

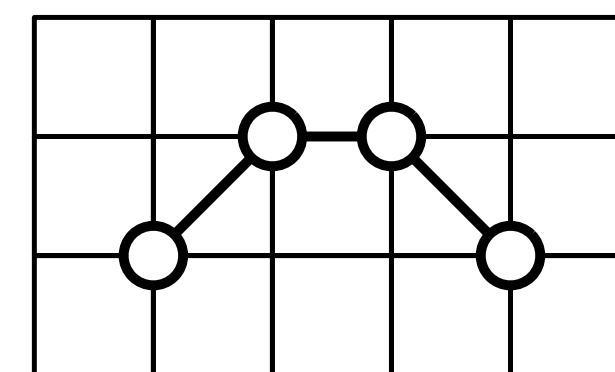
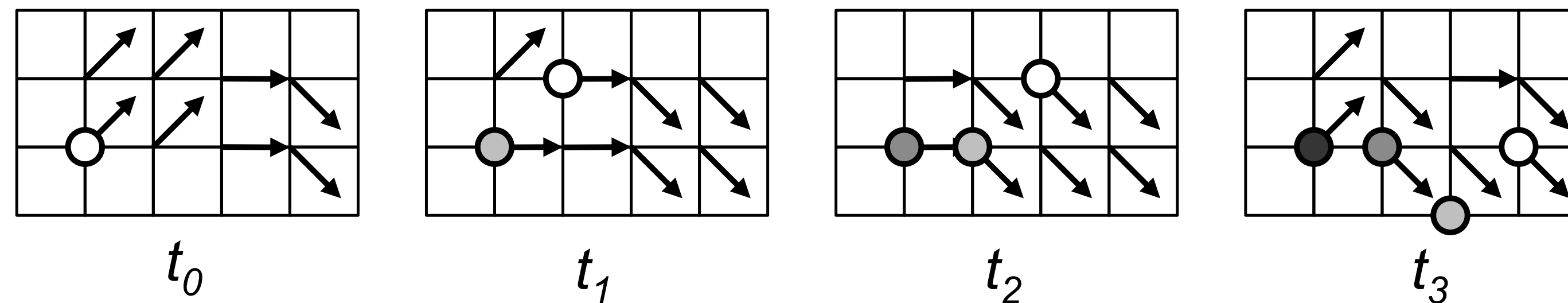
Data Visualization (CSCI 627/490)

Review

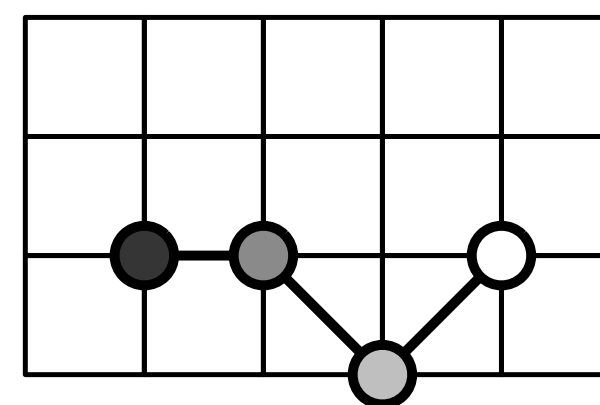
Dr. David Koop

Streamlines & Variants

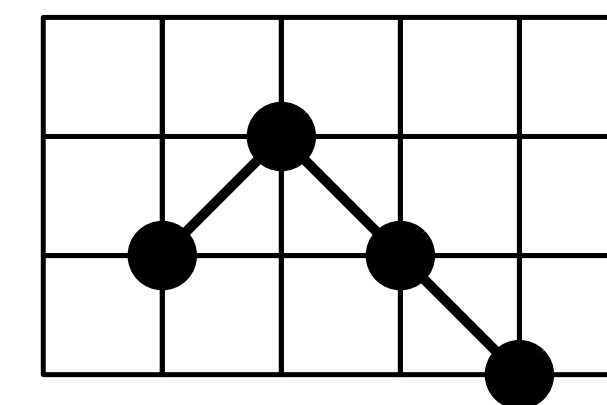
- Steady vs. **Unsteady** flows
 - In unsteady flows, the vector field **changes** over time
- Variants: **Pathlines** and **Streaklines**



pathline



streakline

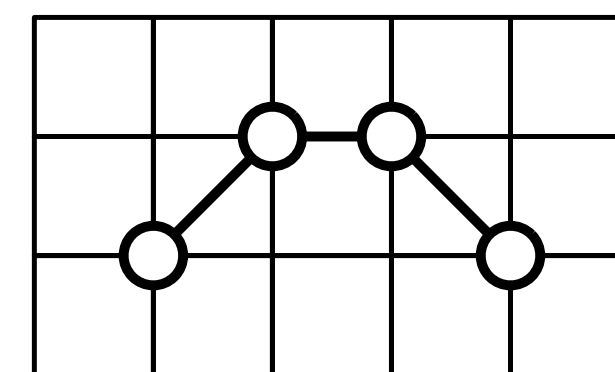
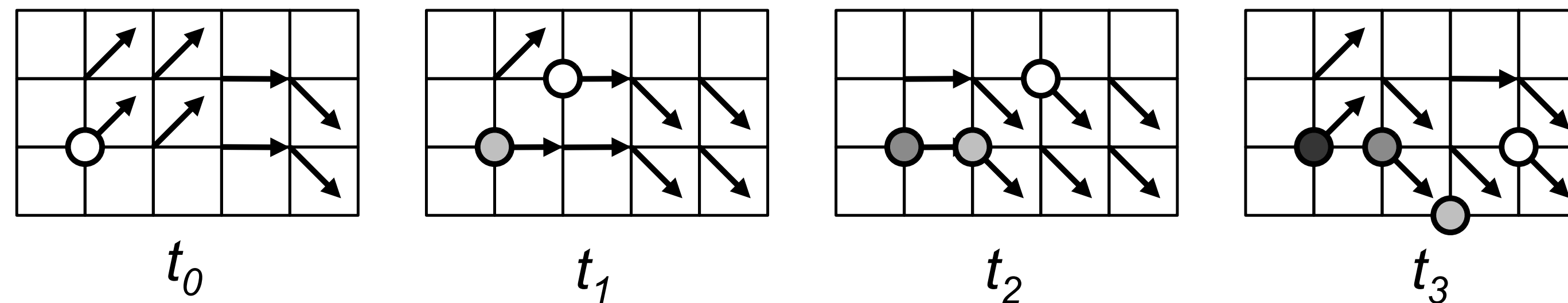


streamline for t_3

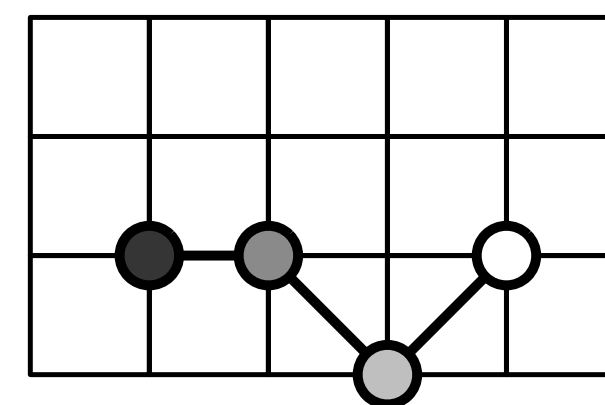
[T. Möller]

Streamlines & Variants

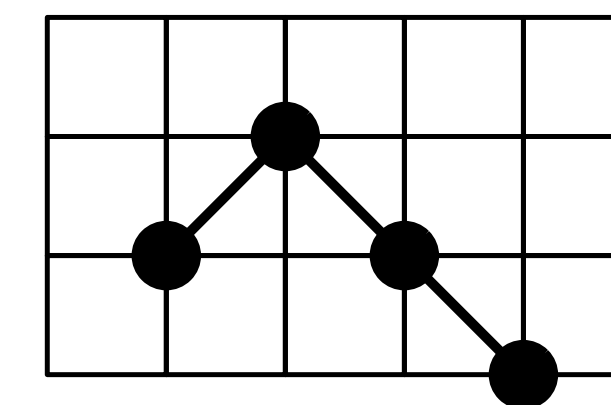
- Steady vs. **Unsteady** flows
 - In unsteady flows, the vector field **changes** over time
- Variants: **Pathlines** and **Streaklines**



pathline



streakline

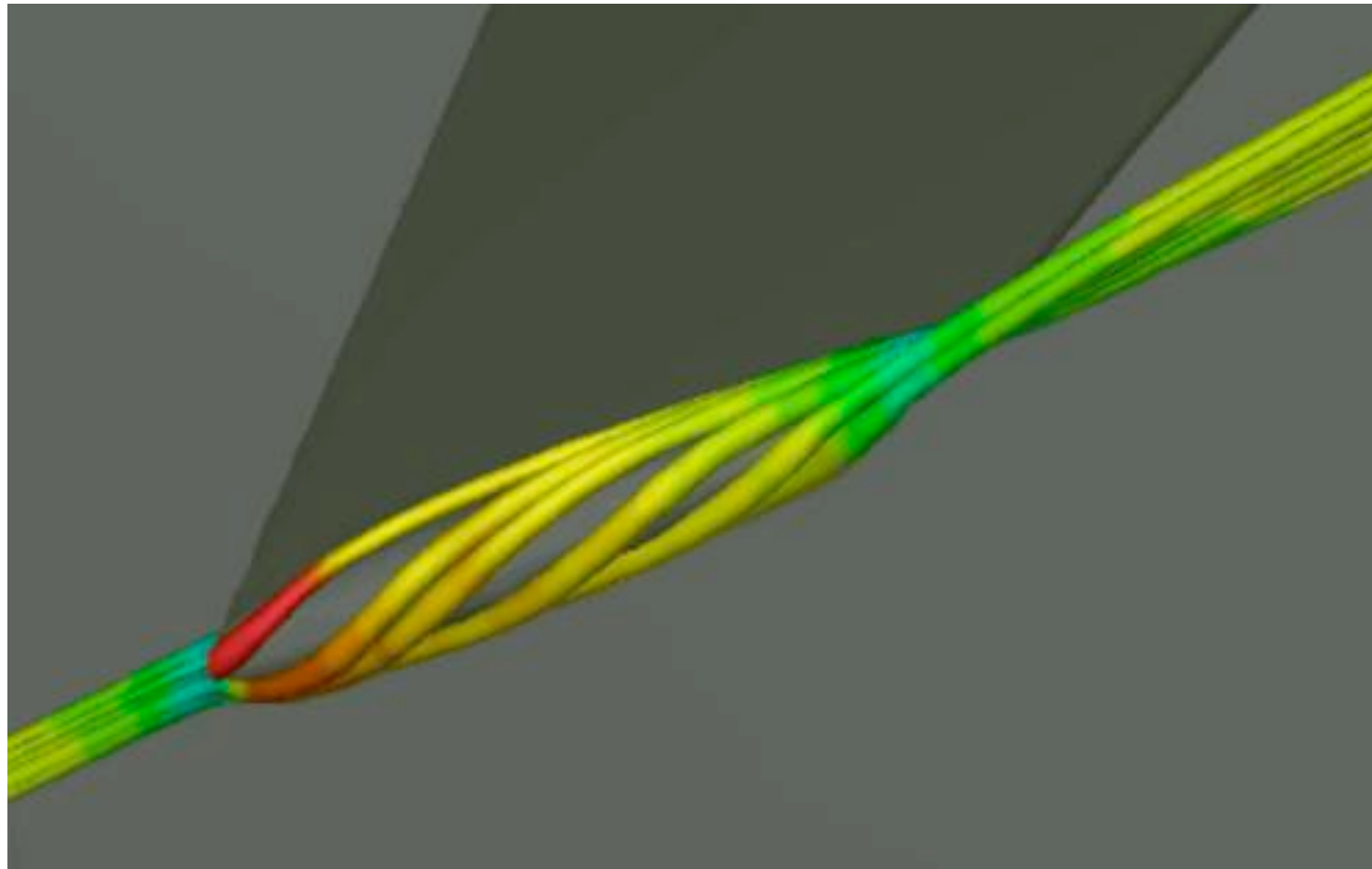


streamline for t_3

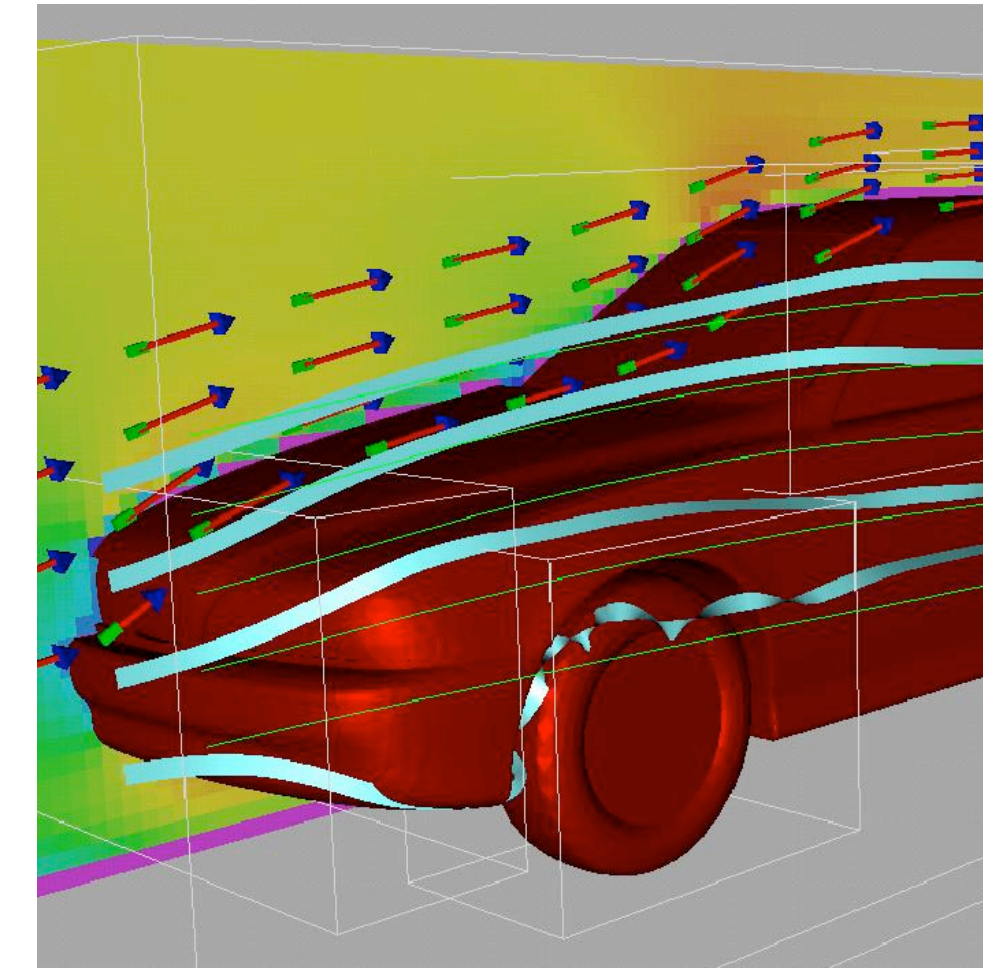
[T. Möller]

All are identical in steady flows!

