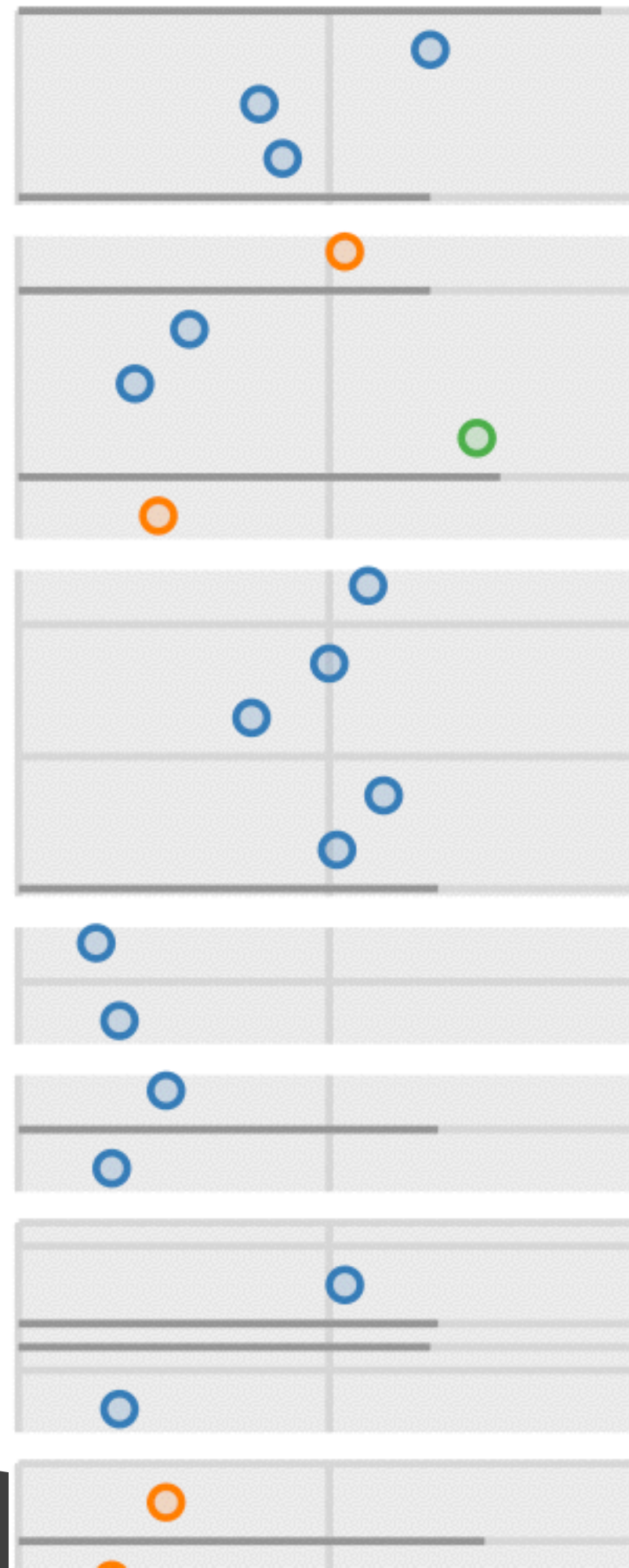
# overlays



# edge bundling



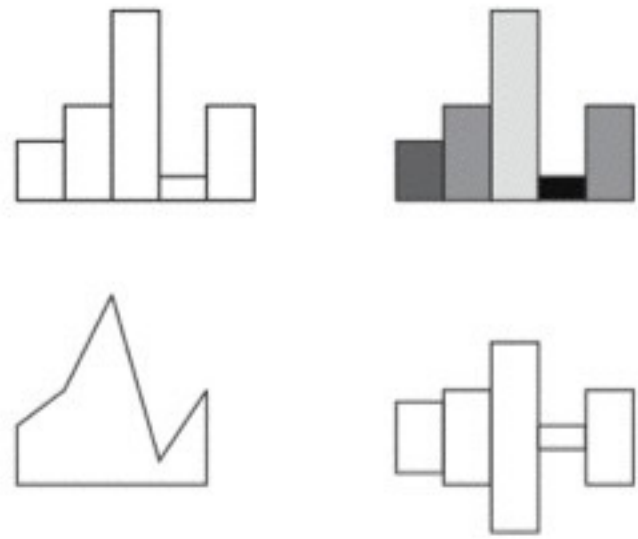
multiple encodings



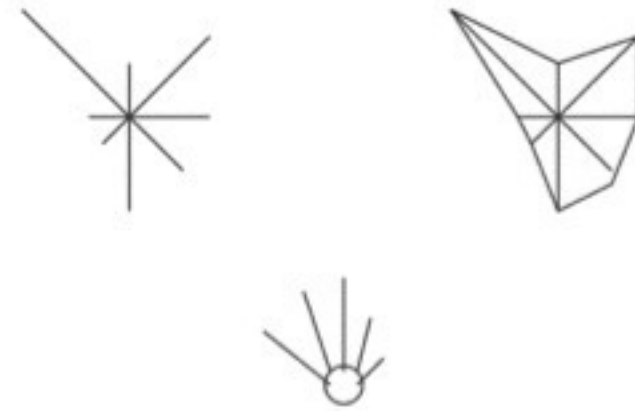


# GLYPHS

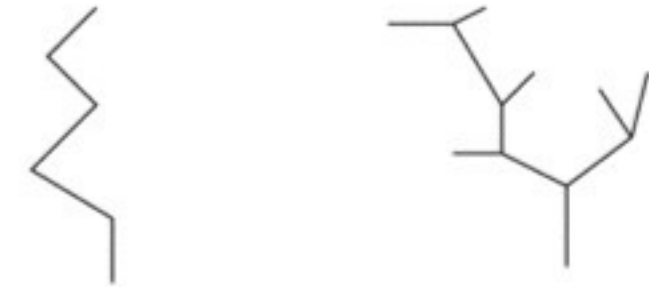
- a graphical object with internal structure that arises from multiple marks
  - ambiguity: little distinct line between glyph and view!



