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https://cspaul.com

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

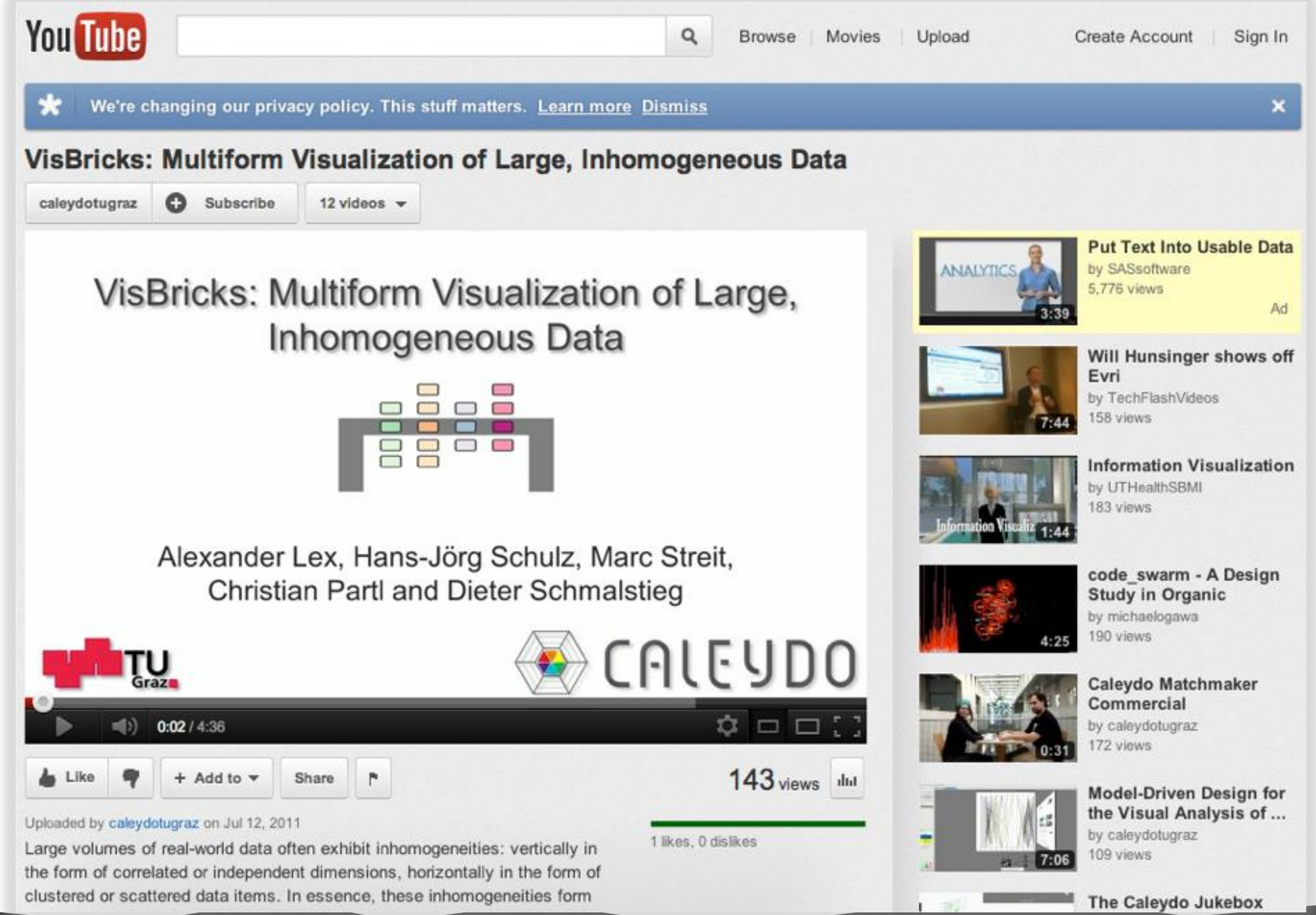
- multiple views that are simultaneously visible and linked together such that actions in one view affect the others

- 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



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

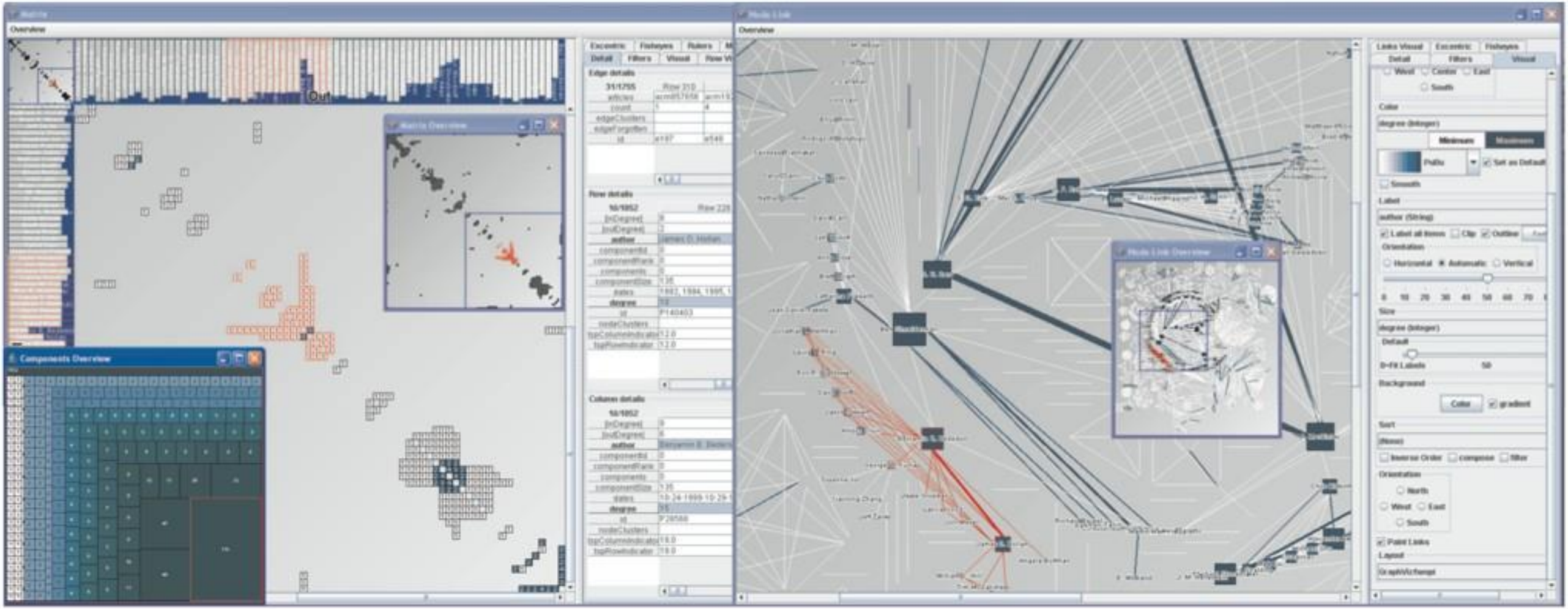
- What to show
  - **encoding**: same or multiform
  - **dataset**: share all, subset, or none

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

SHARED DATA

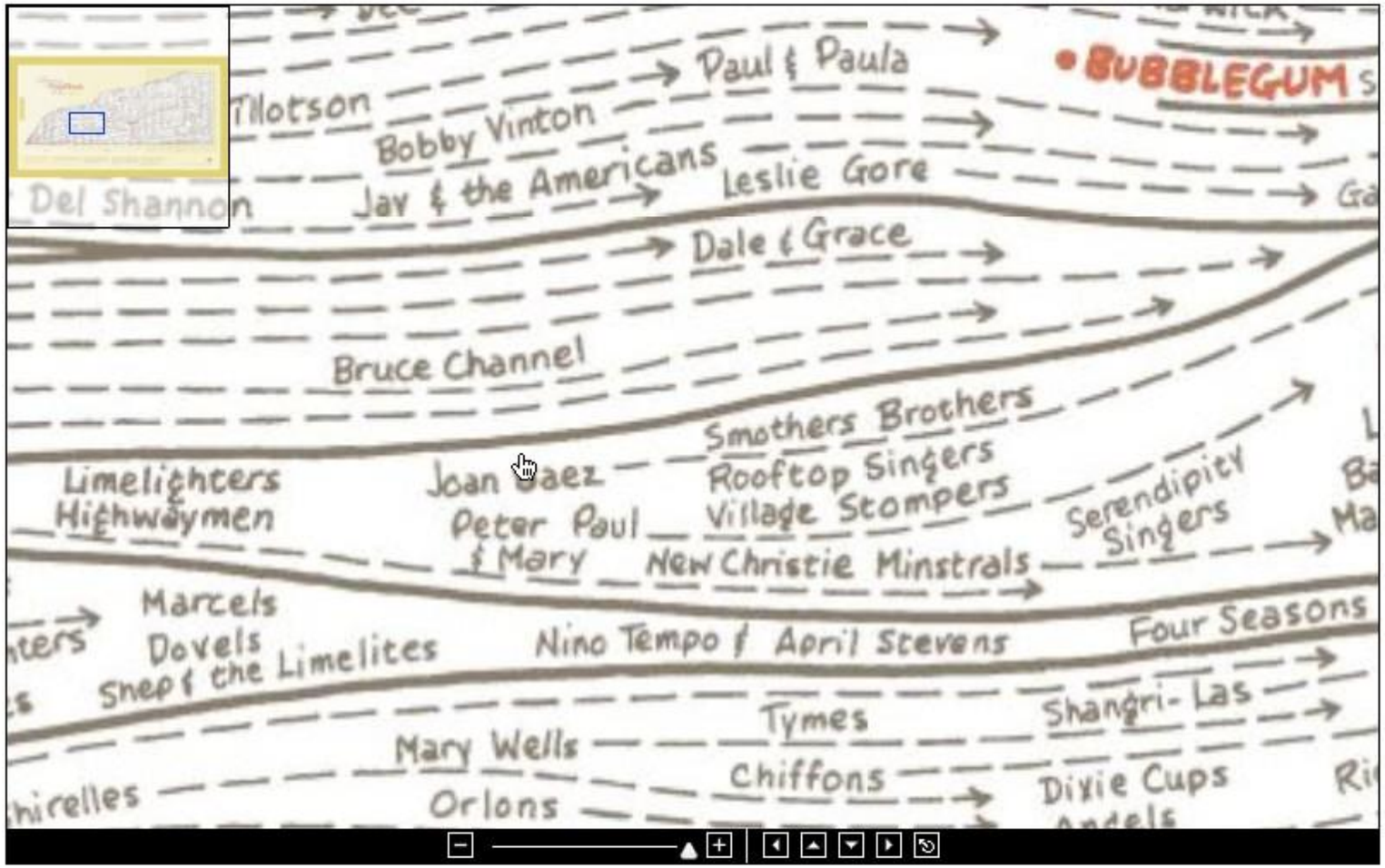
- showing all data in each view, but with different encoding schemes
  - rational: different views support different tasks