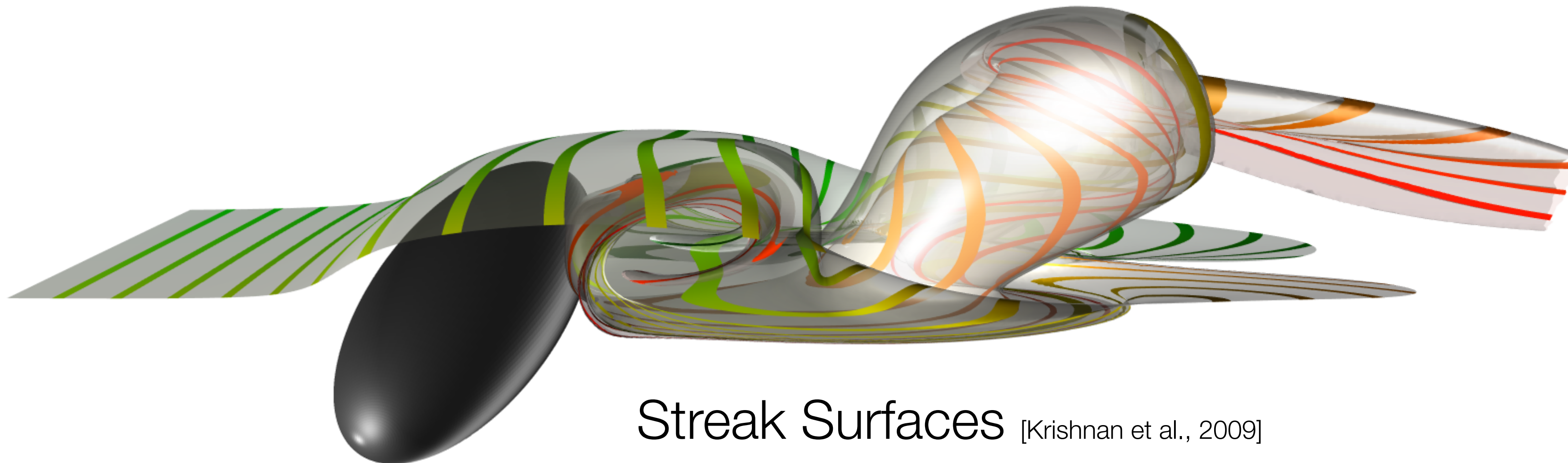
Streamline Variants



Stream Tubes [Weiskopf/Machiraju/Möller]



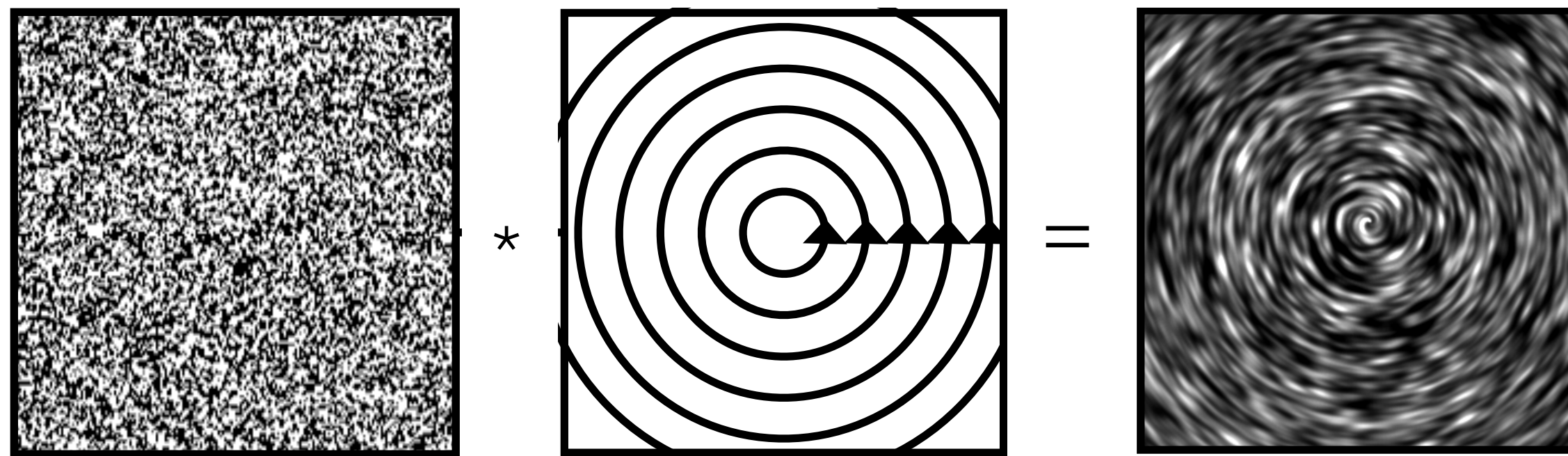
Stream Ribbons [Weiskopf/Machiraju/Möller]



Streak Surfaces [Krishnan et al., 2009]

Line Integral Convolution

- Goal: provide a global view of a steady vector field while avoiding issues with clutter, seeds, etc.
- Remember convolution?
- Start with random noise texture
- Smear according to the vector field
- Need structured data



[Weiskopf/Machiraju/Möller]

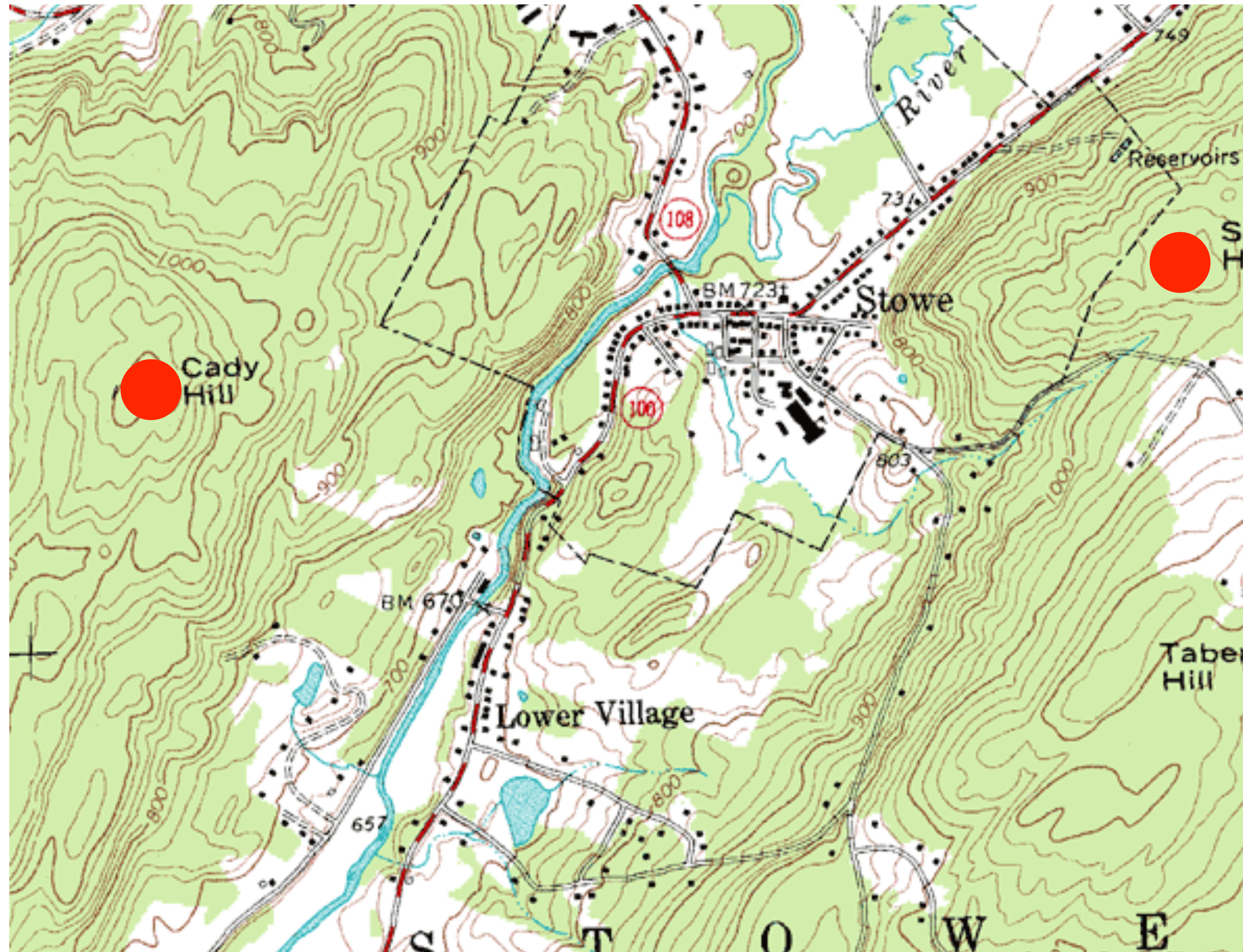


Topology: Find Critical Points



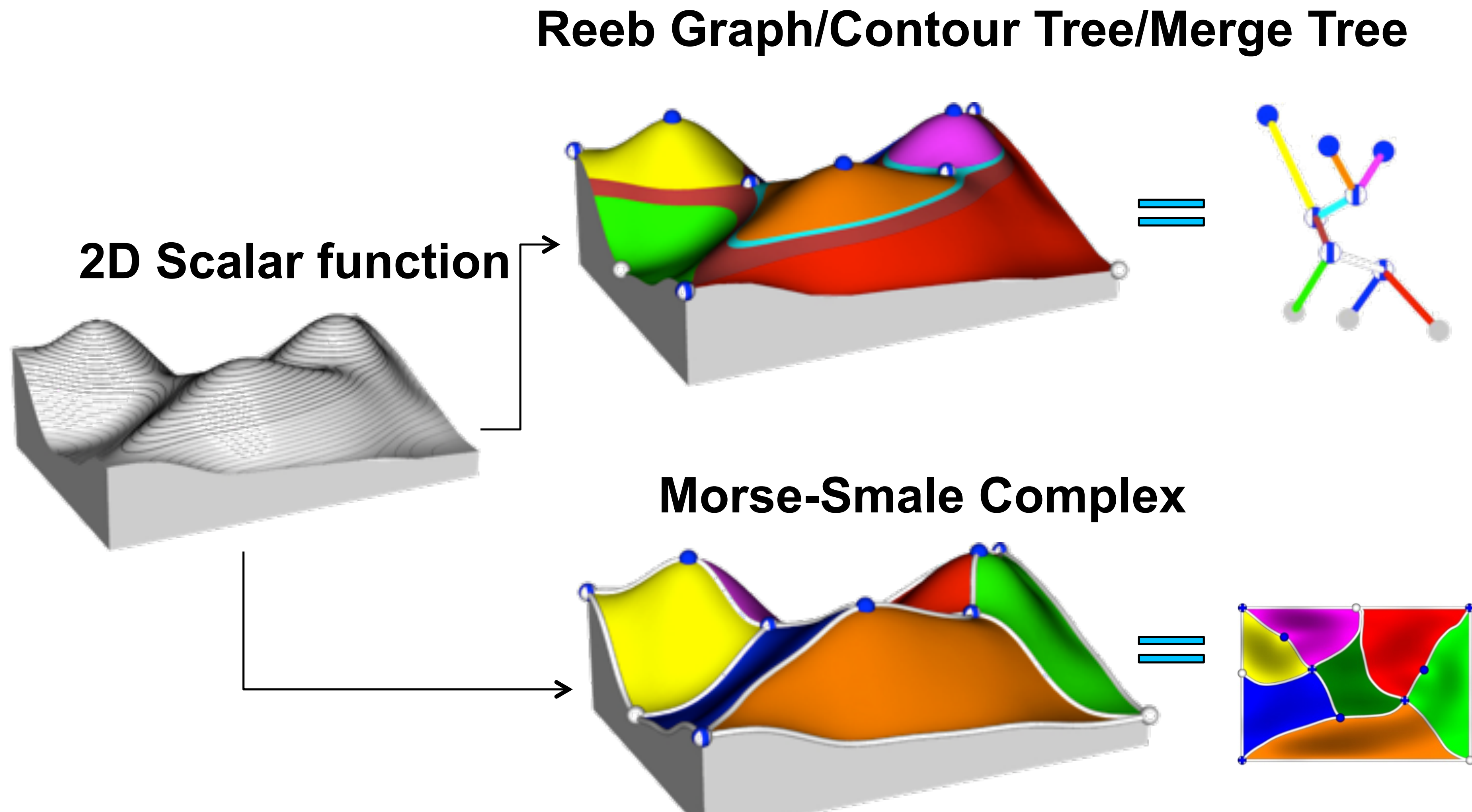
[Wikipedia]

Topology: Find Critical Points



[Wikipedia]

Scalar Field Topology



[via Levine]

Vector Field Topology

- Instead of “guessing” correct seed points for streamlines to understand the field, try to identify structure (topology) of the field

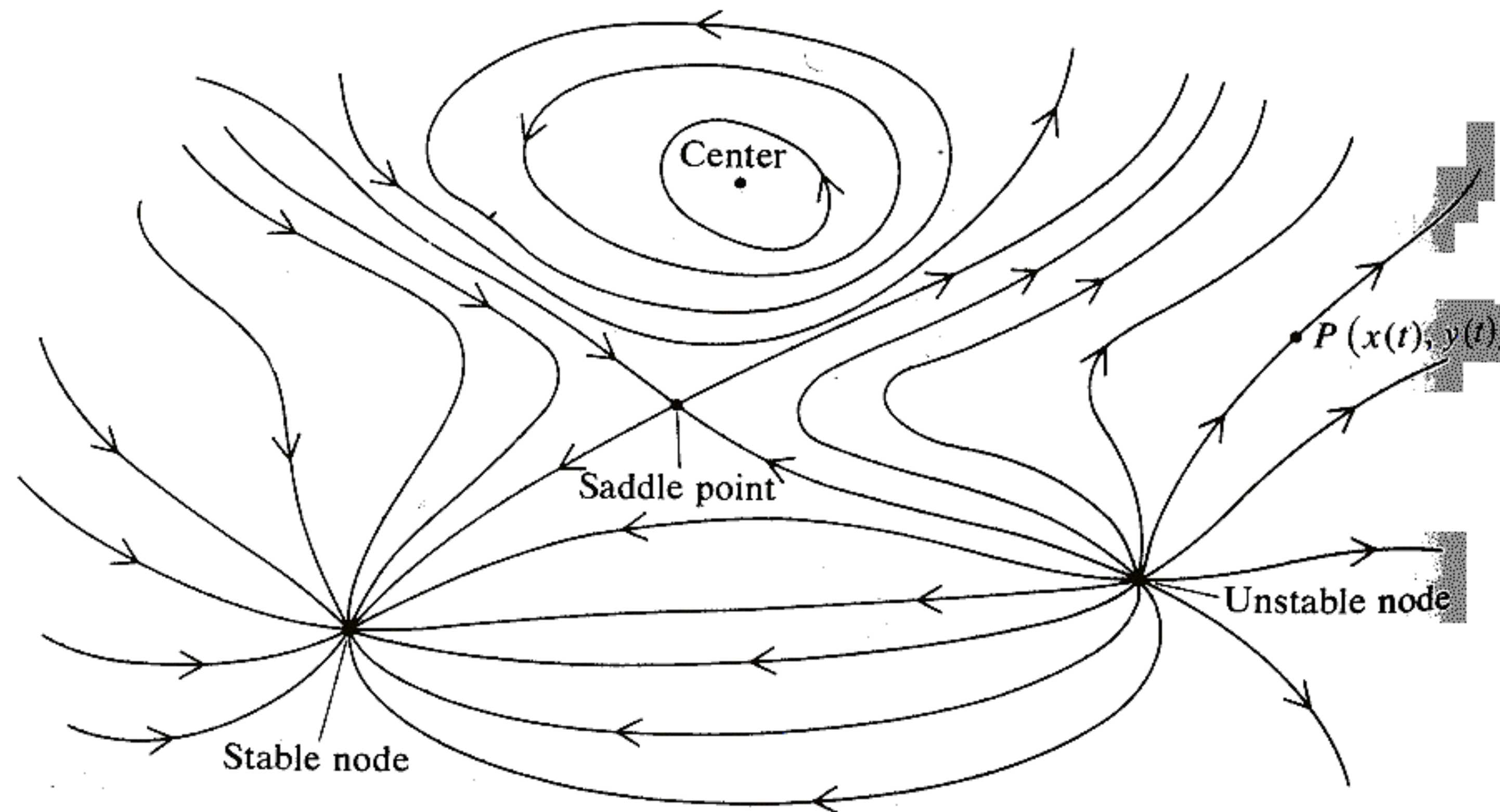


Figure 7.1 A phase portrait.