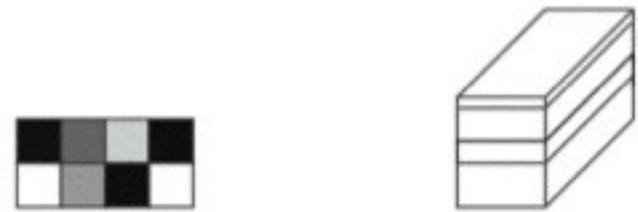
Variations on Profile glyphs



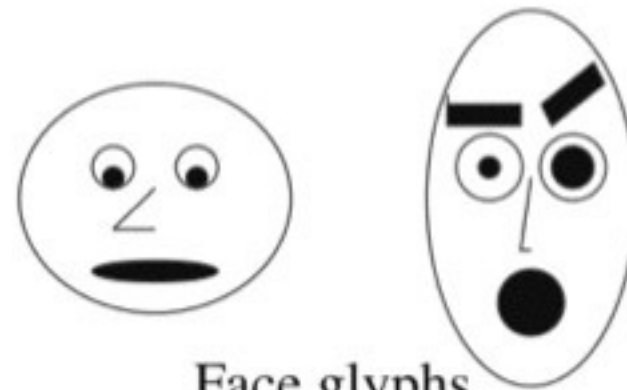
Stars and Anderson/metroglyphs



Sticks and Trees



Autoglyph and box glyph

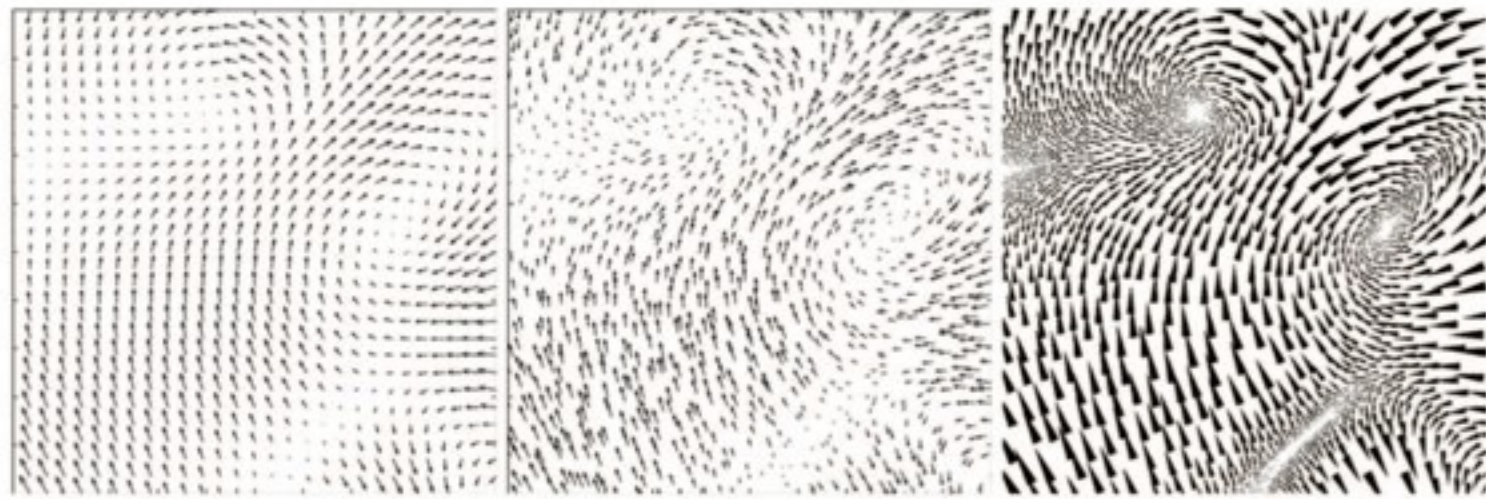


Face glyphs



Arrows and Weathervanes





GRID

JIT

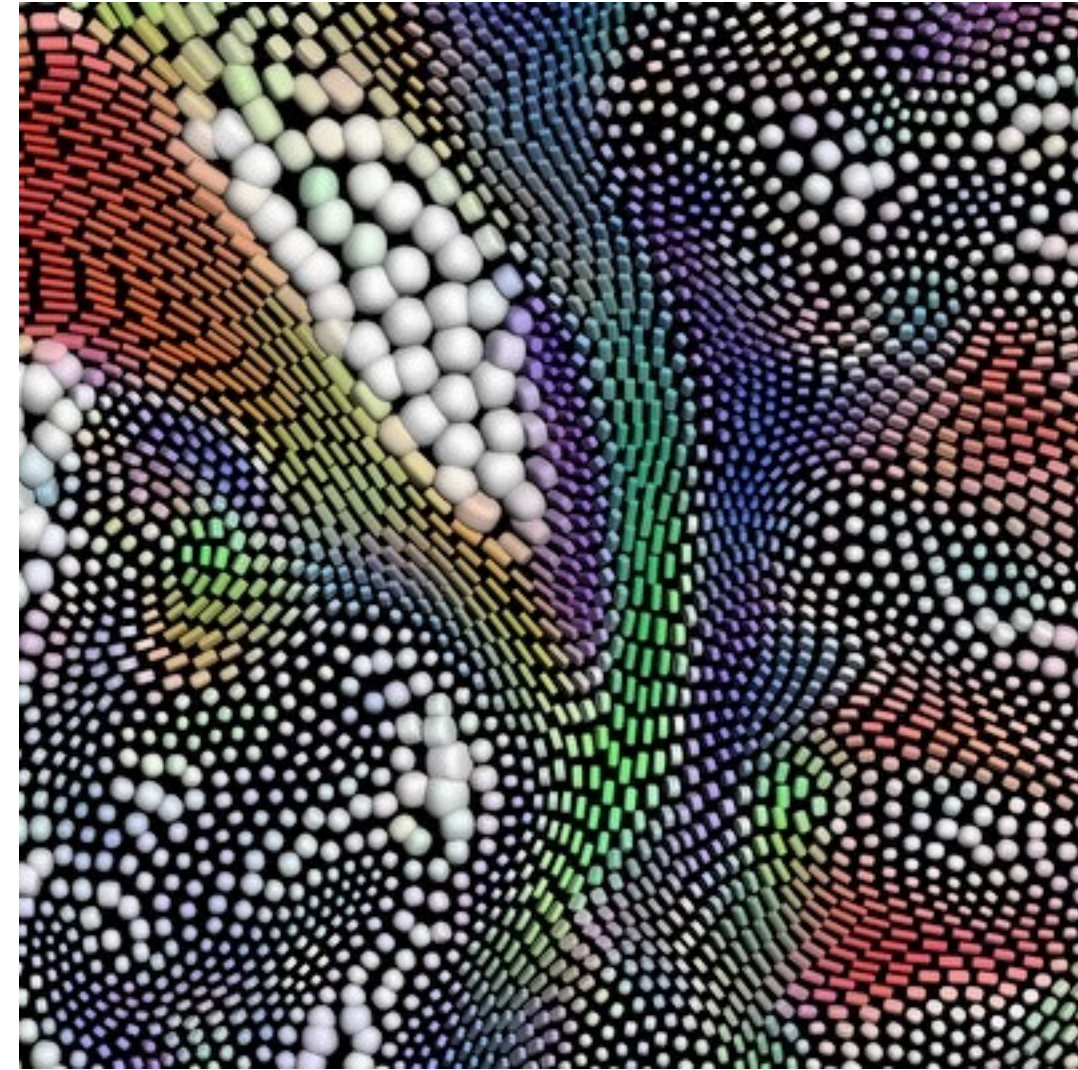
LIT



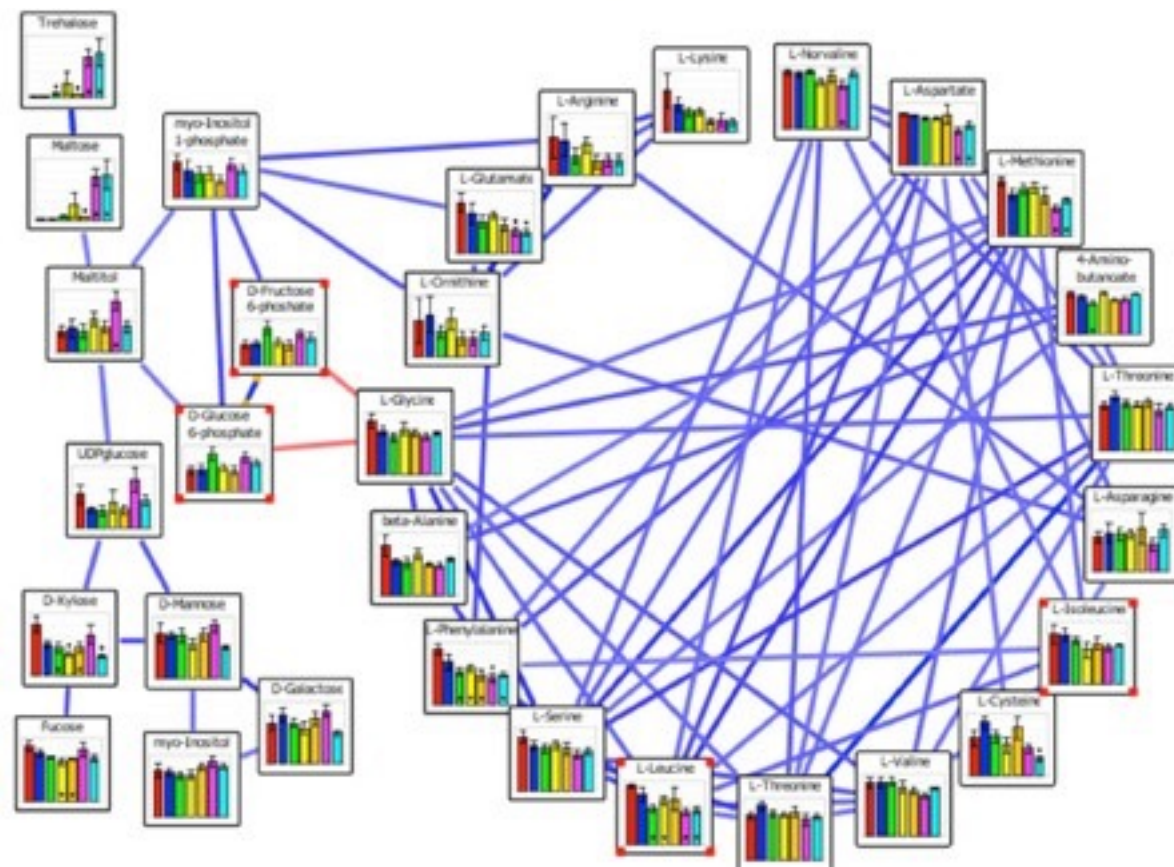
LIC

OSTR

GSTR



Kindlmann 2006



Junker 2006



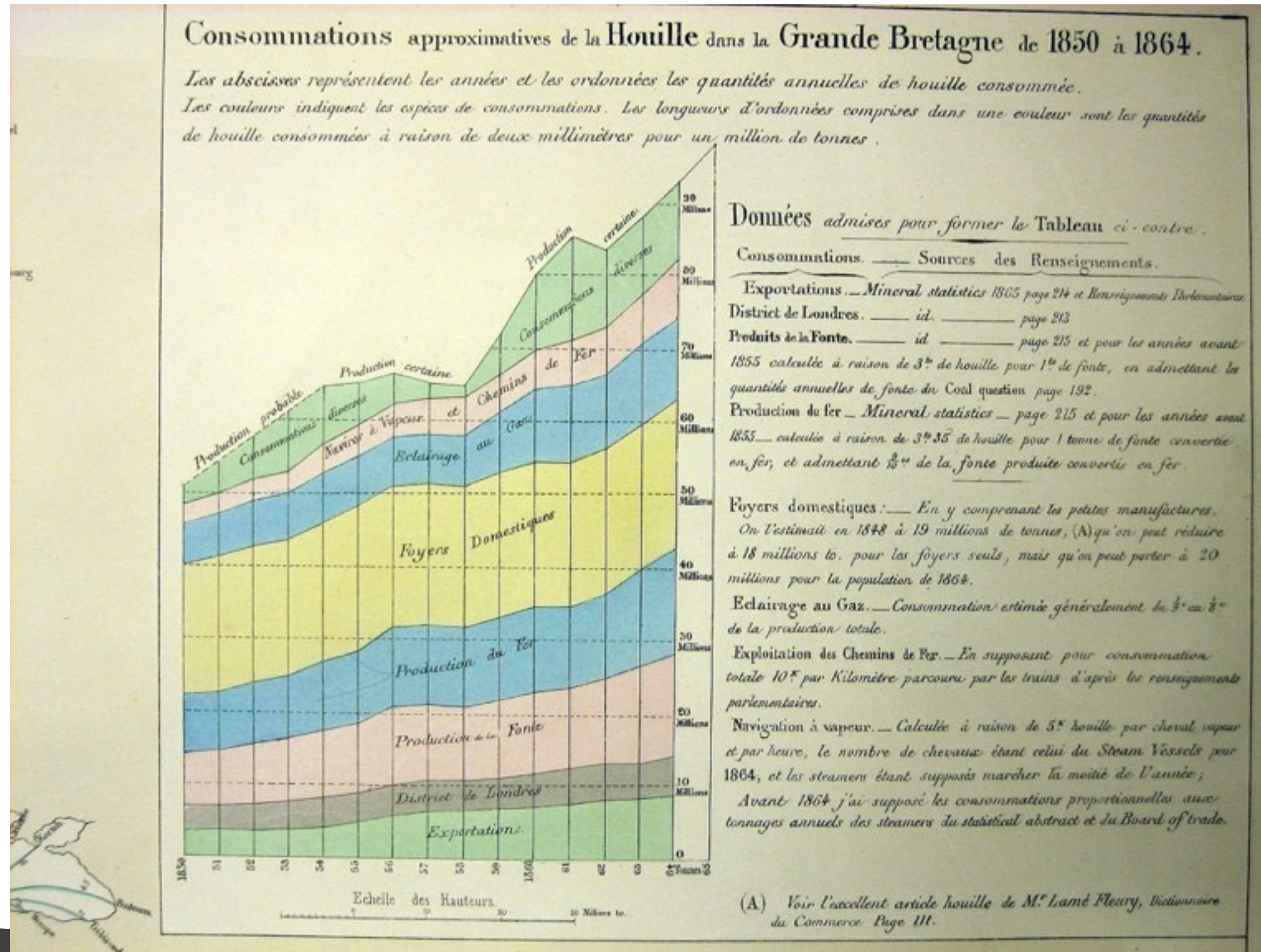
# Process

- gather metadata for obtaining a set of names
  - or, things you want to represent
