Comparative Visualization: Interactive Designs and Algorithms Depending on Data and Tasks

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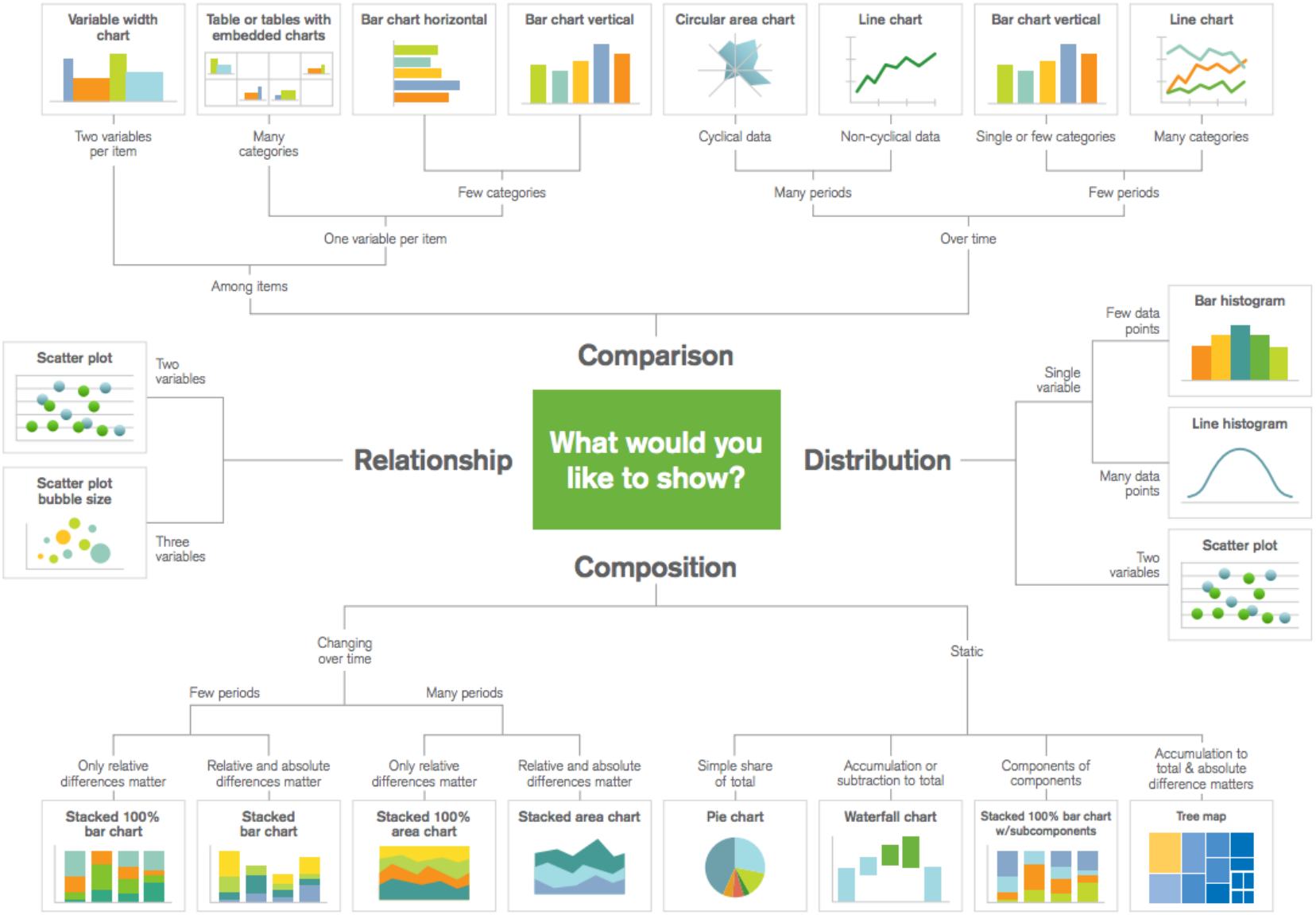
PART 1:
THE COMPARISON PROBLEM

Comparison by Data, Task, and Type



http://bigdata.black/analytics-predictions/visual-analytics/how-to-choose-the-right-chart/

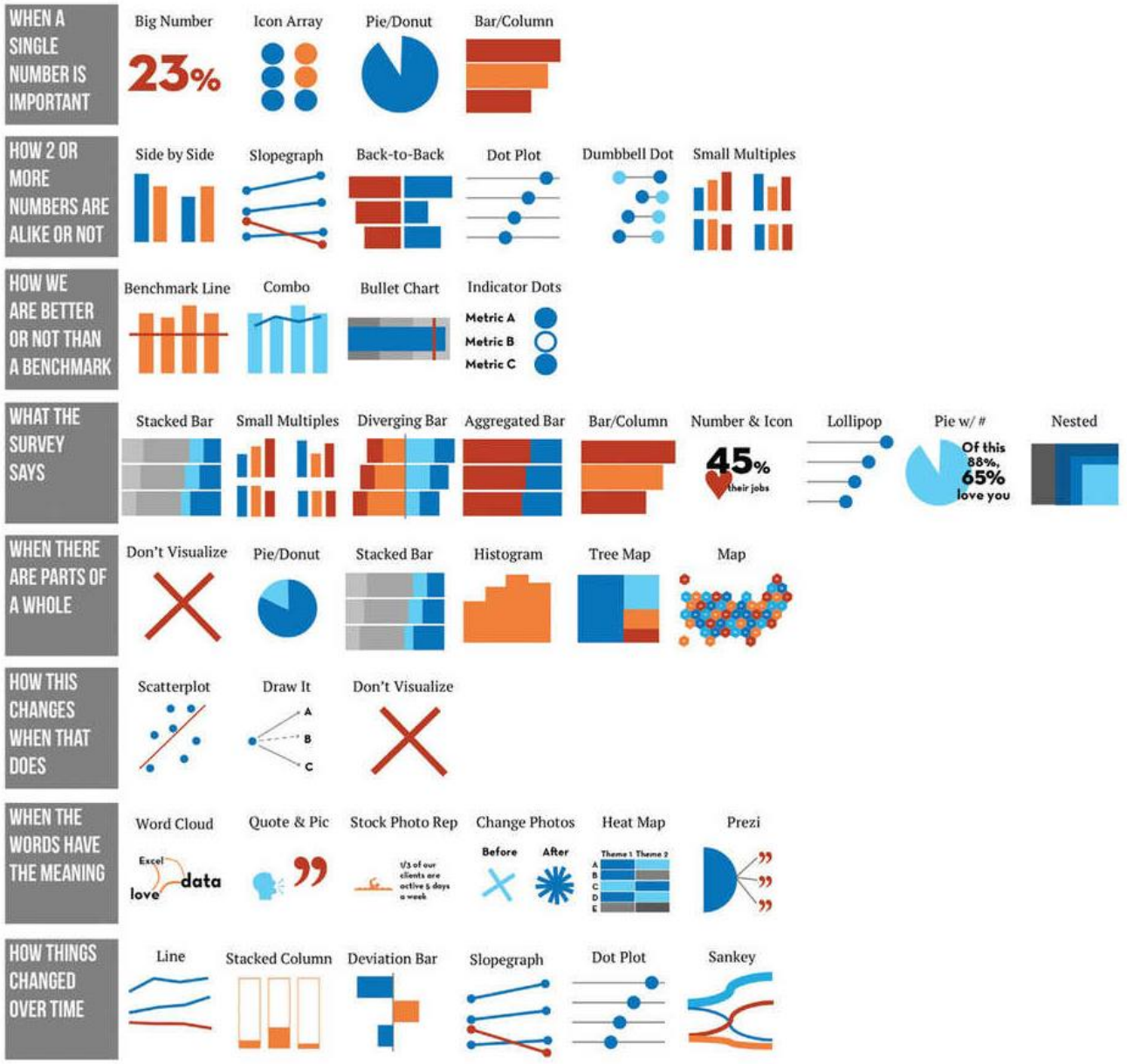


Chart Chooser Cheat Sheet

Evergreen 2017: Effective Data Visualization: The Right Chart for the Right Data

Why is the problem important?

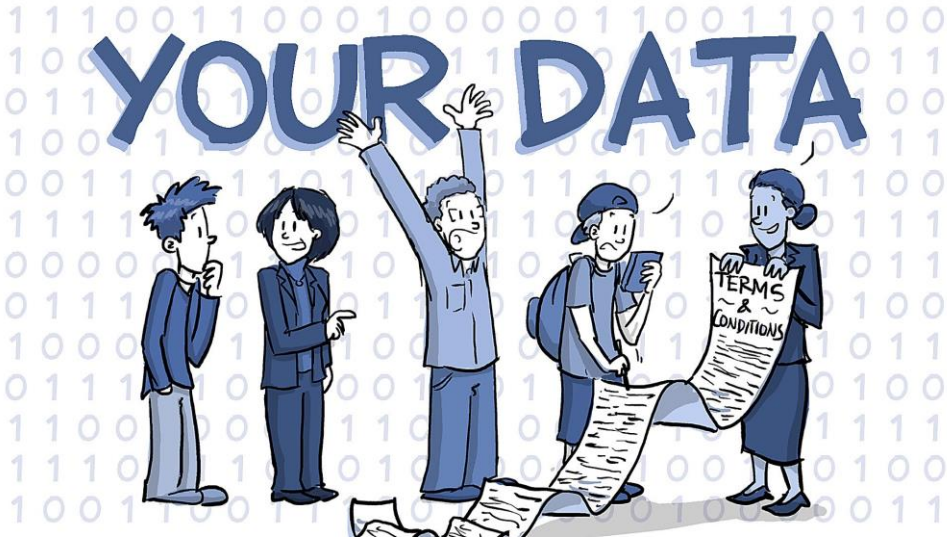
Only when knowing

- the data to be compared,
- the comparison task to be conducted, and
- the type of the comparison

can we design a visual analysis solution that is

- expressive – i.e., optimally reflects the data,
- effective – i.e., optimally supports the task, and
- appropriate – i.e., scales to the desired type.