[M. Henle]

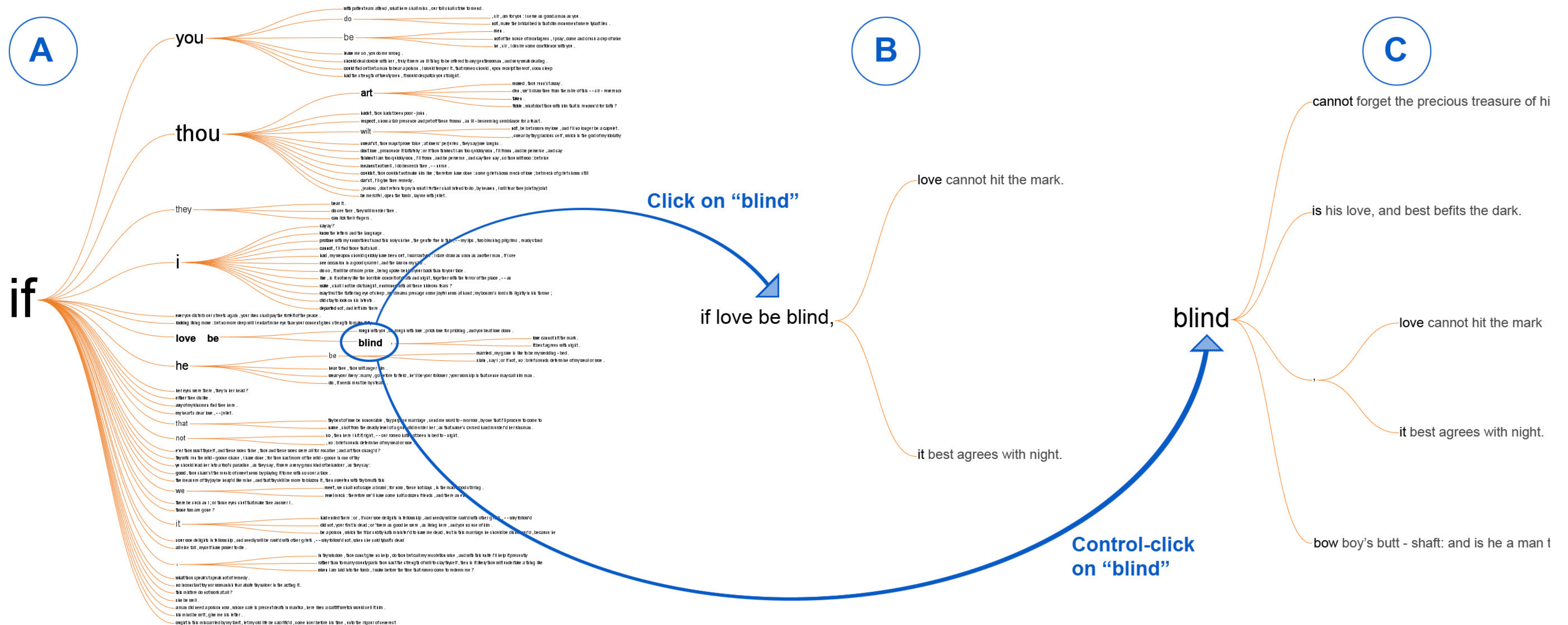
Text Visualization: Tag Cloud

- Derived data: number of occurrences of words
- Channel: Font size
- Potential problem: Amount of ink may not be proportional to occurrences...



[Scray, CC-BY-SA-3.0]

Word Tree



[Wattenberg & Viegas, 2007]

Poetry Analysis

Fed Drapes

Clark Coolidge

FELL FAR BUT THE BARN (came) up & smacked me
Who're you, bleeding? Fled.
Blat in back of a Vistrola Car
is so red is such that sun
fell in the rushes & pen bear appear

the white wrong numeral on the wall
can't take it off with the clock
down with the clock it ...
way
on the board - couch with brass, kindergarten clench joints
backed violet rip into the gas valve
it hemmed & snowed

the wrong way
remnant face
rubber
the pucker

Rhymes

Phonetic Rhymes

Character Clusters

Levenshtein Distance

Identical Rhyme/Rhyme Riche ● ● ● ● ● ● ● ● ● ●

Perfect Rhyme AAR AES
 ● ● ●
 AEKT

Semirhyme . . .

Syllabic Rhyme

Consonant Slant Rhyme ●●●●●●●●●●

Vowel Slant Rhyme ●●●●●●●**●**
OW₁

Pararhyme

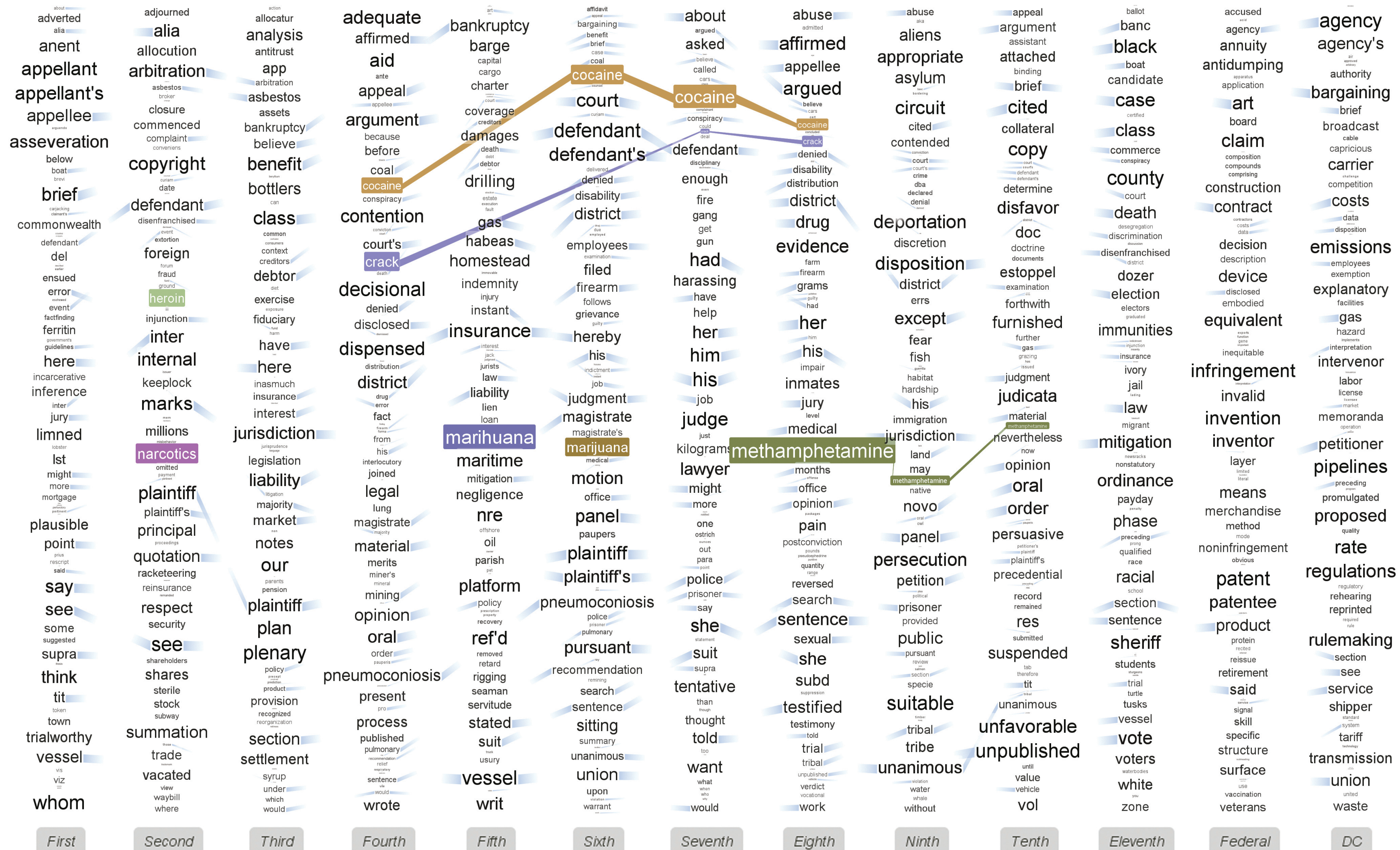
Eye Rhyme

Alliteration ● ● ● ● ● ● ● **KL₁** ● ● ● ● ●

Assonance ●●●●●●●●●●

[N. McCurdy et al., 2015]

Comparing Corpora: Parallel Tag Clouds



[Collins et al., 2009]

Project

- Presentations on **Thursday**:
 - Turn in code for the visualization to **Blackboard** by **Dec. 2 at 11:59pm**
 - **5 minutes** per presenter/group
 - Showcase the visualization (not slides)
 - **Brief** introduction to your data and questions
 - Discuss **design** decisions
 - **Demonstrate** the interactive features of your project
 - For groups, one person should drive but both can help present
- Have until Dec. 6 to turn in final code and report
- Note two assignments on Blackboard (one for presentation, one for report)

Final Exam

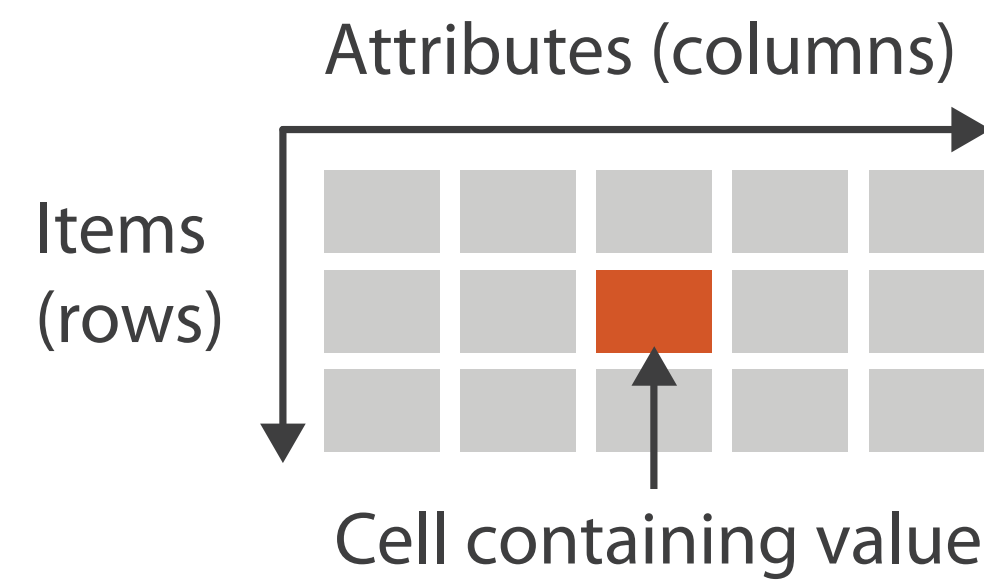
- December 10, 2020, 10-11:50am
- Covers all topics but emphasizes second half of the course
- Similar format as Midterm (multiple choice, free response)
- 627 Students will have a extra questions related to the research papers
- Questions?

“Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.”

