Paul Rosen
paul.rosen@utah.edu
@paulrosenphd
https://cspaul.com

www.sci.utah.edu
THE UNIVERSITY OF UTAH

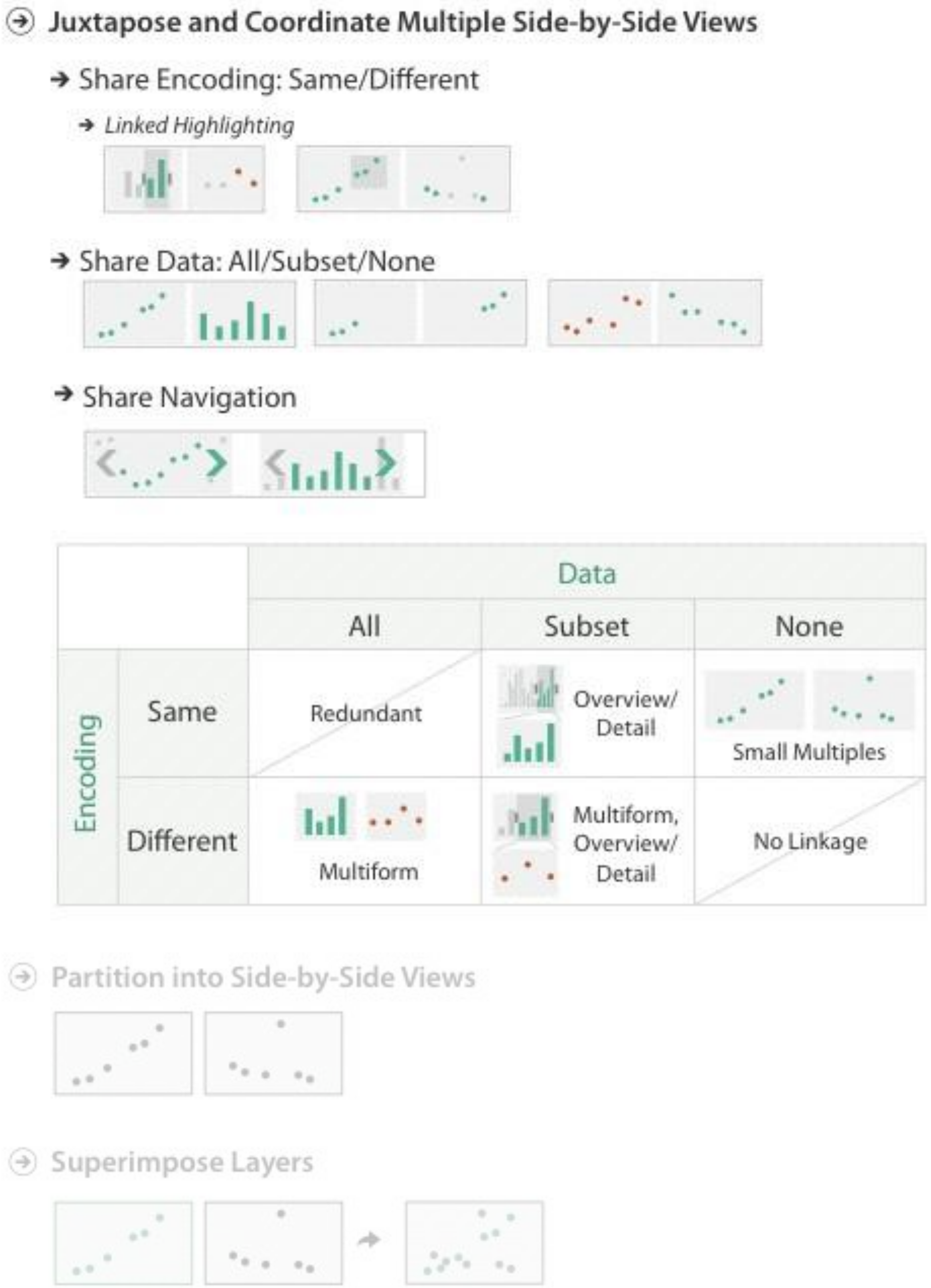
Visualization for Data Science
DS-4630 / CS-5630 / CS-6630

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…



LINKED VIEWS

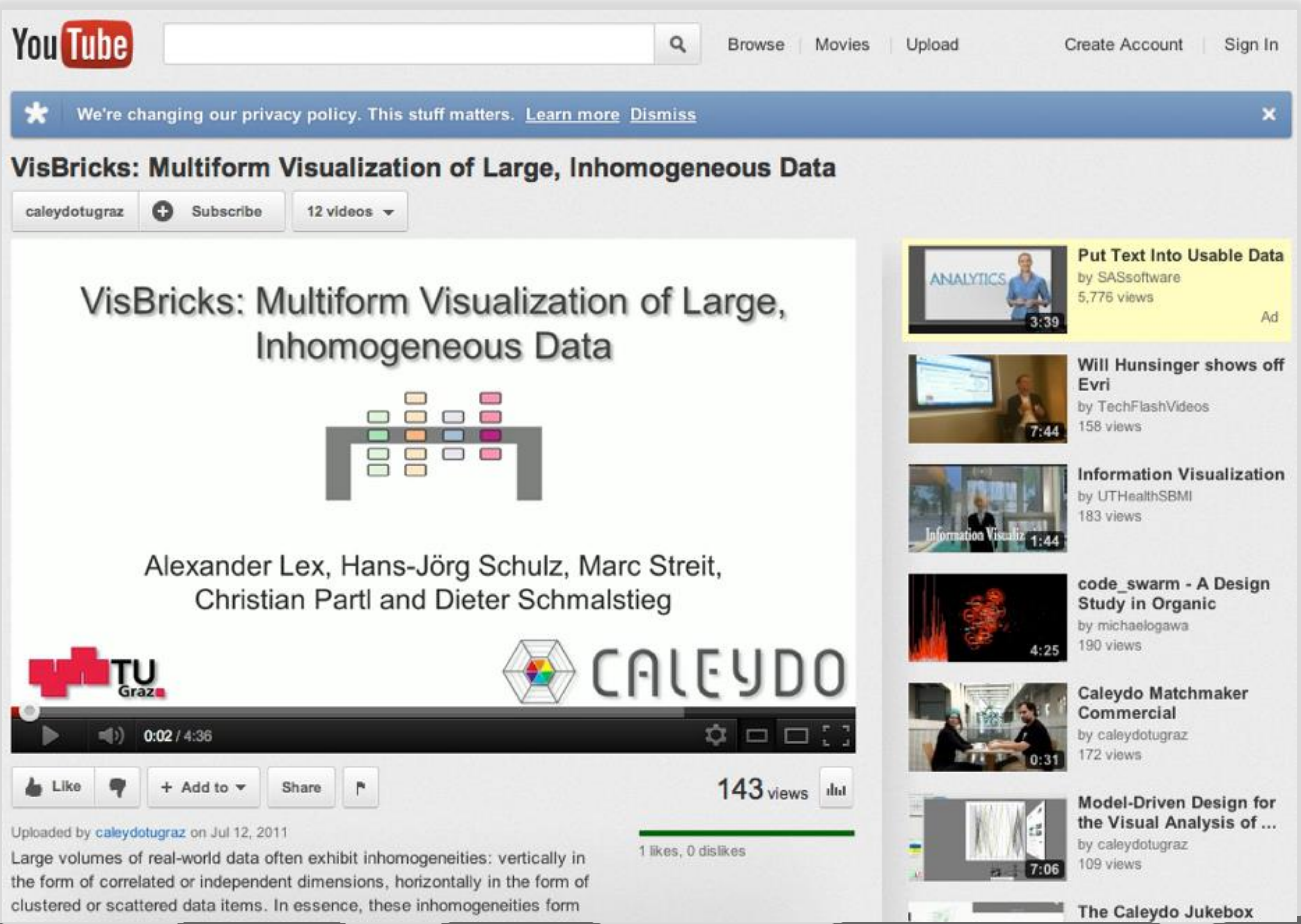
- multiple views that are simultaneously visible and linked together such that actions in one view affect the others

- 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



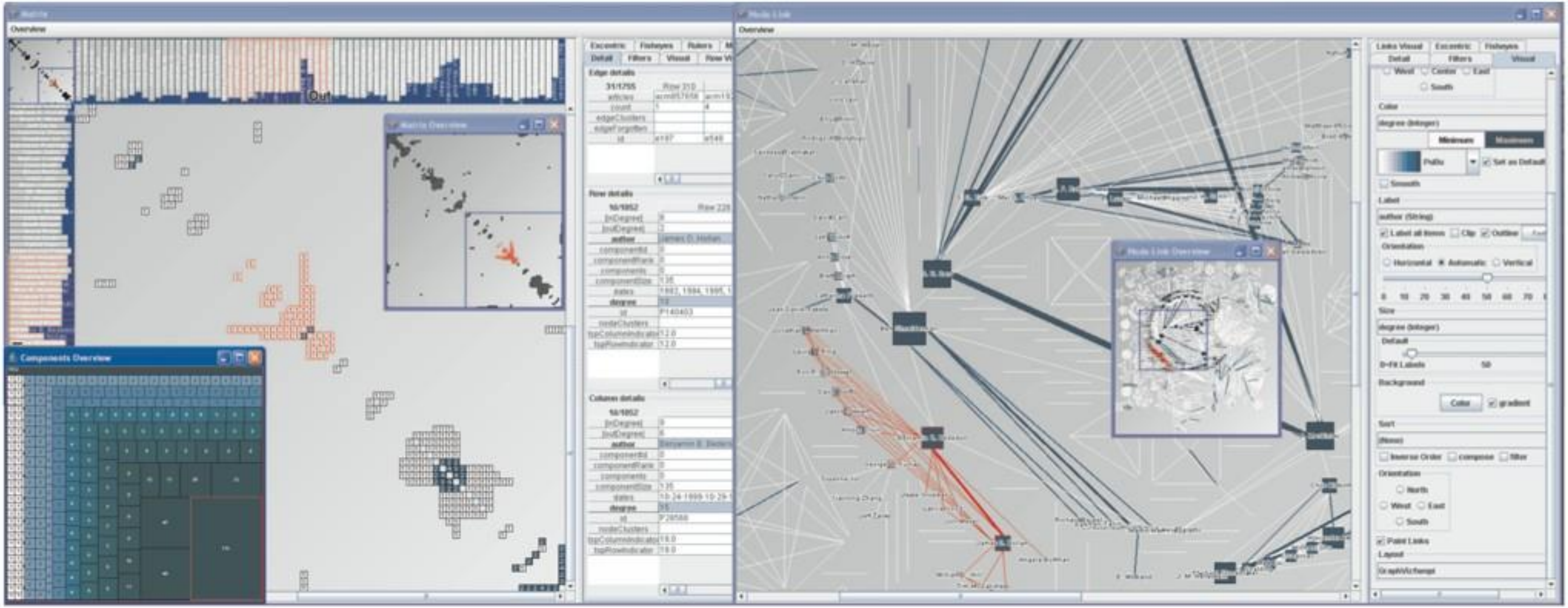
https://www.youtube.com/watch?v=_5J80uDTxD8

- 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

SHARED DATA

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

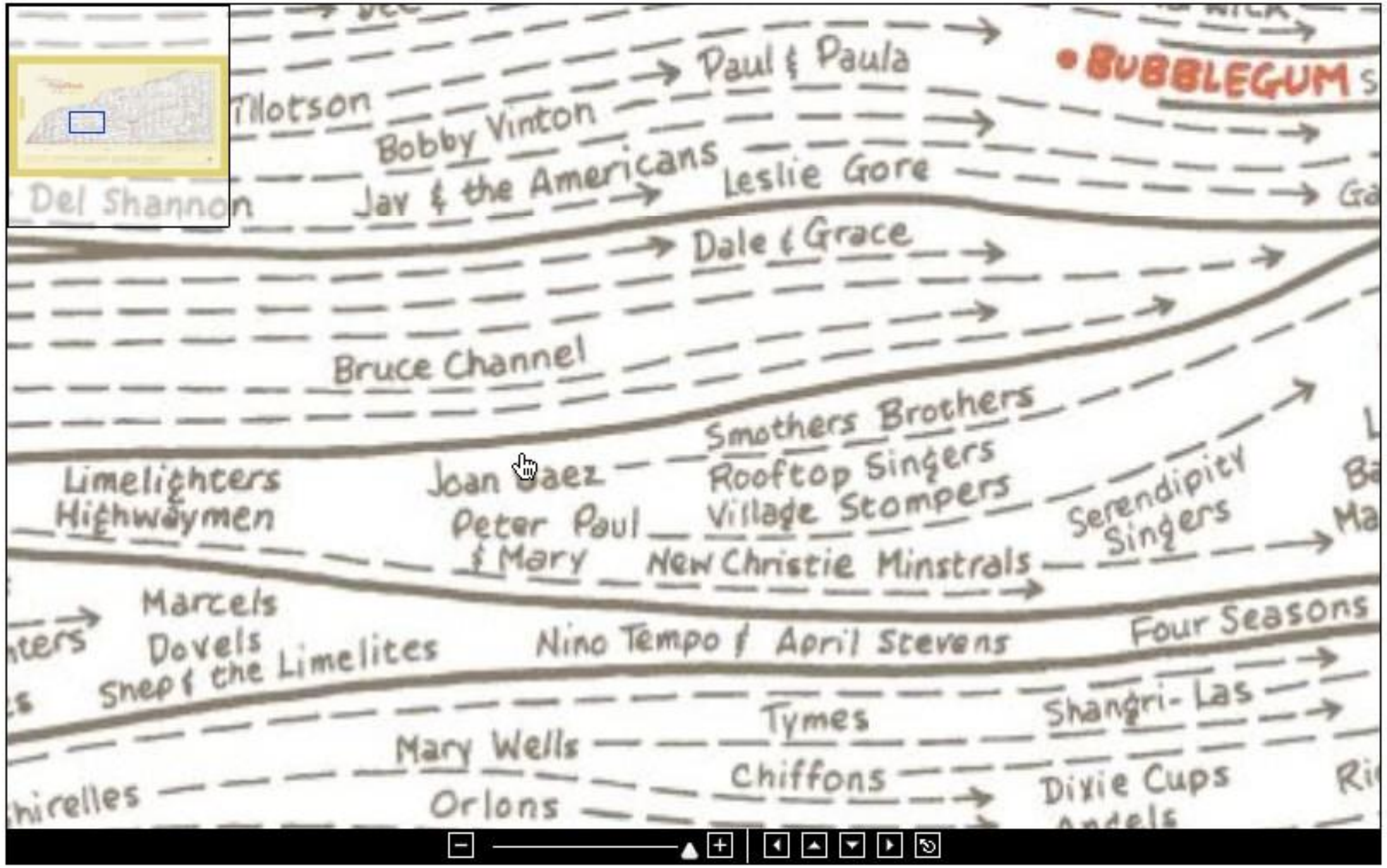
MatrixExplorer



Henry 2006

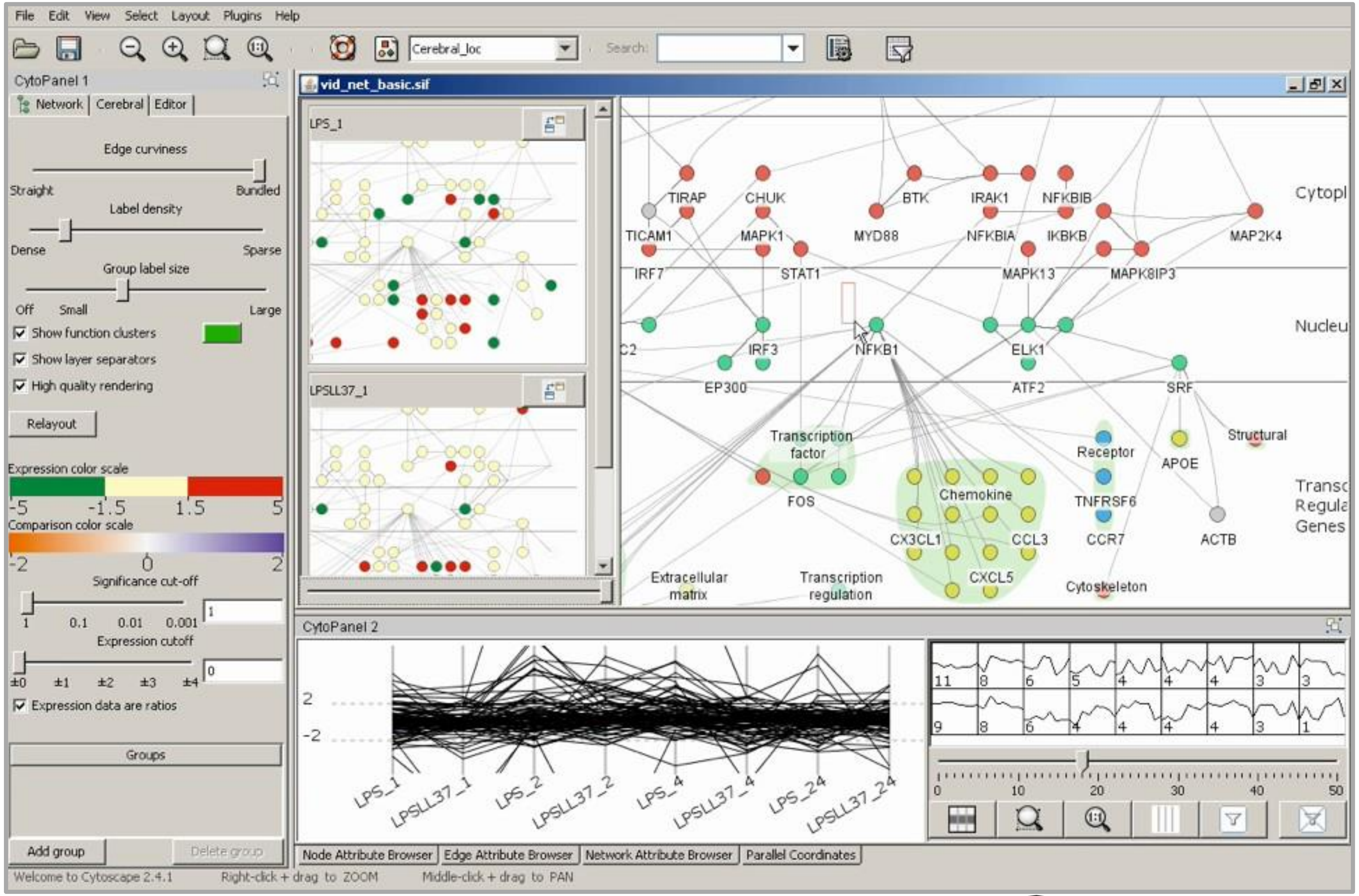
OVERVIEW + DETAIL

- 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


Paul & Paula
BUBBLEGUM
Tillotson
Bobby Vinton
Jay & the Americans
Leslie Gore
Del Shannon
Dale & Grace
Bruce Channel
Smothers Brothers
Rooftop Singers
Village Stompers
Limelighters
Highwaymen
Joan Baez
Peter Paul & Mary
New Christie Minstrals
Serendipity Singers
Marcels
Dovels
Shep & the Limelites
Nino Tempo & April Stevens
Four Seasons
Shangri-Las
Tymes
Mary Wells
Chiffons
Orlons
Dixie Cups