MatrixExplorer



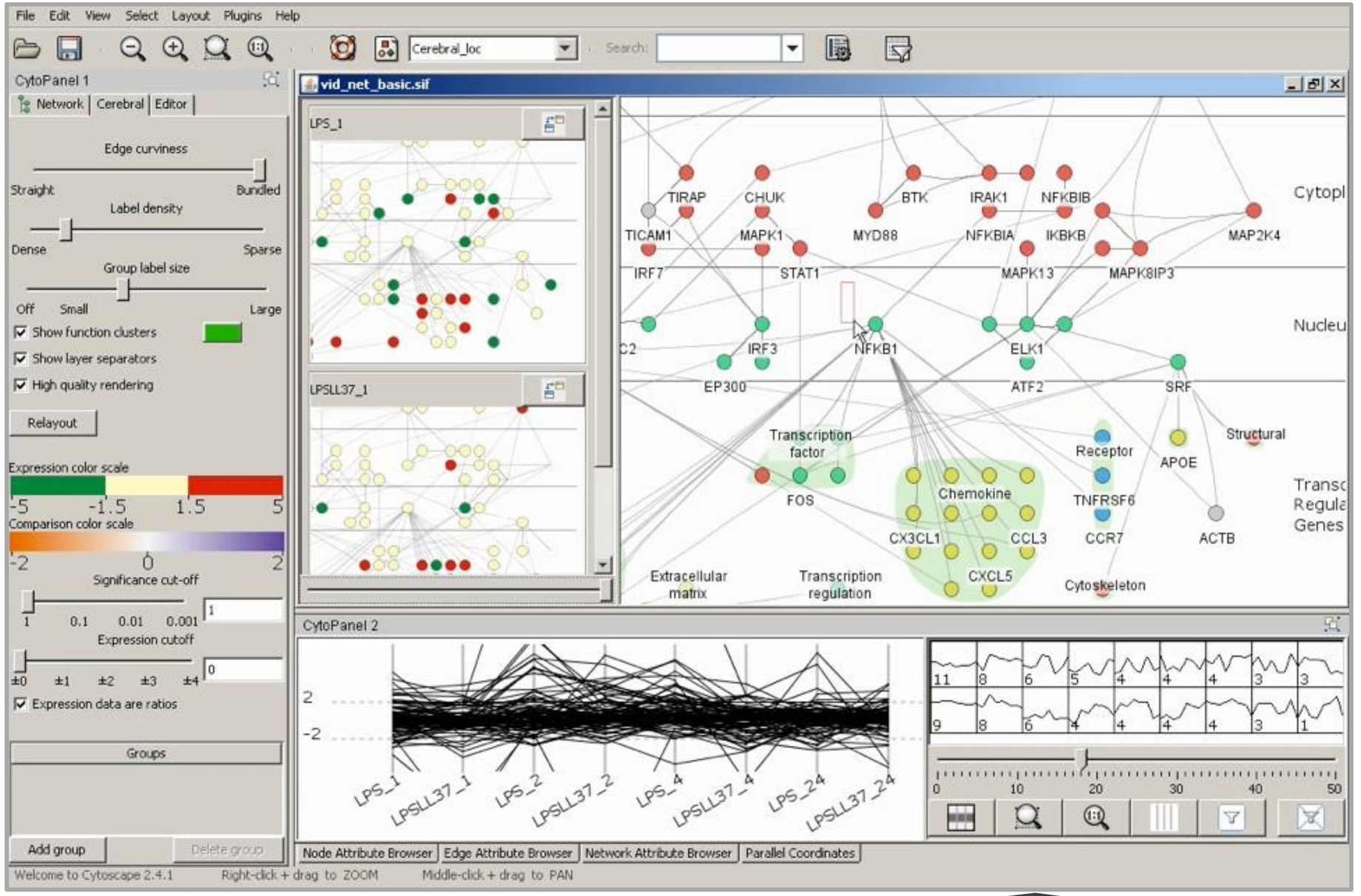
OVERVIEW + DETAIL

- 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


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

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

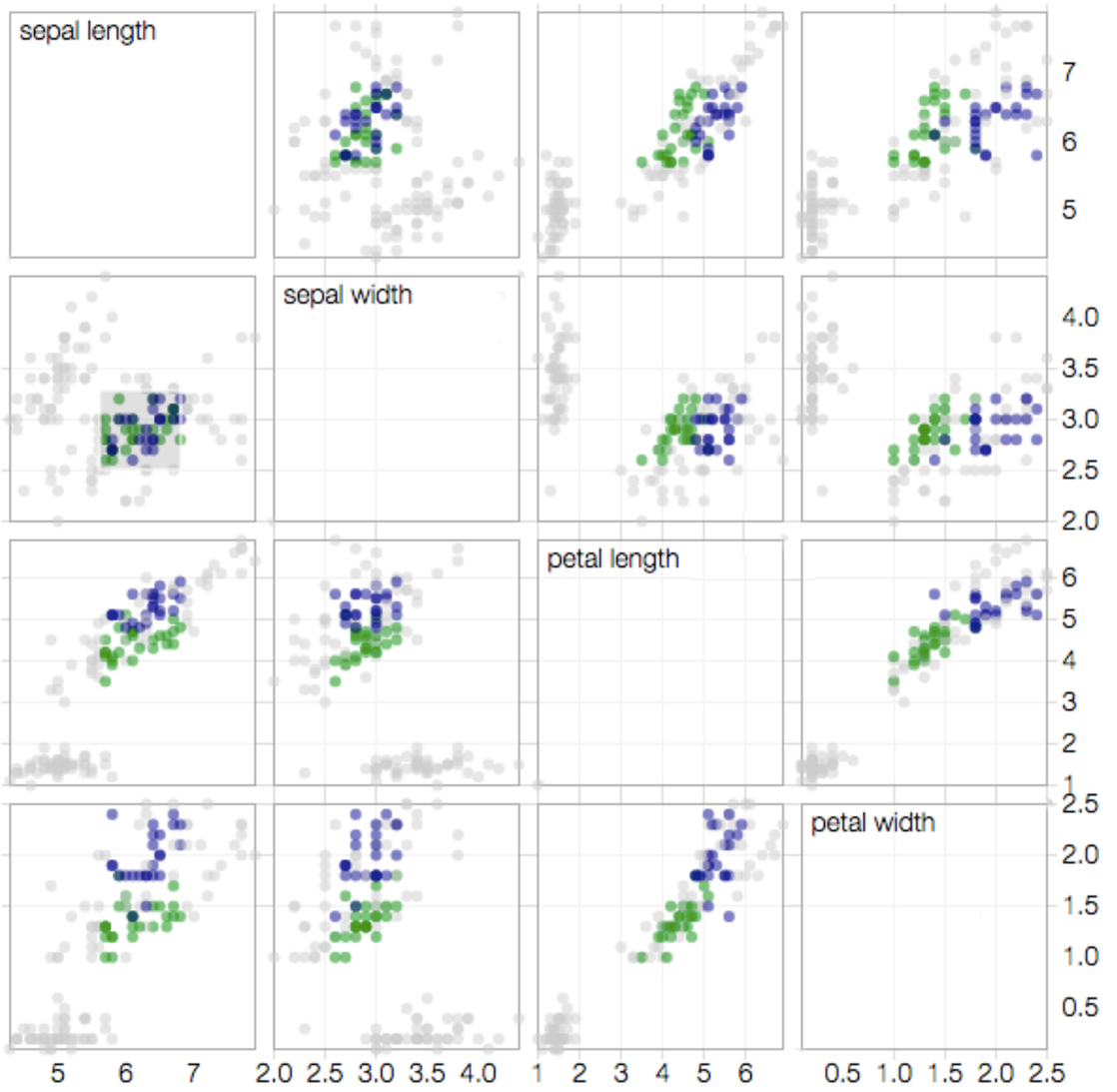

File Edit View Select Layout Plugins Help
Cerebral_loc
Search:
CytoPanel 1
Network Cerebral Editor
Edge curviness
Straight
Bundled
Label density
Dense
Sparse
Group label size
Off Small Large
Show function clusters
Show layer separators
High quality rendering
Relayout
Expression color scale
-5 -1.5 1.5 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
IRF3
NFKB1
ELK1
EP300
ATF2
SRF
FOS
Transcription factor
Chemokine
Receptor
TNFRSF6
APOE
Structural
CX3CL1
CCL3
CCR7
ACTB
CXCL5
Extracellular matrix
Transcription regulation
Cytoskeleton
Cytopl
Nucleu
Transc
Regula
Genes
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