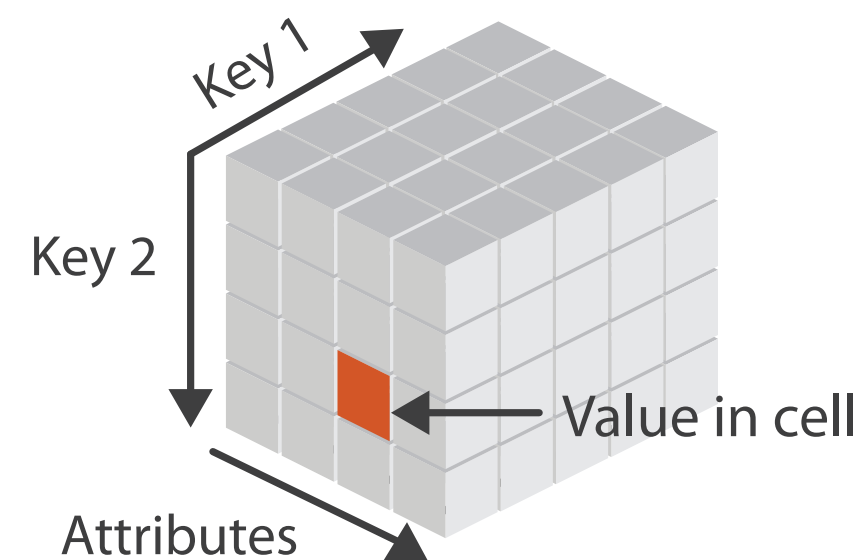
— T. Munzner

Dataset Types

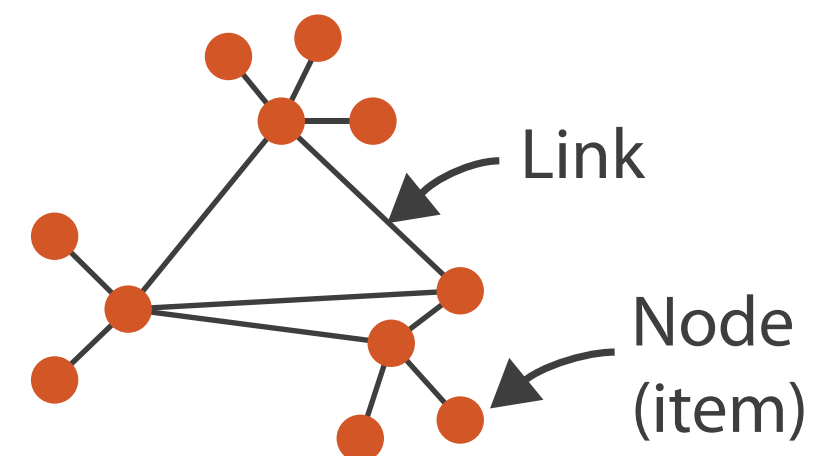
→ Tables



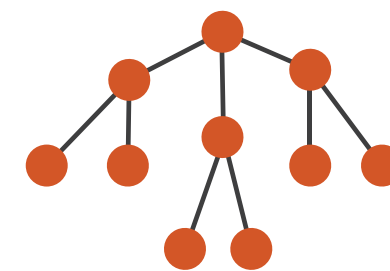
→ *Multidimensional Table*



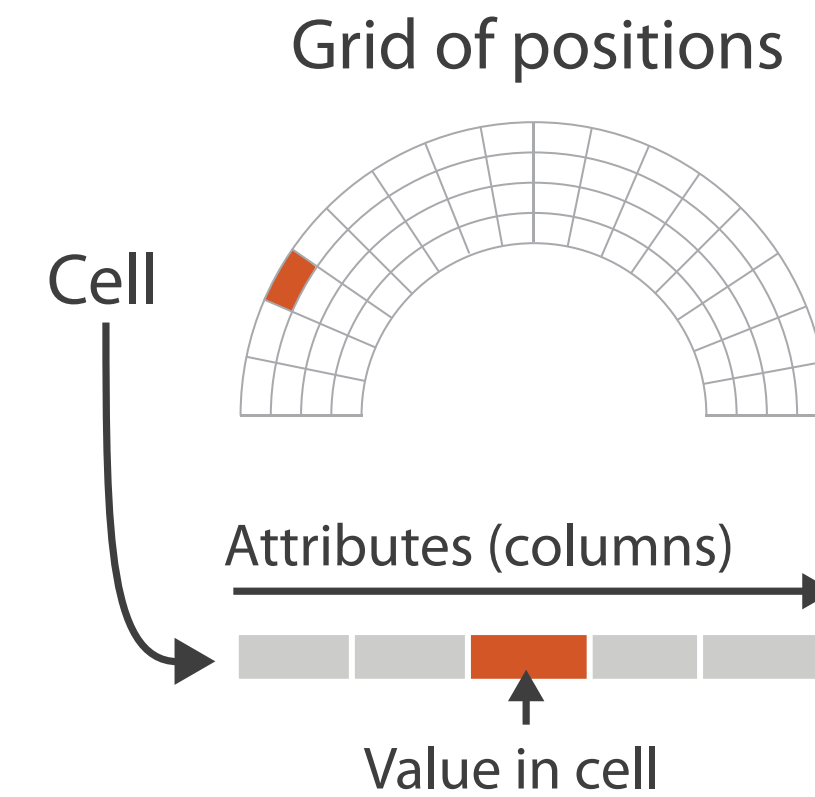
→ Networks



→ Trees



→ Fields (Continuous)



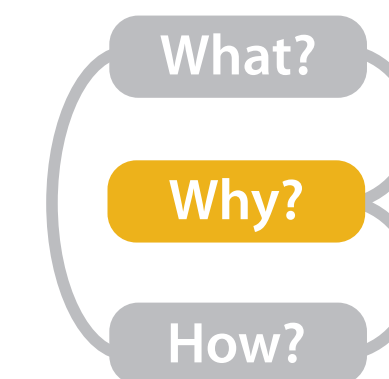
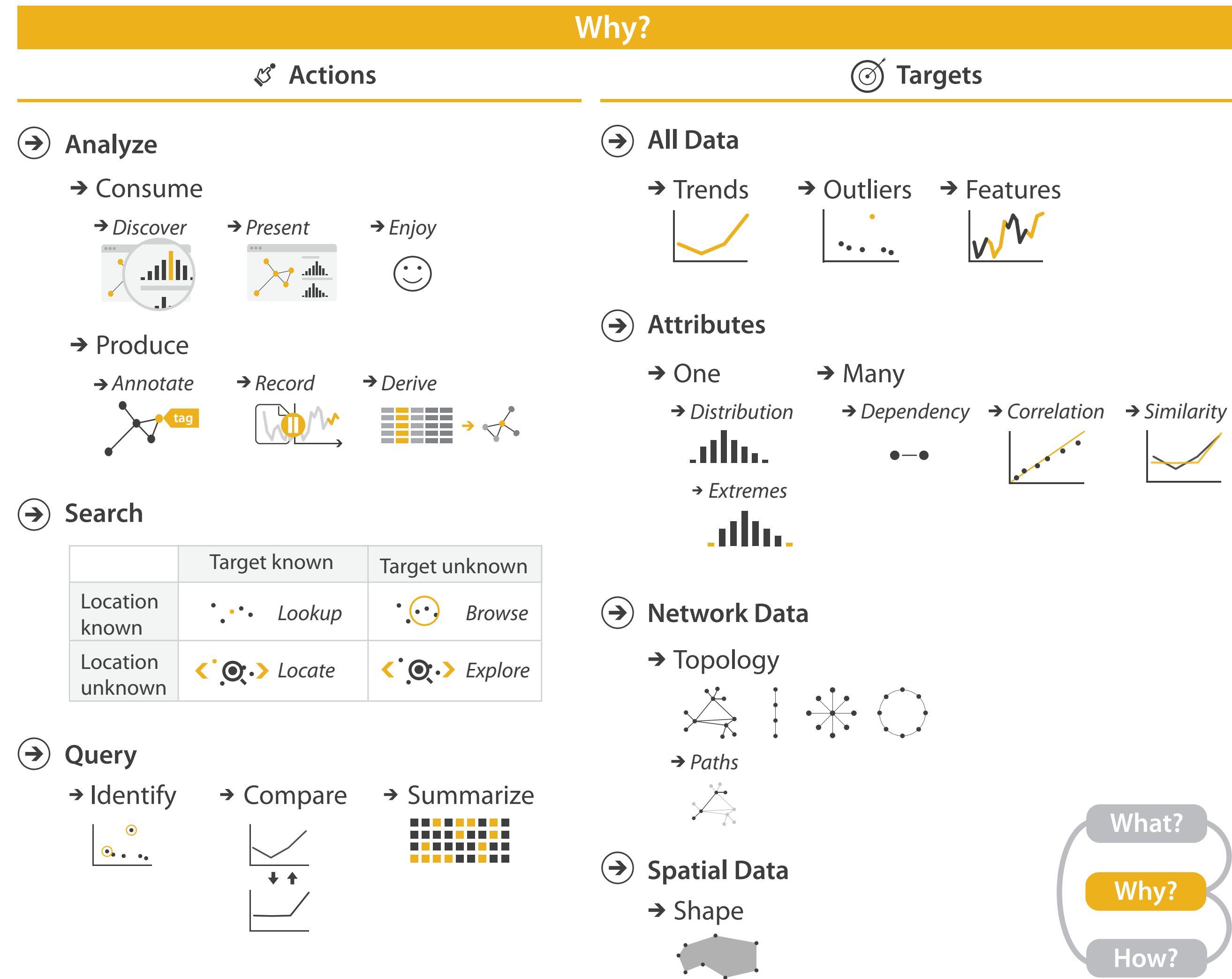
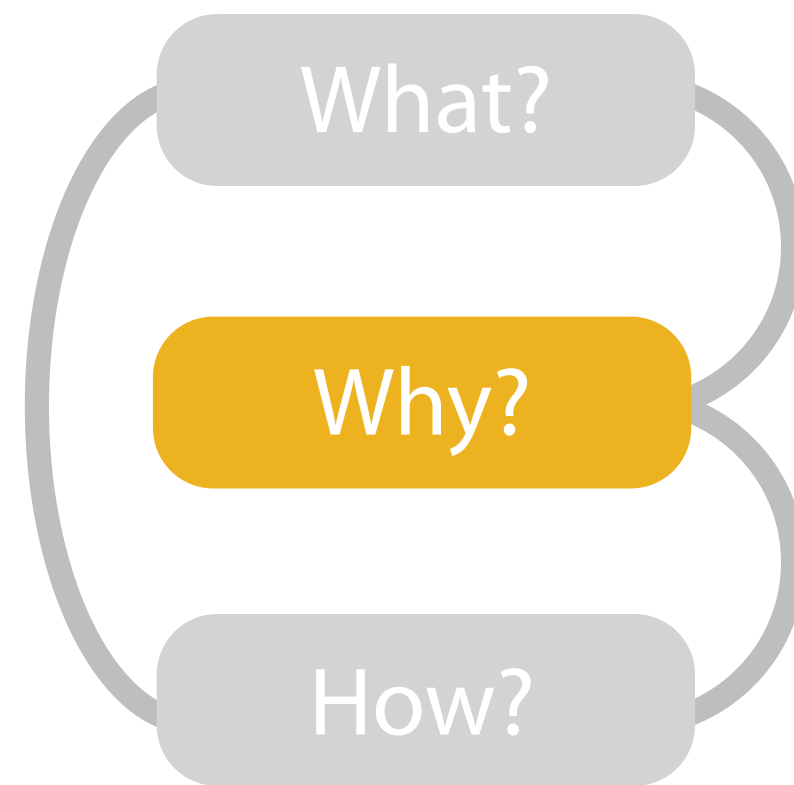
+ Sets
+ Text

→ Geometry (Spatial)



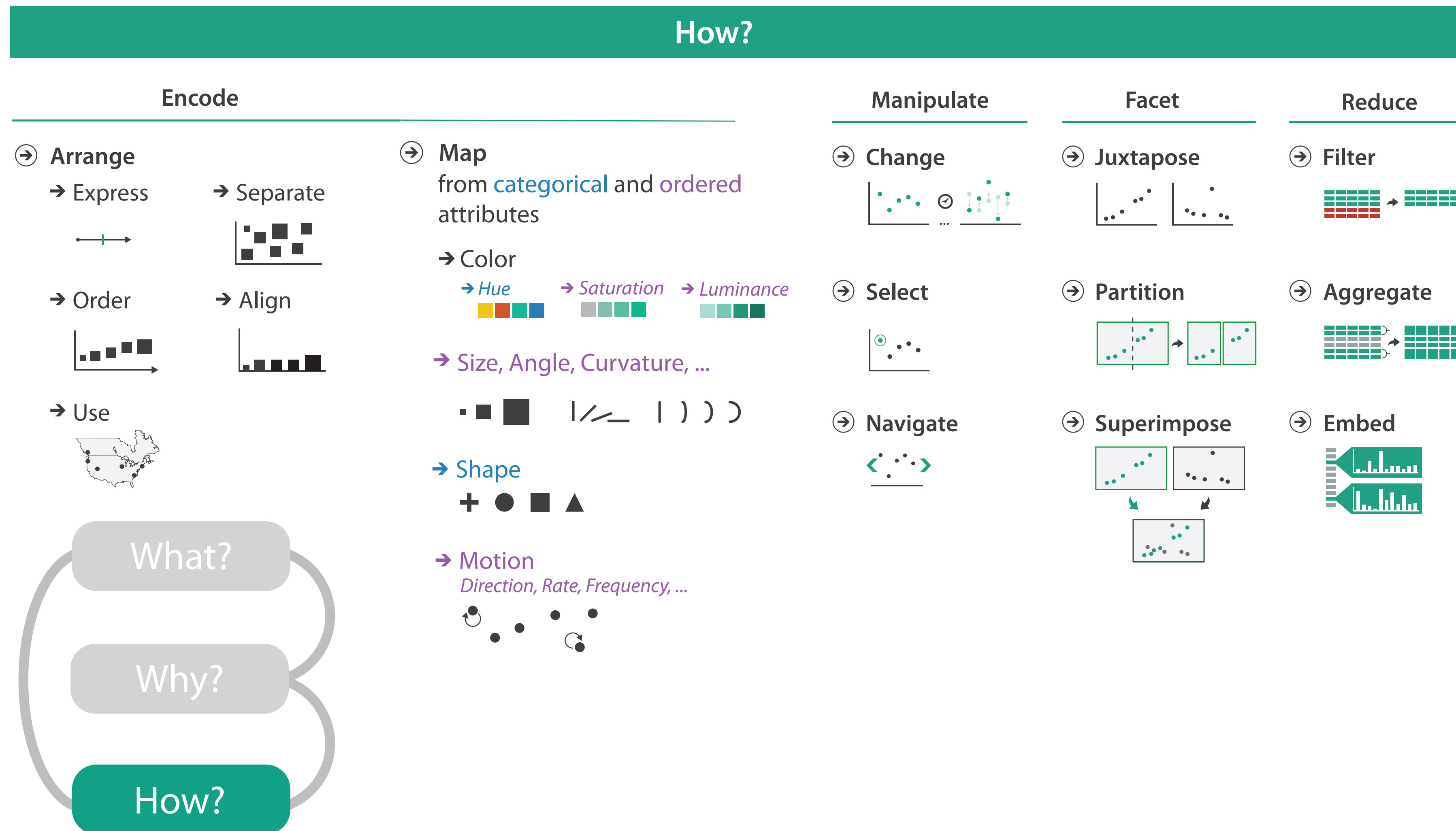
[Munzner (ill. Maguire), 2014]

Tasks



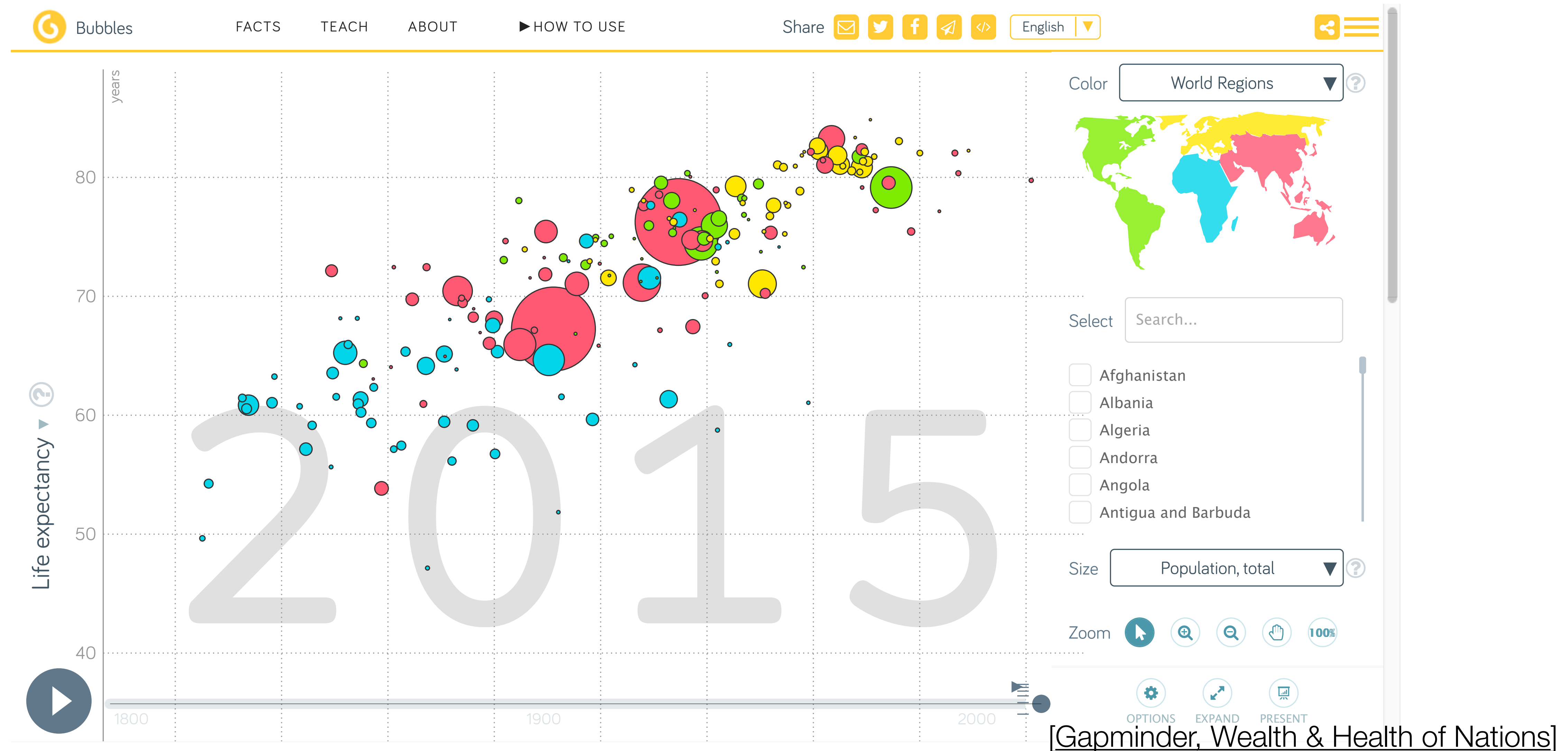
[Munzner (ill. Maguire), 2014]

How do we do visualization?