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

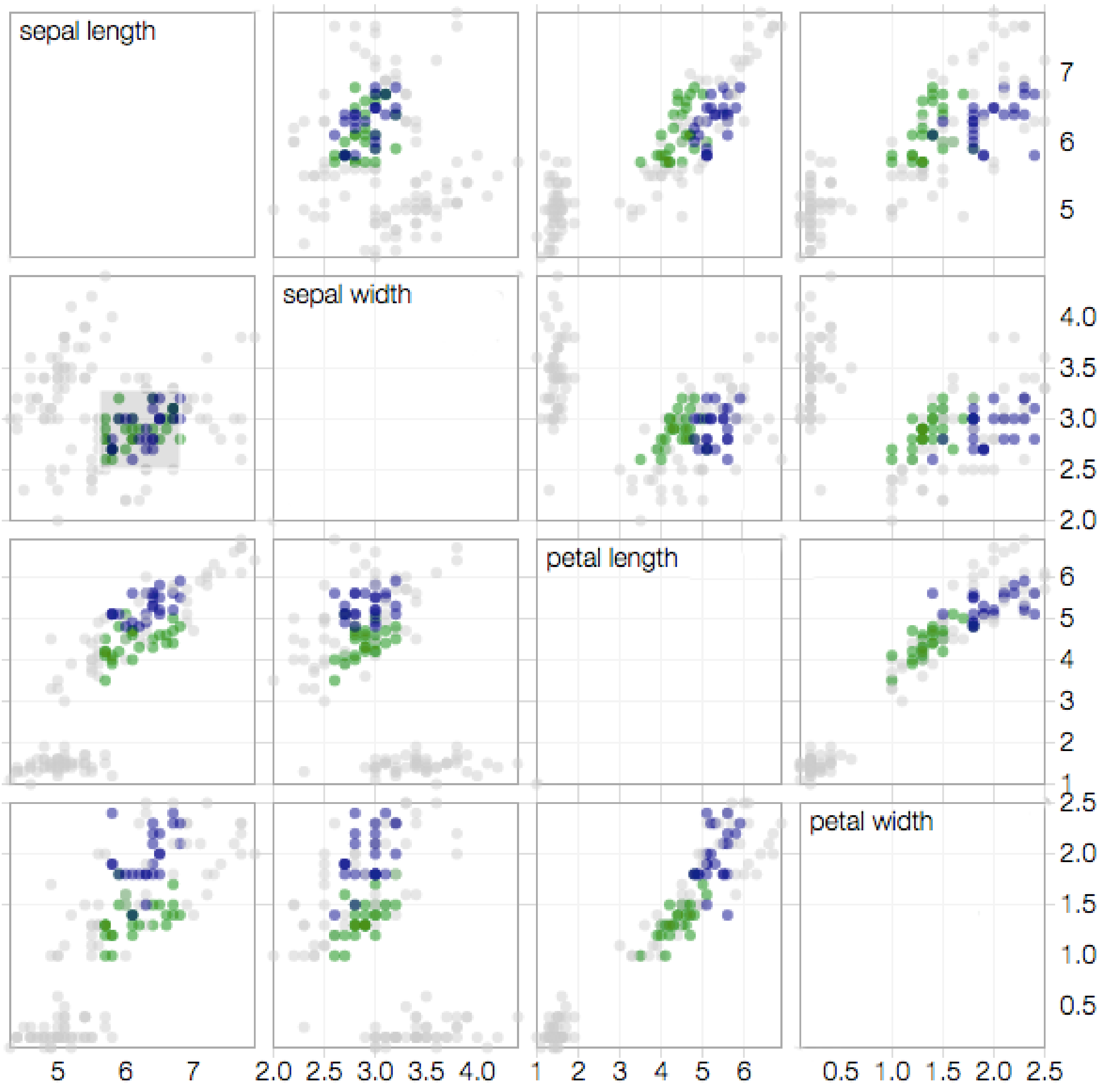

File Edit View Select Layout Plugins Help
Cerebral_loc
Search:
CytoPanel 1
Network
Cerebral
Editor
Edge curviness
Straight
Bundled
Label density
Dense
Sparse
Group label size
Off
Small
Large
Show function clusters
Show layer separators
High quality rendering
Relayout
Expression color scale
-5
-1.5
1.5
5
Comparison color scale
-2
0
2
Significance cut-off
1
0.1
0.01
0.001
Expression cutoff
±0
±1
±2
±3
±4
Expression data are ratios
Groups
Add group
Delete group
vid_net_basic.sif
LPS_1
LPSLL37_1
TIRAP
CHUK
BTK
IRAK1
NFKBIB
TICAM1
MAPK1
MYD88
NFKBIA
IKBKB
MAP2K4
IRF7
STAT1
MAPK13
MAPK8IP3
Cytopl
Nucleu
IRF3
NFKB1
ELK1
EP300
ATF2
SRF
Transcription factor
Receptor
APOE
Structural
FOS
Chemokine
TNFRSF6
CX3CL1
CCL3
CCR7
ACTB
CXCL5
Extracellular matrix
Transcription regulation
Cytoskeleton
CytoPanel 2
LPS_1
LPSLL37_1
LPS_2
LPSLL37_2
LPS_4
LPSLL37_4
LPS_24
LPSLL37_24
Node Attribute Browser
Edge Attribute Browser
Network Attribute Browser
Parallel Coordinates
Welcome to Cytoscape 2.4.1
Right-click + drag to ZOOM
Middle-click + drag to PAN

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

- 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

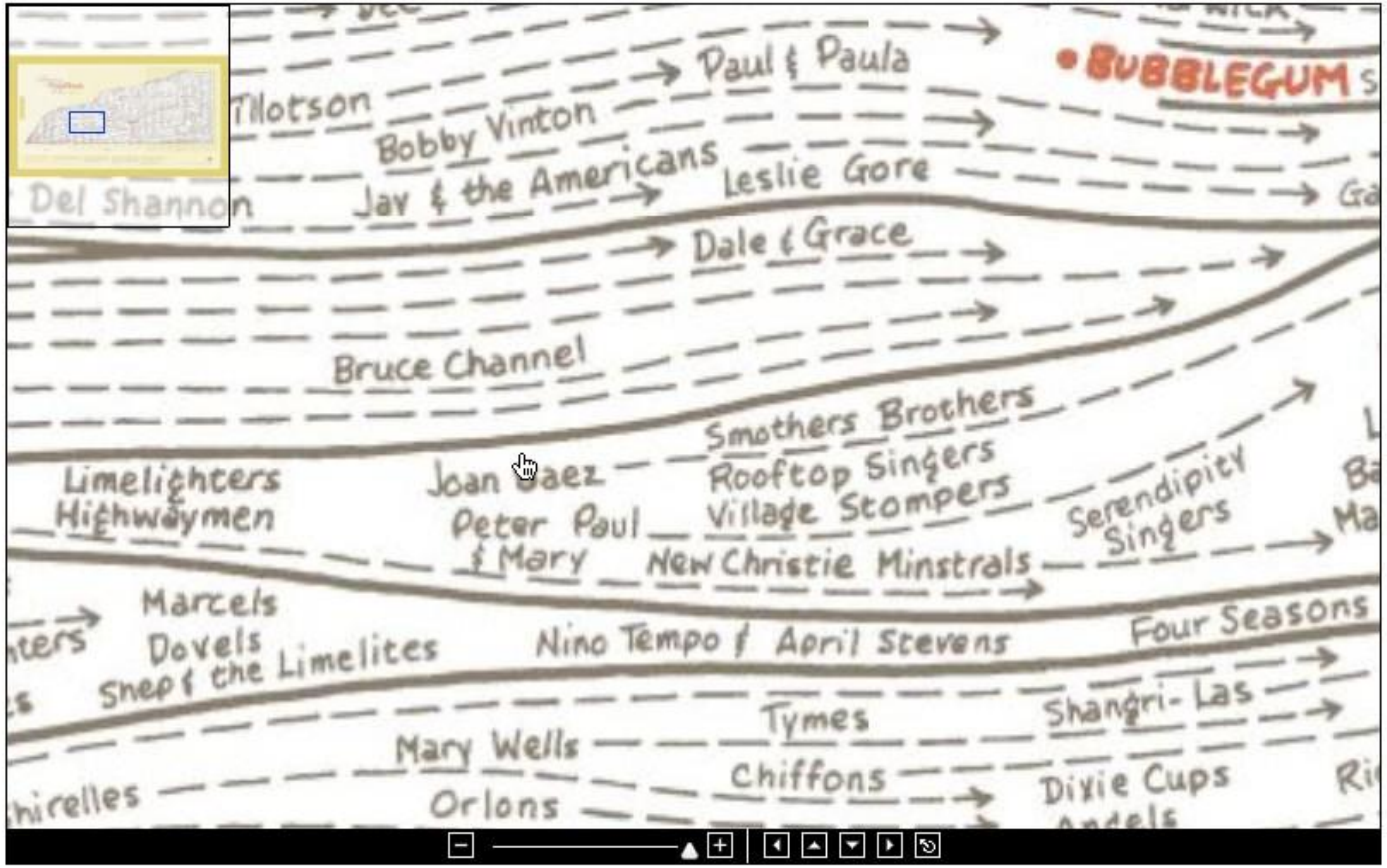
LINKED HIGHLIGHTING



- What to show
  - **encoding**: same or multiform
  - **dataset**: share all, subset, or none

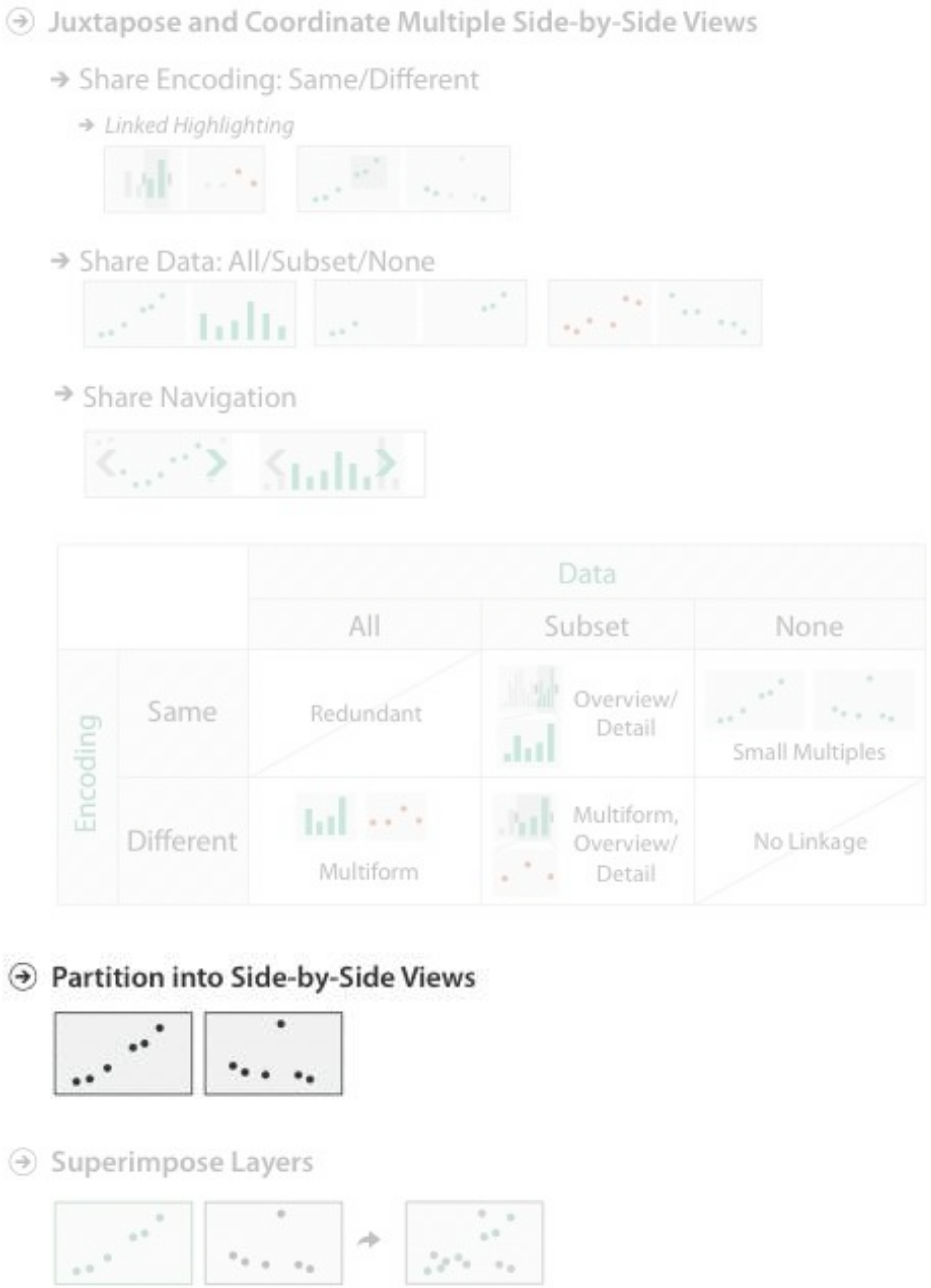
- How to interact
  - **highlighting**: to link, or not
  - **navigation**: to share, or not