- build a taxonomy
  - propose several categorization schemes
- develop visual design
  - determine order of visual channels
  - propose optional mappings
  - identify metaphoric abstractions
- implement a glyph-based system

	design option 1	design option 2	design option 3	design option 4	design option 5	design option 6	design option 7
Inputs and Outputs							
Process							
Biological							
Device							
Chemical							
Data							
In Vitro							
In Vivo							
In Silico							
Data Collection							
Data Processing							
Data Analysis							
Material perturbation							
Material separation							
Material amplification							
Material combination							
Material collection							
Molecule							
Cellular Part							
Cell							
Tissue							
Organ							
Organism							
Population							

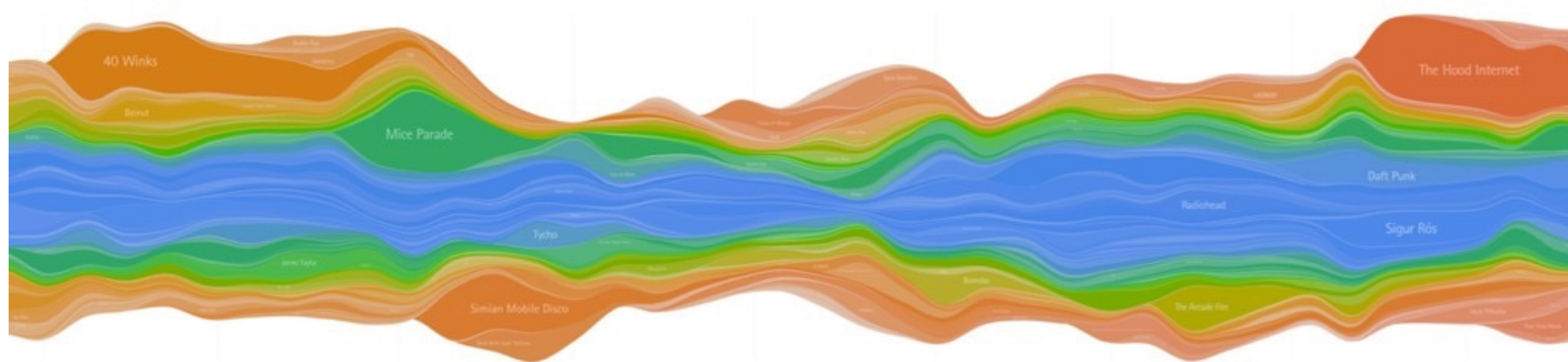


# ITEM-LEVEL STACKING





# streamgraph



Search Business

Go

Financial Tools

Select a Financial Tool ▾

More in Business »

- Global Business
- Markets
- Economy
- DealBook
- Media & Advertising
- Small Business
- Your Money
- Energy & Environment