[Munzner (ill. Maguire), 2014]

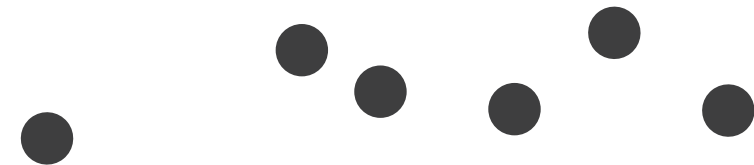
Visual Encoding



Visual Encoding

- How do we encode data visually?
 - **Marks** are the basic graphical elements in a visualization
 - **Channels** are ways to control the appearance of the marks
- Marks classified by dimensionality:

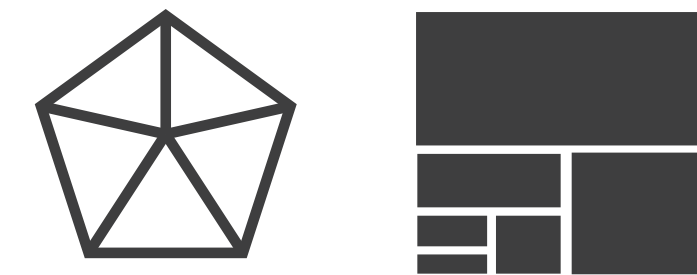
➞ **Points**



➞ **Lines**



➞ **Areas**



- Also can have surfaces, volumes
- Think of marks as a mathematical definition, or if familiar with tools like Adobe

Channels by Effectiveness

Channels: Expressiveness Types and Effectiveness Ranks

➔ **Magnitude** Channels: **Ordered** Attributes



➔ **Identity** Channels: **Categorical** Attributes



[Munzner (ill. Maguire), 2014]

Design

 **Domain situation**
You misunderstood their needs

 **Data/task abstraction**
You're showing them the wrong thing

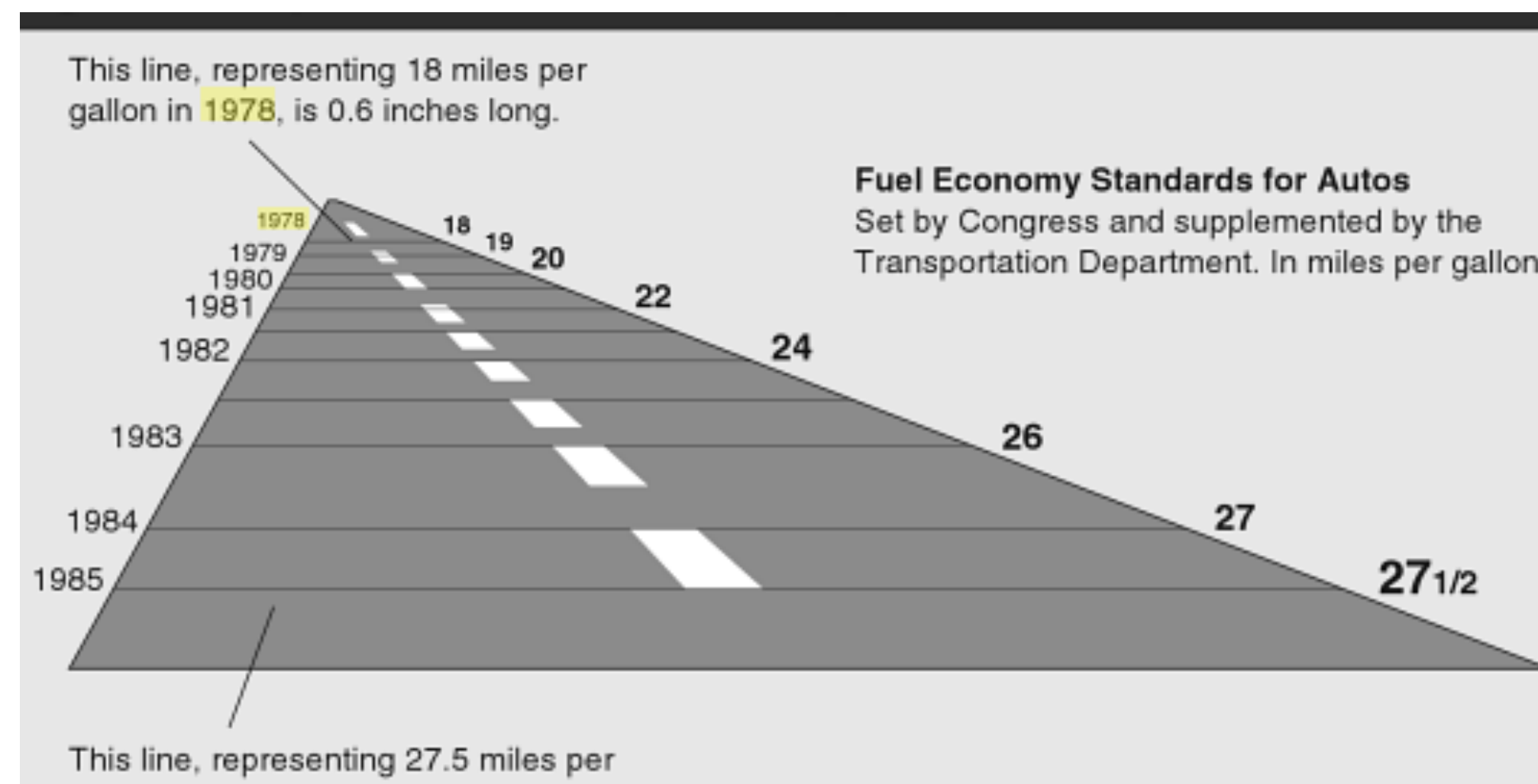
 **Visual encoding/interaction idiom**
The way you show it doesn't work

 **Algorithm**
Your code is too slow

[Munzner (ill. Maguire), 2014]

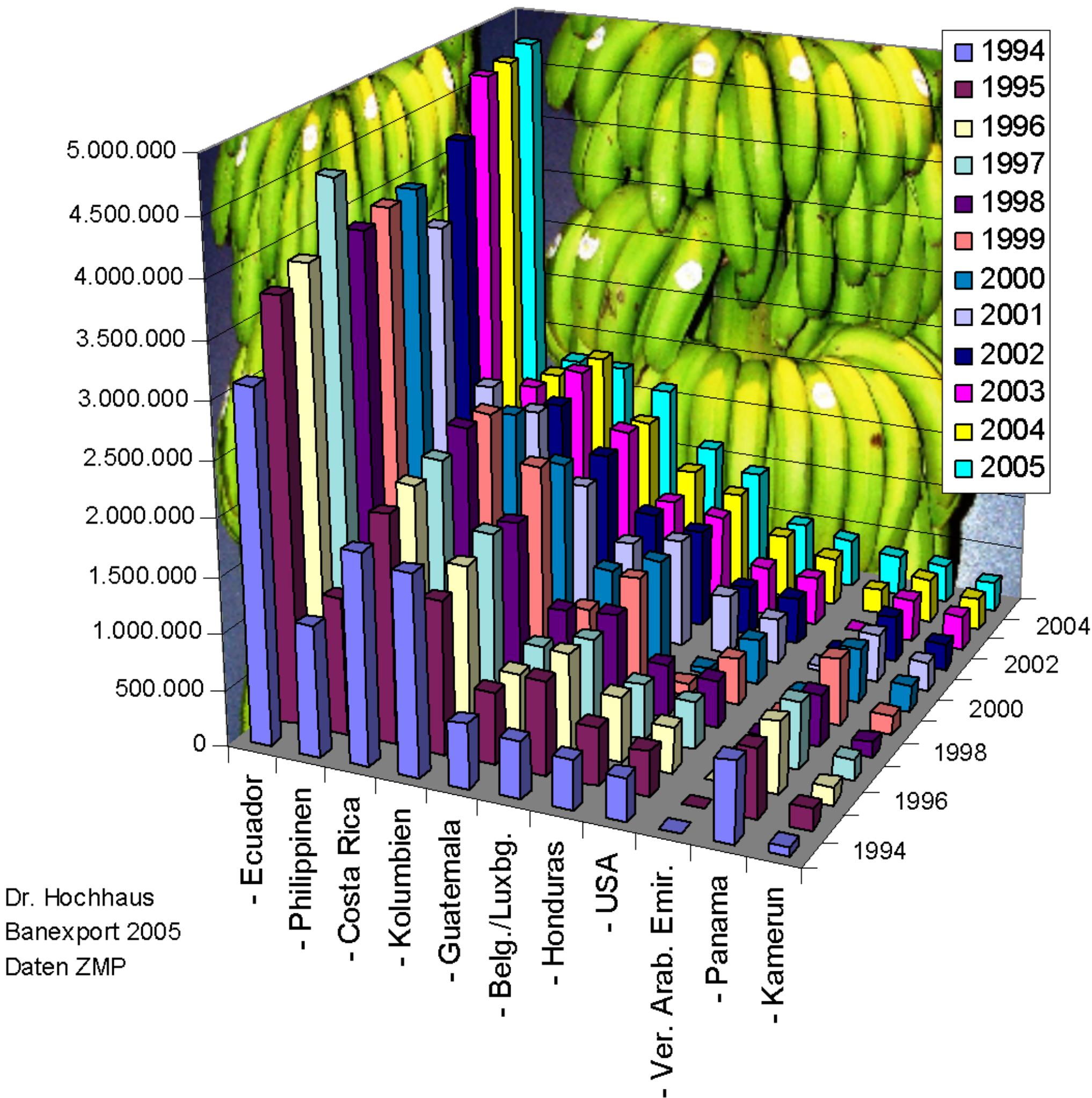
Design Guidelines

- Tufte:
 - Show data variation, not design variation
 - Clear, detailed, and thorough labeling and appropriate scales
 - Size of the graphic effect should be directly proportional to the numerical quantities ("lie factor")

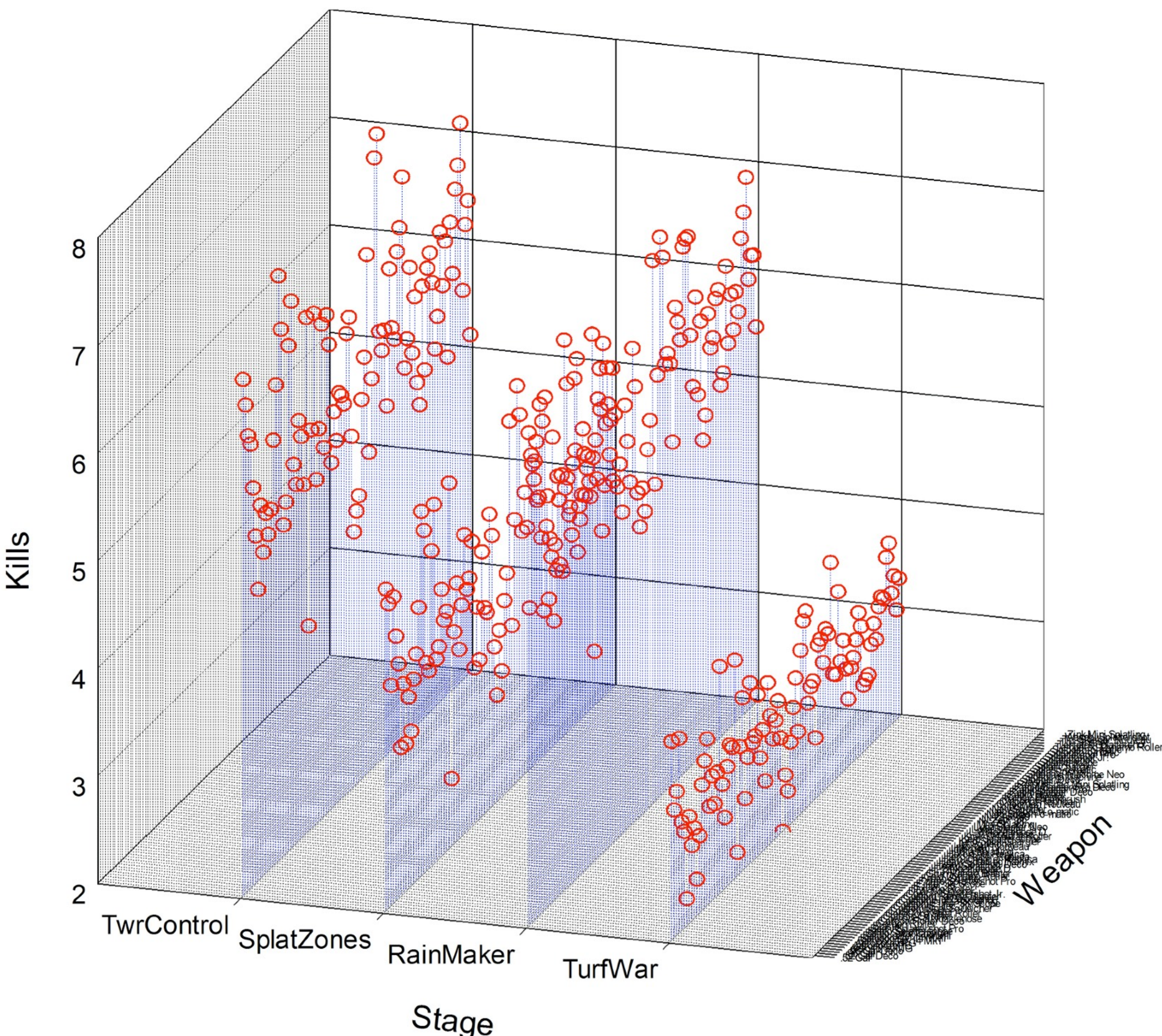


Design Analysis: What is Wrong Here?