LINKED NAVIGATION



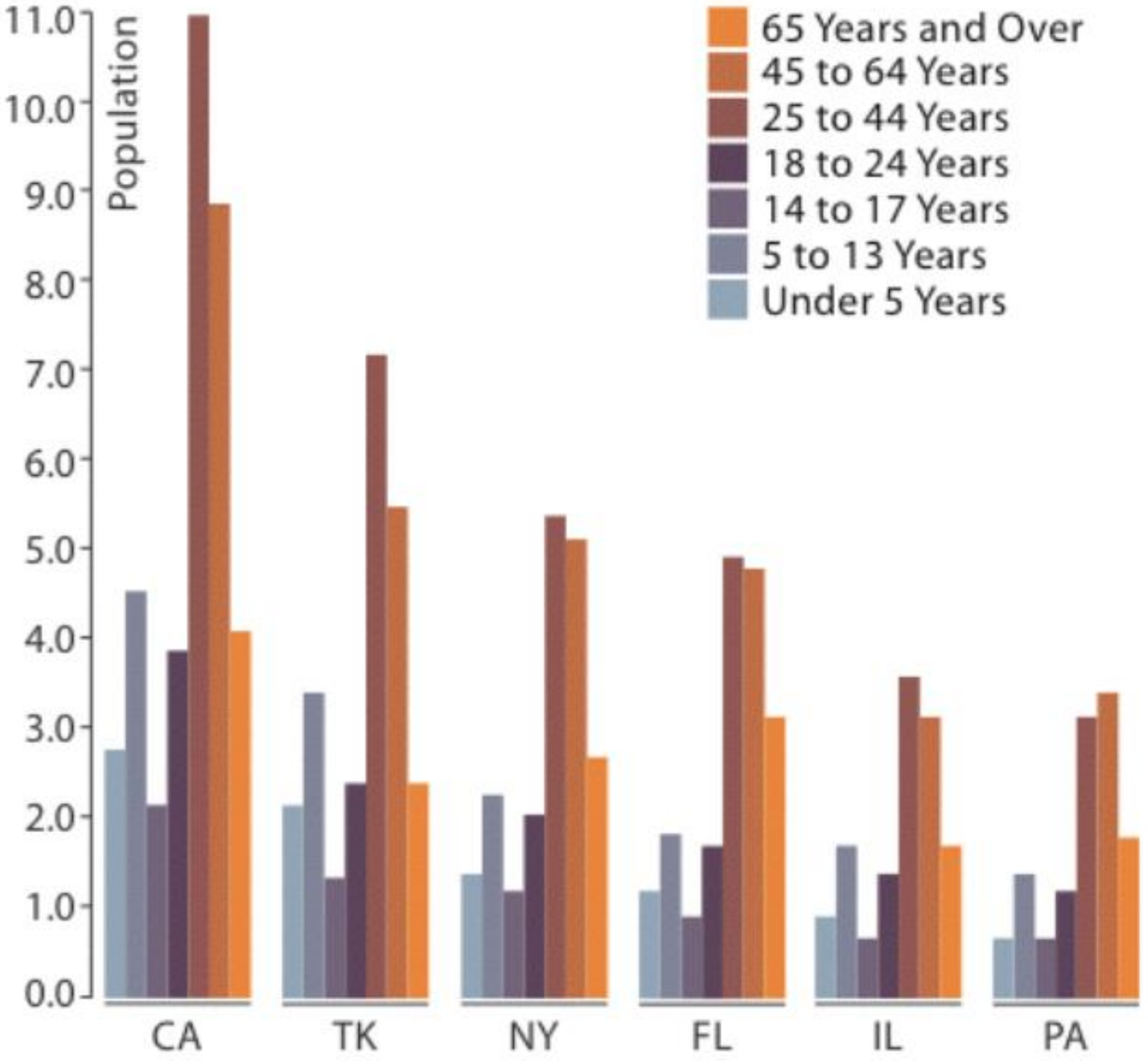
http://www.historyshots.com/rockmusic/

A variety of options…

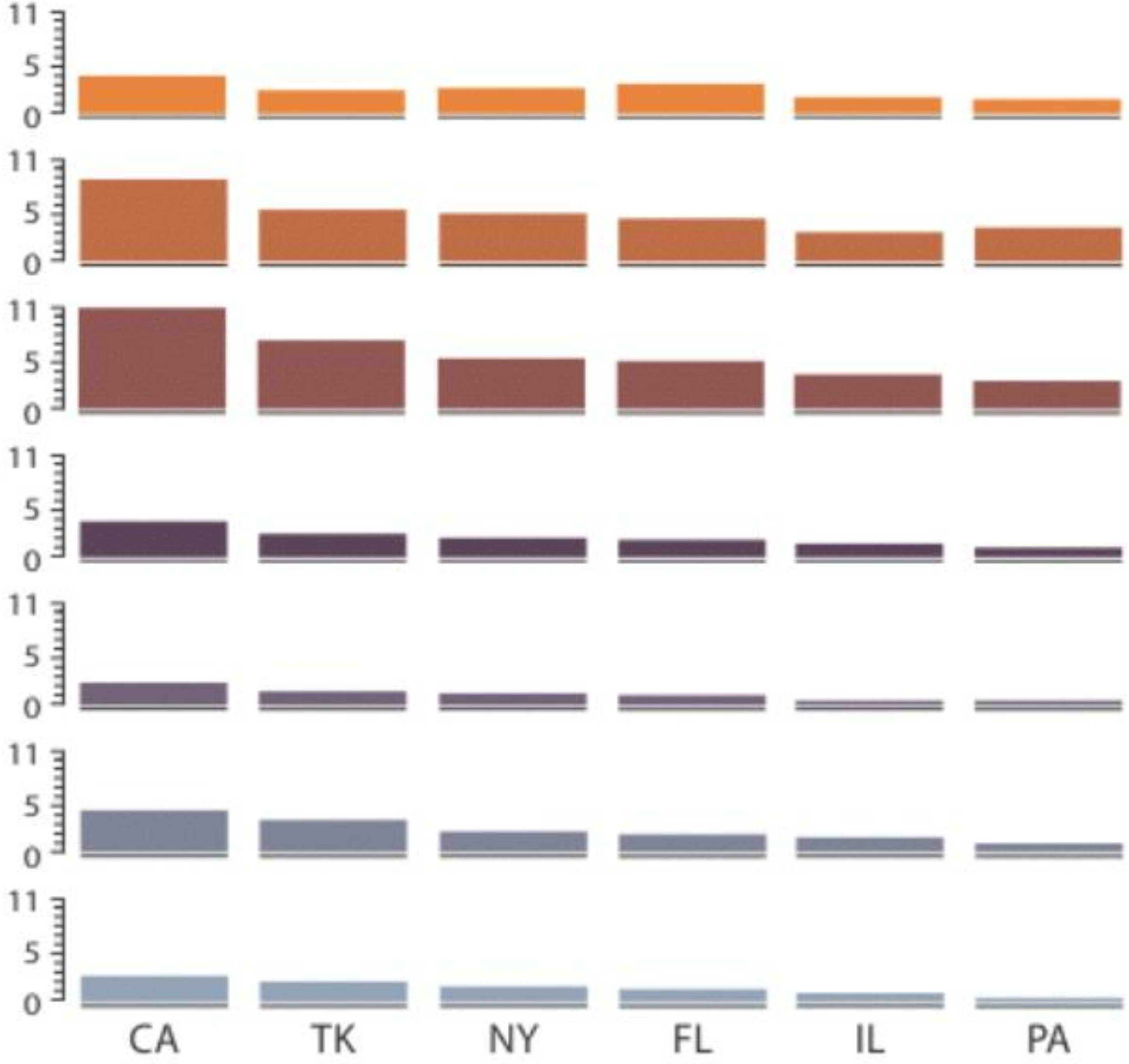


PARTITIONING

- 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

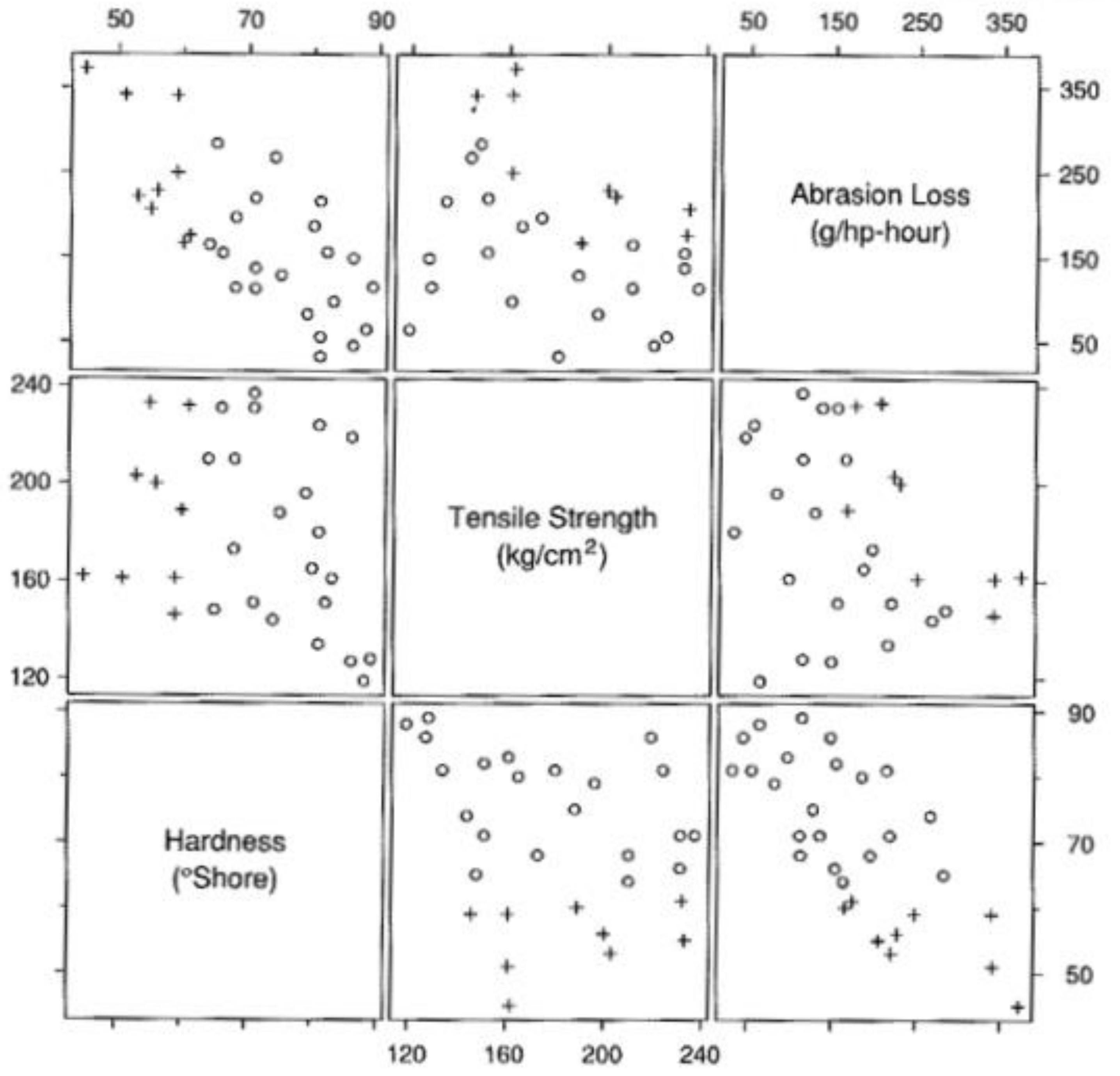


11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Population
65 Years and Over
45 to 64 Years
25 to 44 Years
18 to 24 Years
14 to 17 Years
5 to 13 Years
Under 5 Years
CA
TK
NY
FL
IL
PA



11
5
0
CA
TK
NY
FL
IL
PA

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.

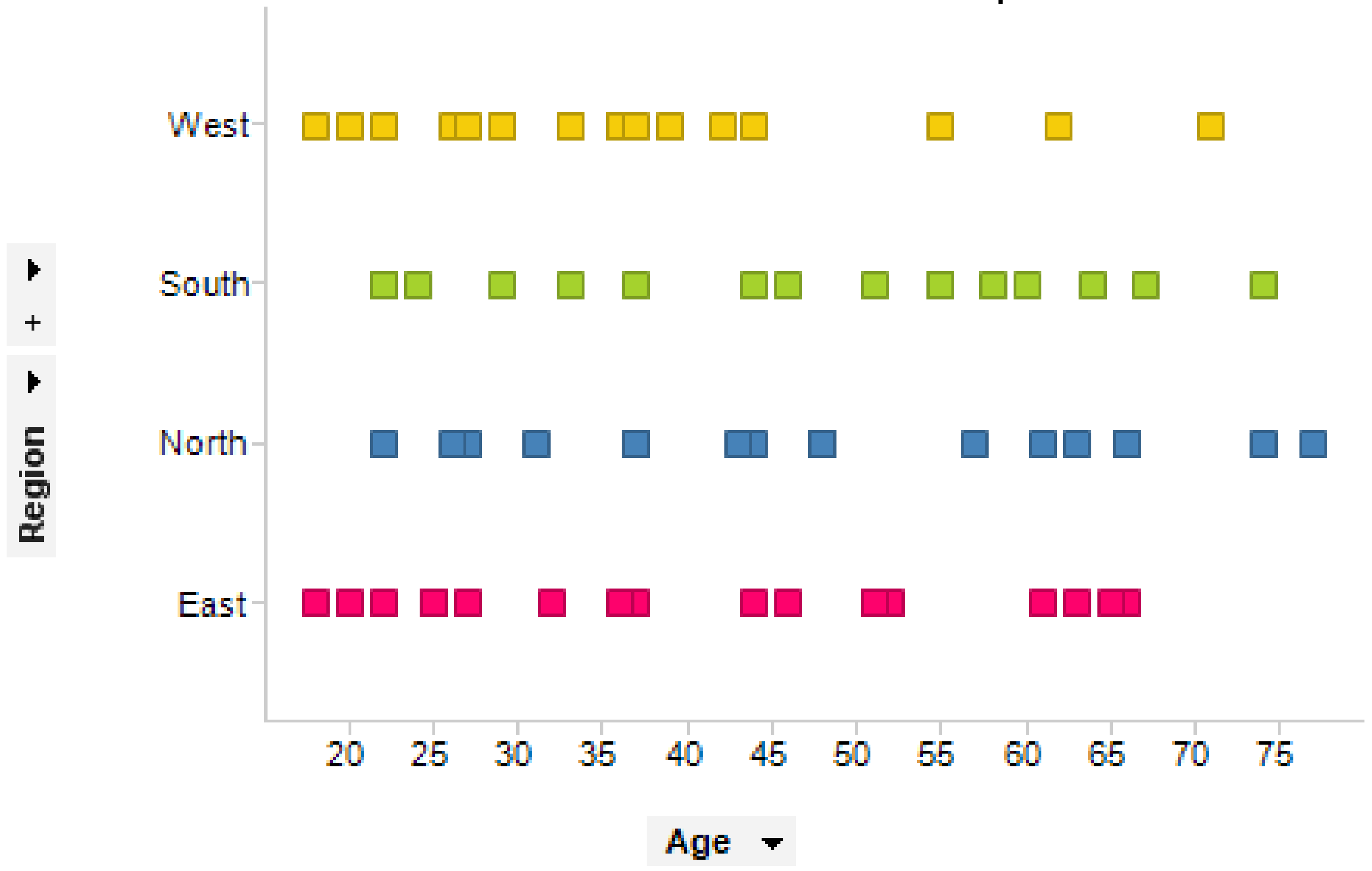
- Cleveland 1994

TRELLISED VIEWS

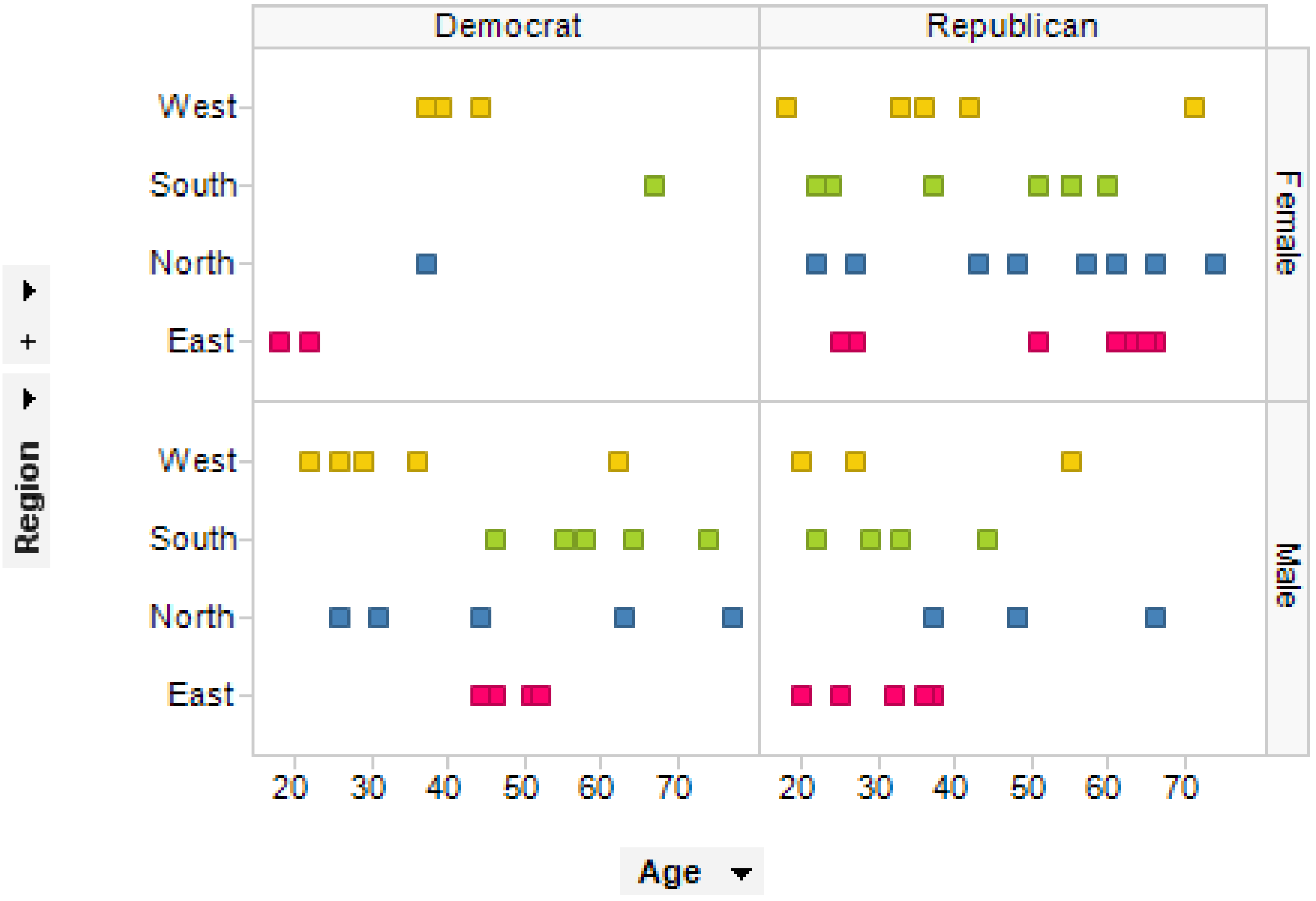
- panel variables: attributes encoded in individual views
- partitioning variables: partitioning attributes assigned to columns, rows, and pages