http://www.brendangregg.com/blog/2017-02-06/flamegraphs-vs-treemaps-vs-sunburst.html



DATA CONSIDERATIONS

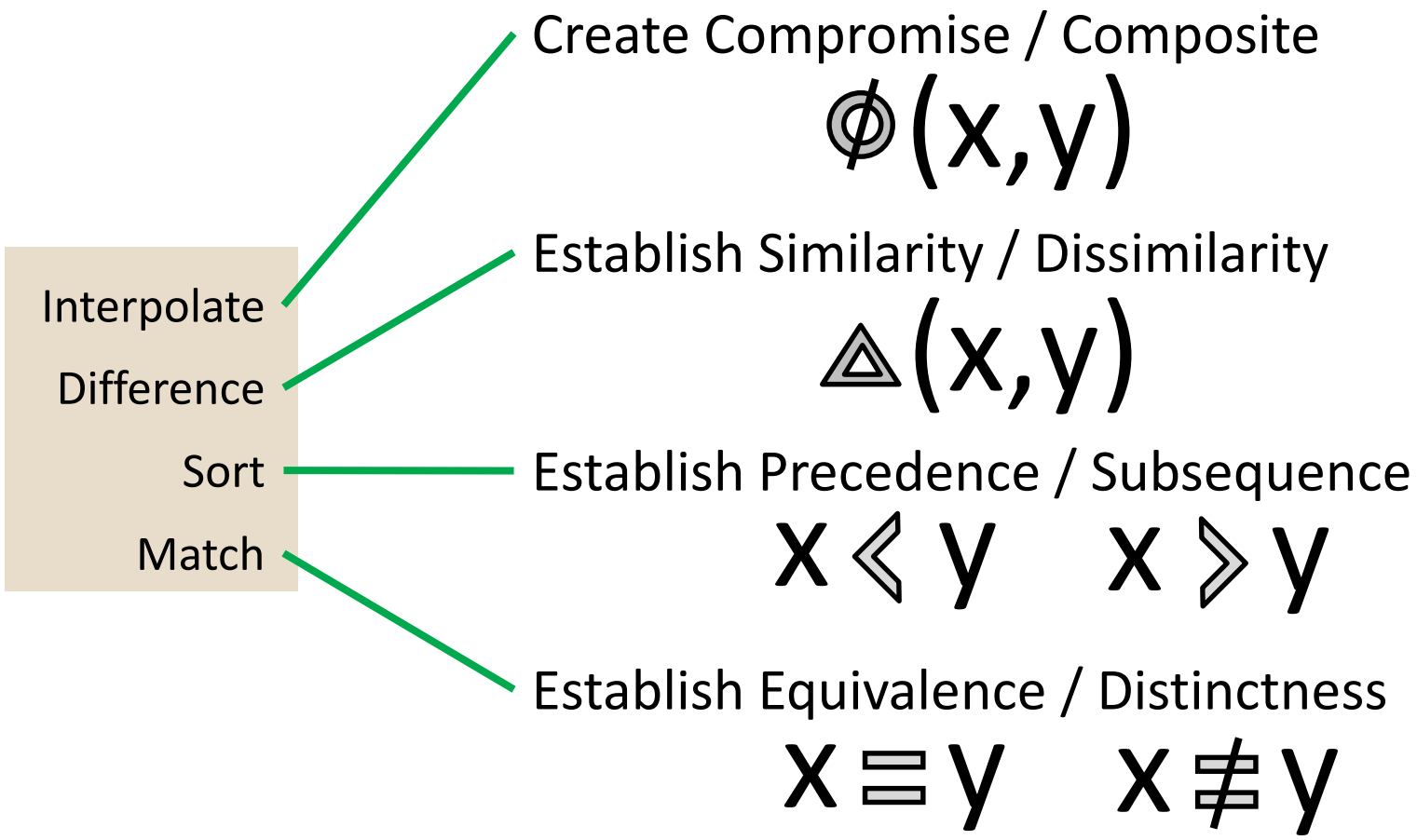
Image source: PhD comics, https://youtu.be/y1txYjoSQQc

Data Considerations for Comparison

	Quantitative Data		Qualitative Data	
	Continuous	Discrete	Ordinal	Categorical
Interpolate	✓			
Difference	✓	✓		
Sort	✓	✓	✓	
Match	✓	✓	✓	✓

Adapted from Stevens: On the Theory of Scales of Measurement (1946)

The Stack of Data Comparison



Distance Metrics for Qualitative Data

Note: Distance ≠ Precedence!

Interpolate

Difference

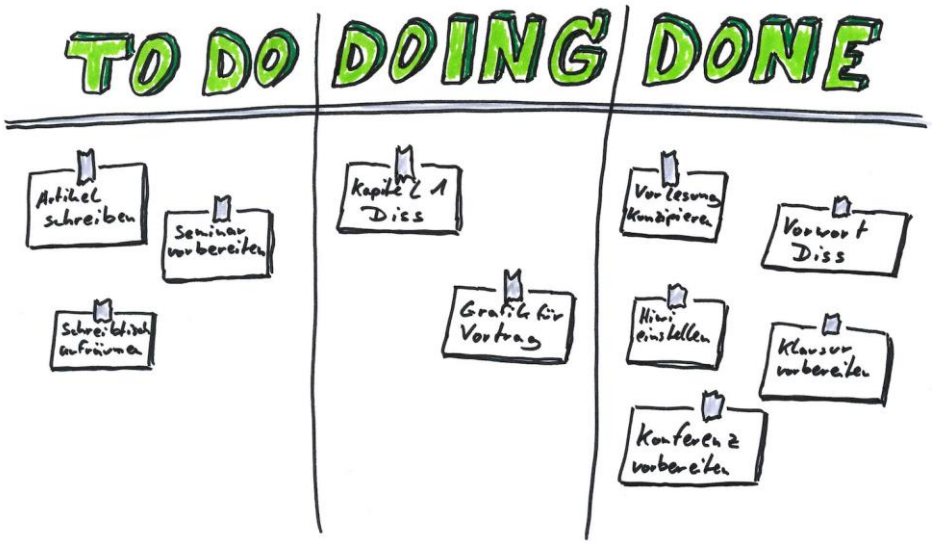
Sort

Match

Establish Similarity / Dissimilarity

$\triangle(x,y)$

- Text / Strings -> Edit Distance
- Graphs / Networks -> Maximal Common Subgraph
- Images -> Pixel by Pixel Color-Comparison in LAB space



TASK CONSIDERATIONS

Comparison Tasks Deconstructed

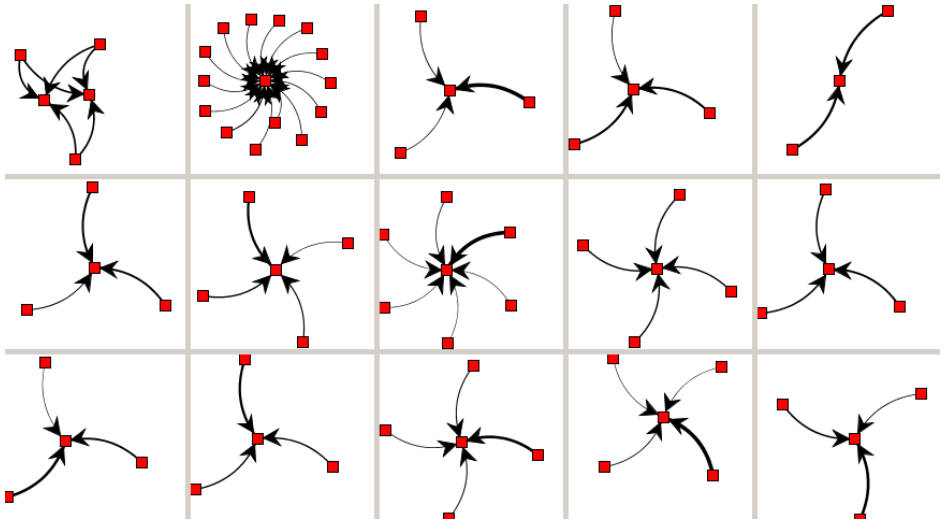
- WHY to compare? – Goal (objective/aim/purpose)
  - Exploration
  - Confirmation
  - Presentation

Modeled after [Schulz et al. 2013]

Comparison Goal - Exploration

Comparison as part of an Exploratory Data Analysis:

hypothesis generation through undirected search



[v.Landesberger et al. 2009]

Comparison Goal - Exploration

Comparison as part of an Exploratory Data Analysis:

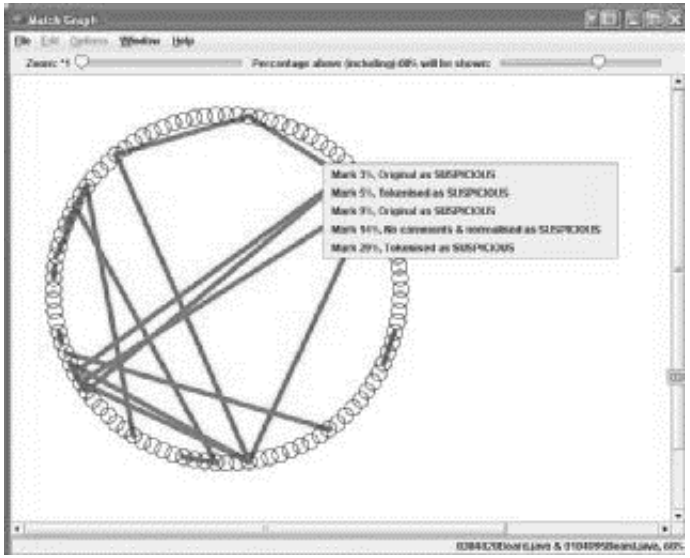
hypothesis generation through undirected search