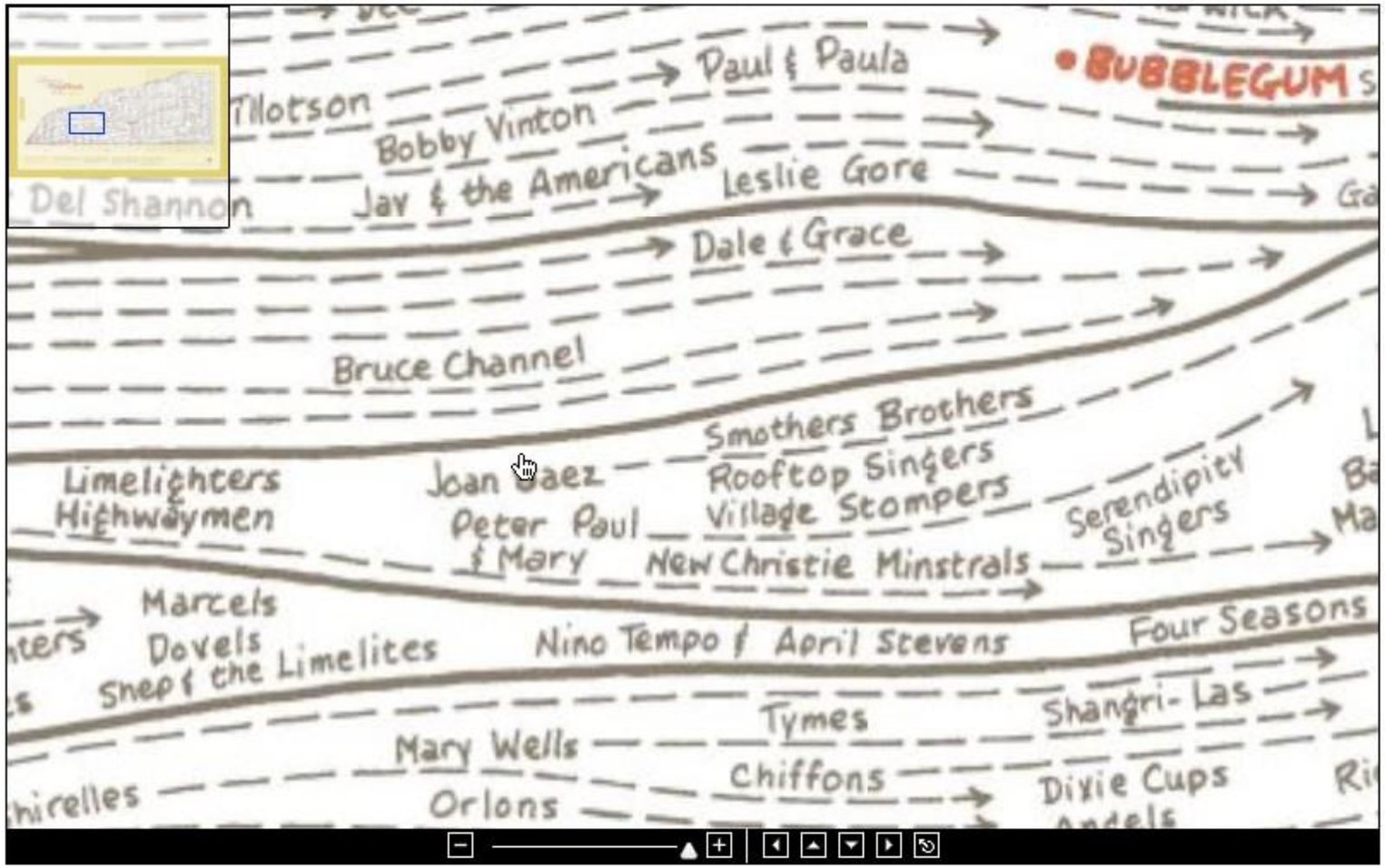
LINKED HIGHLIGHTING



- 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

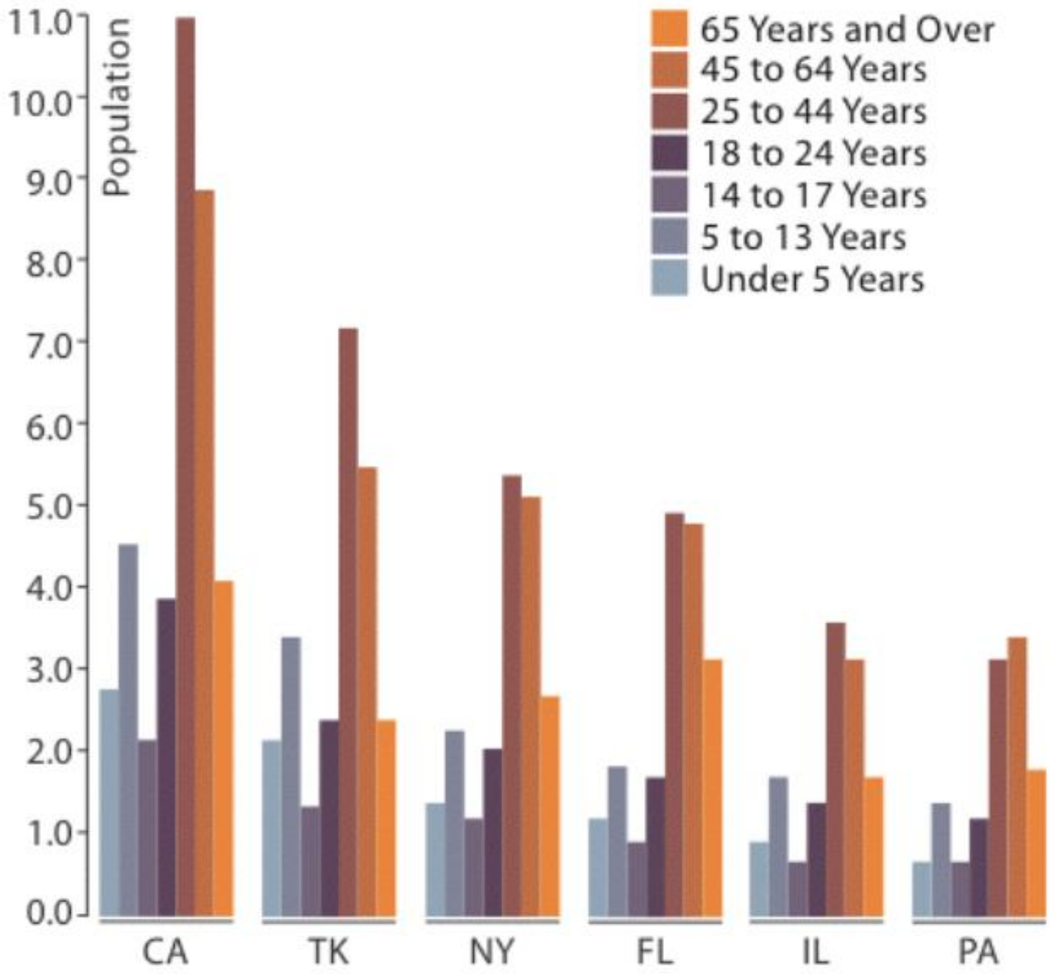


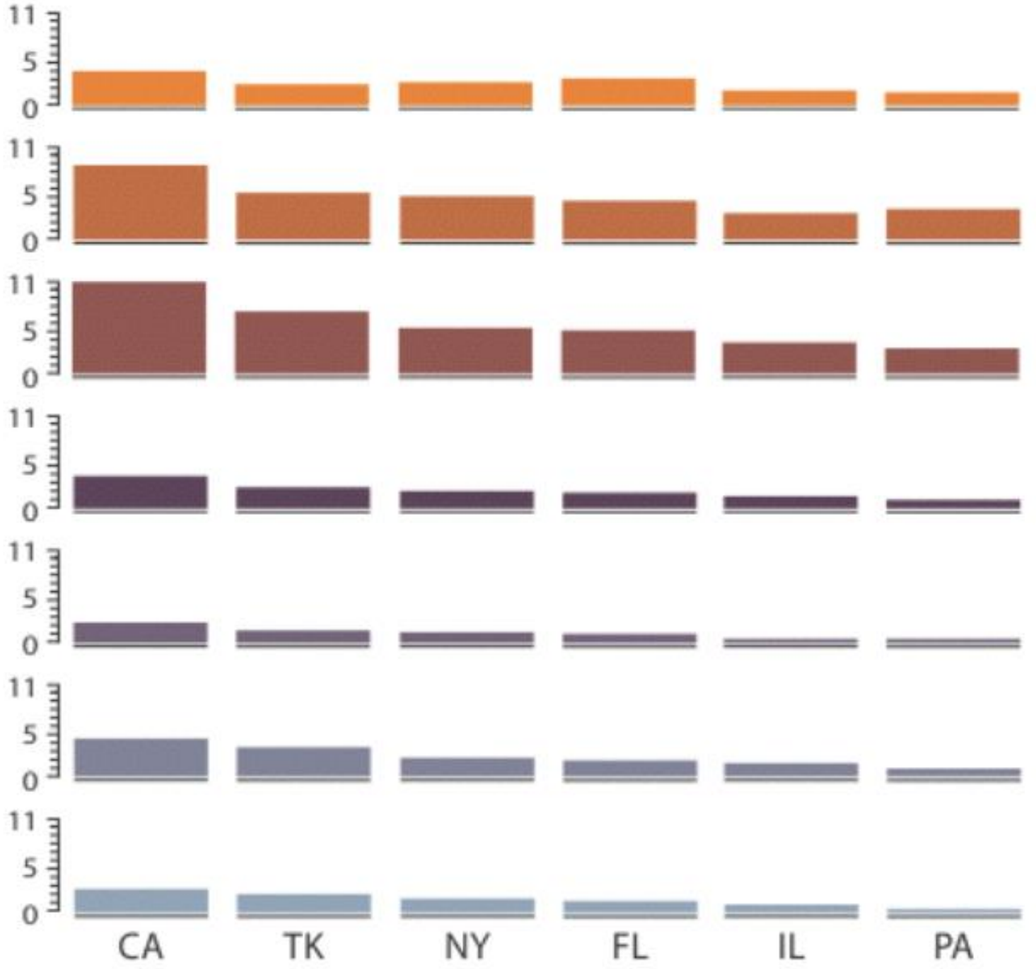
http://www.historyshots.com/rockmusic/

A variety of options…

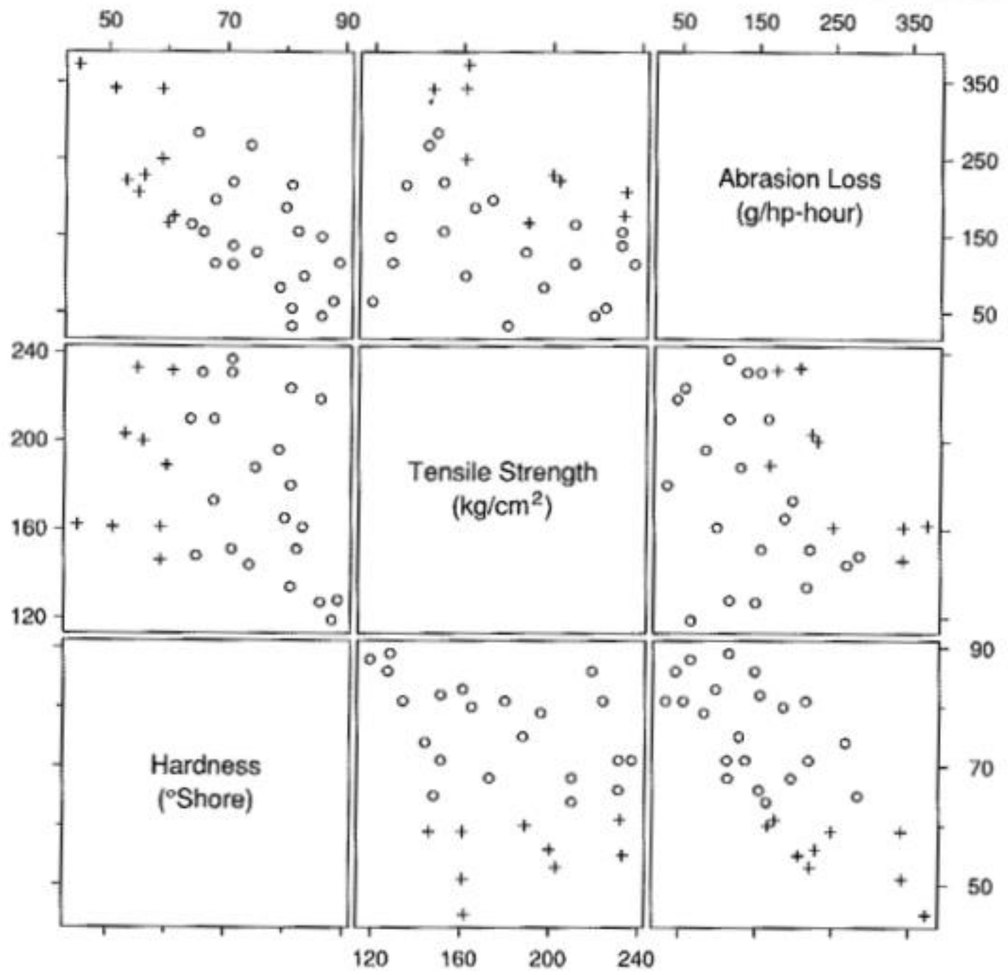
PARTITIONING

- 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


Population
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
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.

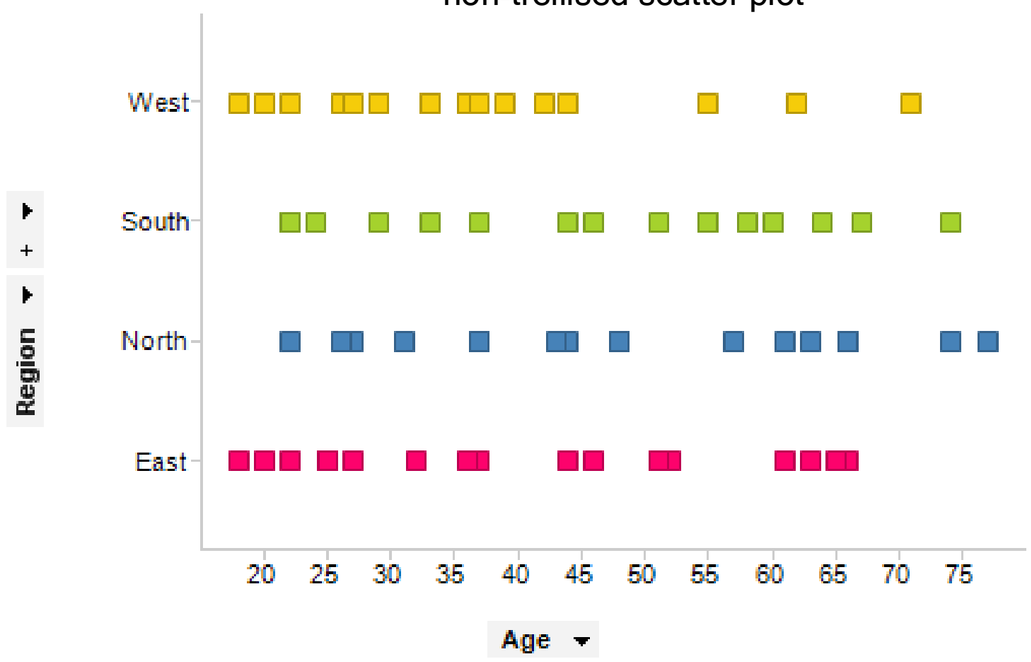
- Cleveland 1994

TRELLISED VIEWS

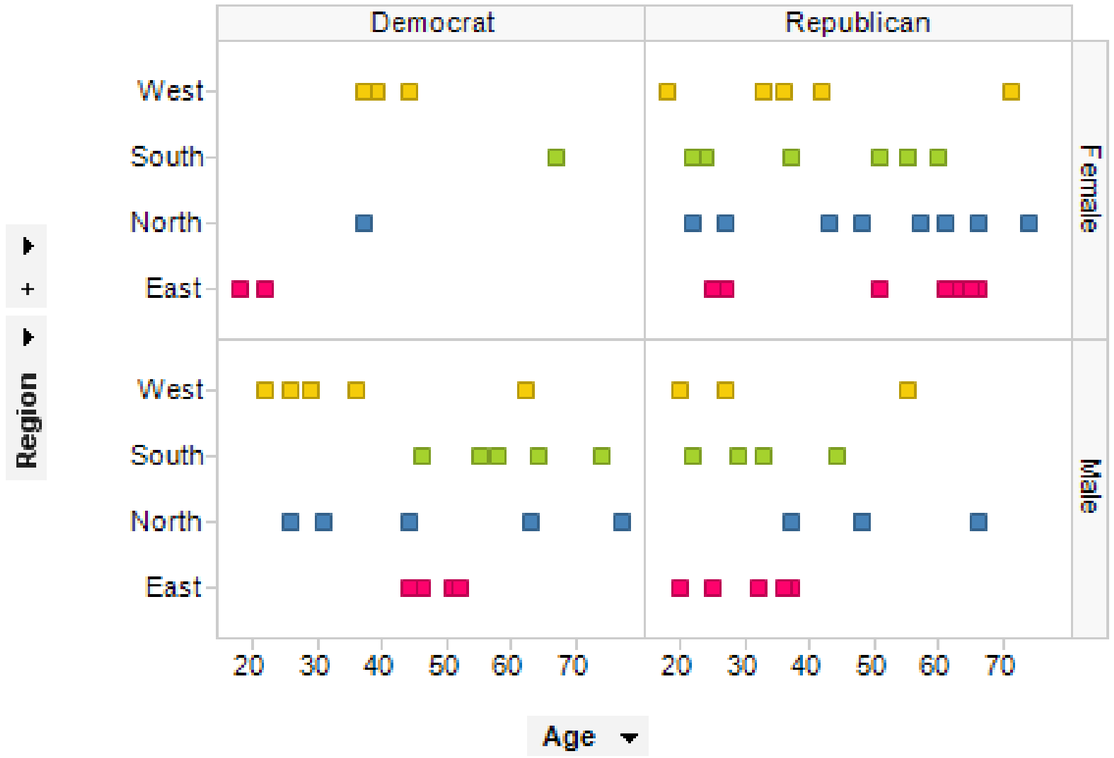
- panel variables: attributes encoded in individual views
- partitioning variables: partitioning attributes assigned to columns, rows, and pages