- Becker 1996

non-trellised scatter plot



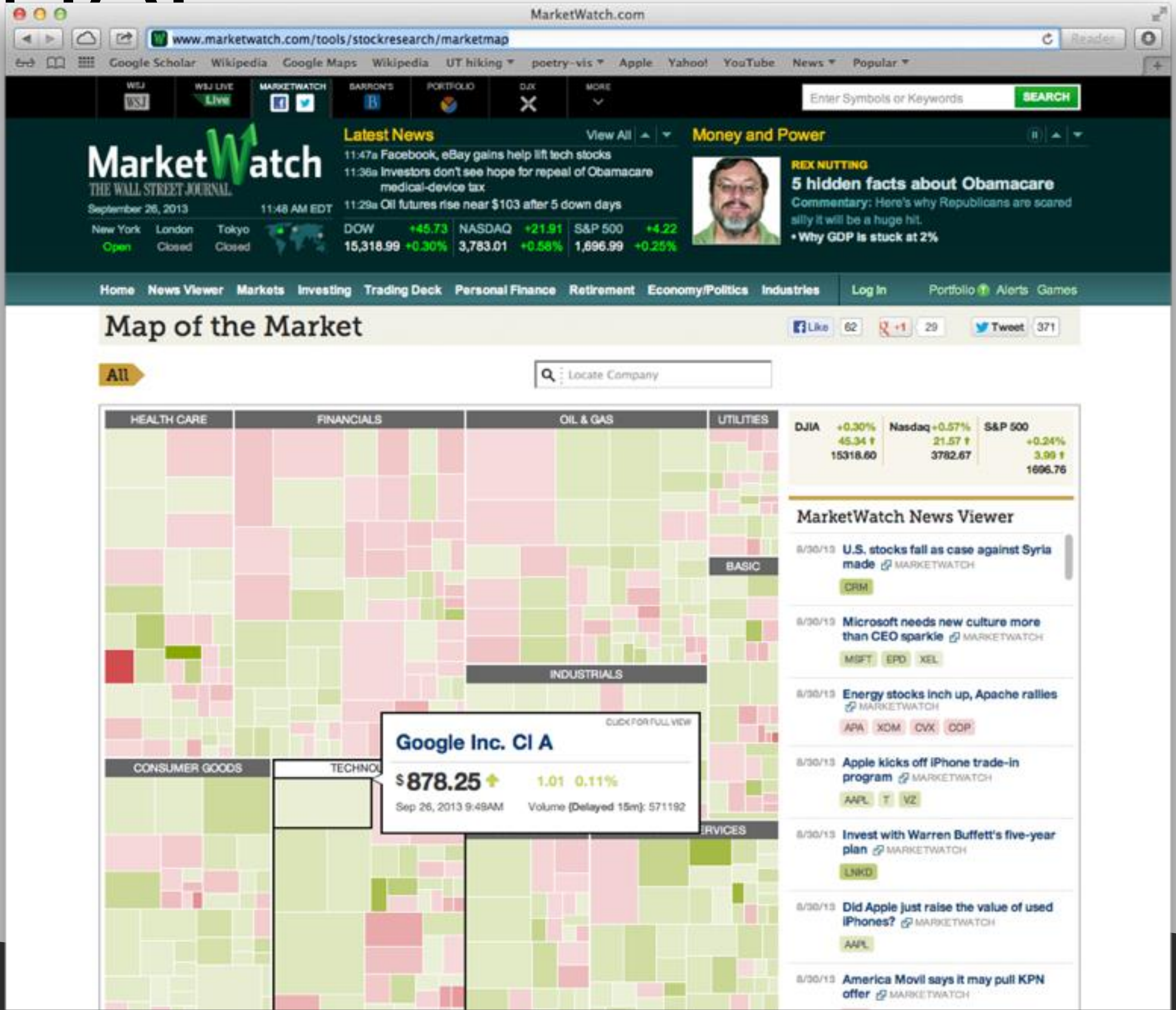
trellising this visualization based on Gender and Political affiliation



HiVE: Hierarchical Visual Expression

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

TREEMAP



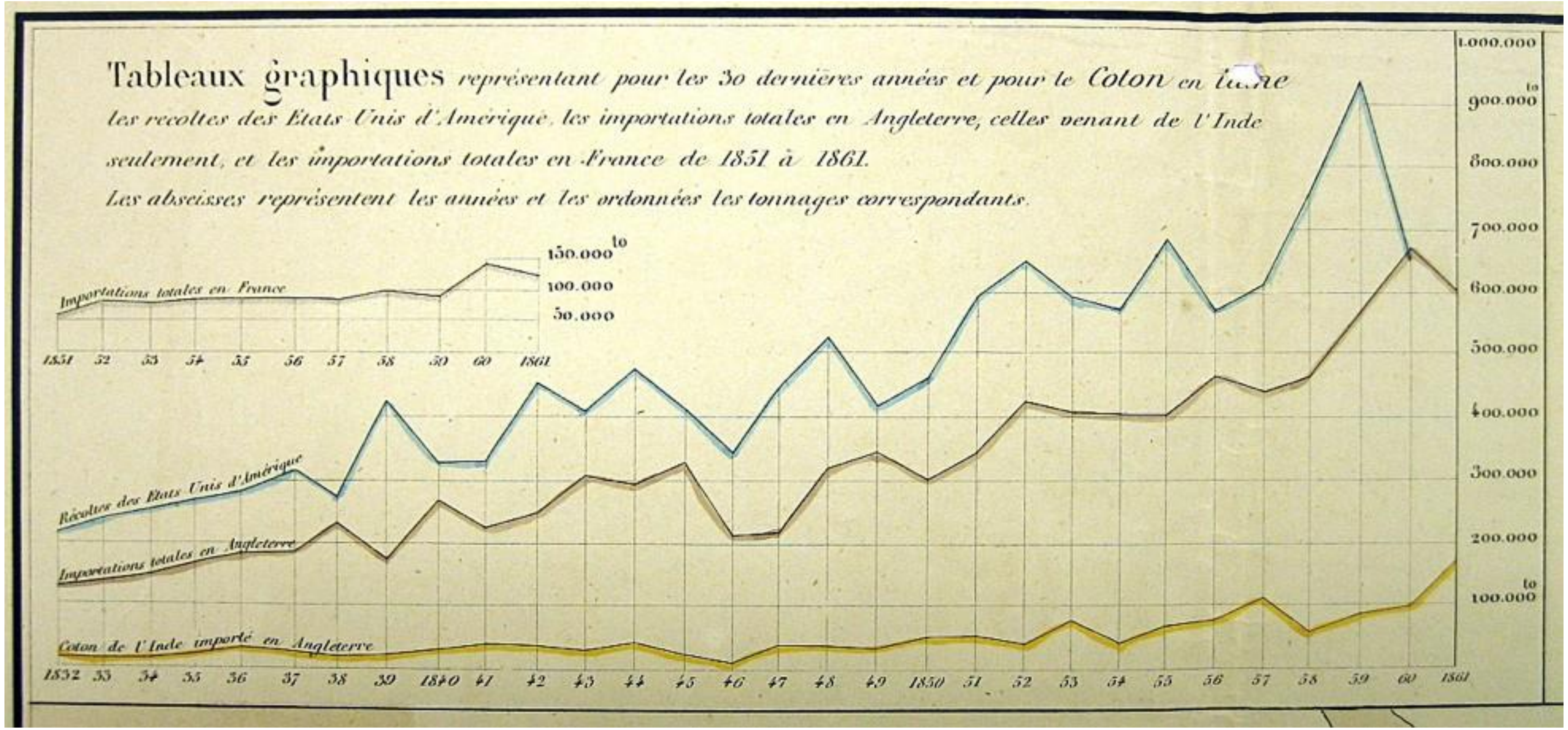
MarketWatch.com
www.marketwatch.com/tools/stockresearch/marketmap
MarketWatch
THE WALL STREET JOURNAL.
Latest News
Money and Power
5 hidden facts about Obamacare
Map of the Market
HEALTH CARE
FINANCIALS
OIL & GAS
UTILITIES
BASIC
INDUSTRIALS
CONSUMER GOODS
Google Inc. Cl A
$878.25
1.01 0.11%
MarketWatch News Viewer

A variety of options…

LAYERING

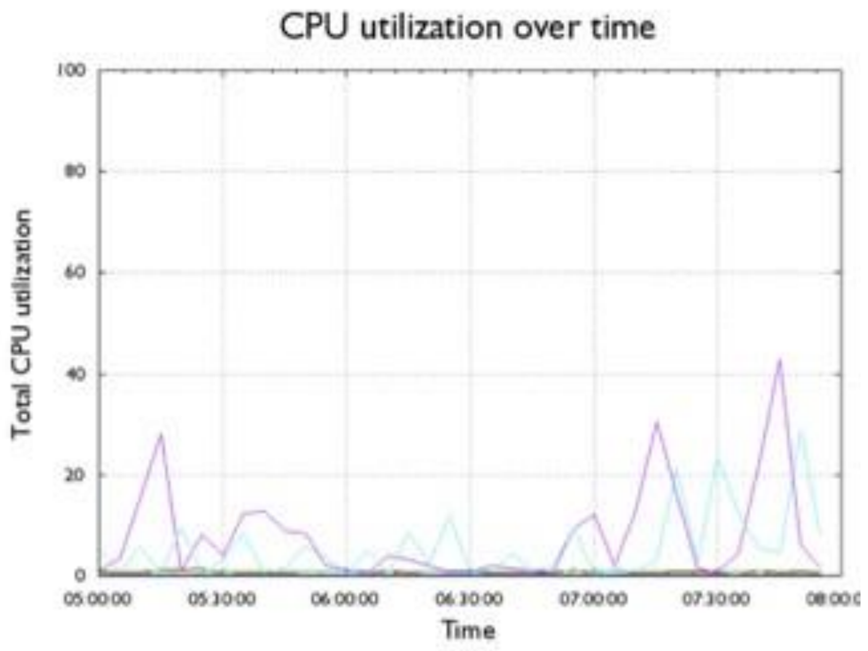
- combining multiple views on top of one another to form a composite view
  - rational: supports a larger, more detailed view than using multiple views
  - trade-off: layering imposes constraints on visual encoding choice as well as number of layers that can be shown

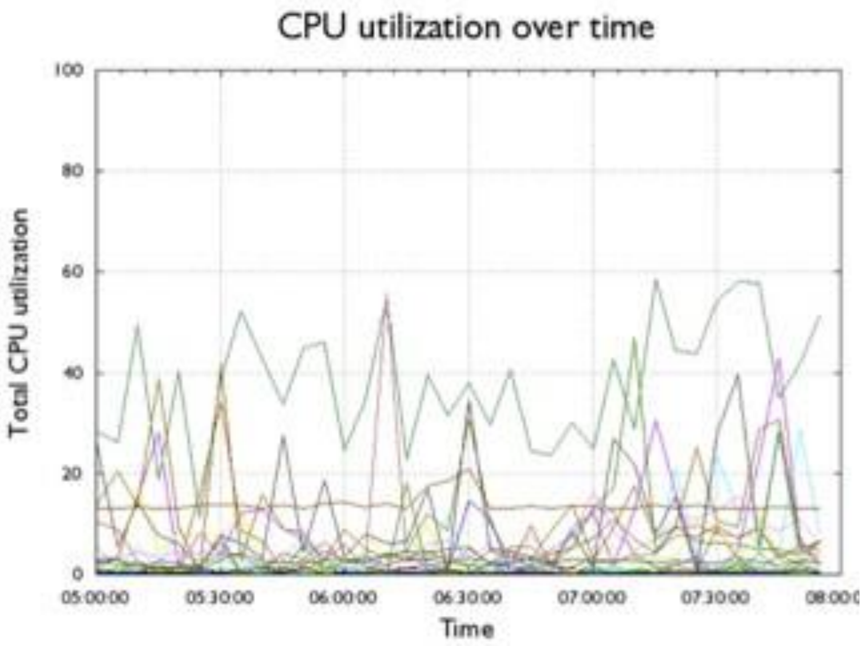
GLOBAL COMPOSITING

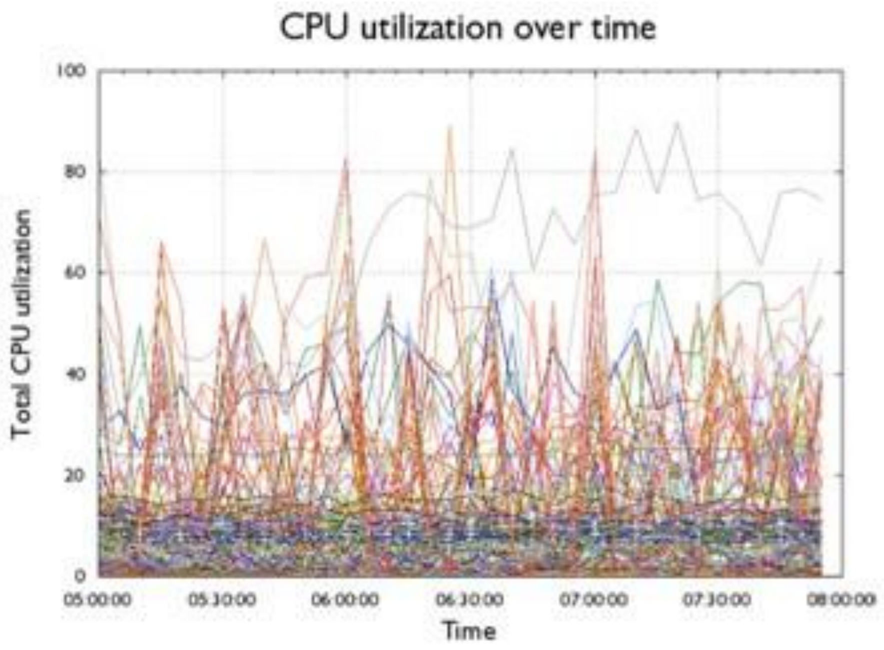


JOSEPH MINARD 1781-1870

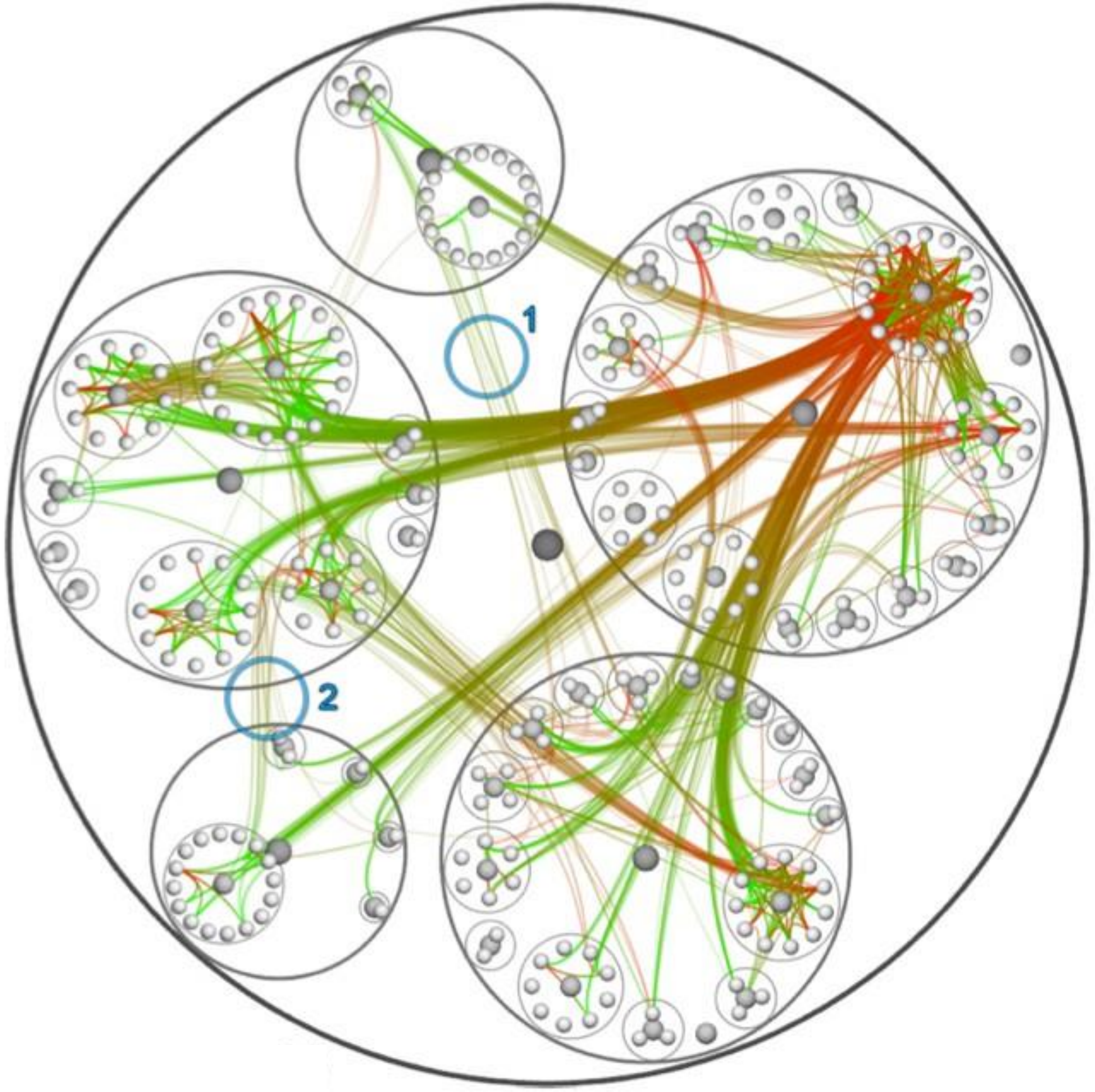
overlays


CPU utilization over time
Total CPU utilization
Time
0
20
40
60
80
100
05:00:00
05:30:00
06:00:00
06:30:00
07:00:00
07:30:00