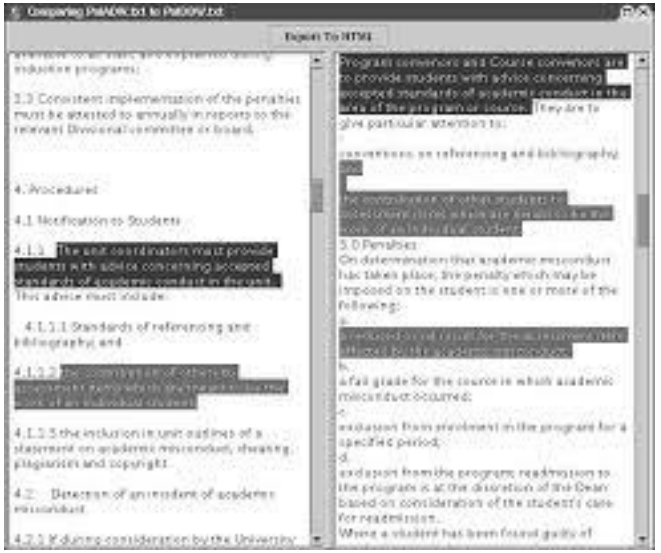
[v.Landesberger et al. 2009]

Comparison Goal - Confirmation

Comparison as part of a Confirmatory Data Analysis:

hypothesis testing through directed search



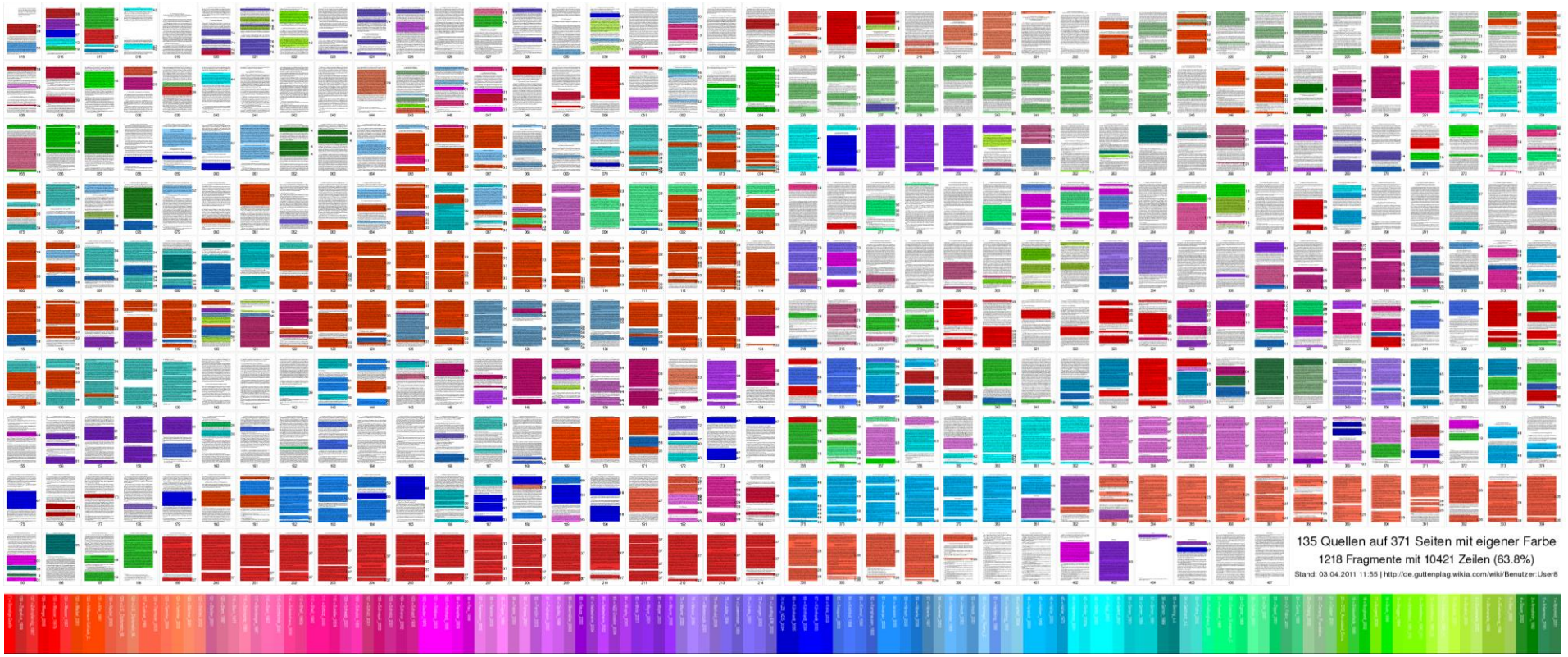


SHERLOCK [White & Joy 2004]

Comparison Goal - Presentation

Comparison as part of Analysis Result Presentation:
communication of similarities

Image source: http://de.guttenplag.wikia.com



Comparison Goal - Presentation

Comparison as part of Analysis Result Presentation:

communication of differences

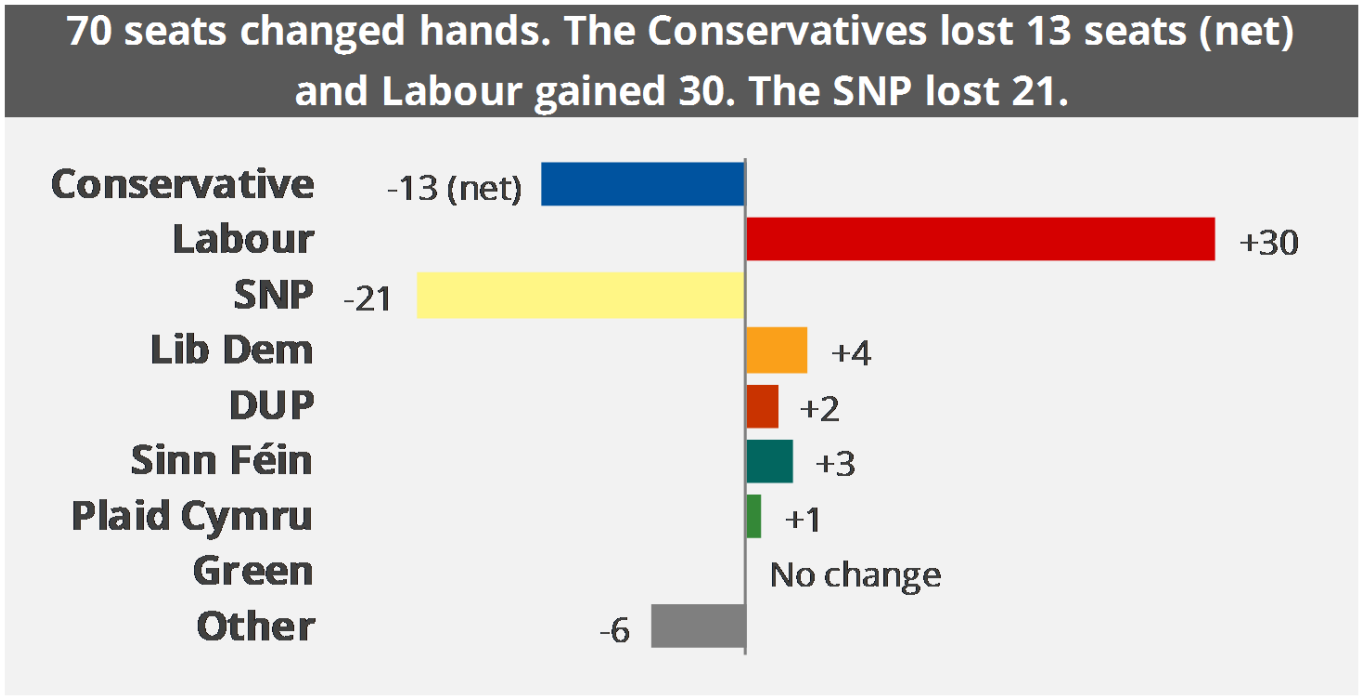
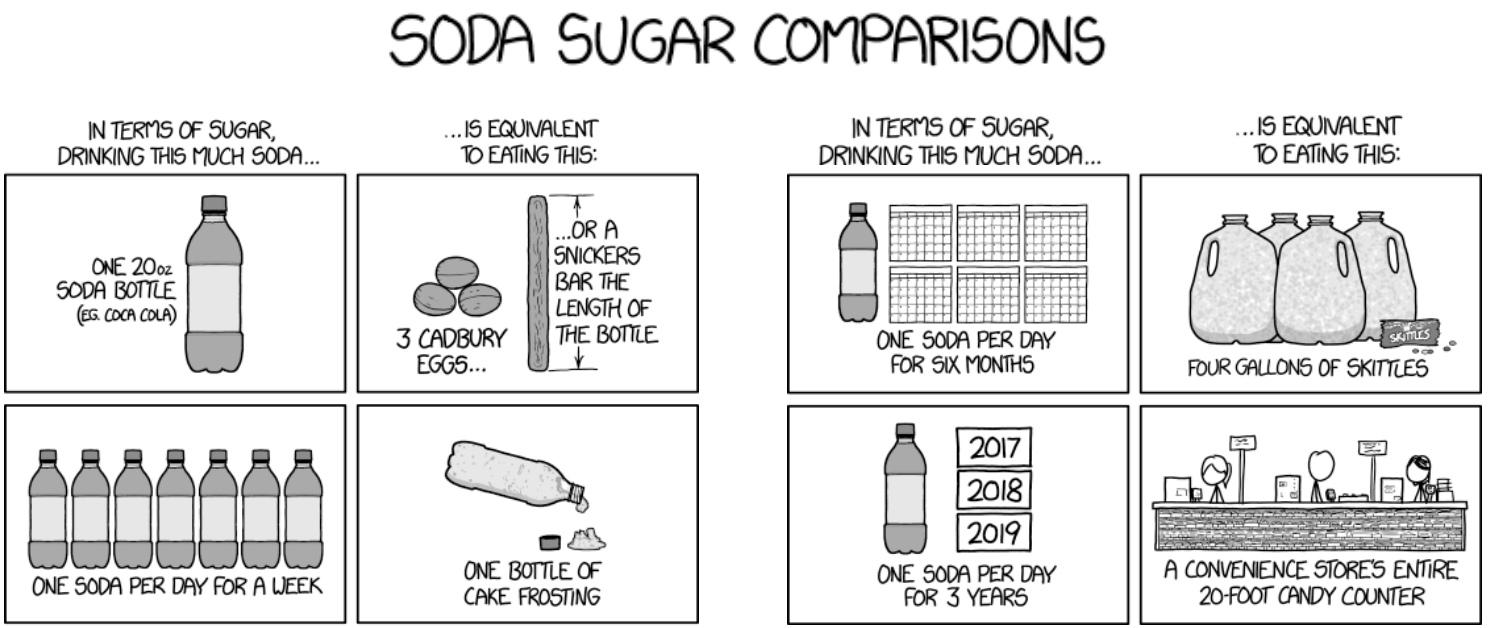