- Becker 1996

non-trellised scatter plot



trellising this visualization based on
Gender and Political affiliation

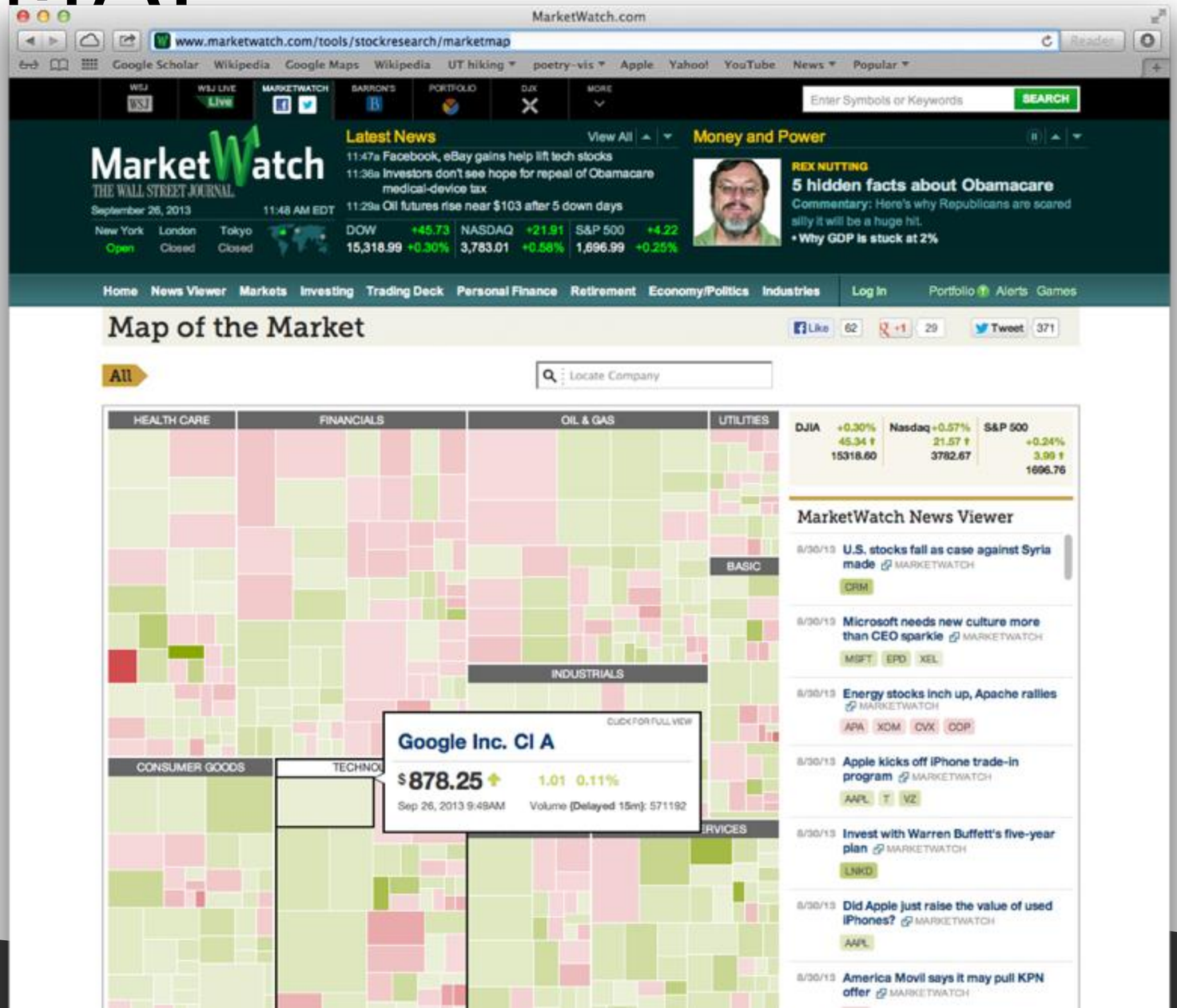


https://docs.tibco.com/pub/spotfire/5.5.0-march-2013/UsersGuide/vis/vis_trellis_visualizations.htm

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
Google Scholar Wikipedia Google Maps Wikipedia UT hiking poetry-vis Apple Yahoo! YouTube News Popular
WSJ LIVE MARKETWATCH BARRON'S PORTFOLIO DJX MORE
Enter Symbols or Keywords SEARCH
MarketWatch
THE WALL STREET JOURNAL
September 26, 2013 11:48 AM EDT
New York Open London Closed Tokyo Closed
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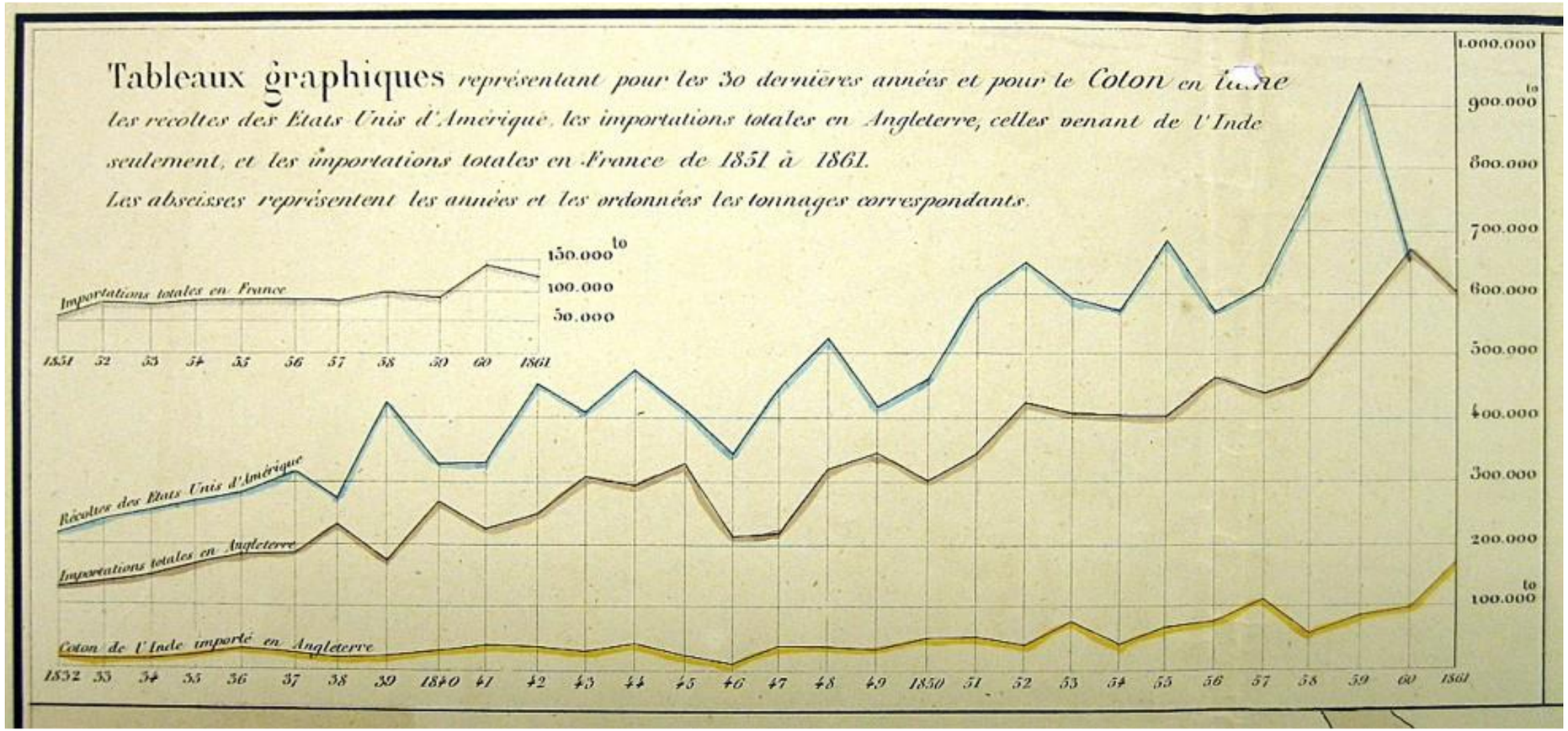
11:36a Investors don't see hope for repeal of Obamacare medical-device tax
11:29a Oil futures rise near $103 after 5 down days
DOW +45.73 15,318.99 +0.30%
NASDAQ +21.91 3,783.01 +0.58%
S&P 500 +4.22 1,696.99 +0.25%
Money and Power
REX NUTTING
5 hidden facts about Obamacare
Commentary: Here's why Republicans are scared silly it will be a huge hit.
• Why GDP is stuck at 2%
Home News Viewer Markets Investing Trading Deck Personal Finance Retirement Economy/Politics Industries Log In Portfolio Alerts Games
Map of the Market
Like 62 +1 29 Tweet 371
All
Locate Company
HEALTH CARE
FINANCIALS
OIL & GAS
UTILITIES
BASIC
INDUSTRIALS
CONSUMER GOODS
CLICK FOR FULL VIEW
Google Inc. Cl A
$878.25 1.01 0.11%
Sep 26, 2013 9:49AM Volume (Delayed 15m): 571192
DJIA +0.30% 45.34 15318.60
Nasdaq +0.57% 21.57 3782.67
S&P 500 +0.24% 3.99 1696.76
MarketWatch News Viewer
8/30/13 U.S. stocks fall as case against Syria made MARKETWATCH CRM
8/30/13 Microsoft needs new culture more than CEO sparkle MARKETWATCH MSFT EPD XEL
8/30/13 Energy stocks inch up, Apache rallies MARKETWATCH APA XOM CVX COP
8/30/13 Apple kicks off iPhone trade-in program MARKETWATCH AAPL T VZ
8/30/13 Invest with Warren Buffett's five-year plan MARKETWATCH LNKD
8/30/13 Did Apple just raise the value of used iPhones? MARKETWATCH AAPL
8/30/13 America Movil says it may pull KPN offer MARKETWATCH

A variety of options…

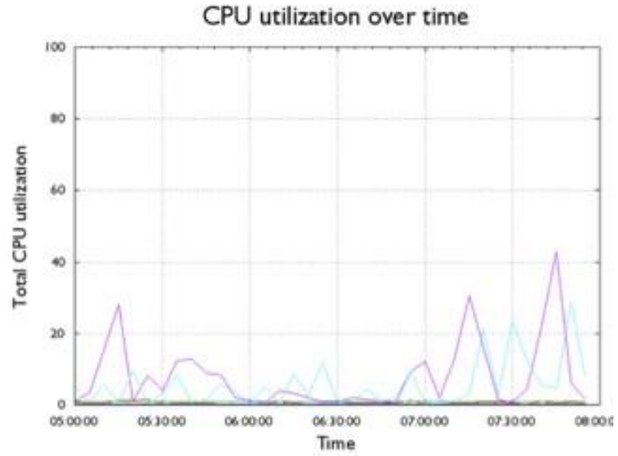
LAYERING

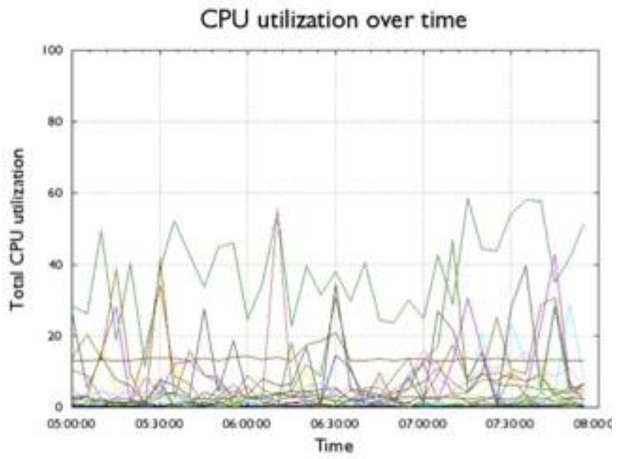
- combining multiple views on top of one another to form a composite view
  - rational: supports a larger, more detailed view than using multiple views
  - trade-off: layering imposes constraints on visual encoding choice as well as number of layers that can be shown