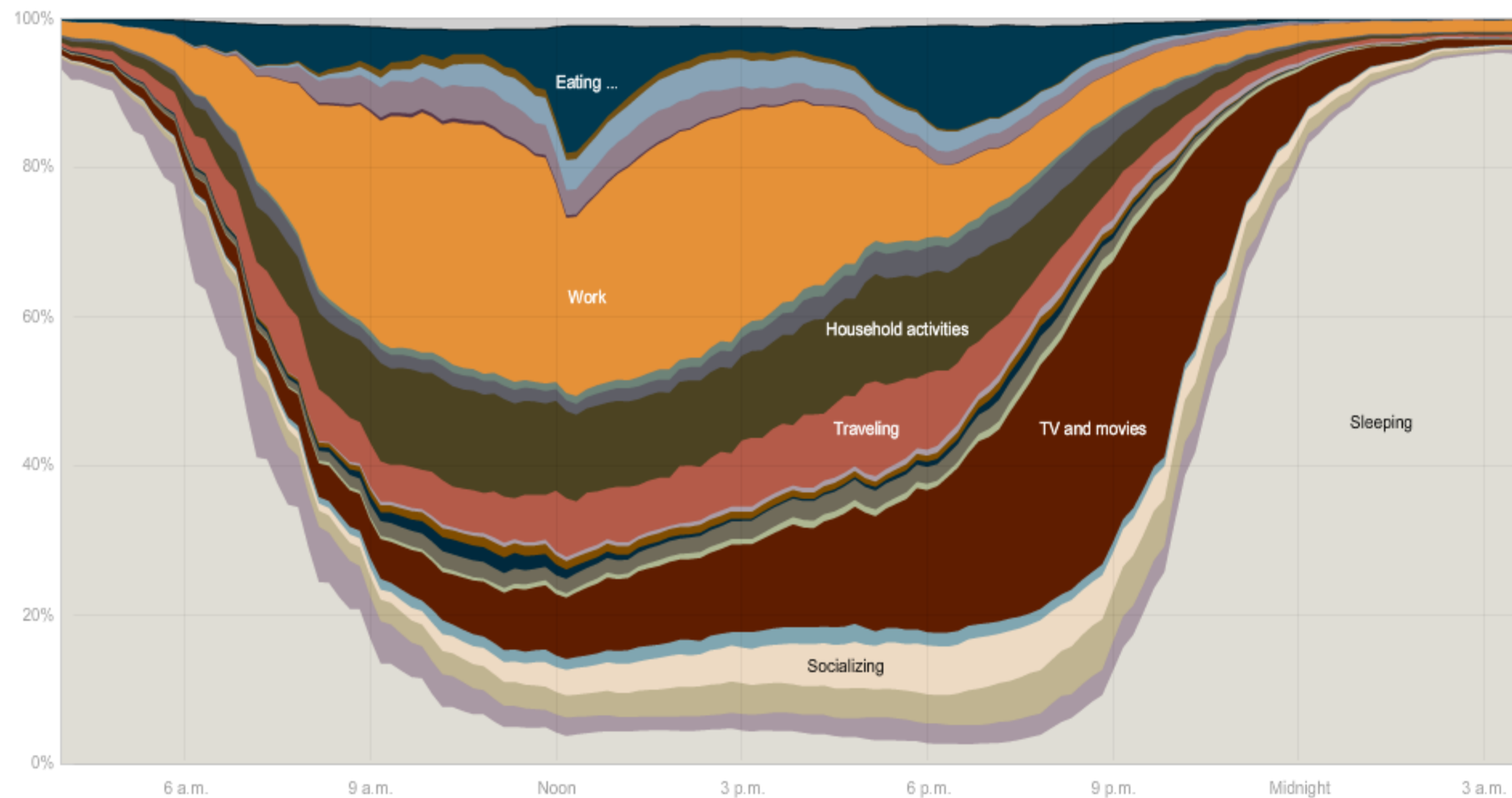
## How Different Groups Spend Their Day

The American Time Use Survey asks thousands of American residents to recall every minute of a day. Here is how people over age 15 spent their time in 2008. [Related article](#)

### Everyone

Sleeping, eating and watching television take up about two-thirds of the average day.

Everyone	Employed	White	Age 15-24	H.S. grads	No children
Men	Unemployed	Black	Age 25-64	Bachelor's	One child
Women	Not in lab...	Hispanic	Age 65+	Advanced	Two+ children



By SHAN CARTER, AMANDA COX, KEVIN QUEALY and AMY SCHOENFELD | [Send Feedback](#)



# FOCUS + CONTEXT

- techniques to show detail (focus) and overview (context) simultaneously
- requires: carefully pick what to show and hinting at what you are not showing

# FOCUS + CONTEXT

- synthesis of visual encoding and interaction
- user selects region of interest (focus) through navigation or selection
- provide context through aggregation, reduction, or layering



# focus+context

## → Embed

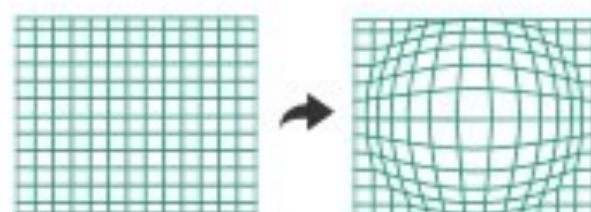
### → Elide Data



### → Superimpose Layer



### → Distort Geometry



# elision

## → Embed

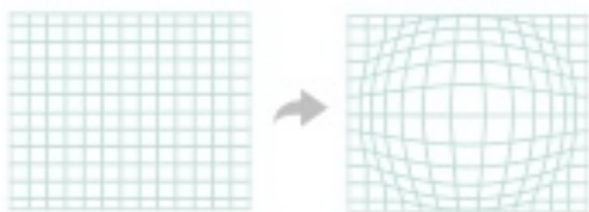
### → Elide Data



### → Superimpose Layer



### → Distort Geometry



- means “suppression”
- focus items shown in detail, other items summarized (suppressed) for context

# SpaceTree



2002 spacetree

Catherine Plaisant

Subscribe 38

87 views

+ Add to Share ... More

0 0

# DOI

- degree of interest
- 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 Tree

- interactive trees 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 Tree

Degree-of-Interest Tree with extras

Created with Flip4Mac Trial  
www.Flip4Mac.com

0:01 / 0:47

### Degree-of-Interest Tree with extras

rekamso [Subscribe](#) 301+ views

[+](#) Add to [Share](#) [...](#) More [0](#) [0](#)