Image source: https://researchbriefings.parliament.uk/ResearchBriefing/Summary/CBP-7979

Comparison Goal - Presentation

Comparison through a familiar frame of reference for communicating scale:



[XKCD 1793]

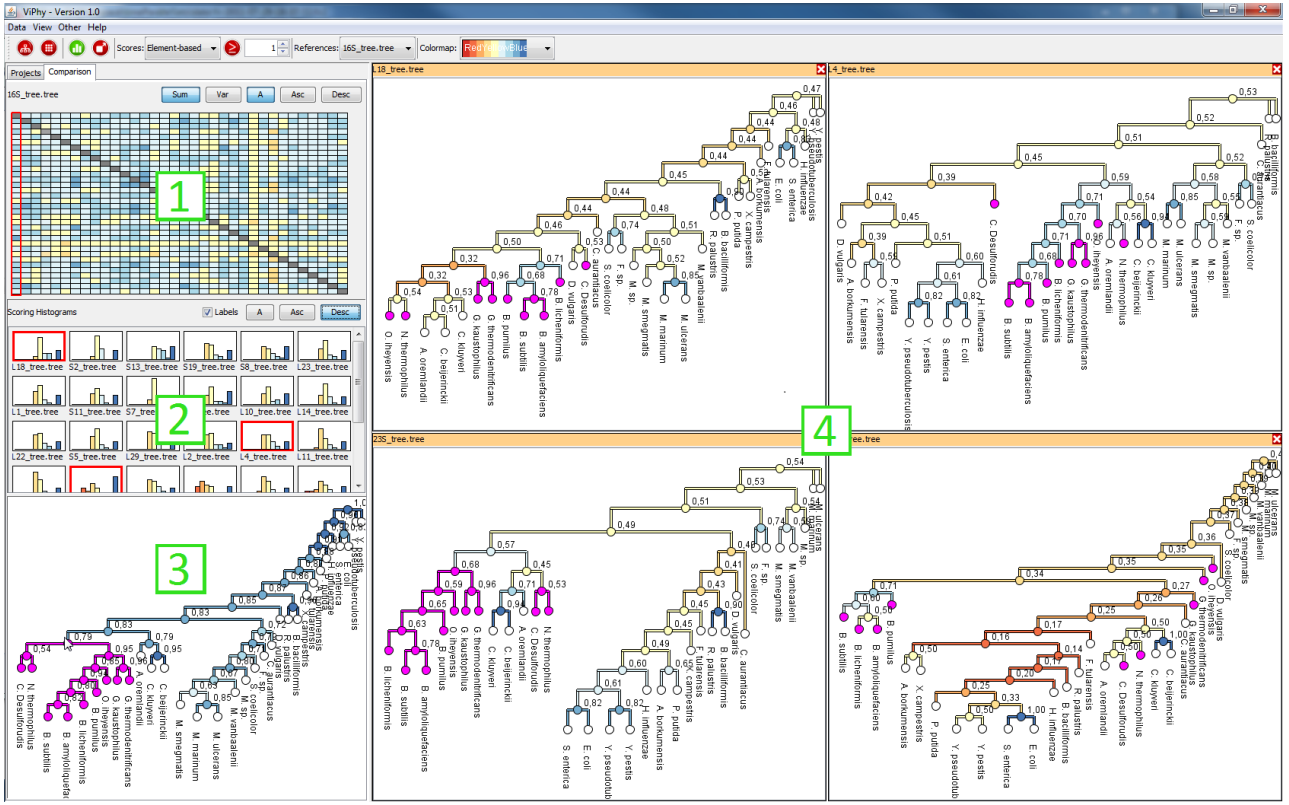
Comparison Tasks Deconstructed

- WHY to compare? – Goal (objective/aim/purpose)
  - Exploration
  - Confirmation
  - Presentation
- HOW to compare? – Means (action, task)
  - Search / Match
  - Sort / Order
  - Group / Relate

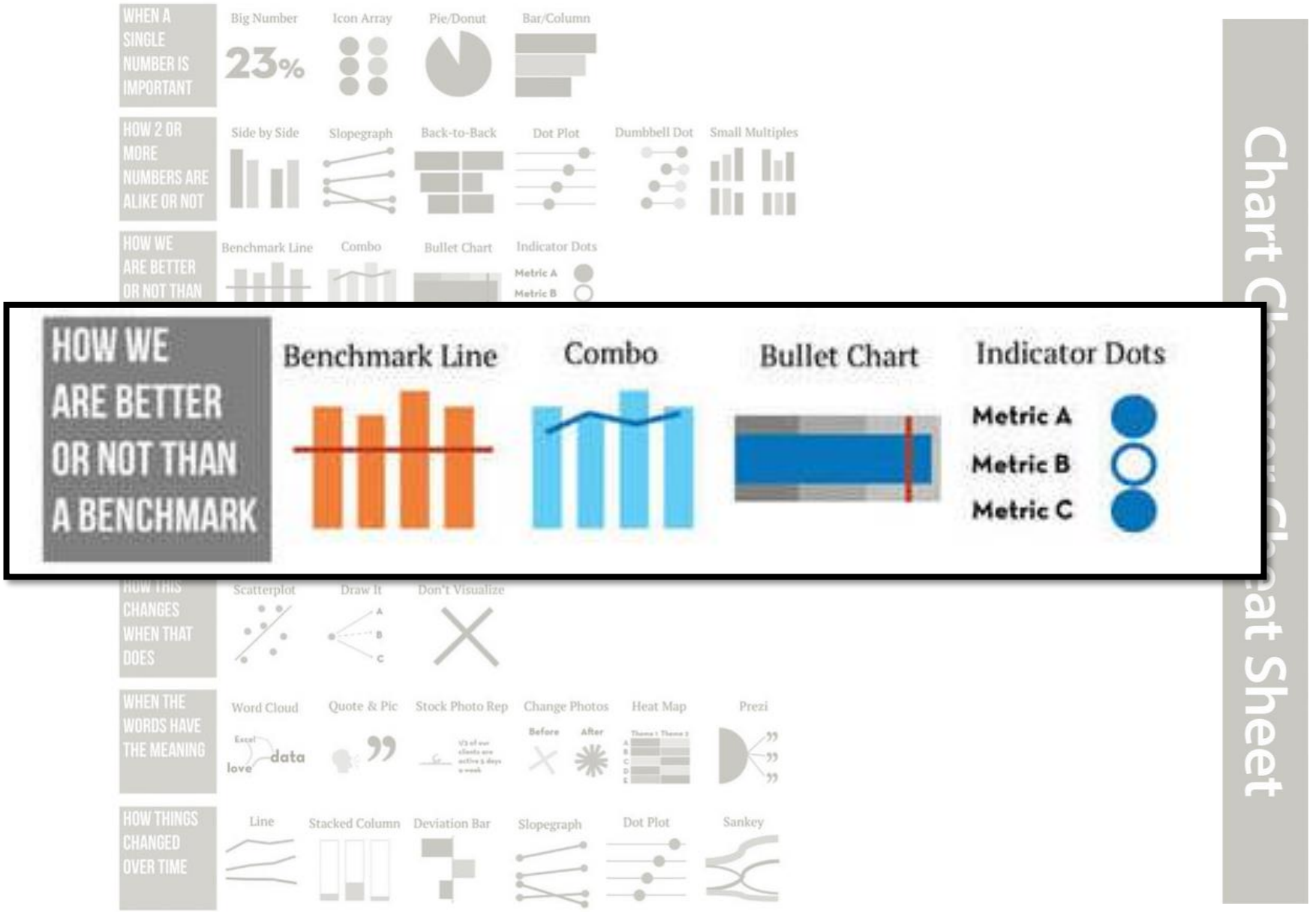
Modeled after [Schulz et al. 2013]