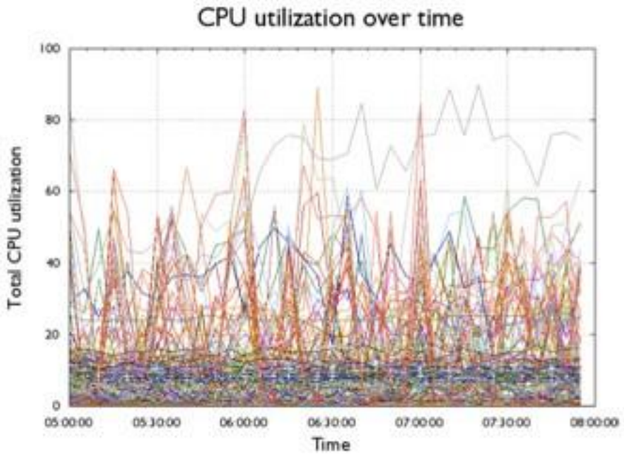
GLOBAL COMPOSITING



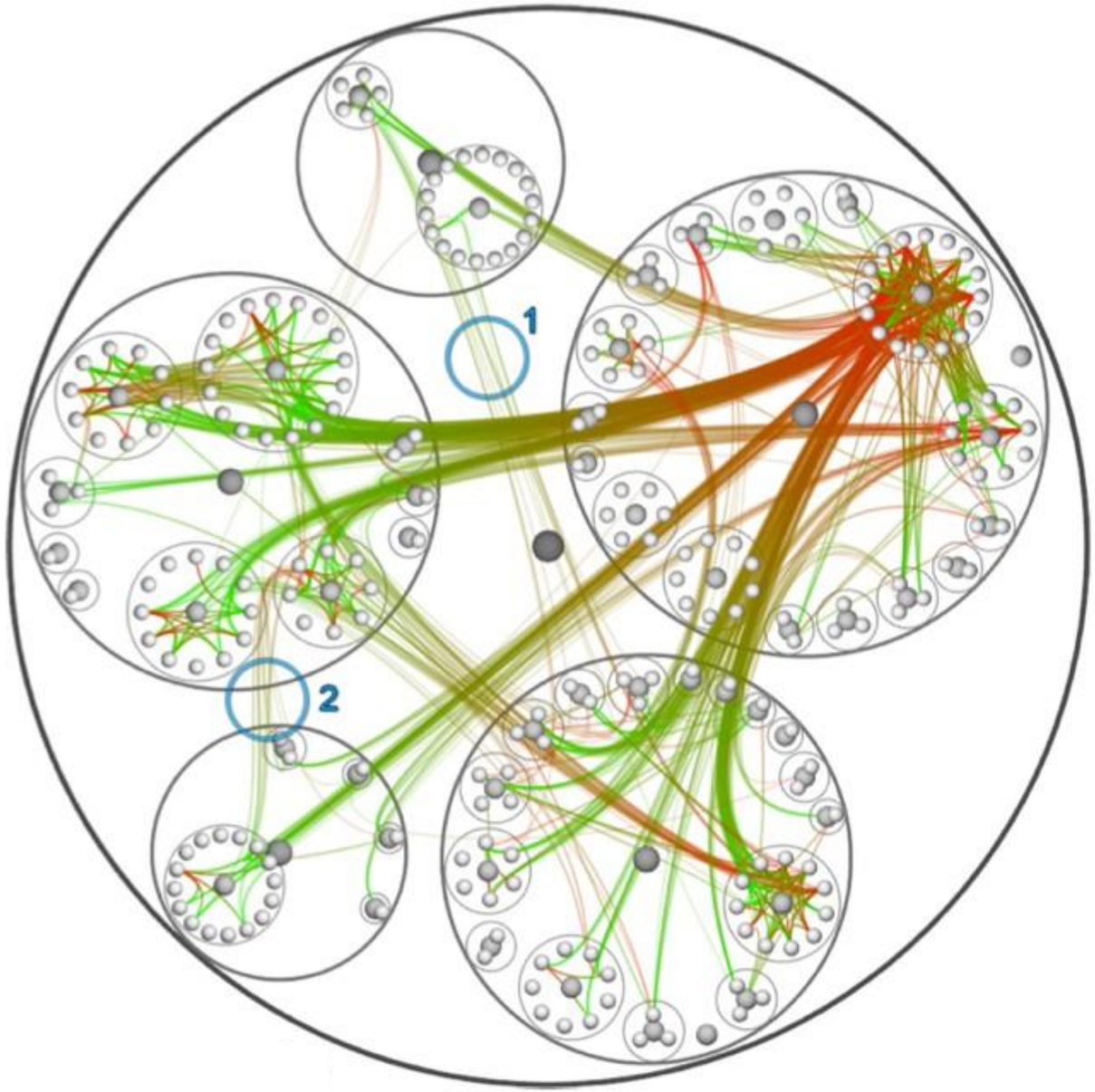
overlays


CPU utilization over time
Total CPU utilization
Time

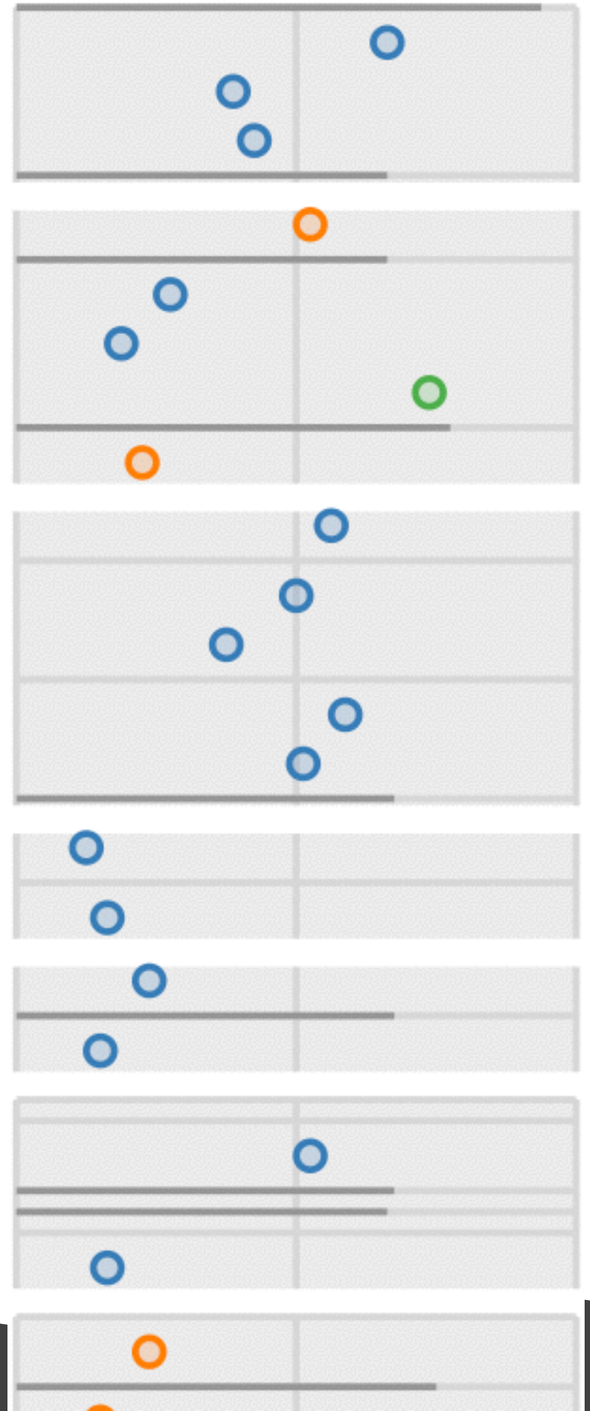

CPU utilization over time
Total CPU utilization
Time


CPU utilization over time
Total CPU utilization
Time

edge bundling

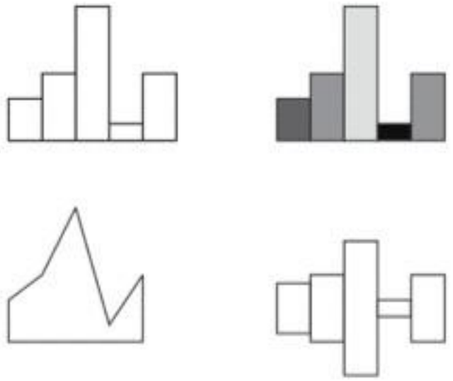


multiple encodings

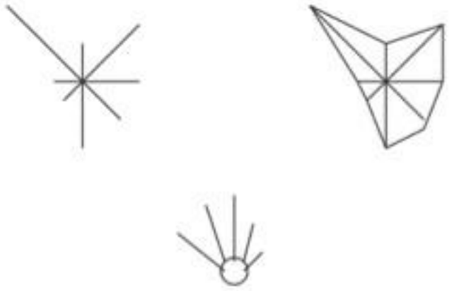


GLYPHS

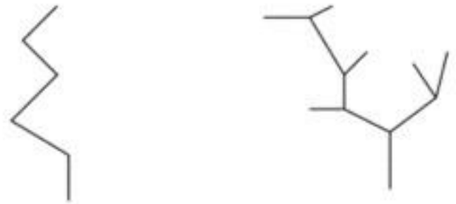
- a graphical object with internal structure that arises from multiple marks
  - ambiguity: little distinct line between glyph and view!