# Superimpose

## → Embed

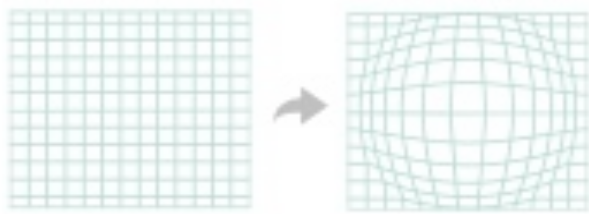
→ Elide Data



→ Superimpose Layer

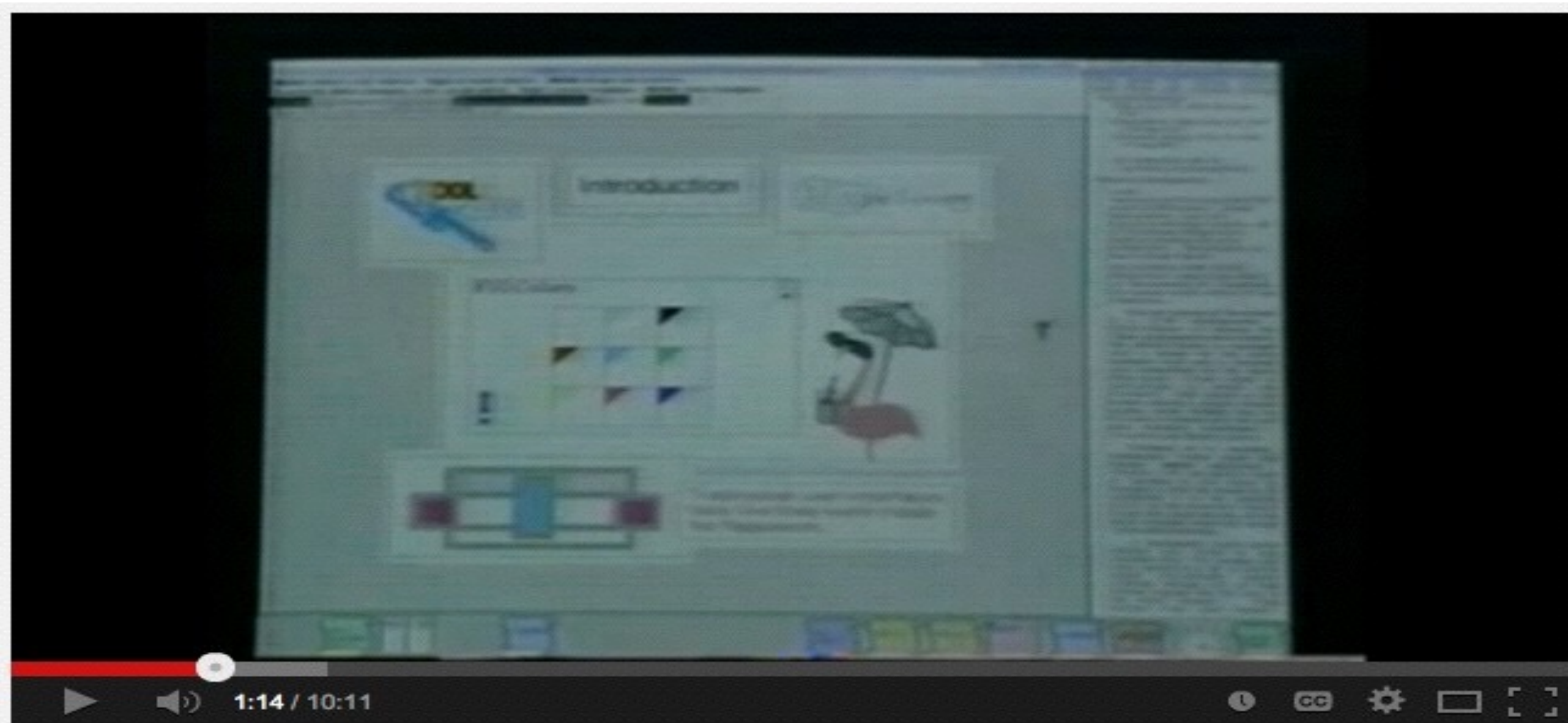


→ Distort Geometry



- focus layer limited to a local region of view, instead of stretching across the entire view