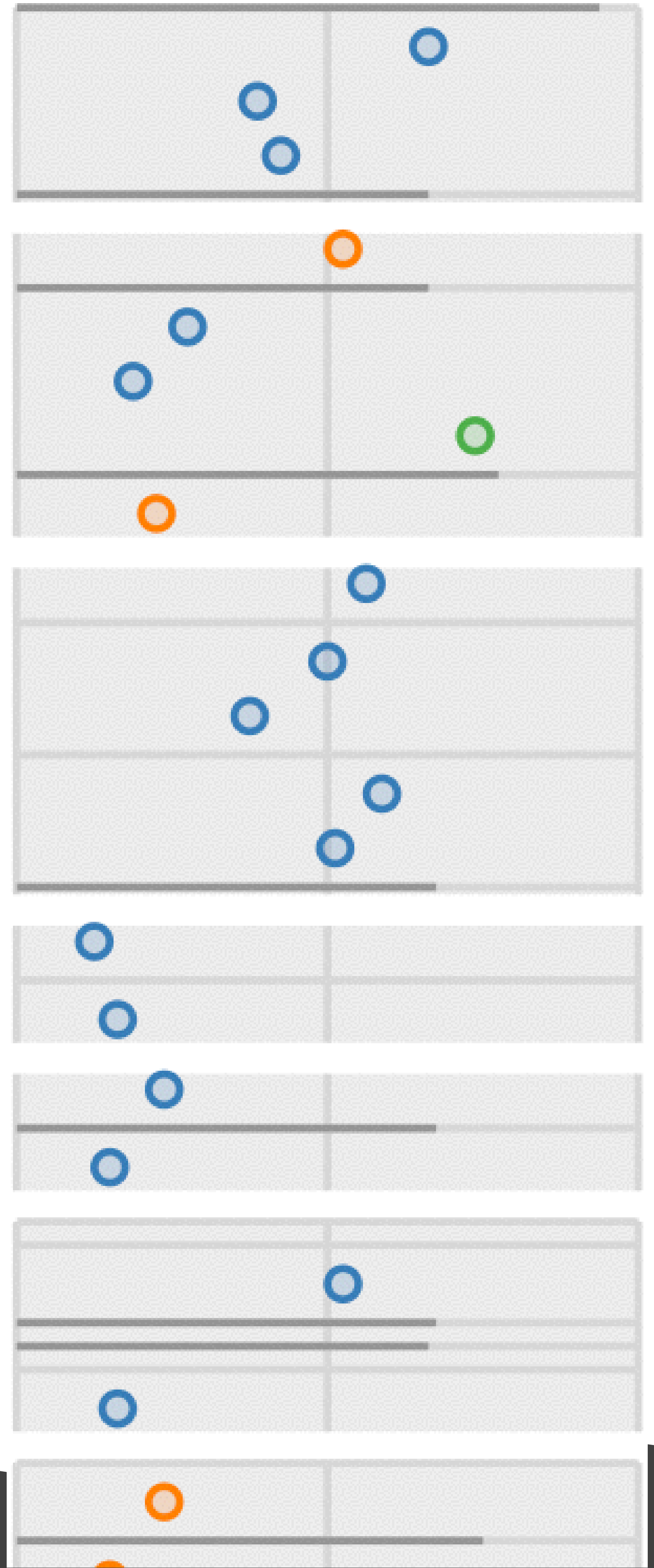

CPU utilization over time
Total CPU utilization
Time
0
20
40
60
80
100
05:00:00
05:30:00
06:00:00
06:30:00
07:00:00
07:30:00


CPU utilization over time
Total CPU utilization
Time
0
20
40
60
80
100
05:00:00
05:30:00
06:00:00
06:30:00
07:00:00
07:30:00
08:00:00

edge bundling

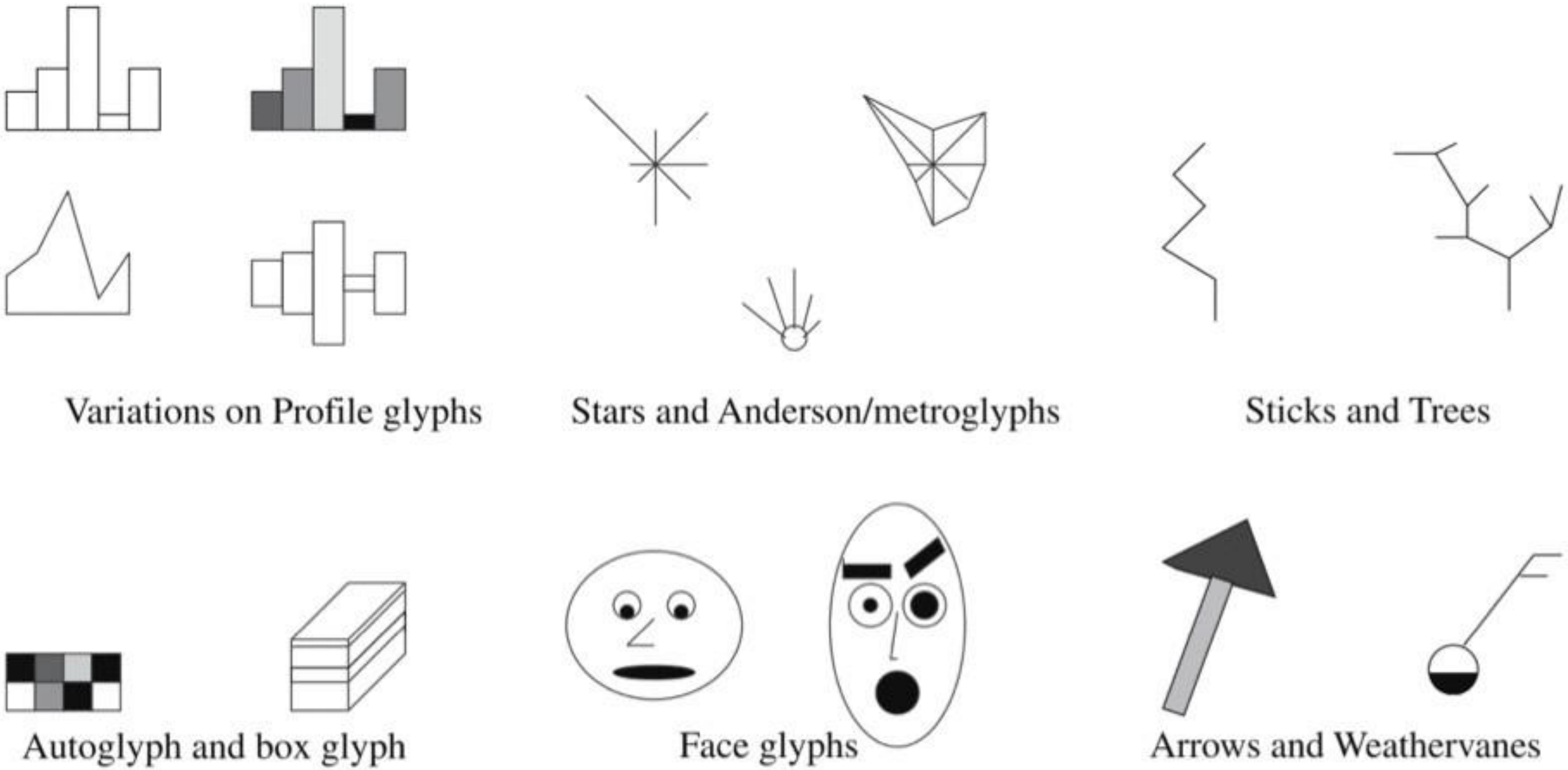


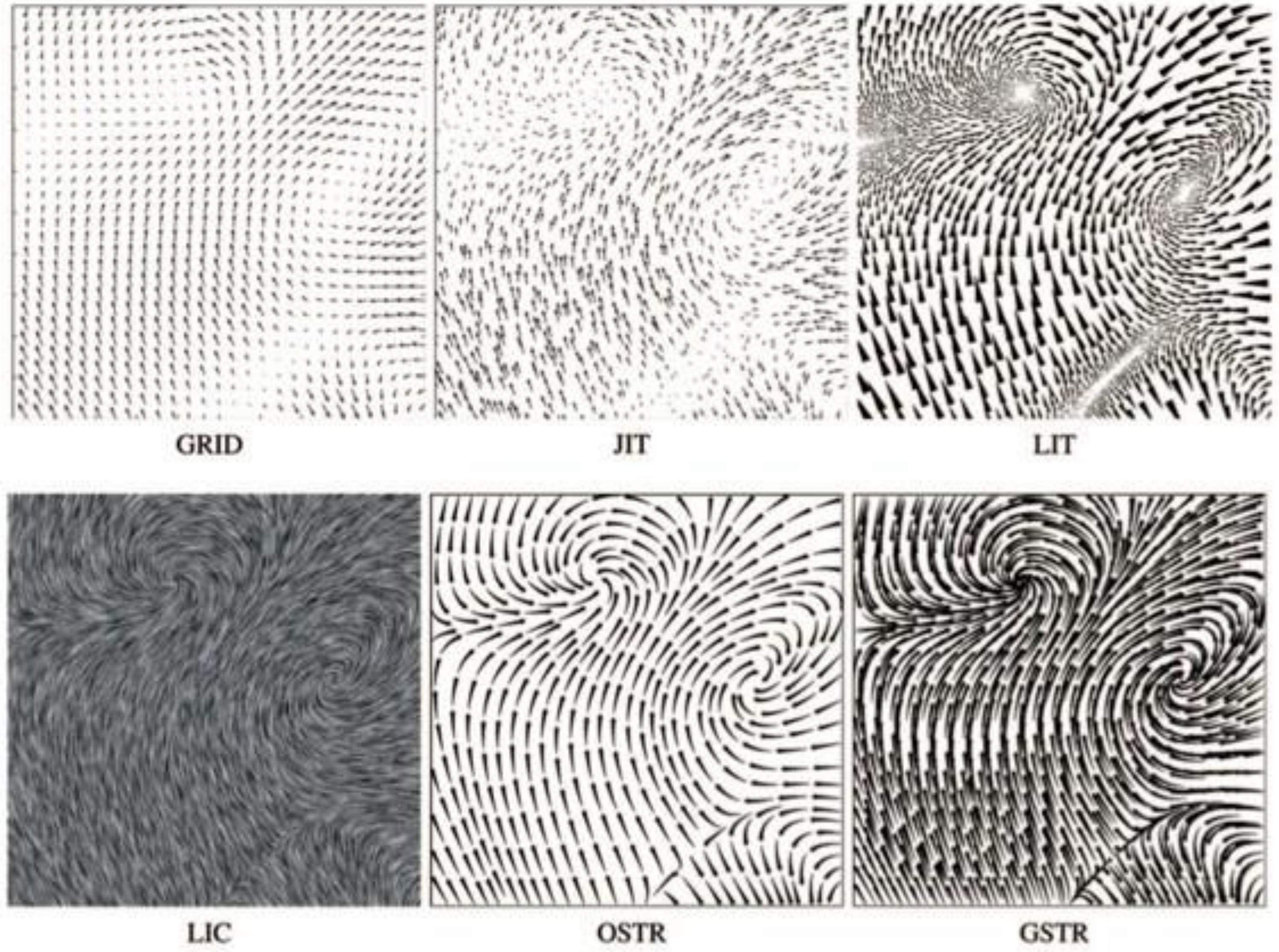
multiple encodings

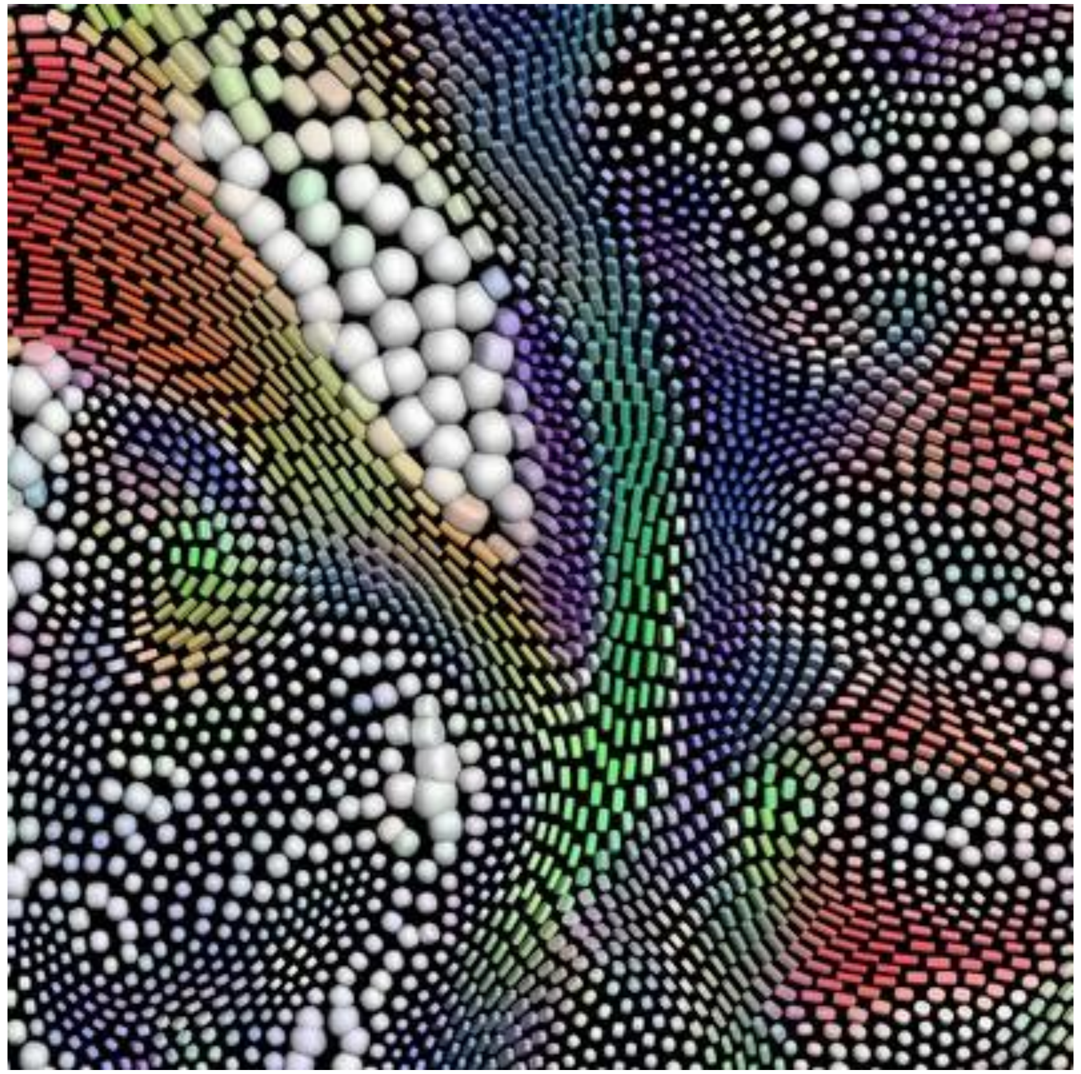


GLYPHS

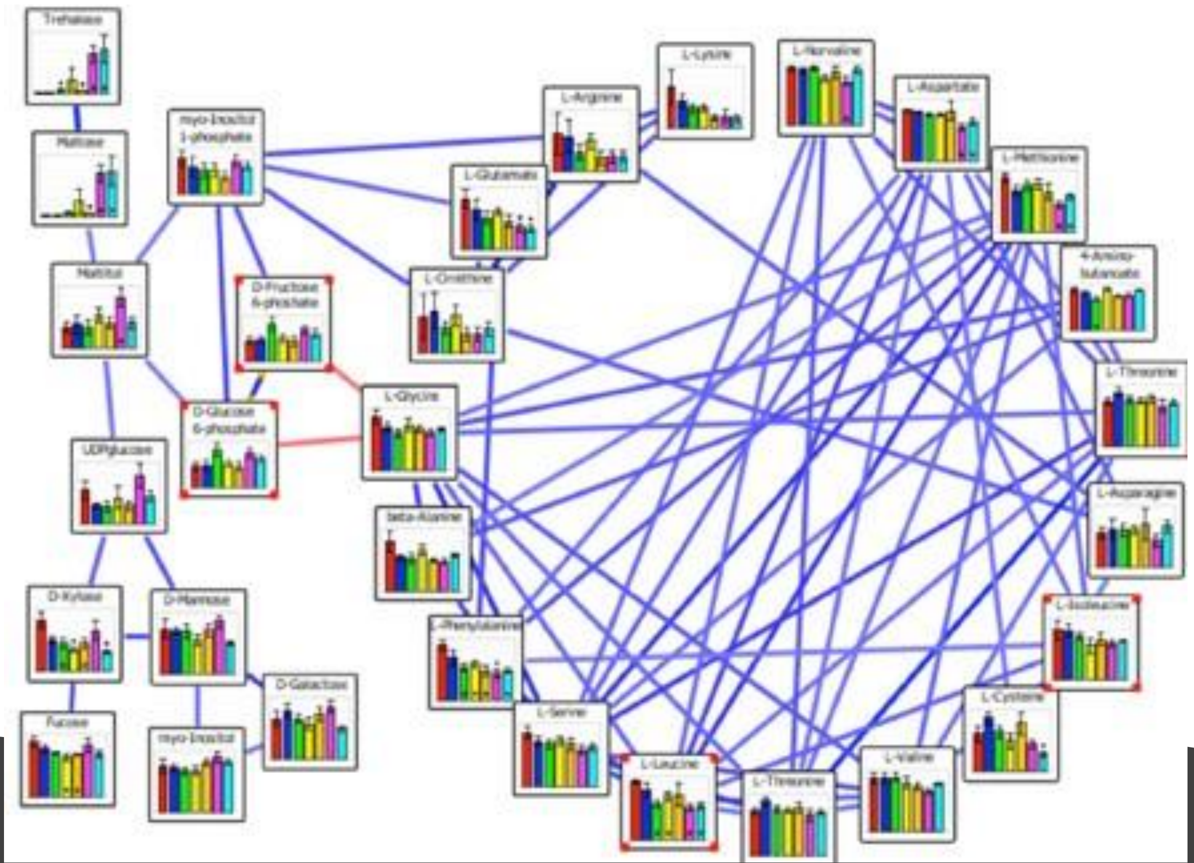
- a graphical object with internal structure that arises from multiple marks
  - ambiguity: little distinct line between glyph and view!