Variations on Profile glyphs

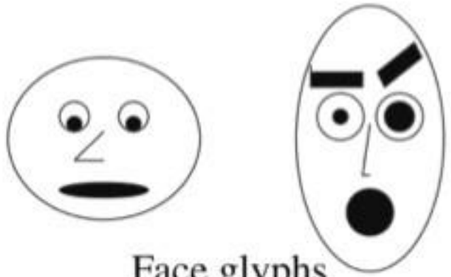


Stars and Anderson/metroglyphs



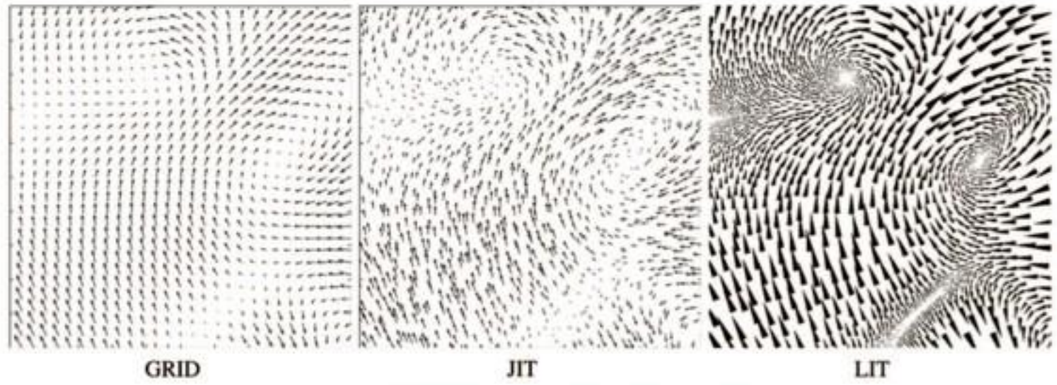
Sticks and Trees

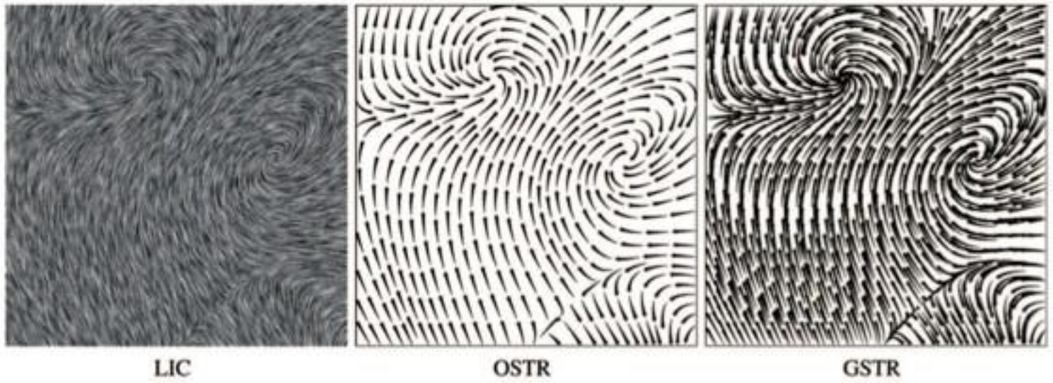
Autoglyph and box glyph

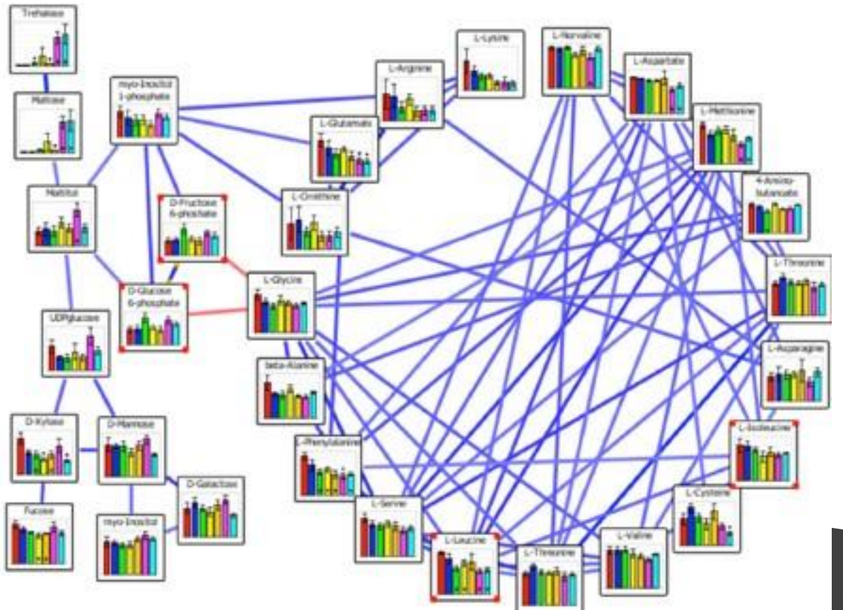


Face glyphs

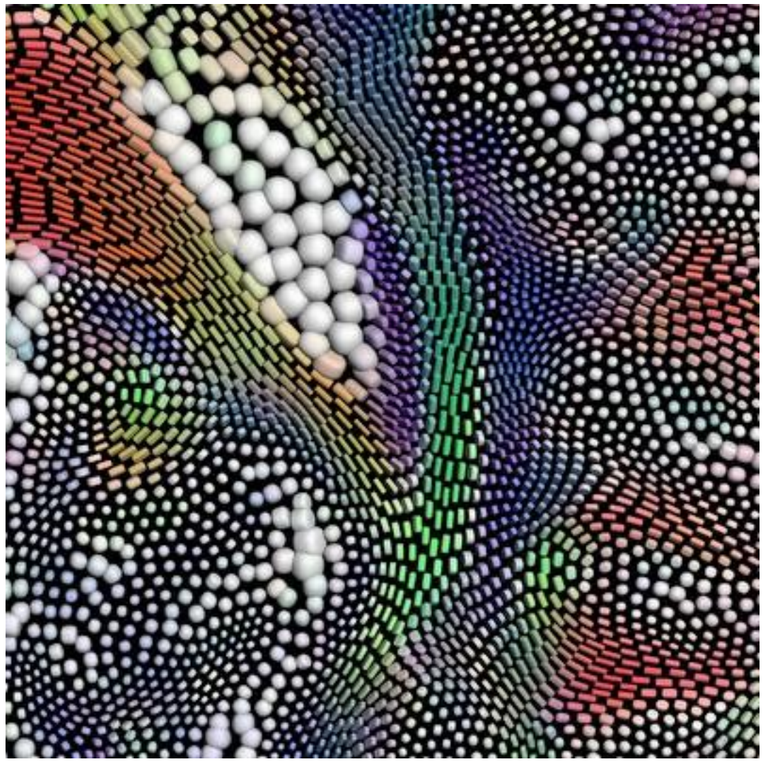
Arrows and Weathervanes







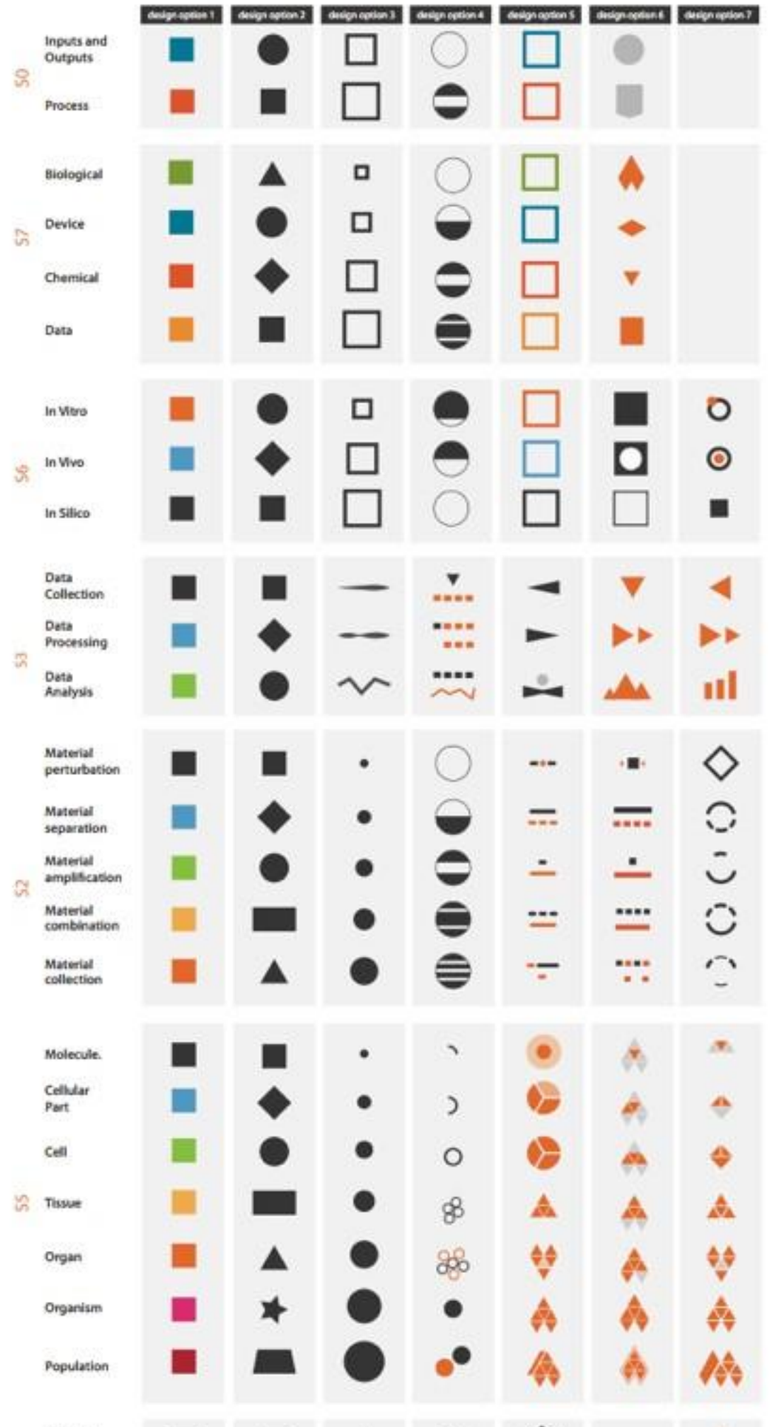
Junker 2006



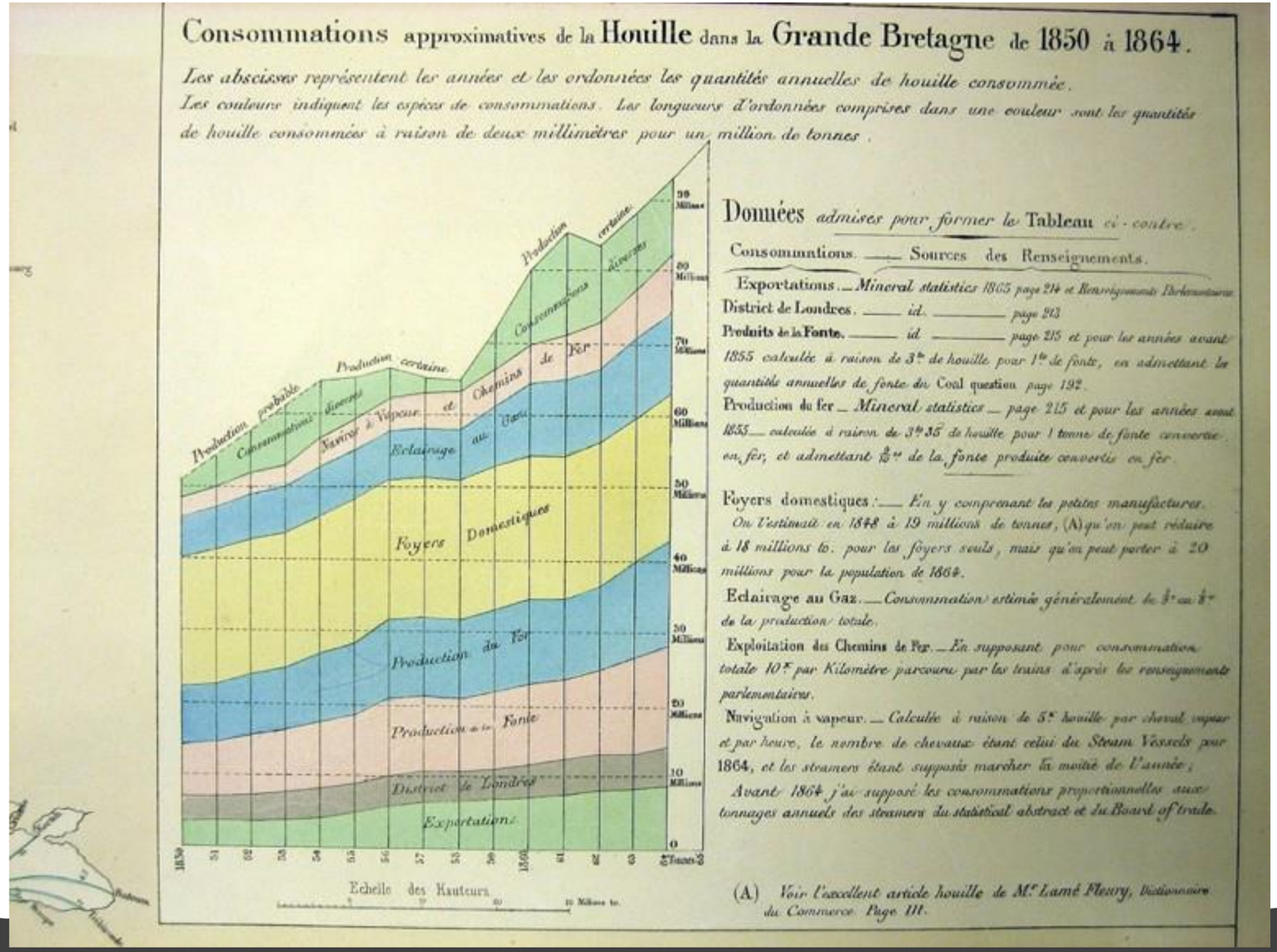
Kindlmann 2006

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

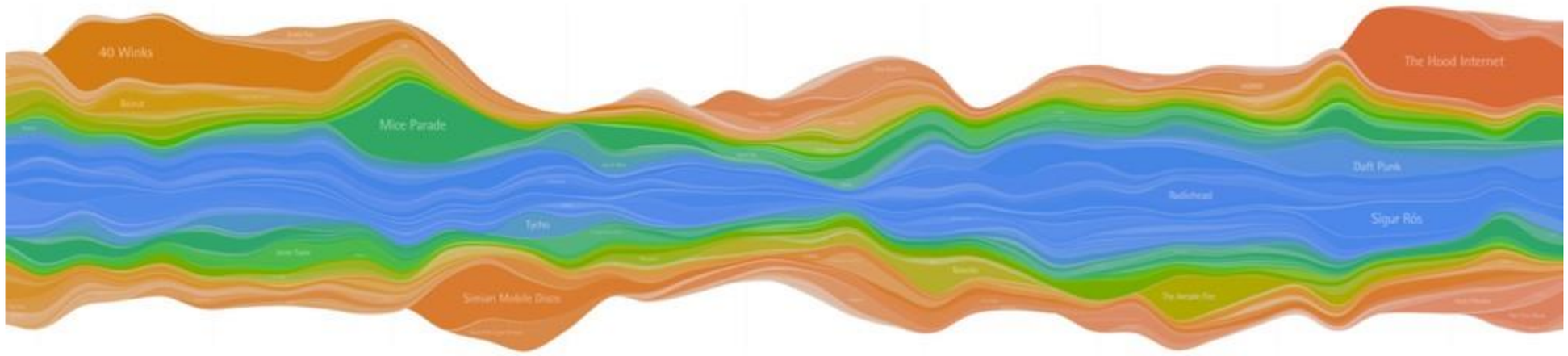


ITEM-LEVEL STACKING



JOSEPH MINARD 1781-1870

streamgraph



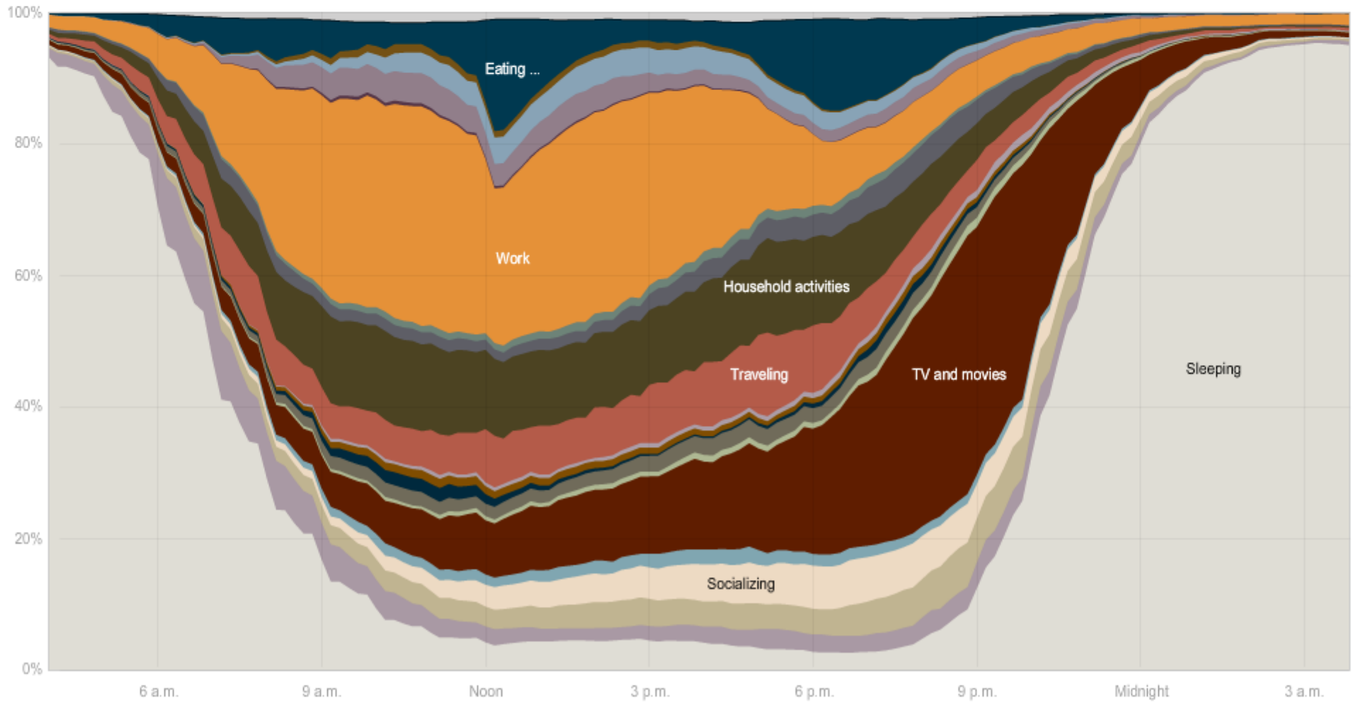
How Different Groups Spend Their Day

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, working 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

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

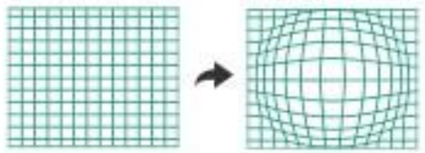
- synthesis of visual encoding and interaction