Export von Bananen in Tonnen von 1994-2005



3D Category Scatter



D3

- <http://d3js.org/>
- Supports data as a core piece of Web elements
 - **Correspondence** between data and DOM elements
 - Dealing with changing data (joins, enter/update/exit)
 - Data drives the marks and channels
- Selections (similar to CSS) that allow greater manipulation
- Integrated layout algorithms, axes calculations, etc.
- Focus on interaction support
 - Straightforward support for transitions
 - Event handling support for user-initiated changes

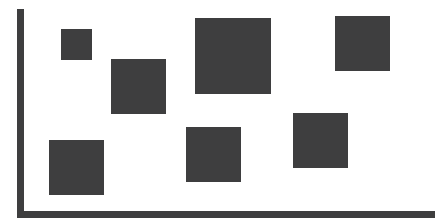
Arrange Tables

➔ Express Values

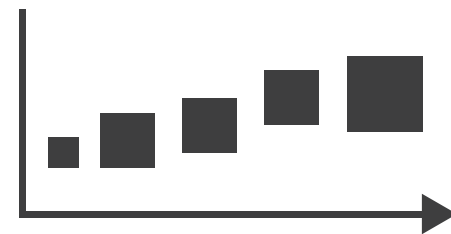


➔ Separate, Order, Align Regions

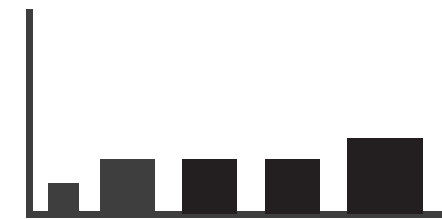
➔ Separate



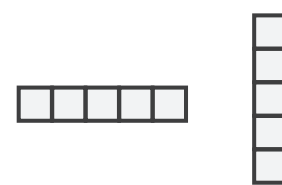
➔ Order



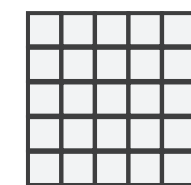
➔ Align



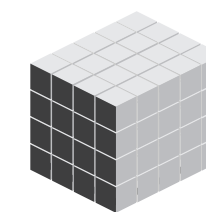
➔ 1 Key
List



➔ 2 Keys
Matrix



➔ 3 Keys
Volume

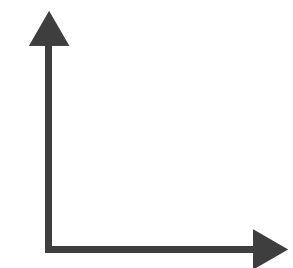


➔ Many Keys
Recursive Subdivision



➔ Axis Orientation

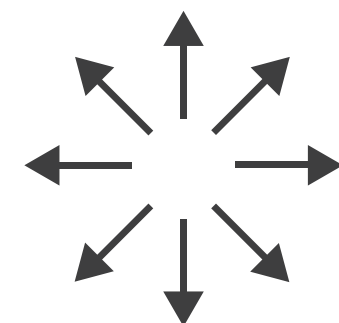
➔ Rectilinear



➔ Parallel

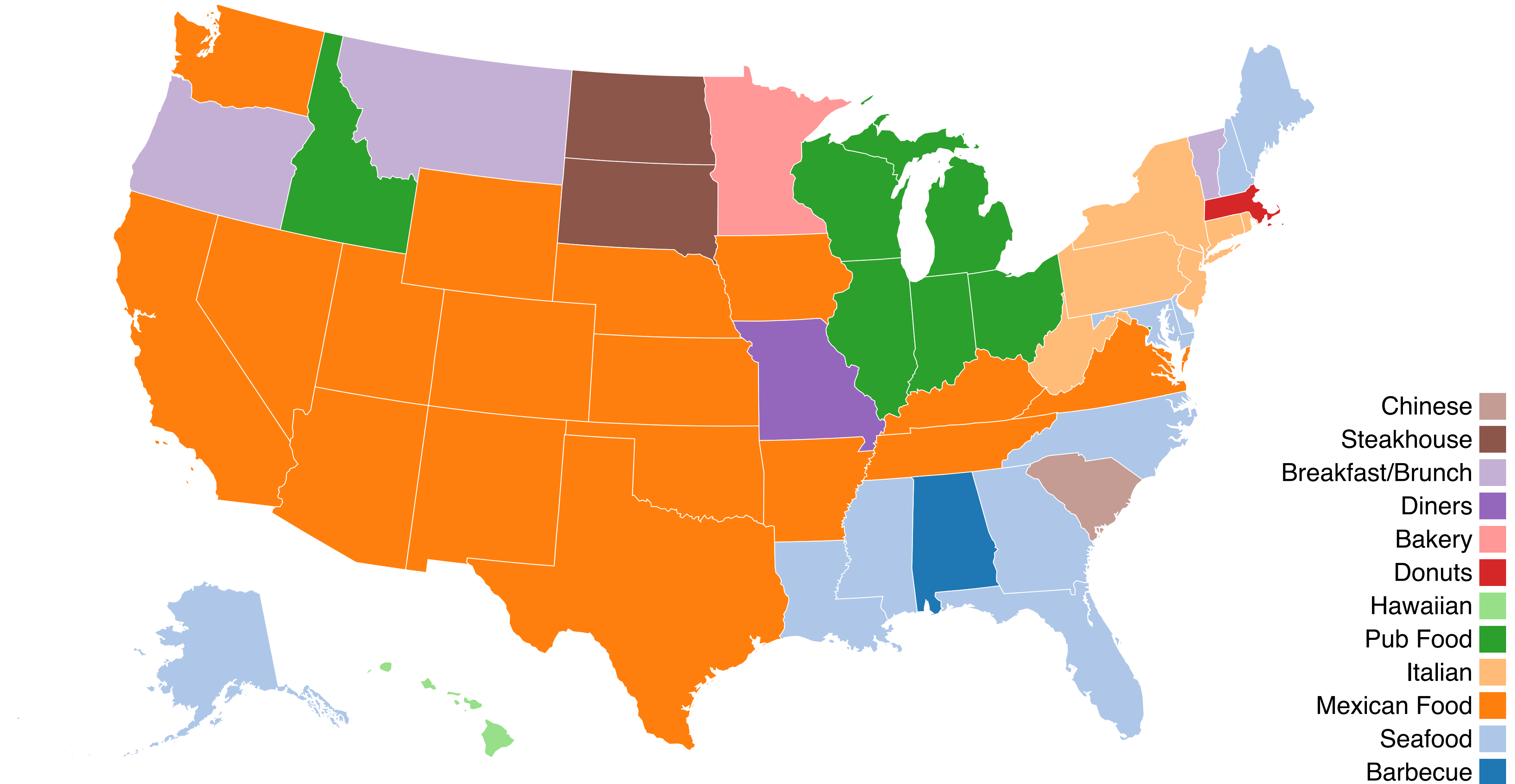


➔ Radial

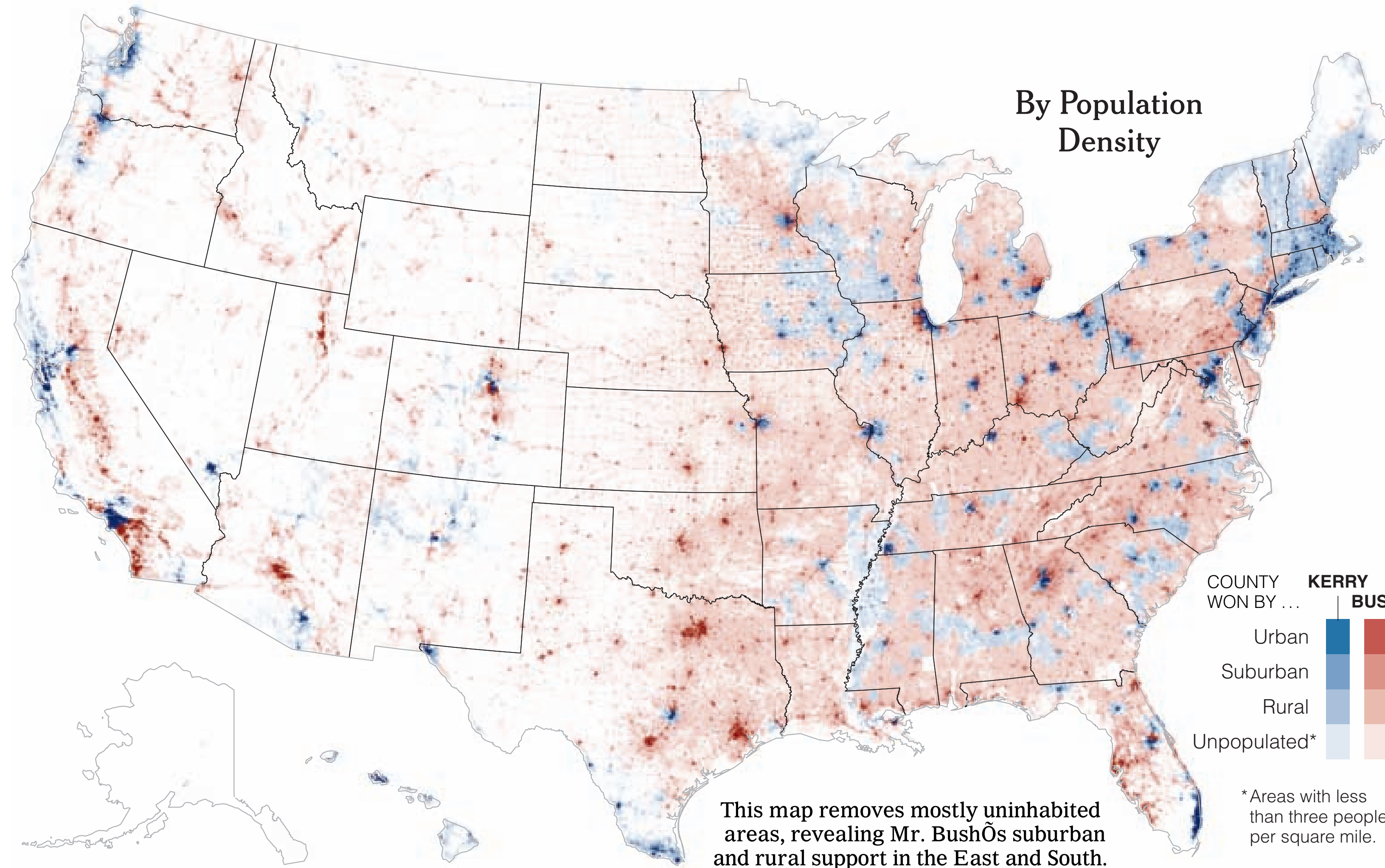


[Munzner (ill. Maguire), 2014]

Categorical Map

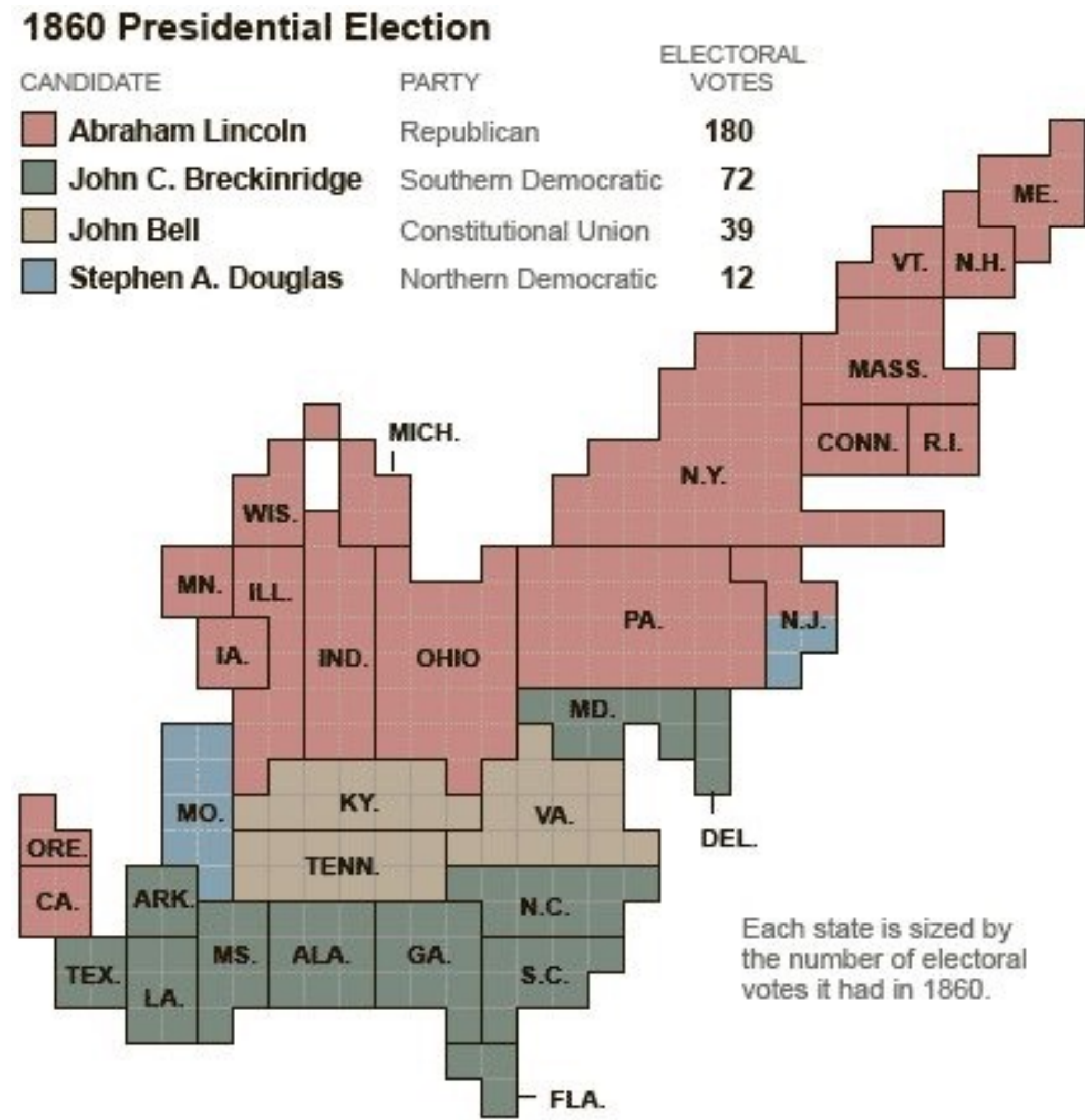


Map with Two Variables



[M. Ericson, New York Times]

Rectangular Cartogram

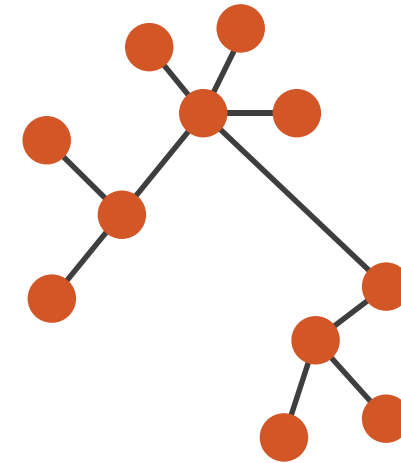


[New York Times]