Means of Comparison - Search/Match

Comparison to Template or Exemplar

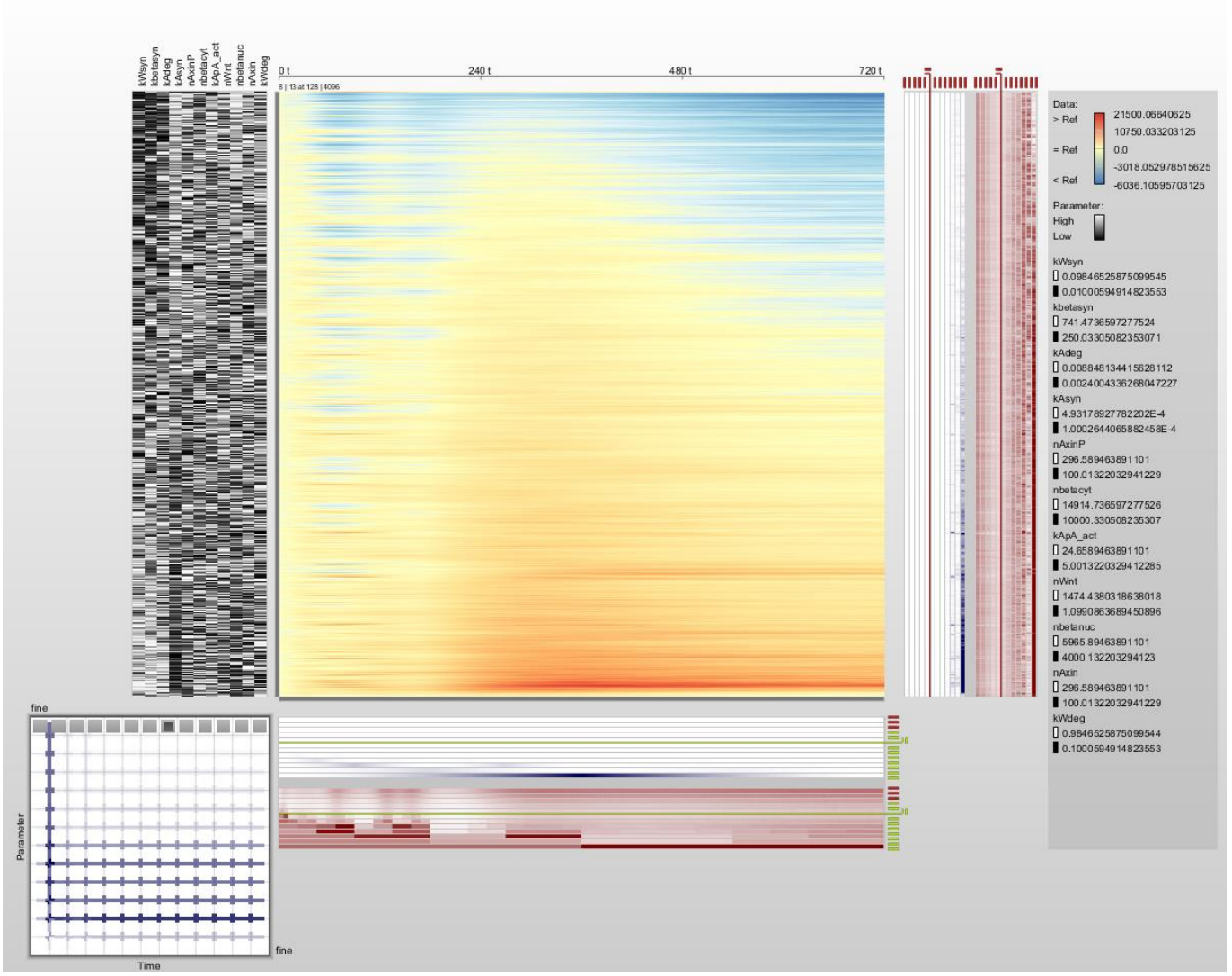


[Bremm et al. 2011]



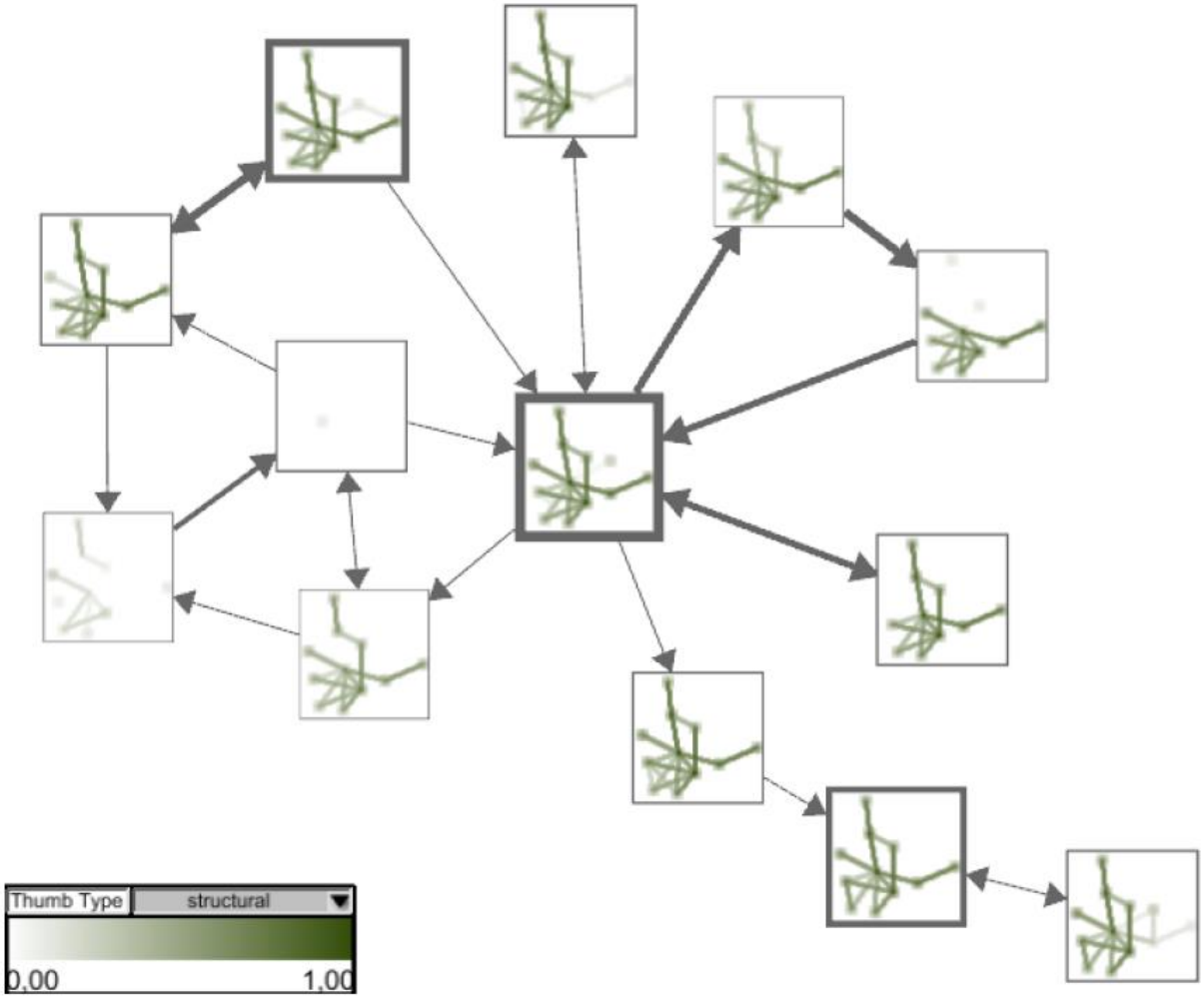
Evergreen 2017: Effective Data Visualization: The Right Chart for the Right Data

Means of Comparison - Sort/Order



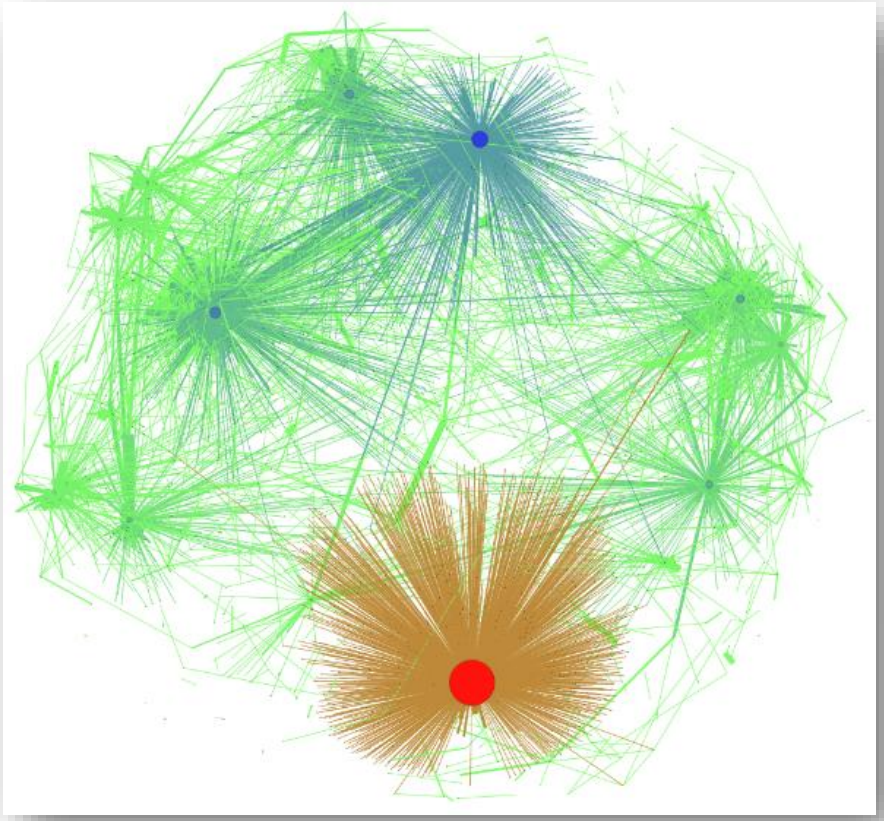
[Luboschik et al. 2014]

Means of Comparison - Group/Relate



[Hadlak 2015]