- user selects region of interest (focus) through navigation or selection
- provide context through aggregation, reduction, or layering

focus+context

- **Embed**
  - Elide Data

  - Superimpose Layer

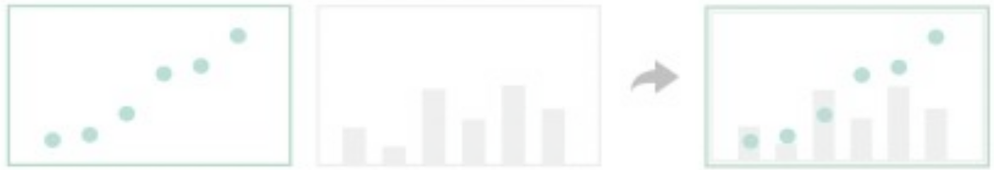
  - Distort Geometry



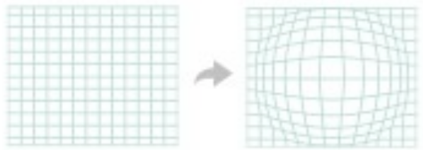
elision

- **Embed**
  - Elide Data

  - Superimpose Layer



  - Distort Geometry



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

SpaceTree

Grosjean 2002

DOI

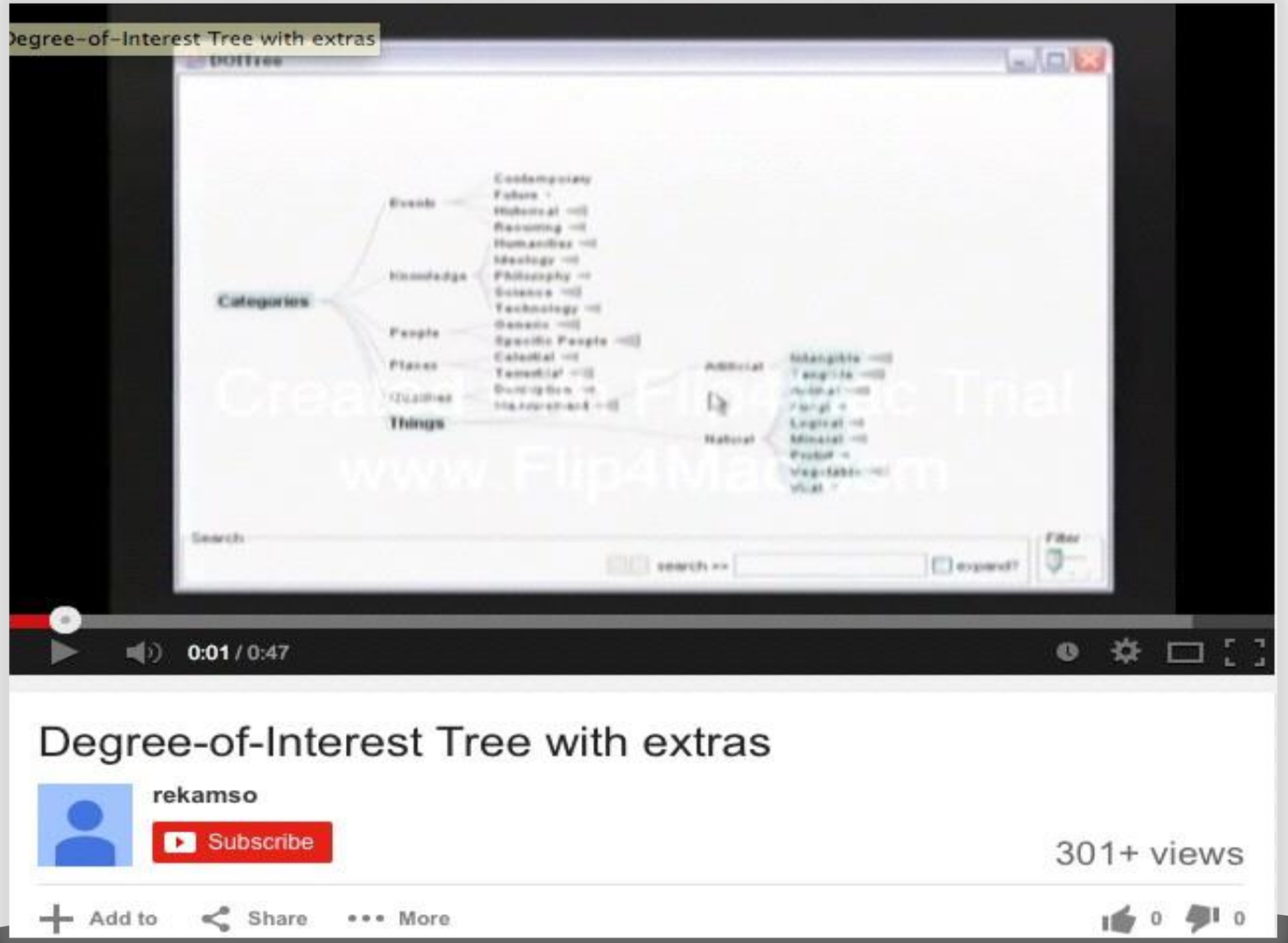
- degree of interest
- based on observation that humans often represent their own neighborhood in detail, yet only major landmarks far away
- goal is balance between local detail and global context

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

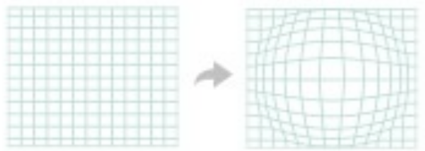

Degree-of-Interest Tree with extras
Categories
Things
0:01 / 0:47
Degree-of-Interest Tree with extras
rekamso
Subscribe
301+ views
Add to
Share
More