# Toolglass & Magic Lenses



## Toolglass & Magic Lenses: The See-Through Interface



tabletopresearch201

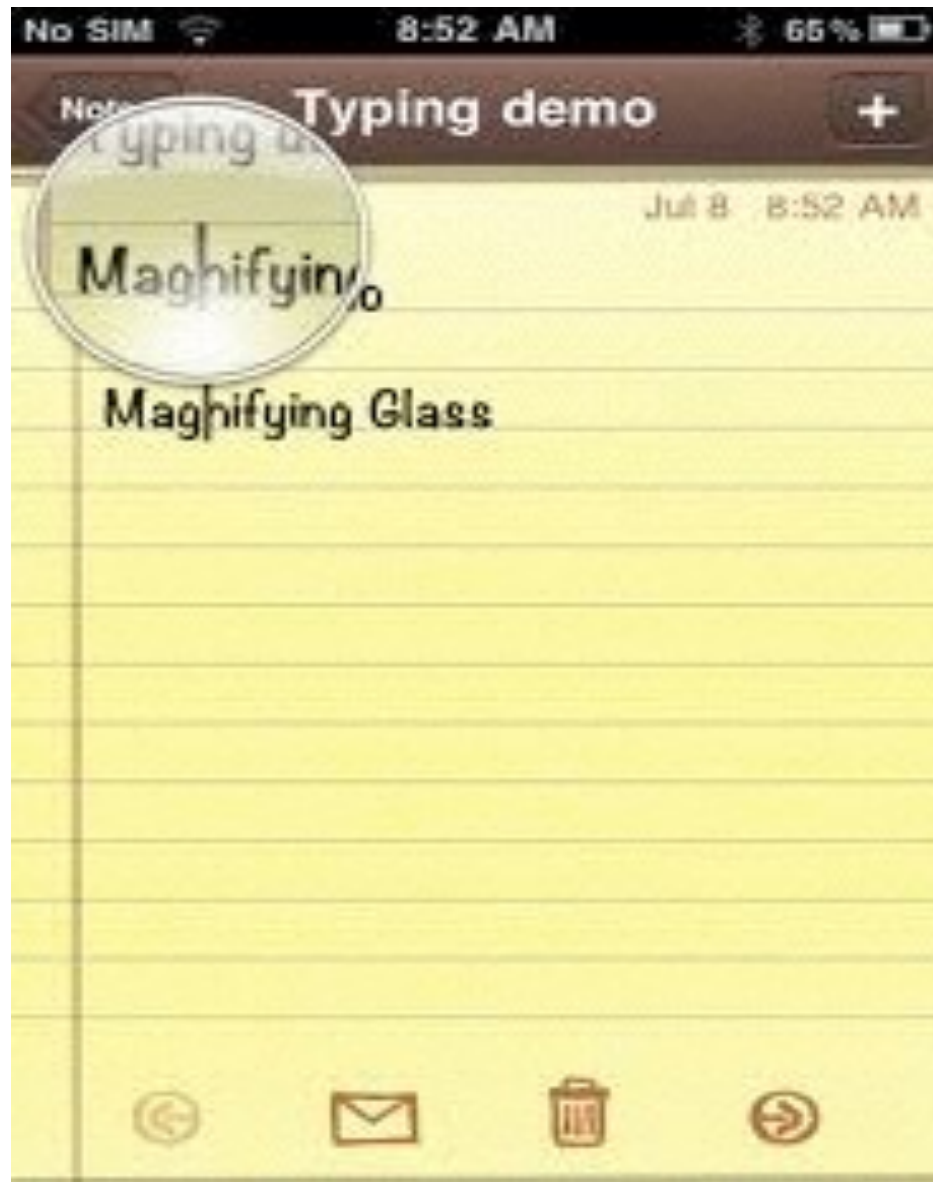
Subscribe 36

4,179

+ Add to Share ... More

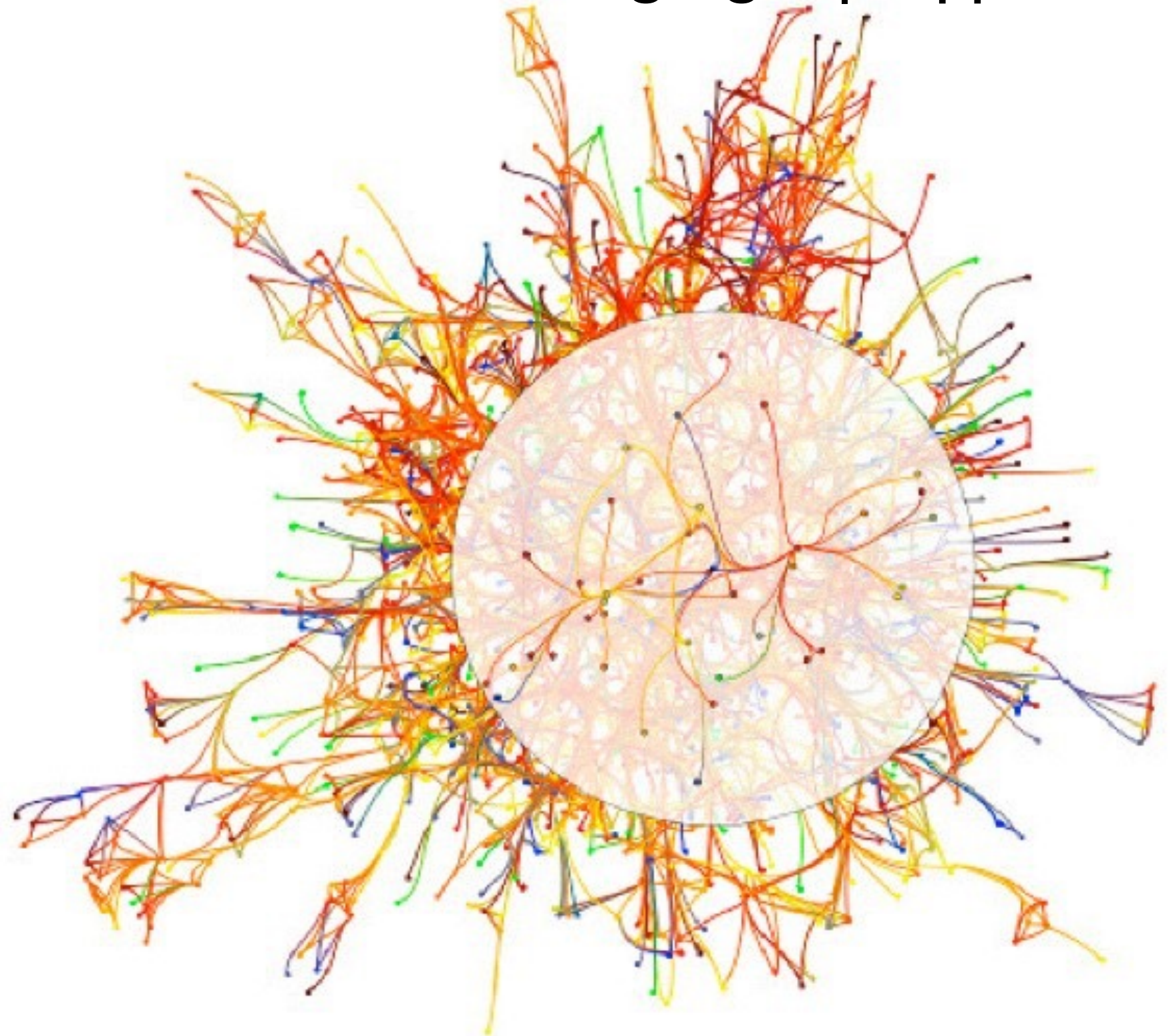
9 0





magnification

highlight | suppress



# Distort

## → Embed

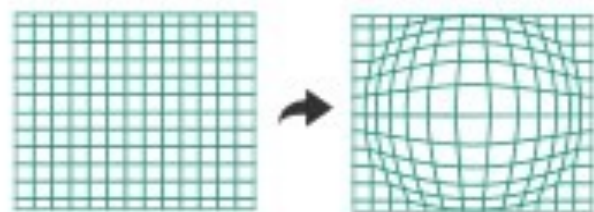
→ Elide Data



→ Superimpose Layer



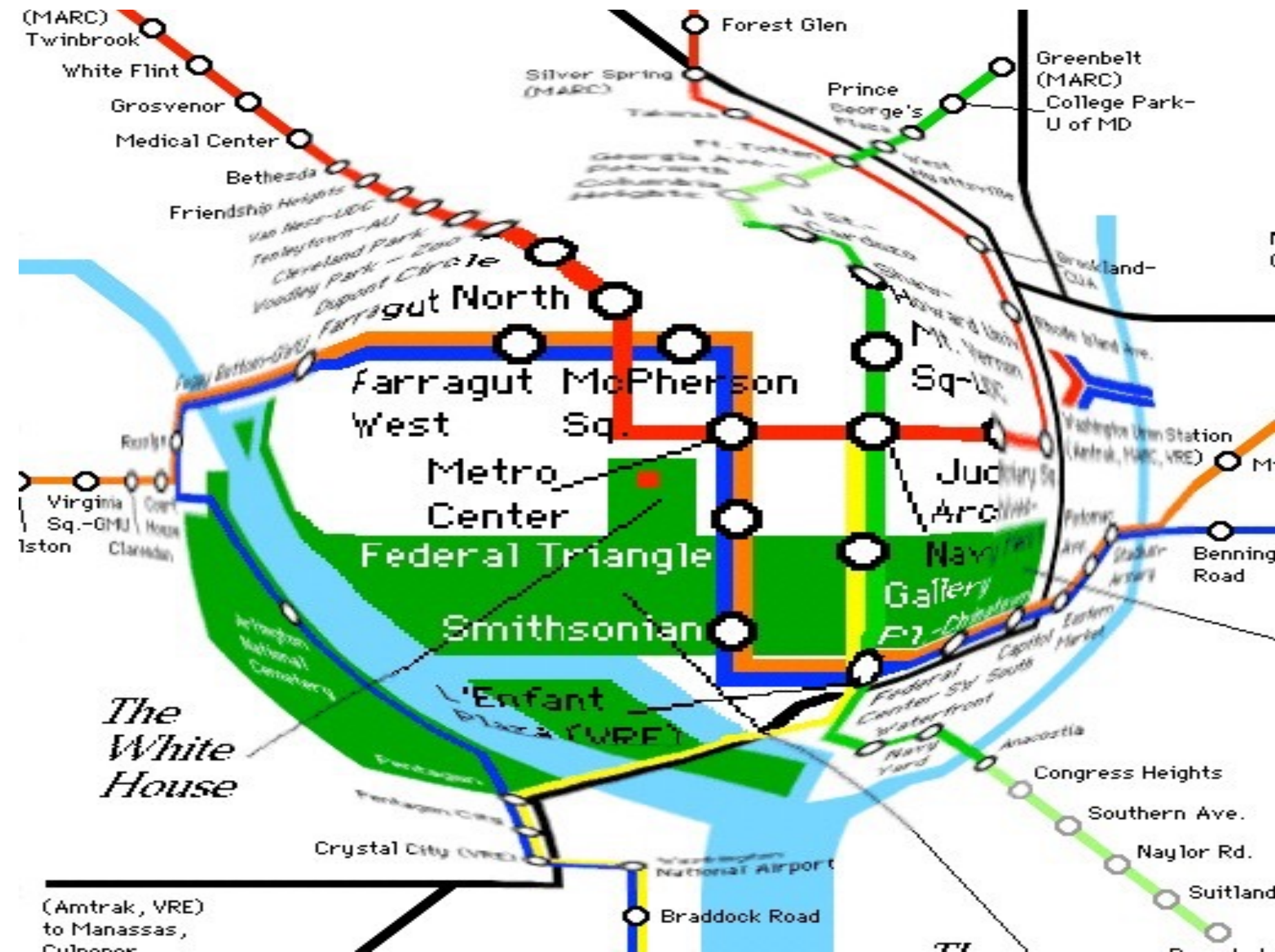
→ Distort Geometry



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



# FISHEYE



<http://www.cs.umd.edu/class/fall2002/cmsc838s/tichi/fisheye.html>






# Unfolding - Fisheye and Zoom lens example

The screenshot shows a 'Fisheye Tree View' of a file system. The tree is centered on the node 'albert, einstein, life (11)'. The nodes are arranged in a circular pattern around this central node, with the distance from the center representing the depth of the hierarchy. The visible nodes include:


- albert, einstein, life (11)
  - albert, einstein, life
  - einstein, famous
  - where, was, einstein, born
  - albert, einstein, was, born, when
  - what, was, einstein, famous, for
  - what, year, was, einstein, born
  - what, is, einstein, famous, for
- einstein, born (2)
  - einstein, born
  - albert, e
- persons, of, world, famous, scientists (4)
  - persons, of, world, famous, scientists
  - persons, of, world, famous, scientists
  - persons, of, world, famous, scientists
  - persons, of, world, famous, scientists

The video player interface at the bottom shows a progress bar at 0:55 / 1:21, along with play, volume, and settings icons.