Means of Comparison - Group/Relate



https://sctr7.com/2014/08/14/network-analytics-more-than-pretty-pictures/

https://petapixel.com/2016/09/14/20-composition-techniques-will-improve-photos/

Means of Comparison - Combinations

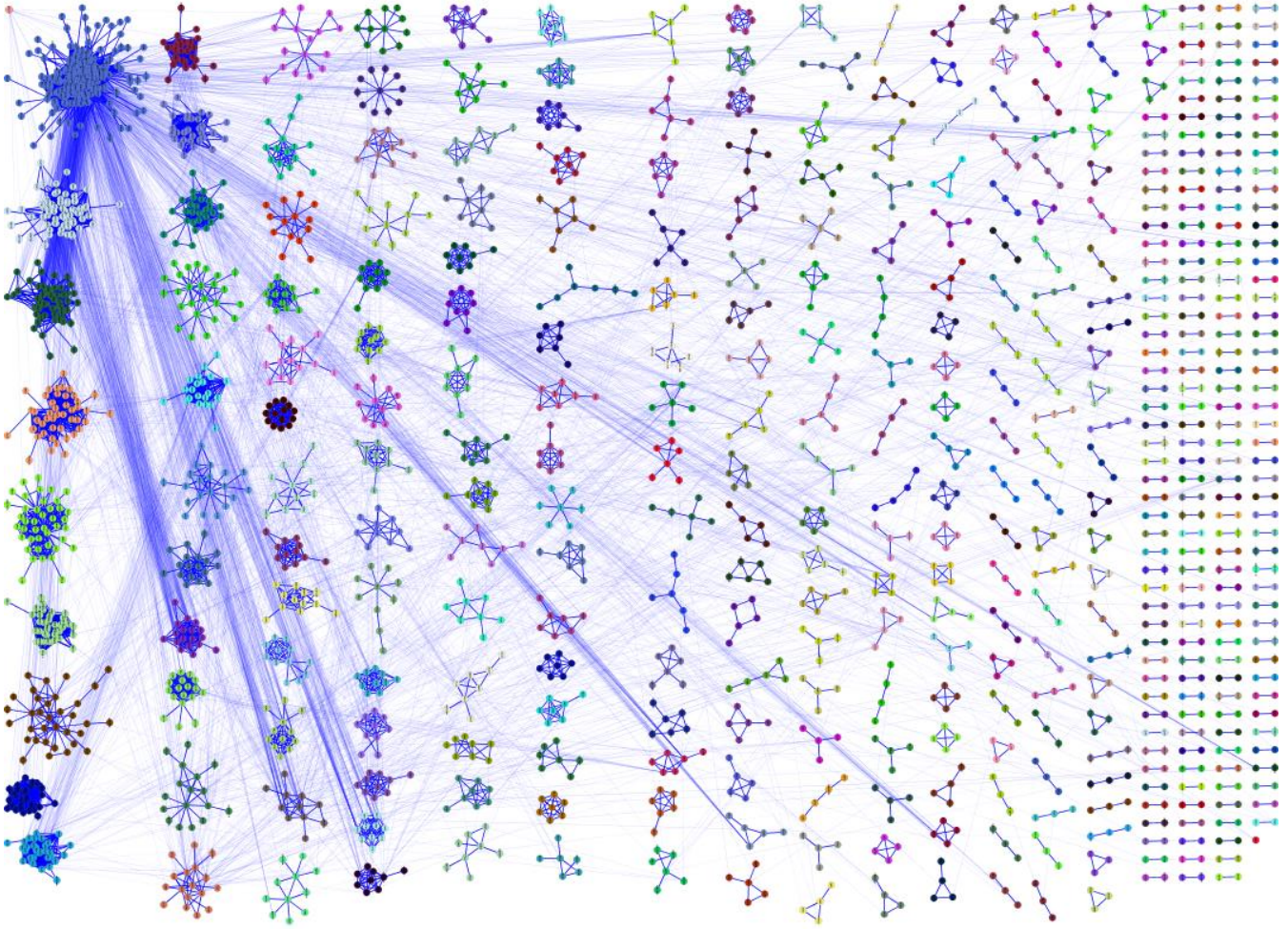


Image Source: http://www.rbvi.ucsf.edu/cytoscape/clusterMaker2/

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- WHY to compare? – Goal (objective/aim/purpose)
  - Exploration
  - Confirmation
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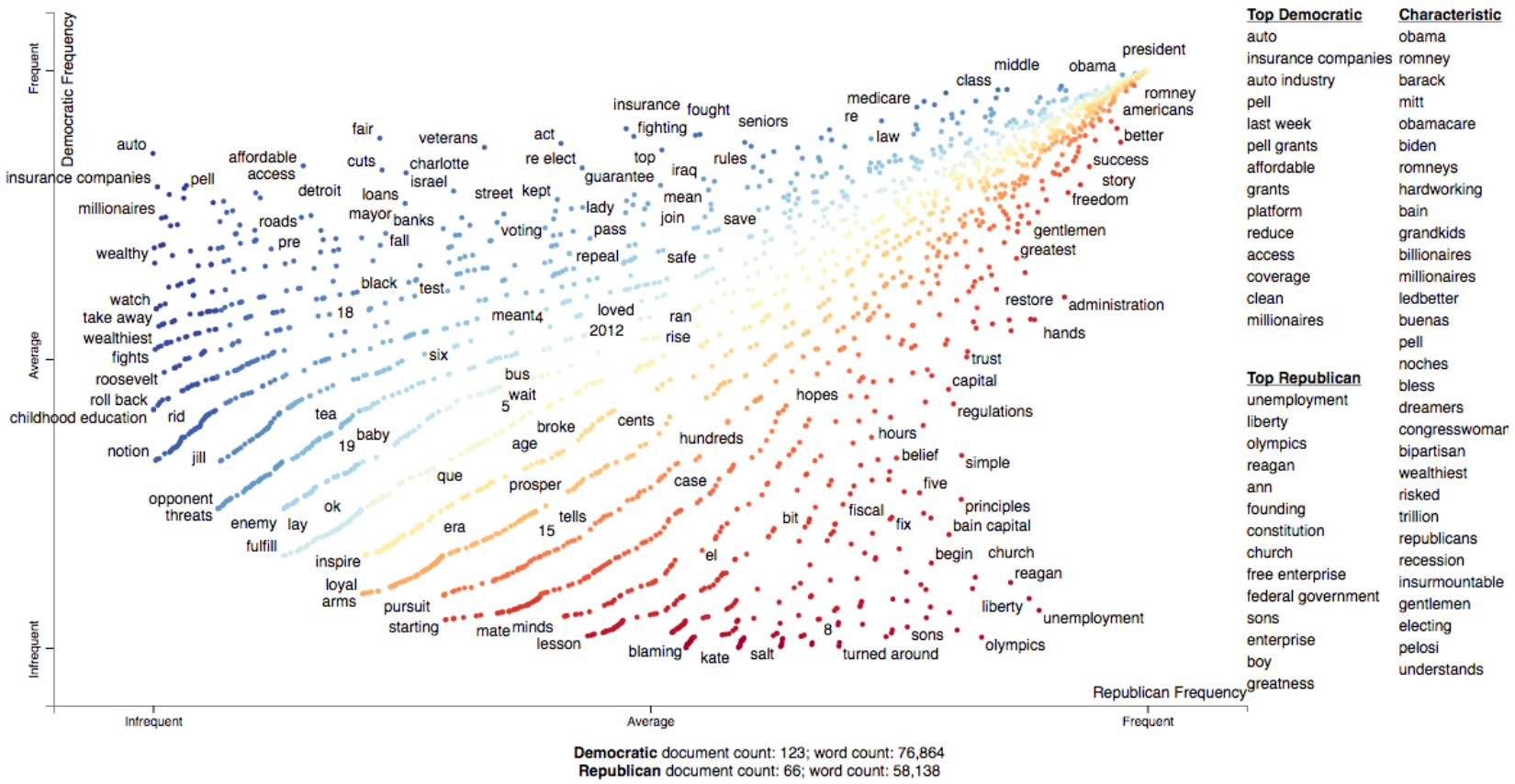
- HOW to compare? – Means (action, task)
  - Search / Match
  - Sort / Order
  - Group / Relate
- WHAT to compare? – Data characteristics (data aspect)
  - Data type
  - Data level / granularity
  - Data cardinality

Modeled after [Schulz et al. 2013]

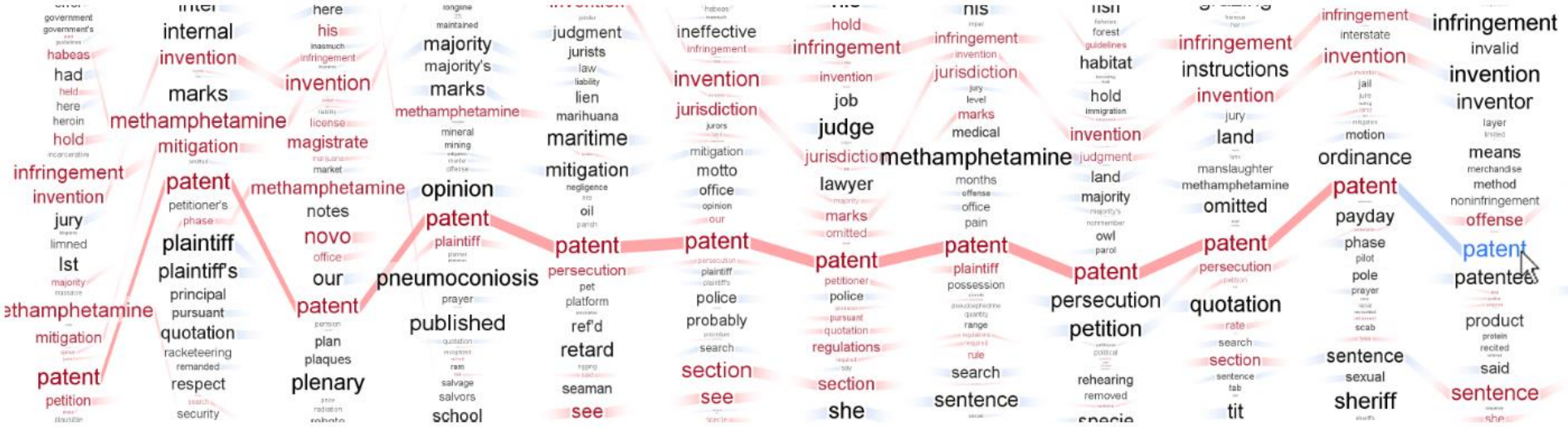
Data Type - Document Collections



Top Democratic	Characteristic
auto	obama
insurance companies	romney
auto industry	barack
pell	mitt
last week	obamacare
pell grants	biden
affordable	romneys
grants	hardworking
platform	bain
reduce	grandkids
access	billionaires
coverage	millionaires
clean	ledbetter
millionaires	buenas
	pell
	noches
Top Republican	bless
unemployment	dreamers
liberty	congresswoman
olympics	bipartisan
reagan	wealthiest
ann	risked
founding	trillion
constitution	republicans
church	recession
free enterprise	insurmountable
federal government	gentlemen
sons	electing
enterprise	pelosi
boy	understands
greatness	