Variations on Profile glyphs
Stars and Anderson/metroglyphs
Sticks and Trees
Autoglyph and box glyph
Face glyphs
Arrows and Weathervanes





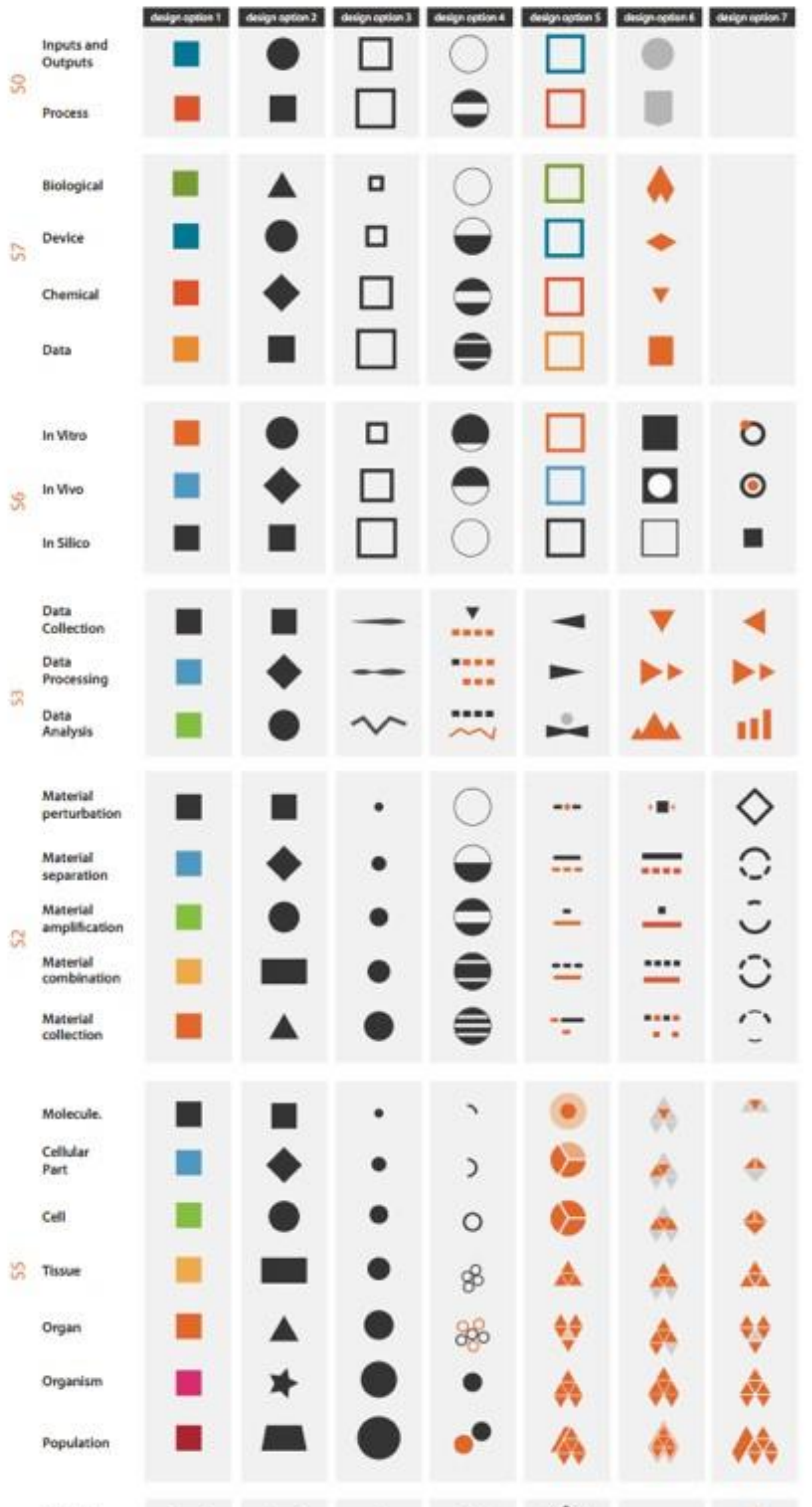
Kindlmann 2006



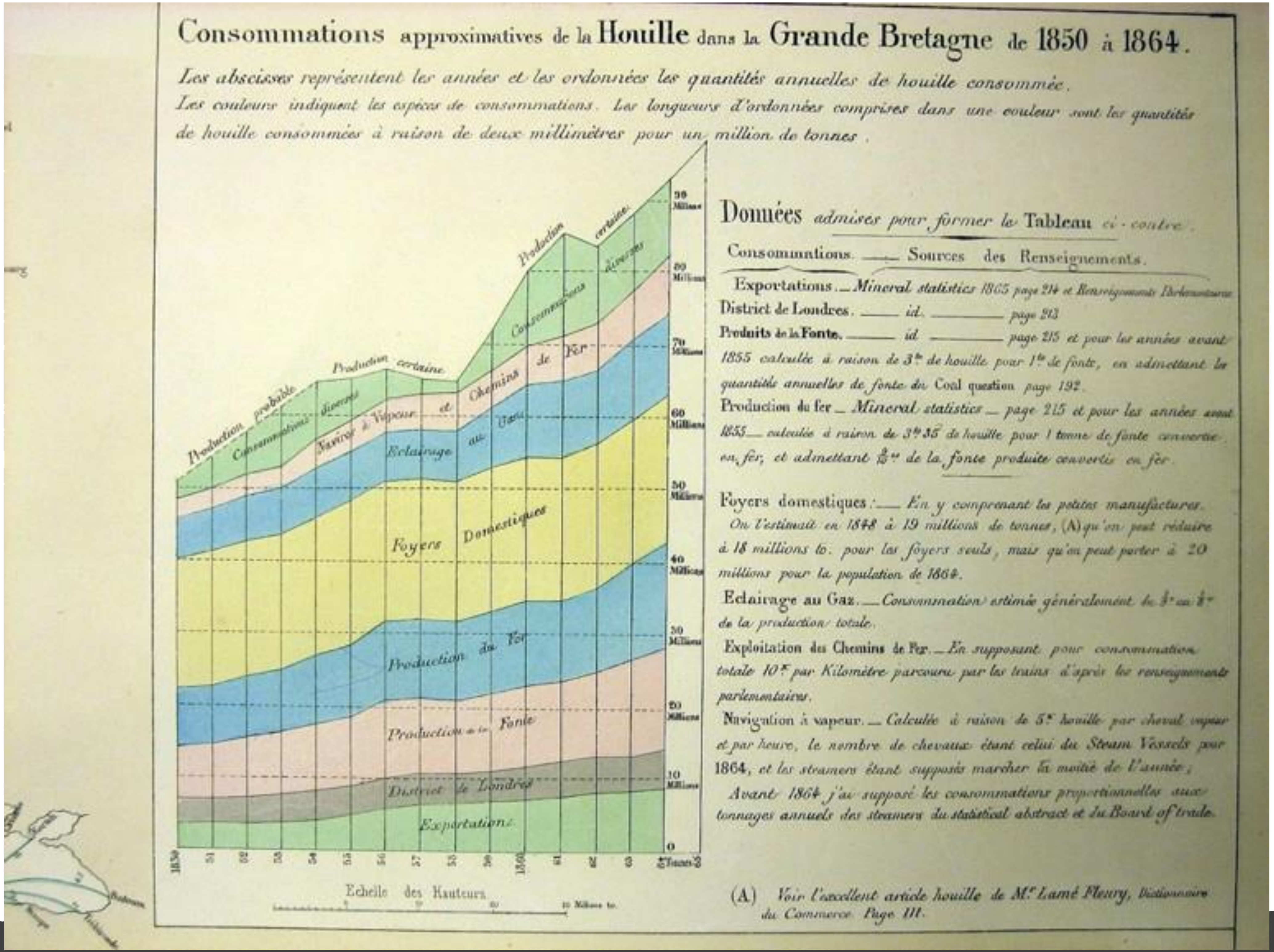
Junker 2006

Process

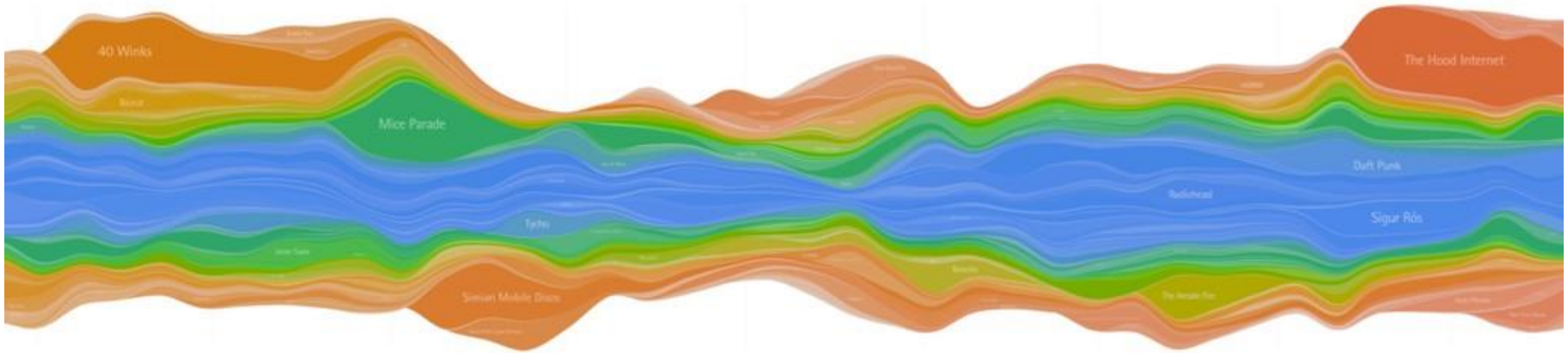
- gather metadata for obtaining a set of names
  - or, things you want to represent
- build a taxonomy
  - propose several categorization schemes
- develop visual design
  - determine order of visual channels
  - propose optional mappings
  - identify metaphoric abstractions
- implement a glyph-based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

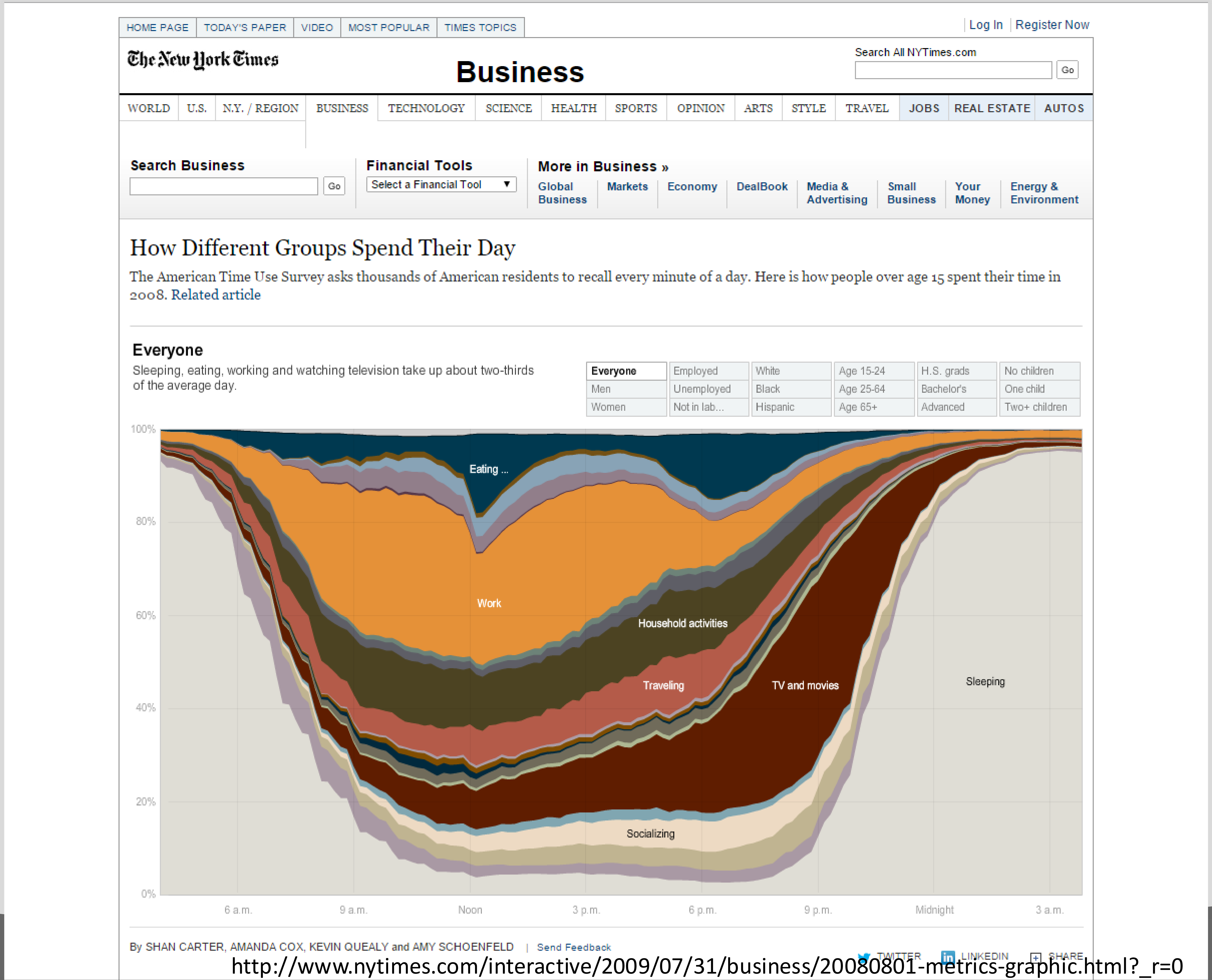


ITEM-LEVEL STACKING



streamgraph





http://www.nytimes.com/interactive/2009/07/31/business/20080801-metrics-graphic.html?_r=0