Arrange Networks and Trees

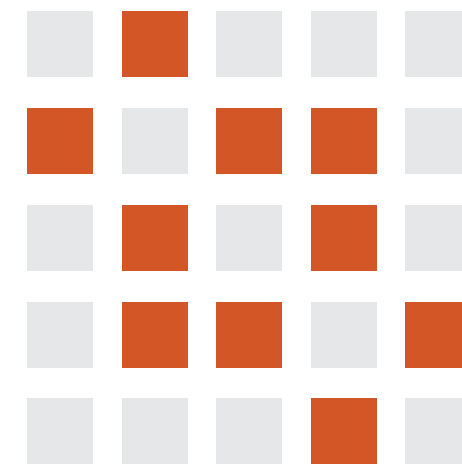
➔ Node–Link Diagrams Connection Marks

✓ NETWORKS ✓ TREES



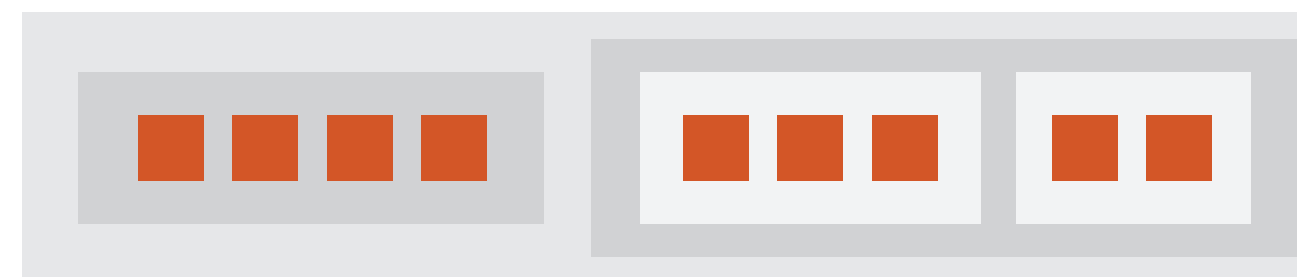
➔ Adjacency Matrix Derived Table

✓ NETWORKS ✓ TREES



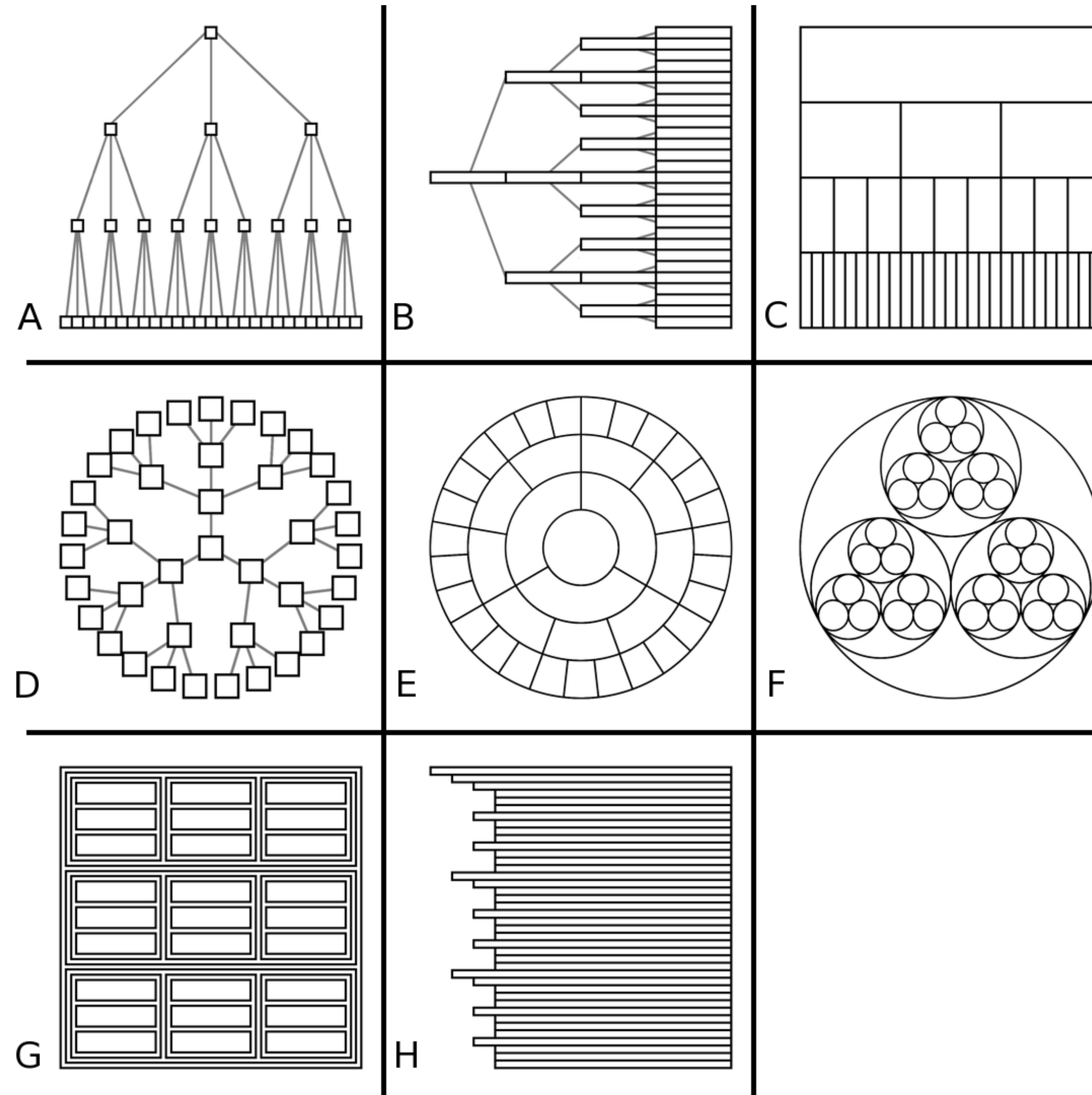
➔ Enclosure Containment Marks

✗ NETWORKS ✓ TREES



[Munzner (ill. Maguire), 2014]

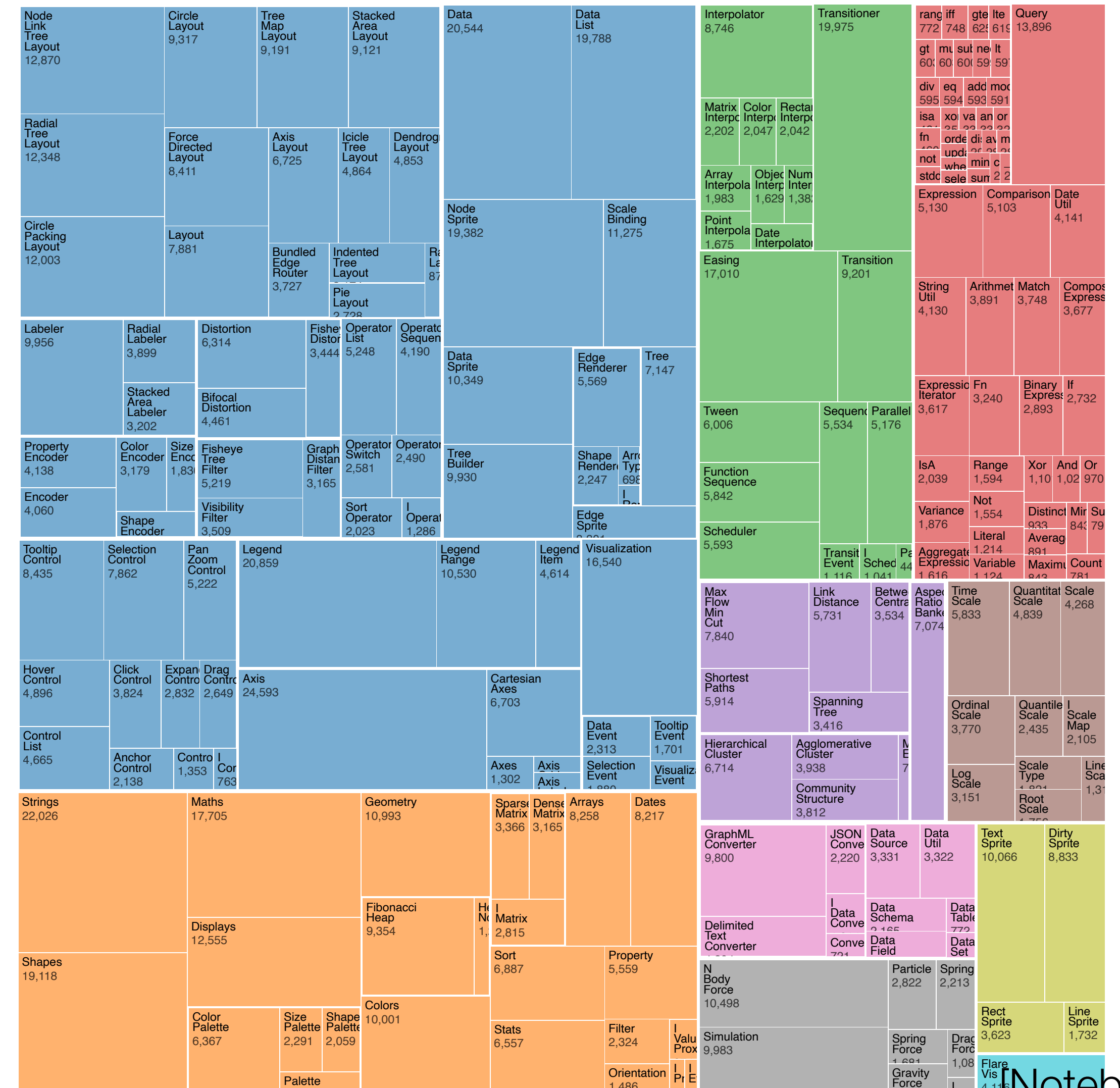
Tree Visualizations



[McGuffin and Robert, 2010]

Treemaps

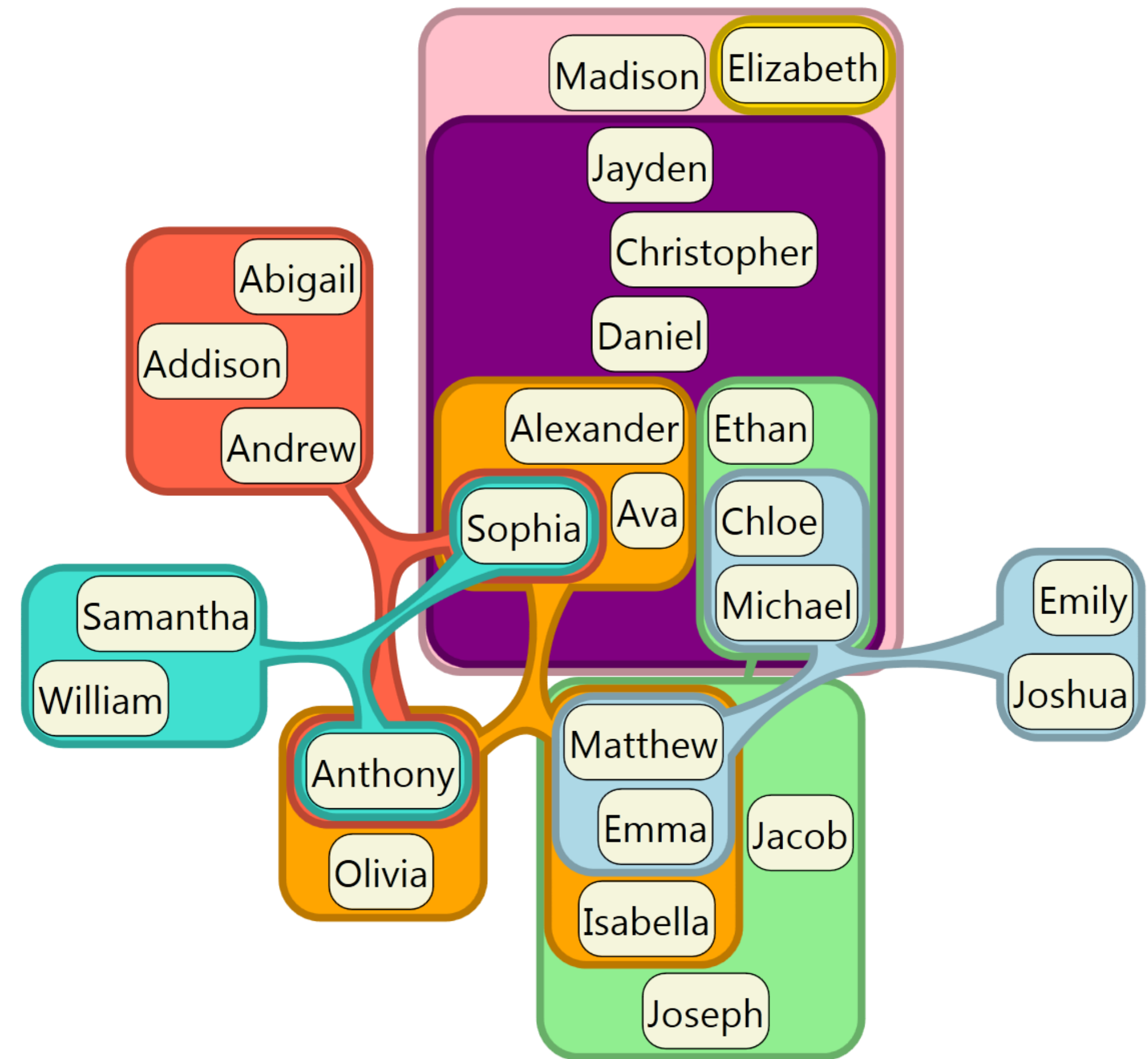
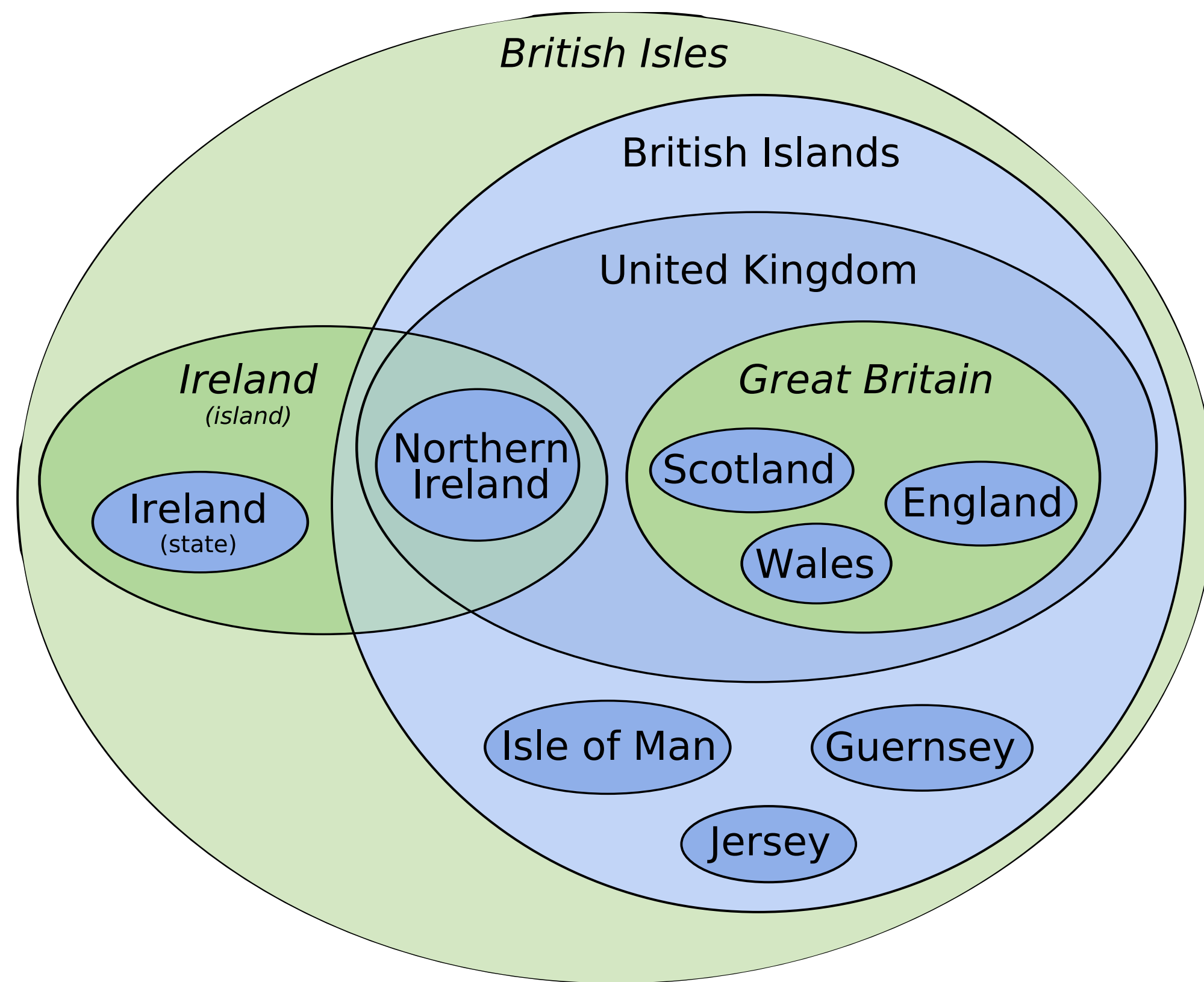
- Containment marks instead of connection marks
- Encodes some attribute of the items as the **size** of the rectangles
- Not as easy to see the intermediate rectangles
- Scalability: millions of leaf nodes and links possible
- Need a layout algorithm!
 - Slice-and-Dice vs. Squarify
 - Viewing Hierarchy: Cushion Treemap