Superimpose

- **Embed**
  - Elide Data

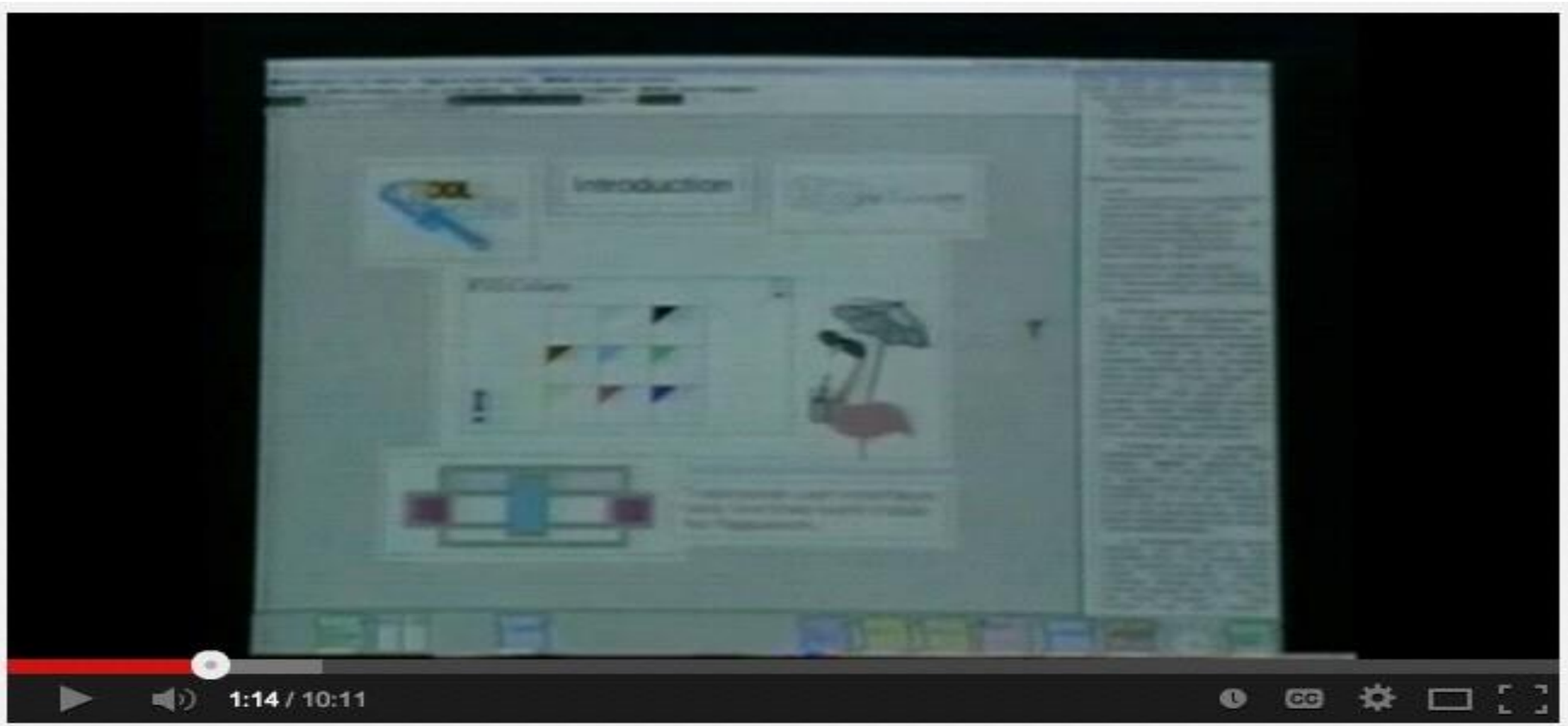
  - Superimpose Layer

  - 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

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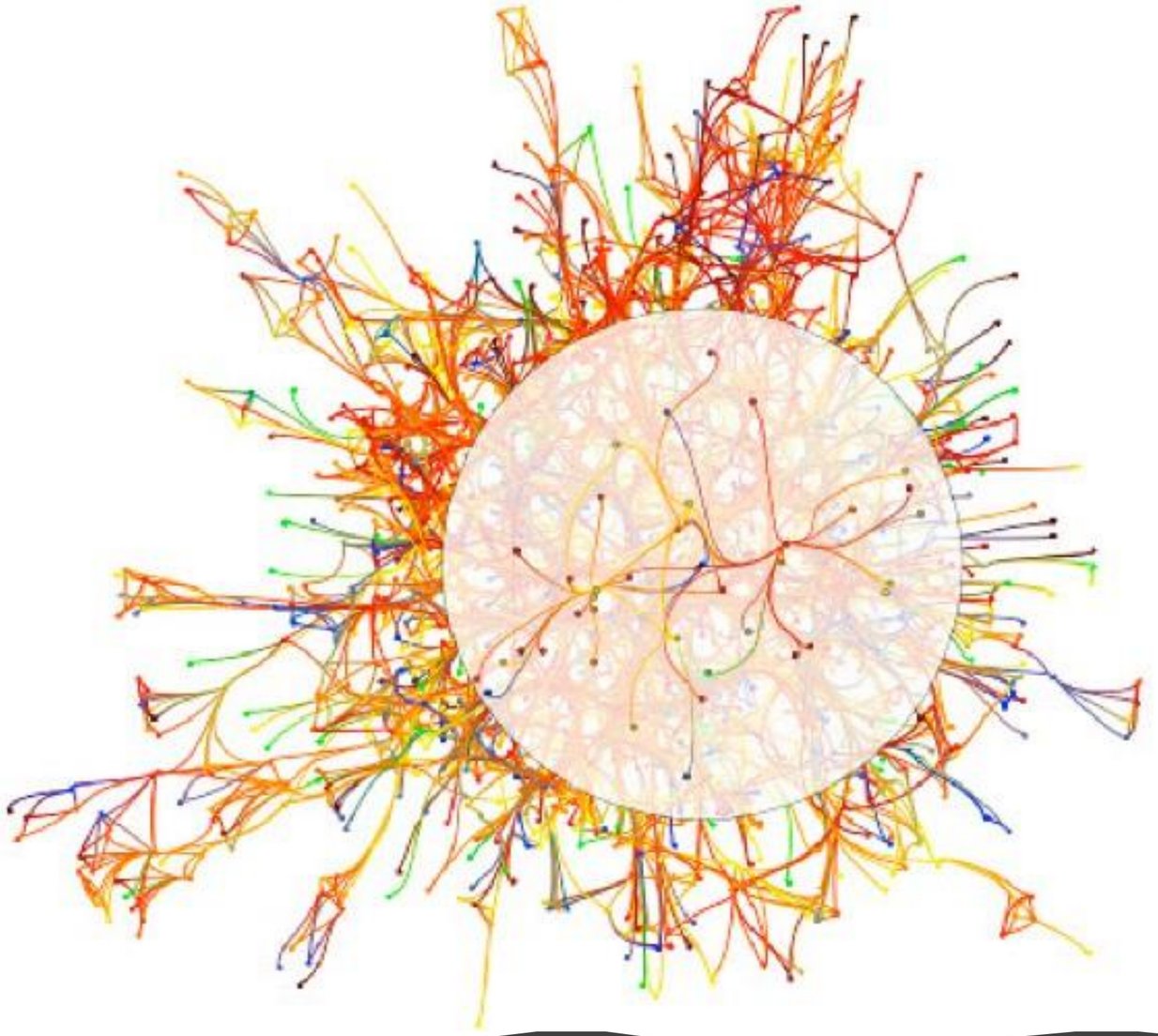
magnification

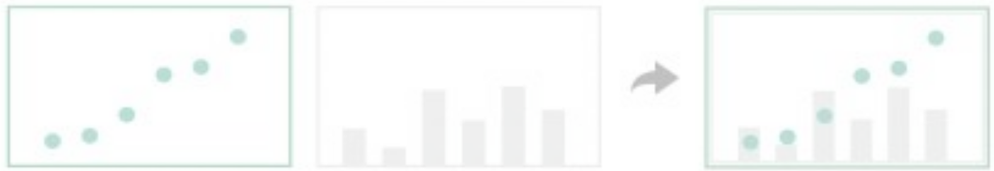
highlight | suppress



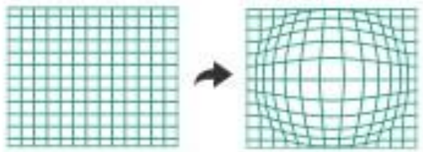
Distort

- **Embed**
  - Elide Data

  - Superimpose Layer

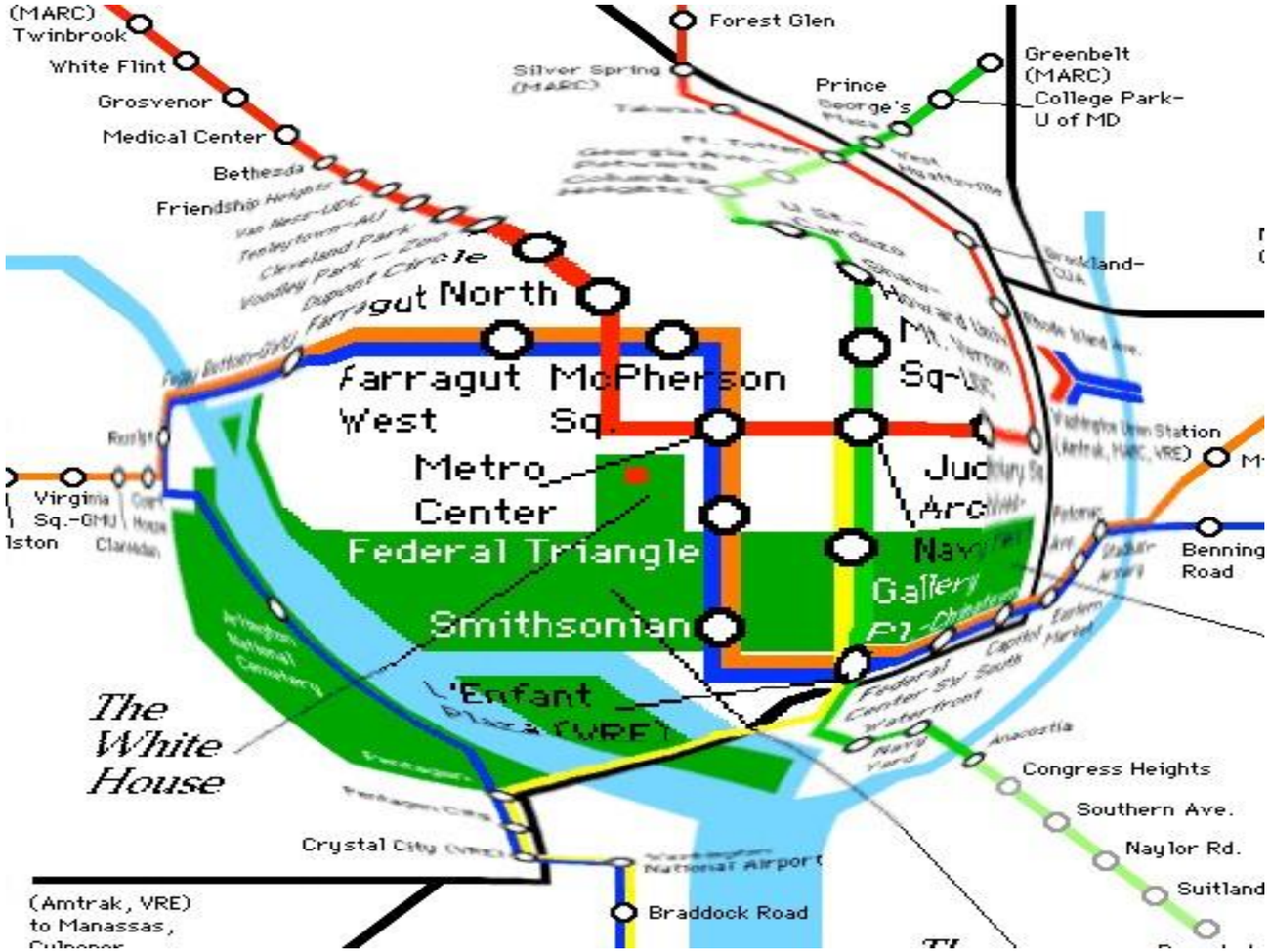


  - Distort Geometry

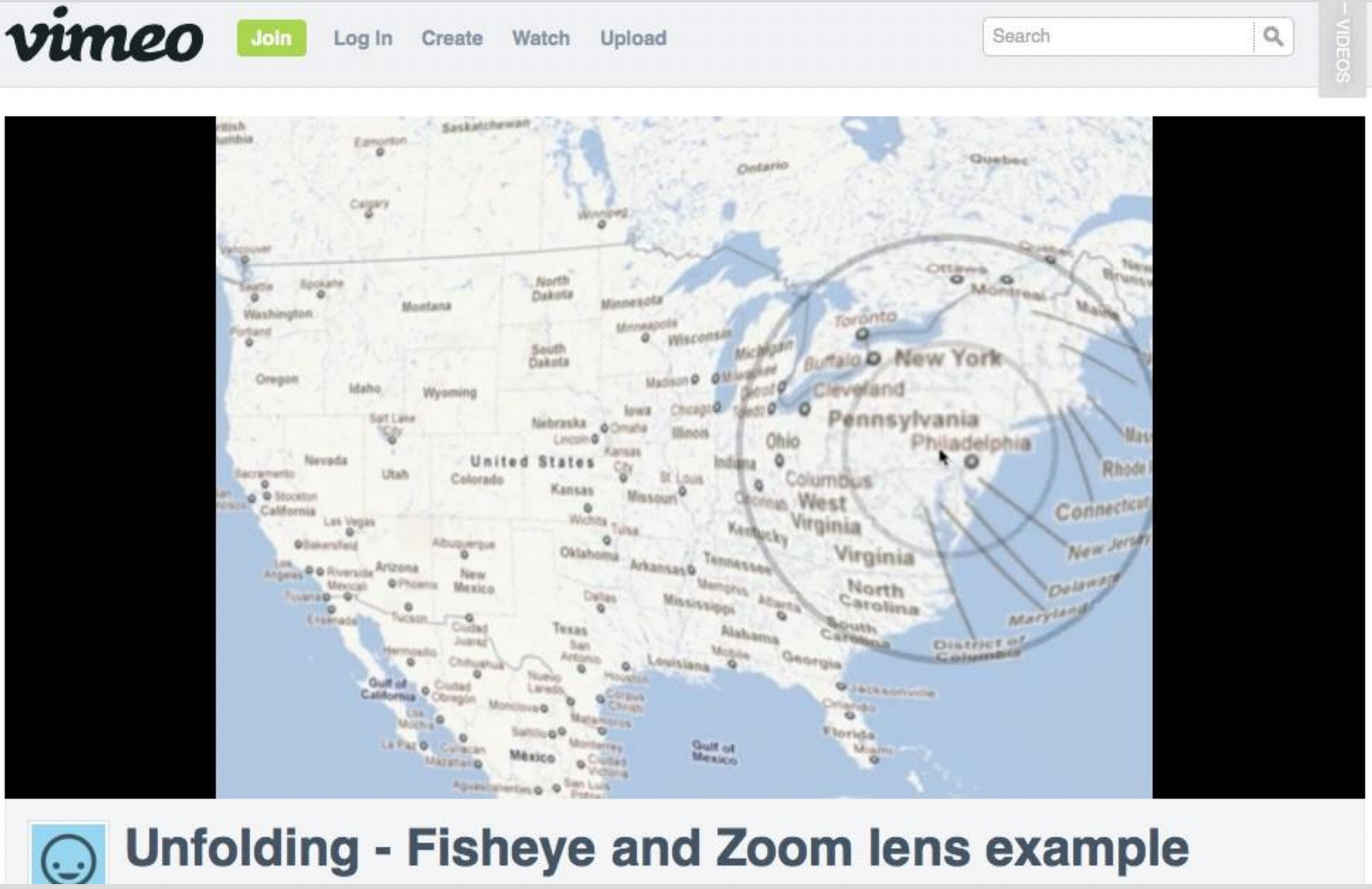


- use geometric distortion of the contextual regions to make room for the details in the focus region(s)

FISHEYE



http://www.cs.umd.edu/class/fall2002/cmsc838s/tichi/fisheye.html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Unfolding - Fisheye and Zoom lens example


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what, was, einstein, famous, for
what, year, was, einstein, born
what, is, einstein, famous, for
0:55 / 1:21
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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