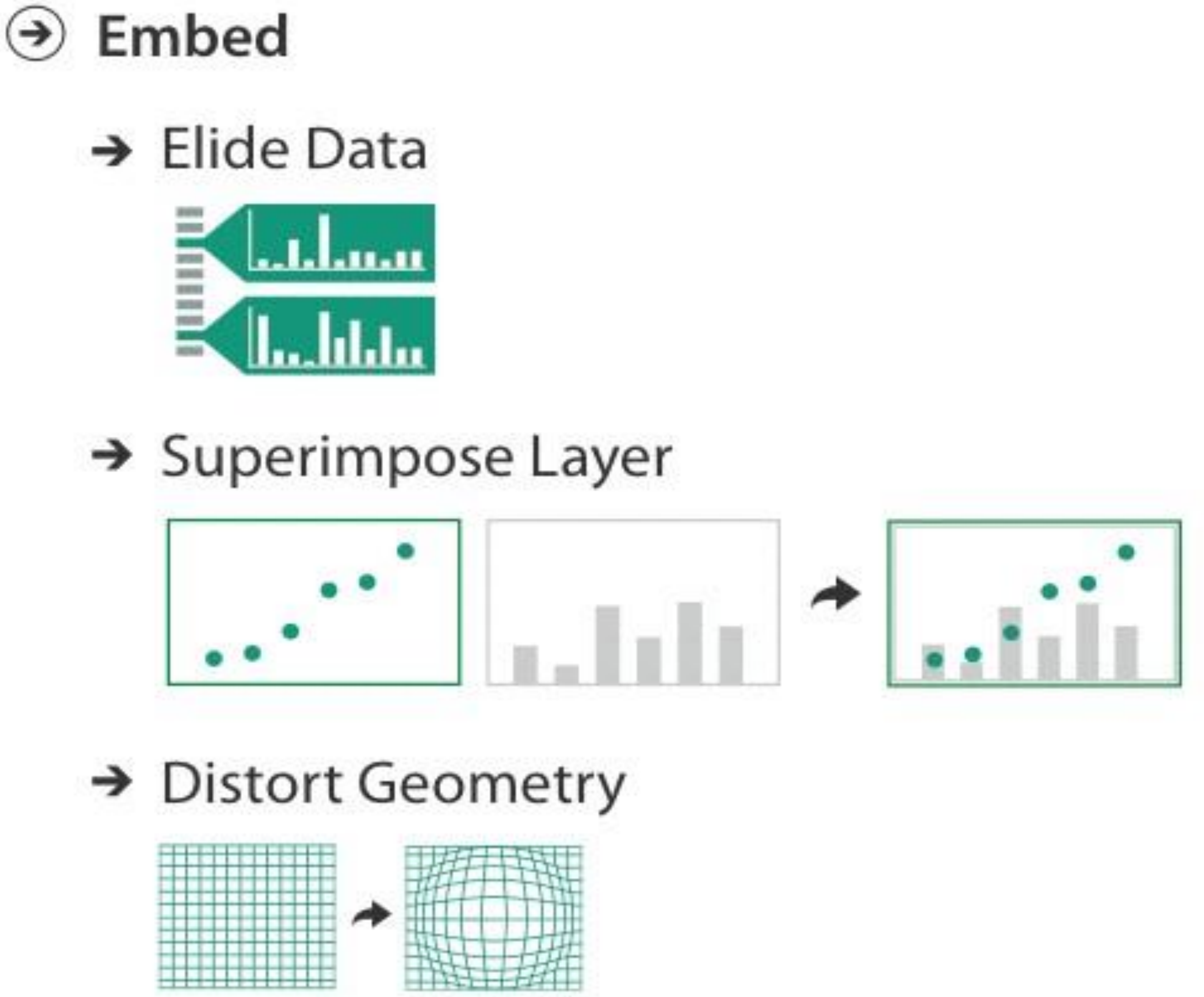
FOCUS + CONTEXT

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

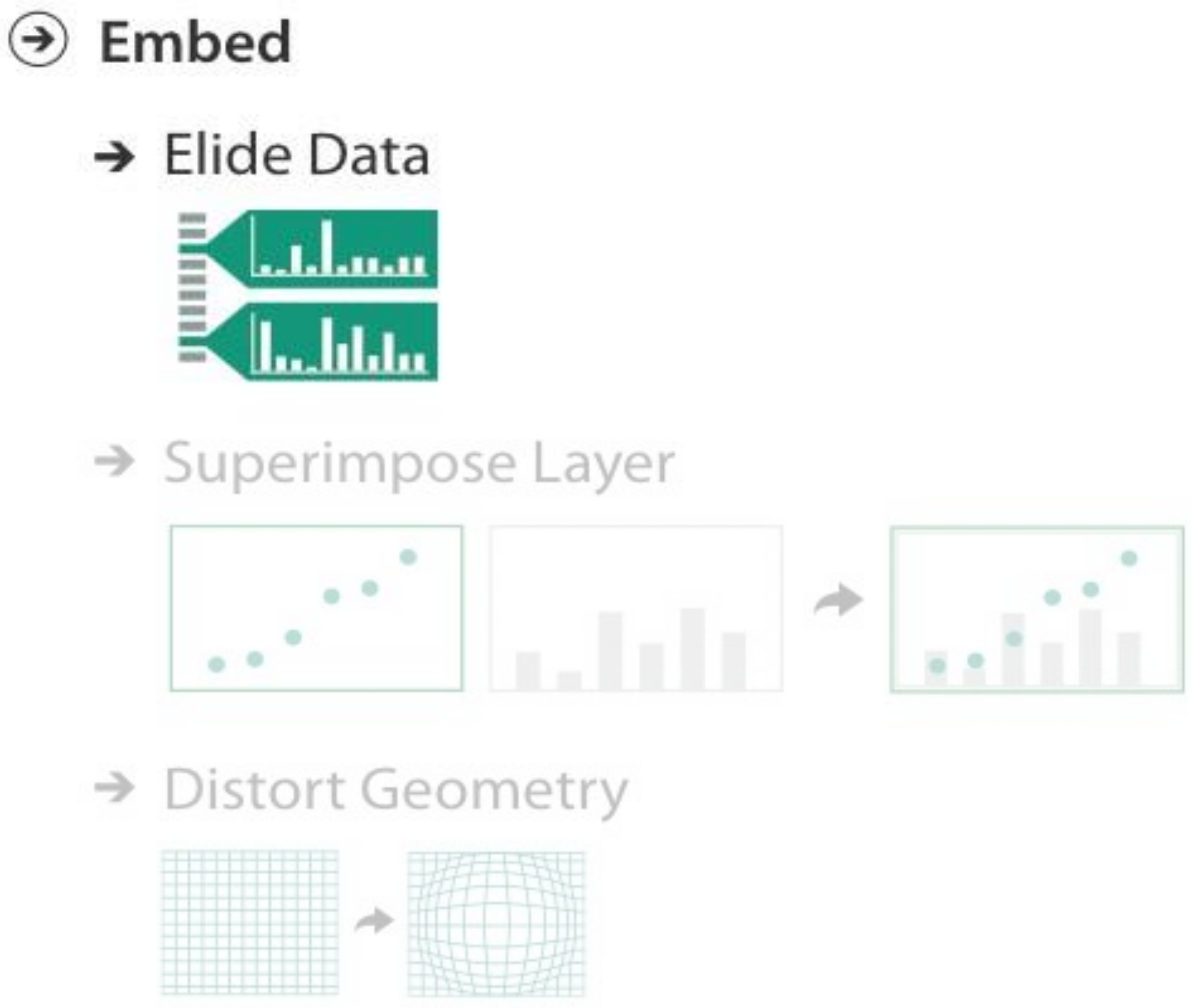
FOCUS + CONTEXT

- 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



elision



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

SpaceTree

Grosjean 2002

DOI

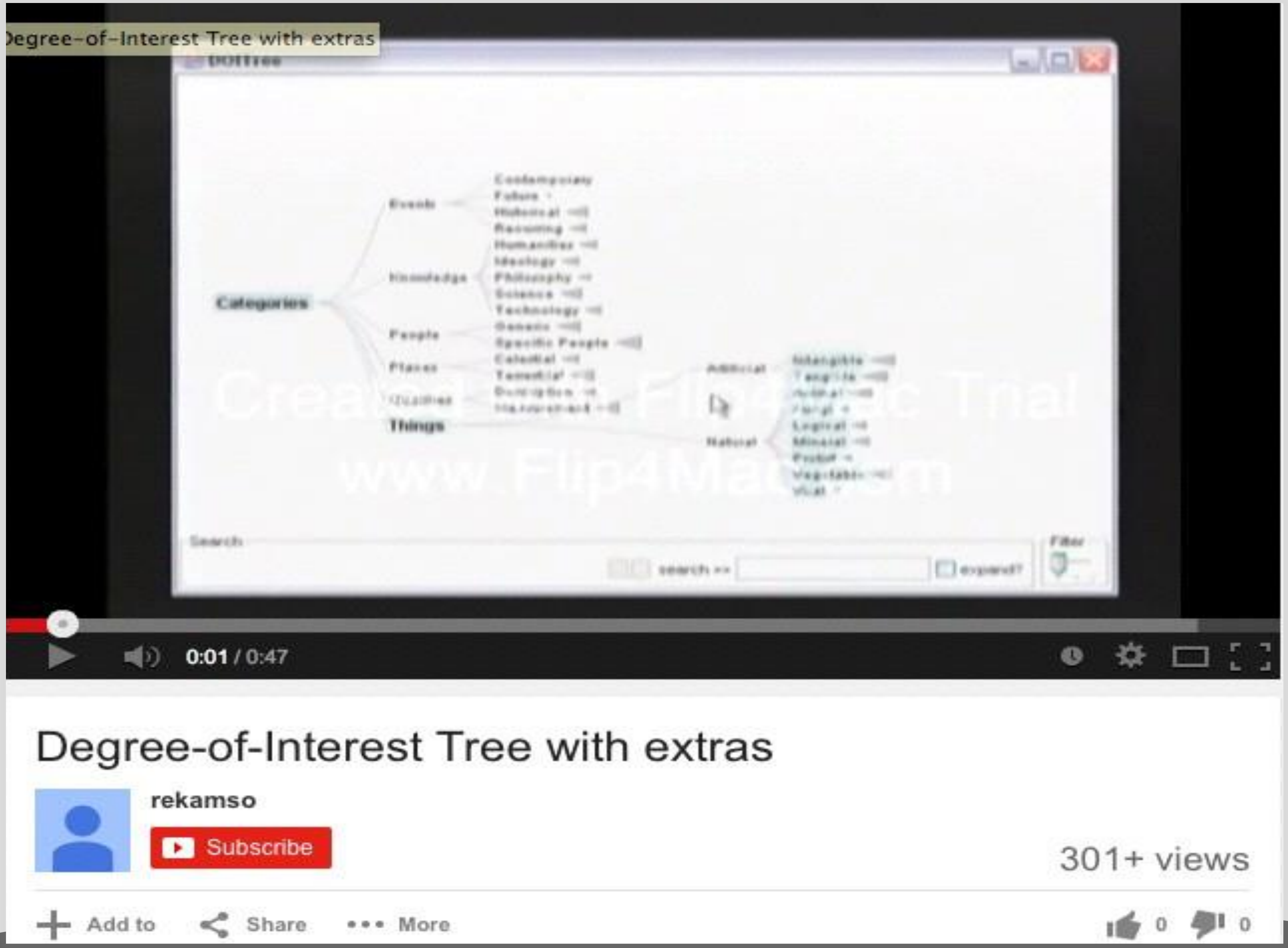
- degree of interest
- based on observation that humans often represent their own neighborhood in detail, yet only major landmarks far away
- goal is balance between local detail and global context

DOITree

- 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

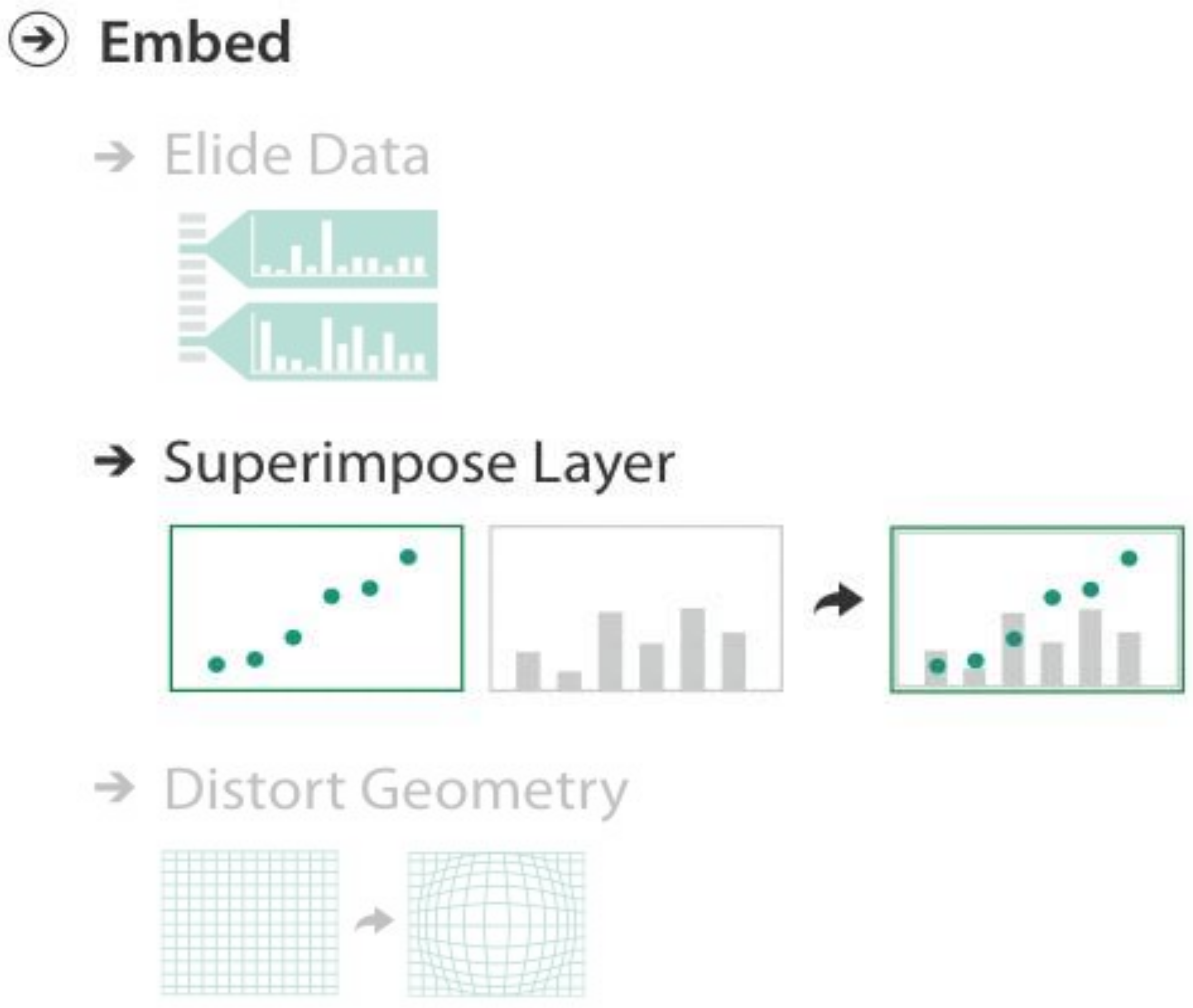
Heer 2004

DOITree



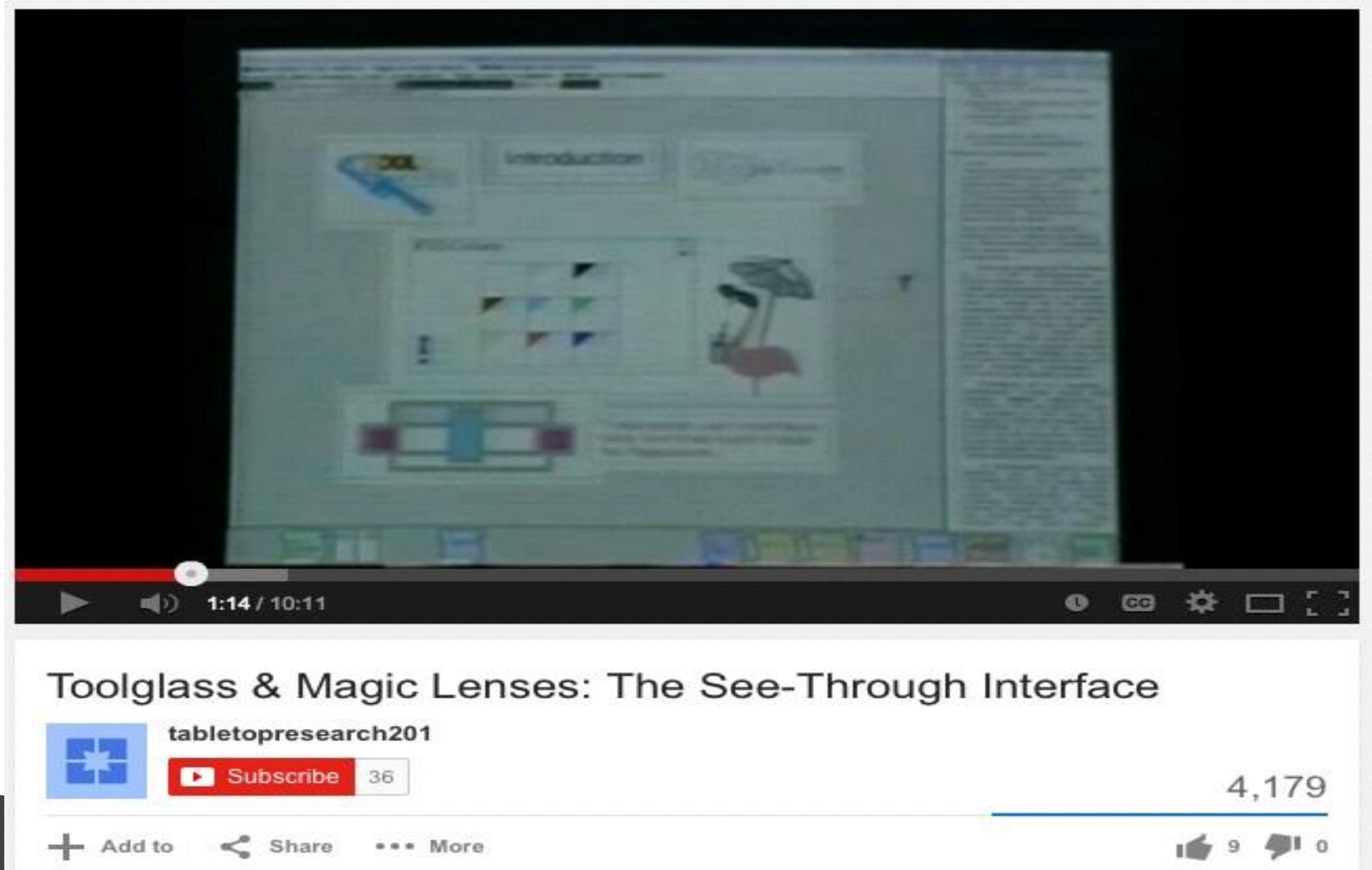
Degree-of-Interest Tree with extras
0:01 / 0:47
Degree-of-Interest Tree with extras
rekamso
Subscribe
301+ views
Add to
Share
More
0
0