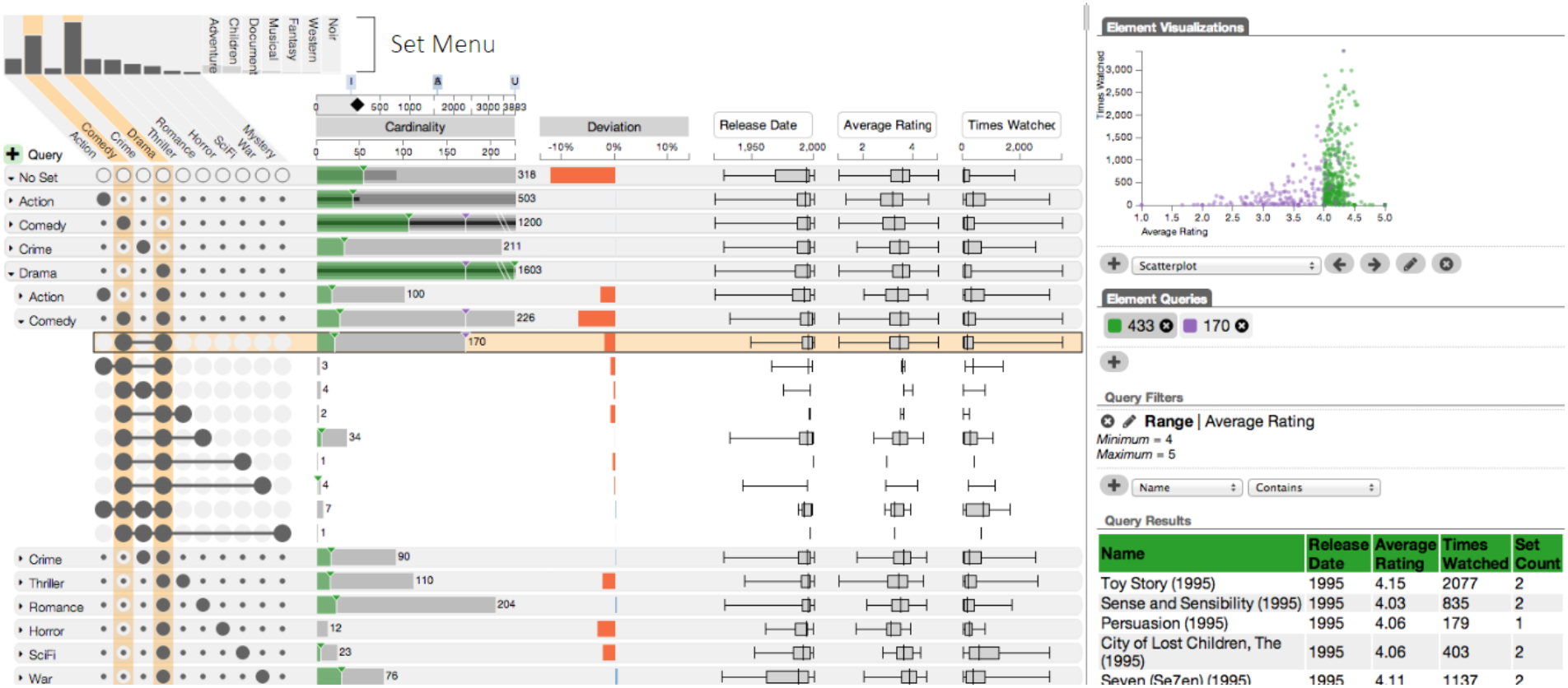
ScatterText - [Kessler 2017]

Data Type - Document Collections



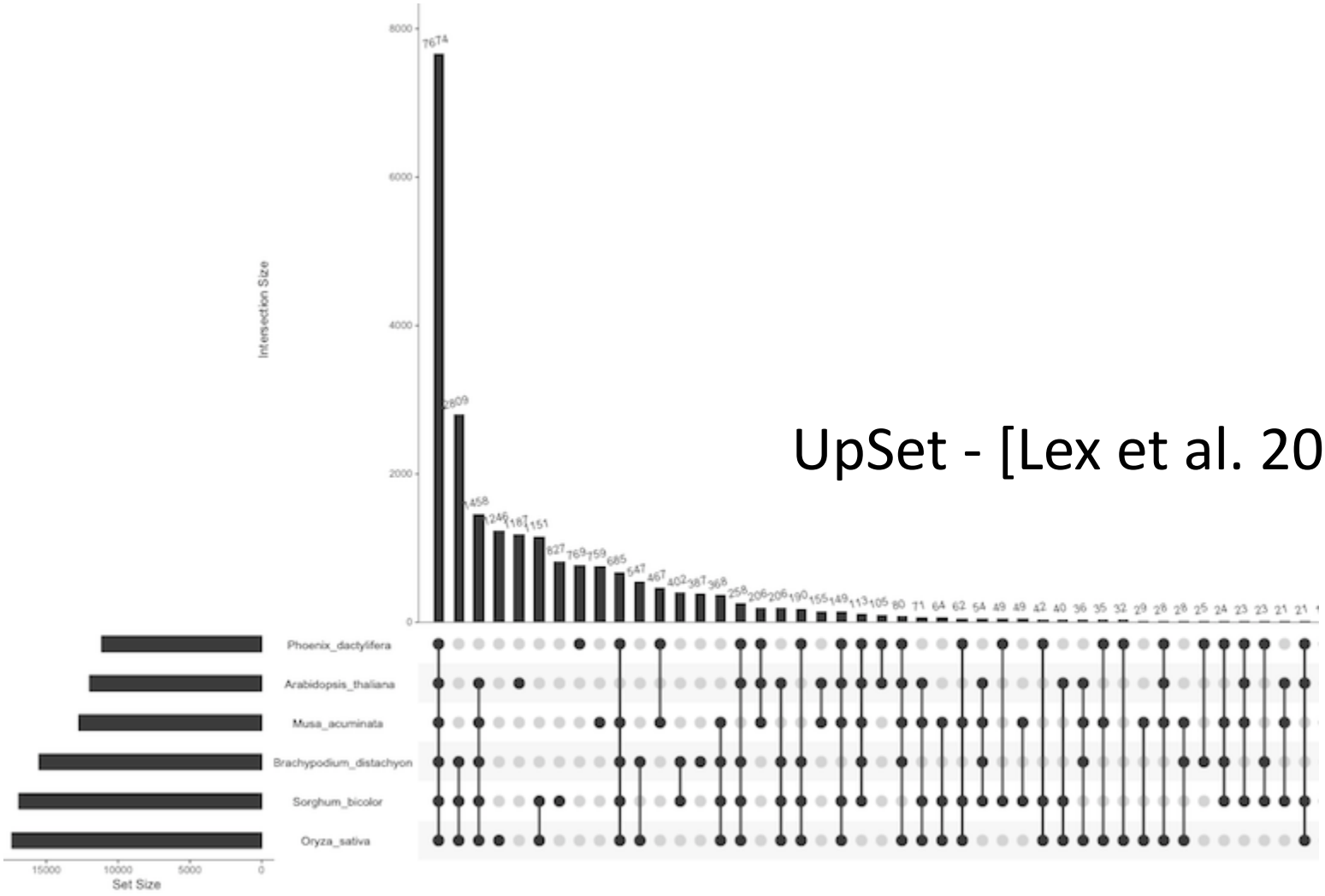
Parallel Tag Clouds - [Collins et al. 2009]

Data Type - Sets



UpSet - [Lex et al. 2014]