# Fisheye Tree View

 **ctominski**  
 **Subscribe** 2

100 views

 Add to  Share  More

 0  0

# hyperbolic geometry



The video player displays a screenshot of a software interface titled "Hyperbolic Tree Browser". The interface shows a complex, branching tree structure rendered in a hyperbolic geometry, where the distance from the root to the leaves increases exponentially. The tree is composed of numerous small rectangular nodes connected by lines, forming a dense, fan-like shape. A single node in the center-left of the tree is highlighted in red. The video player interface includes a progress bar at 0:47 / 3:01, a volume icon, and various control icons. Below the video, the title "Hyperbolic Tree Browser -- 1995" is displayed, along with the channel name "Ramana Rao", a "Subscribe" button with 4 subscribers, and a view count of 6,603. At the bottom, there are options to "Add to", "Share", and "More", along with a thumbs-up icon showing 19 likes and a thumbs-down icon showing 0 dislikes.



# distortion concerns

- unsuitable for relative spatial judgments
- overhead of tracking distortion
- visual communication of distortion
  - (use gridlines, shading, etc.)

# distortion concerns (cont.)

- target acquisition problem
  - lens displacing items away from screen location
- mixed results compared to separate views and temporal navigation
- fisheye follow-up: concern with enthusiasm over distortion
  - what is being shown: selective filtering
  - how it is being shown: distortion as one possibility