Superimpose



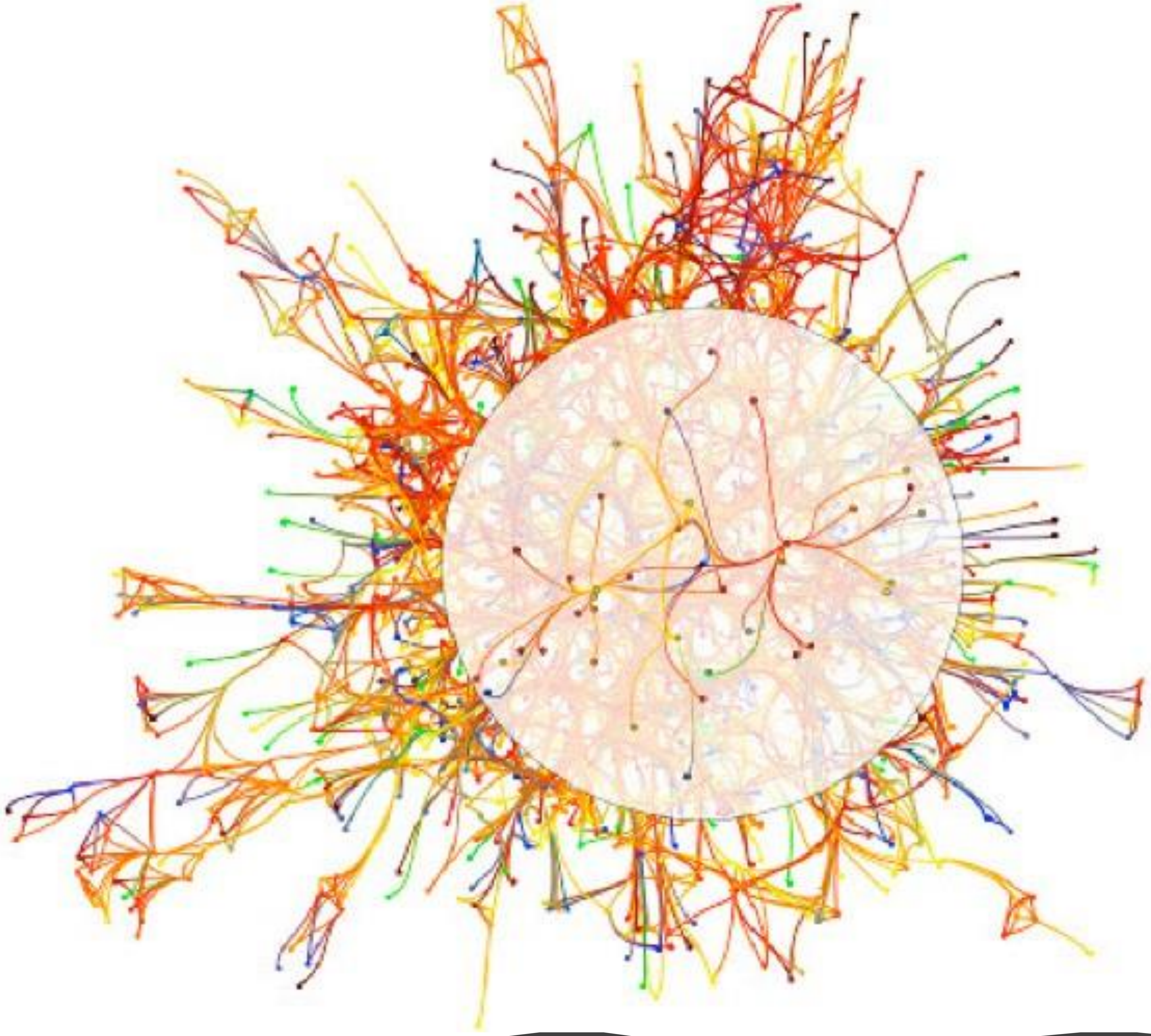
- focus layer limited to a local region of view, instead of stretching across the entire view

Toolglass & Magic Lenses

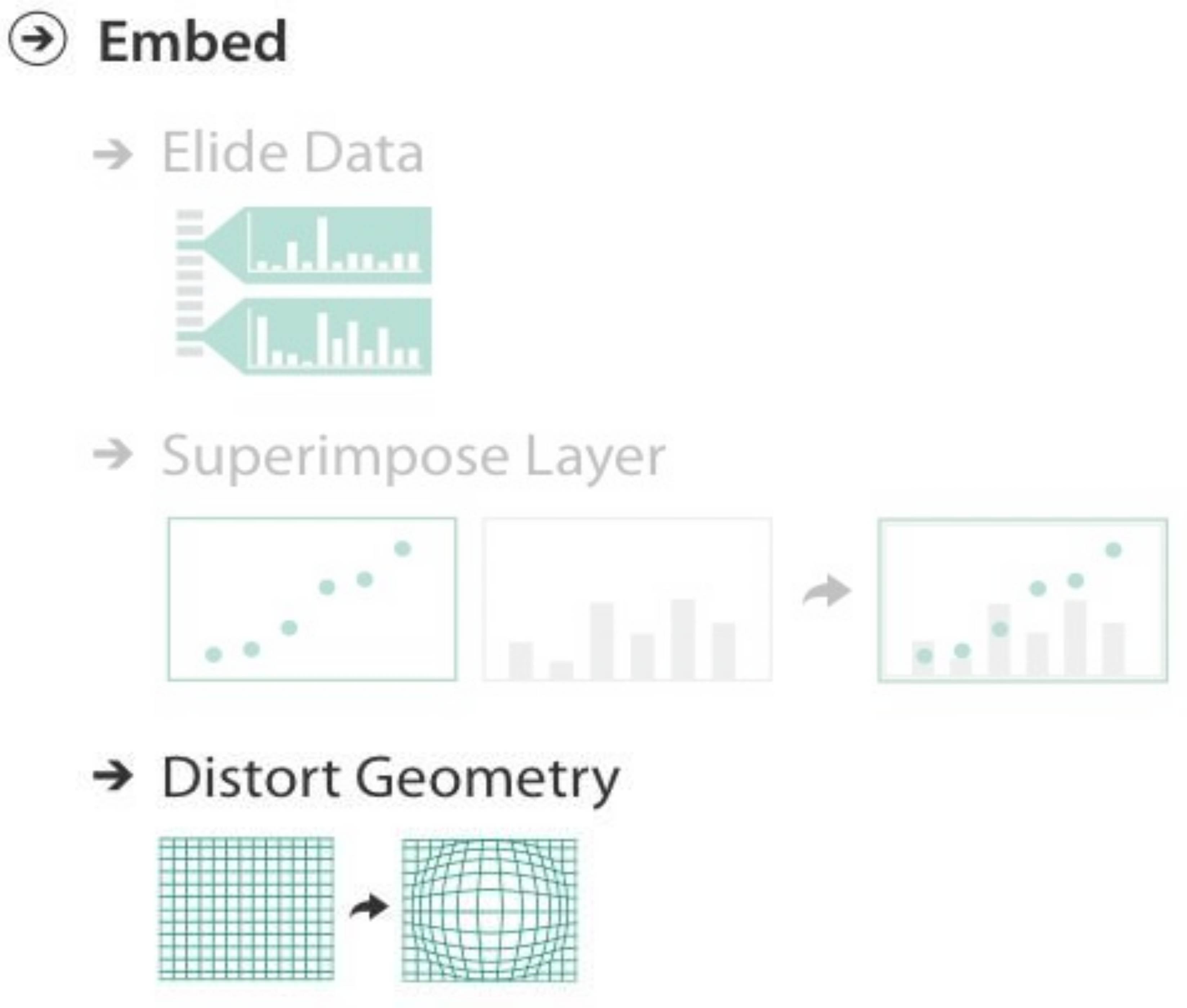


magnification

highlight | suppress

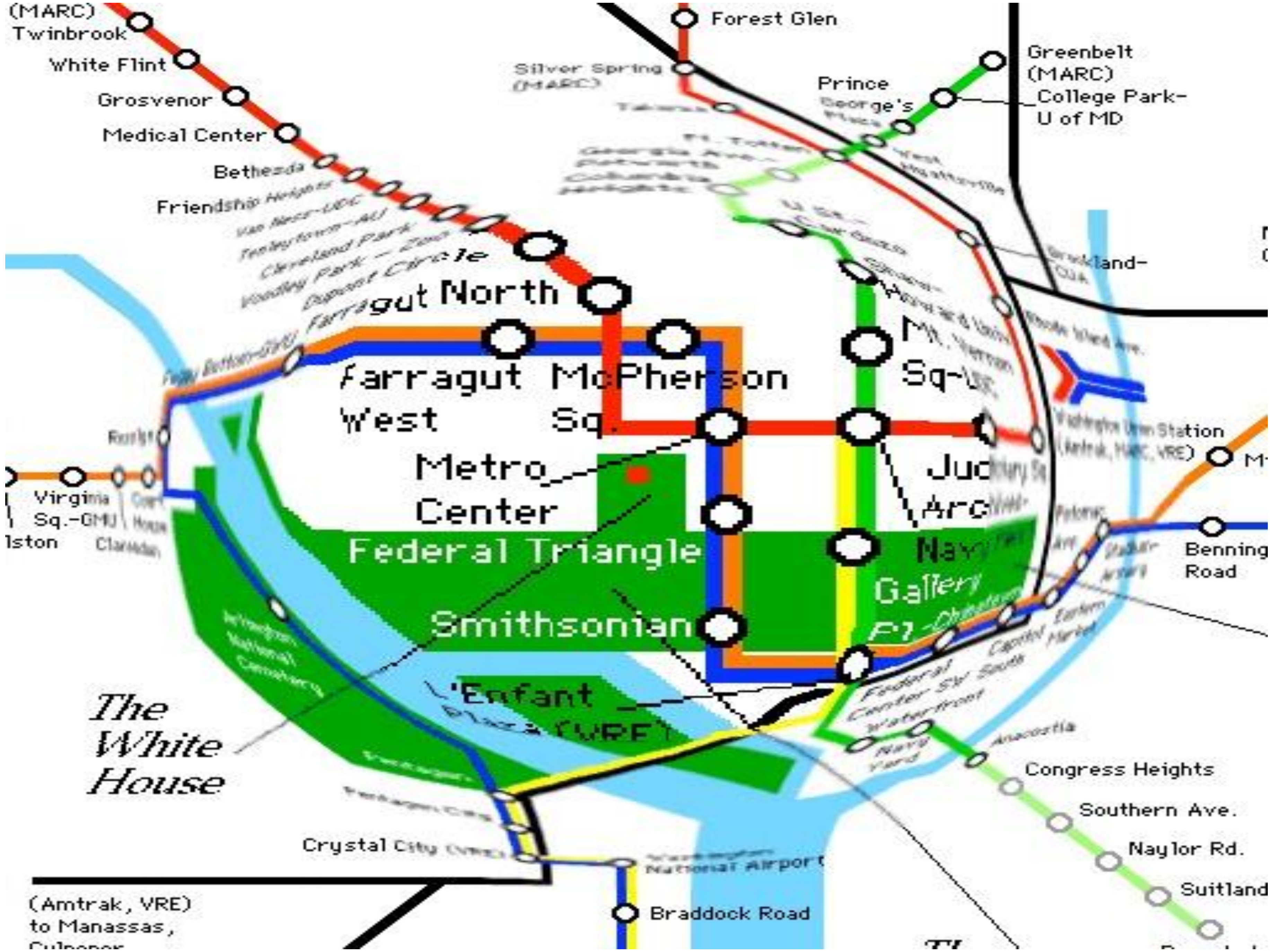


Distort



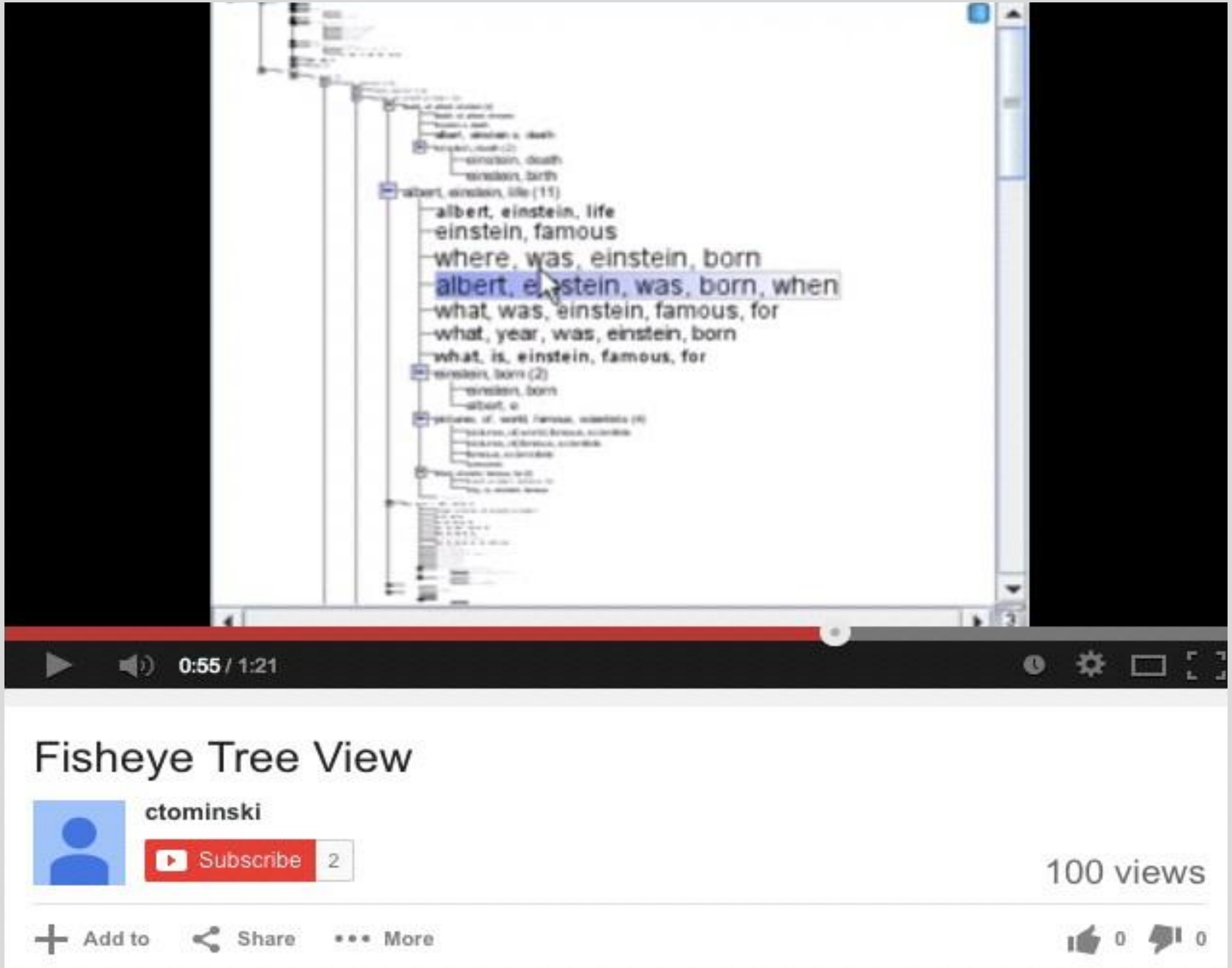
- use geometric distortion of the contextual regions to make room for the details in the focus region(s)

FISHEYE



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

vimeo
Join
Log In
Create
Watch
Upload
Search
VIDEOS
Unfolding - Fisheye and Zoom lens example


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
0:55 / 1:21
Fisheye Tree View
ctominski
Subscribe 2
100 views
Add to
Share
More
0
0

hyperbolic geometry

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