Data Type - Sets



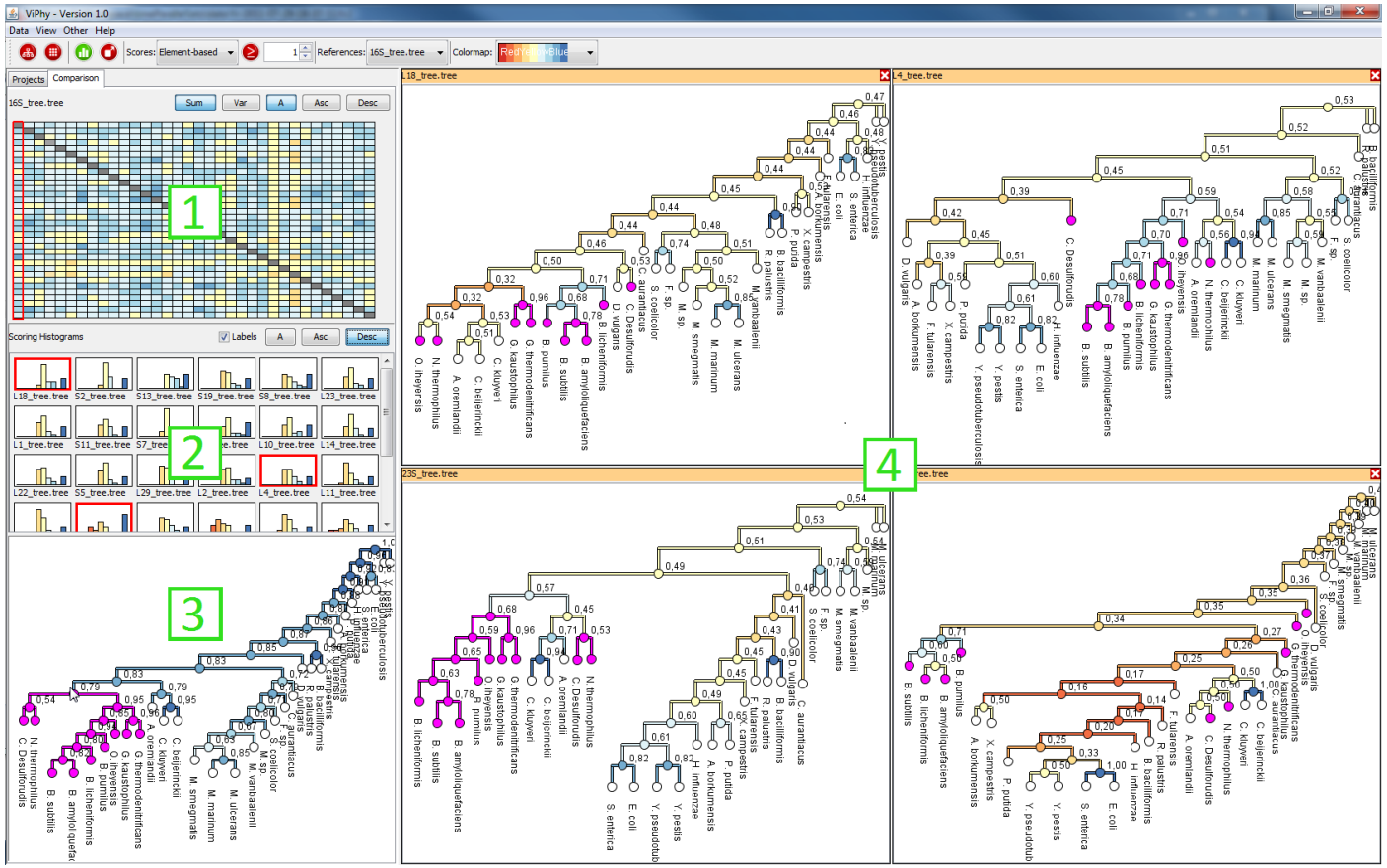
UpSet - [Lex et al. 2014]

Data Level / Granularity

We assume a simple hierarchical data model:

- $\{attrib_1,\ldots,attrib_i\}$ = data item
- $\{item_1,\ldots,item_j\}$ = data cluster
- $\{cluster_1,\ldots,cluster_k\}$ = data set
- $\{set_1,\ldots,set_l\}$ = data landscape

Overview -> Detail: We often need to compare at multiple levels!



[Bremm et al. 2011]

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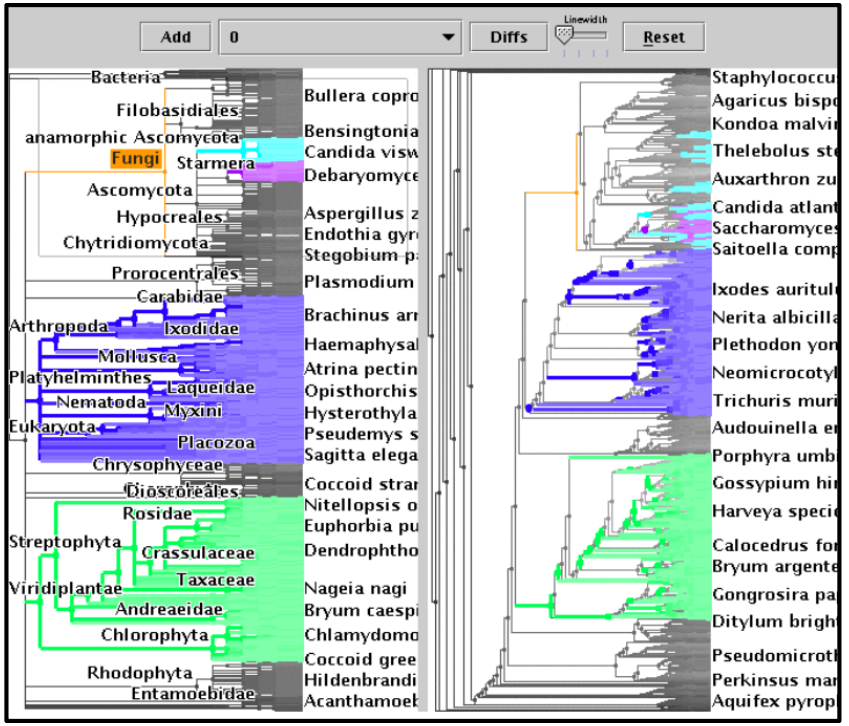
Modeled after [Schulz et al. 2013]

Data Cardinality -> Comparison Type

- 1:1 Comparison

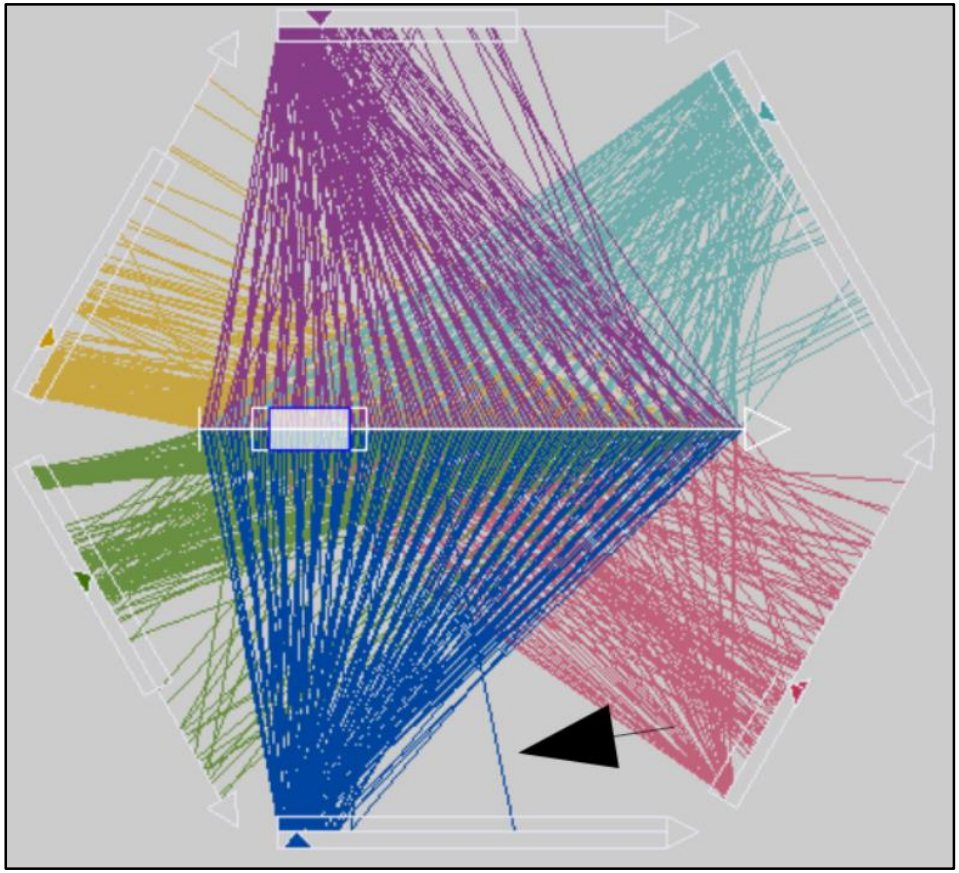


TreeJuxtaposer [Munzner et al. 2003]

Data Cardinality -> Comparison Type

- 1:1 Comparison

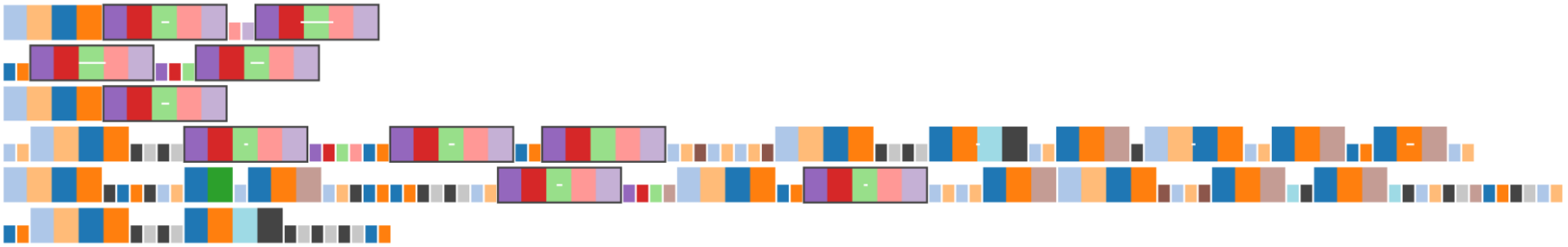
- 1:many Comparison



VisAxes [Tominski et al. 2004]

Data Cardinality -> Comparison Type

- 1:1 Comparison
- 1:many Comparison
- many:many Comparison



Action Sequences [Nguyen et al. 2018]