[Notebook]

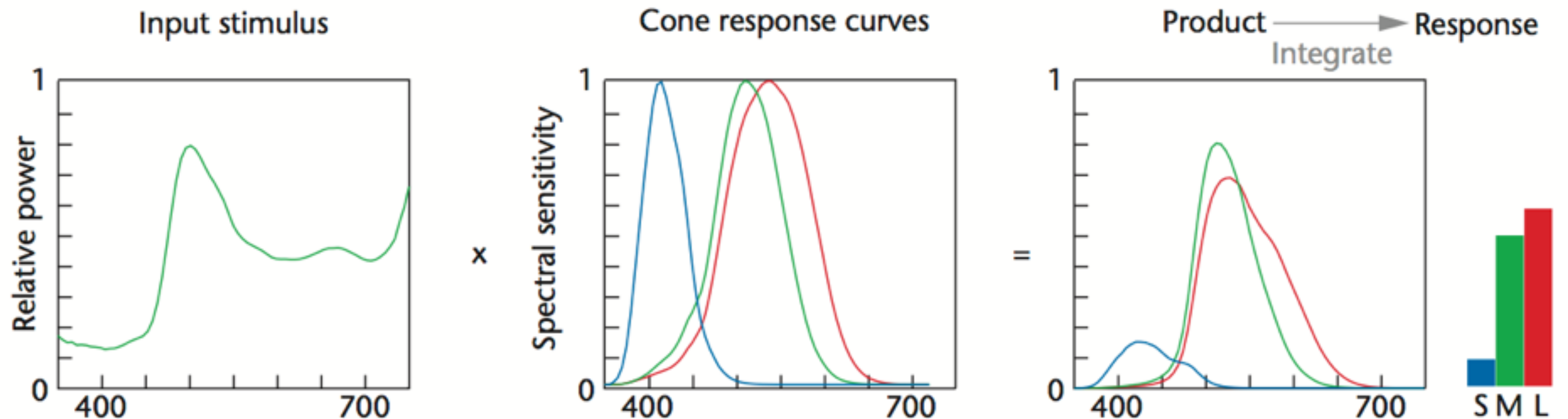
Set Visualizations

- How to show the intersection of sets?



[Wikipedia]

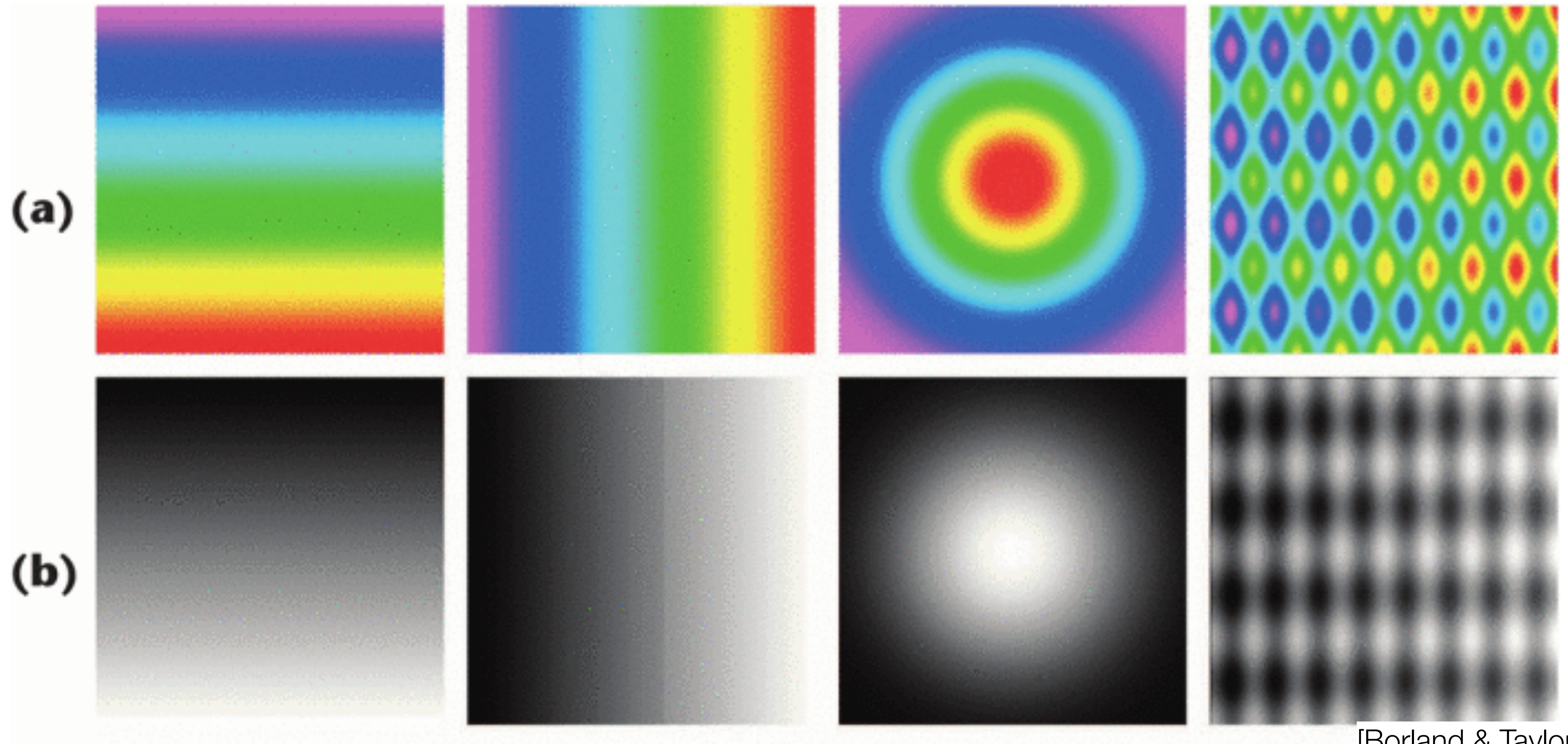
Human Color Perception



Metamerism: same three responses == same color

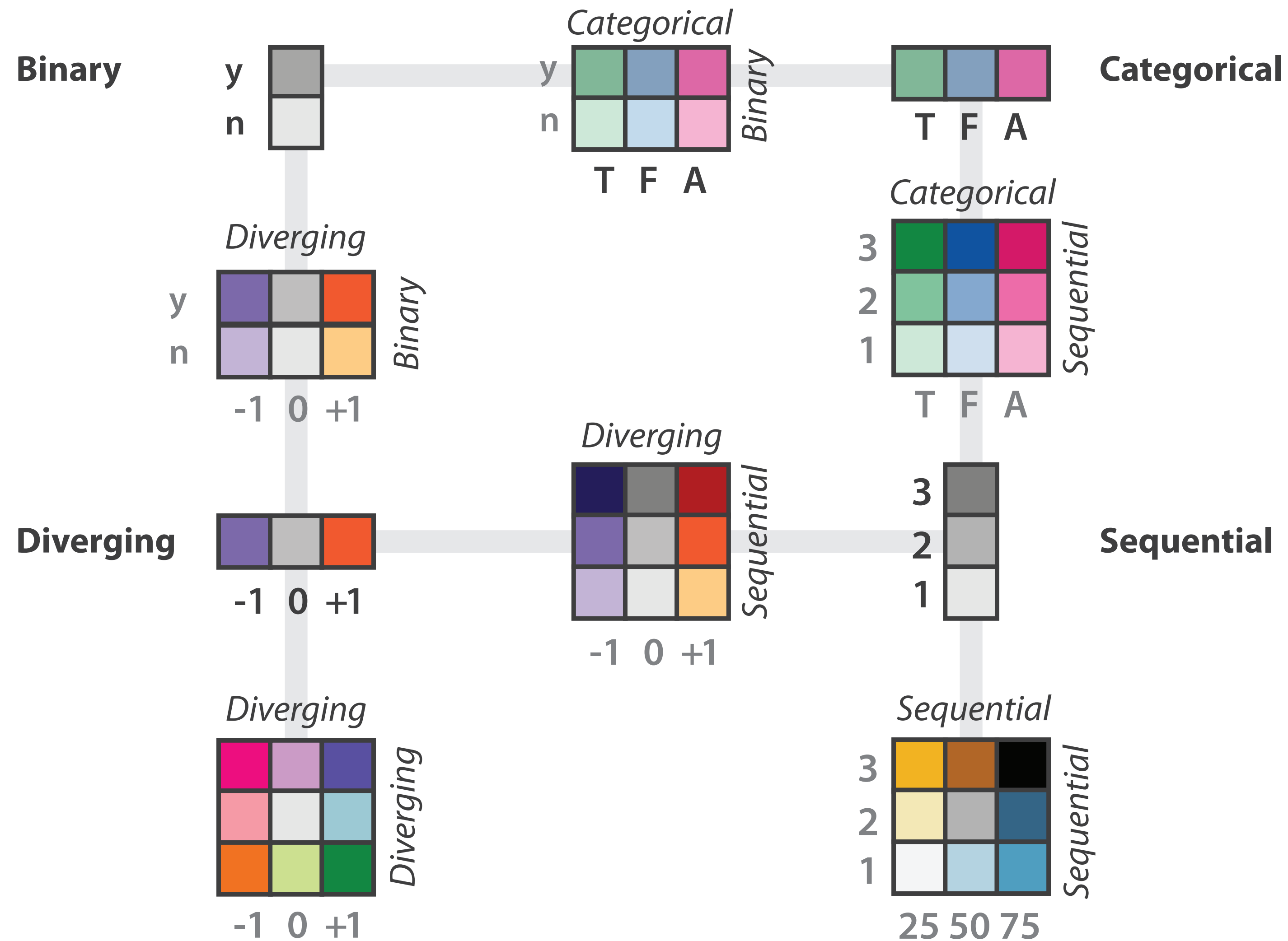
[via M. Meyer]

Avoid Rainbow Colormaps!



[Borland & Taylor, 2007]

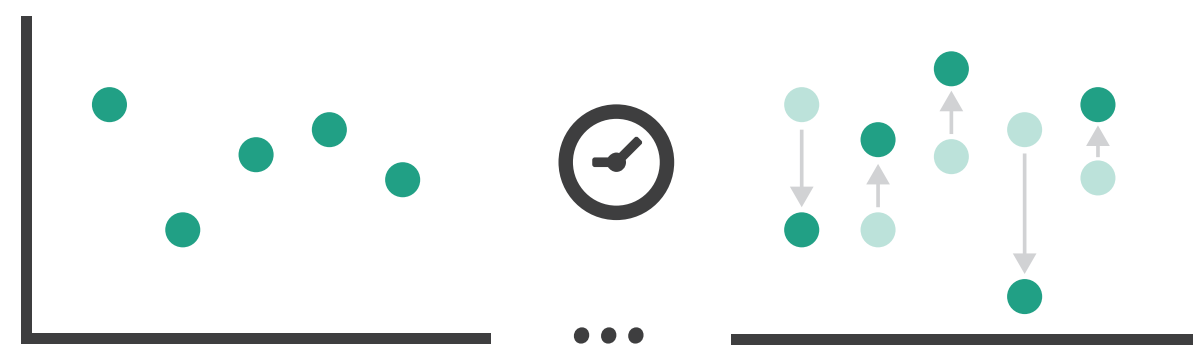
Colormaps



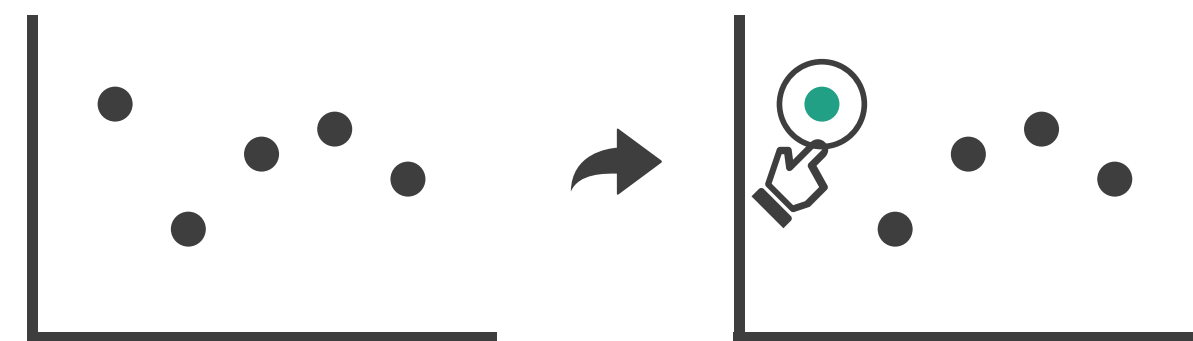
[Munzner (ill. Maguire), 2014]

Interaction Overview

→ Change over Time



→ Select

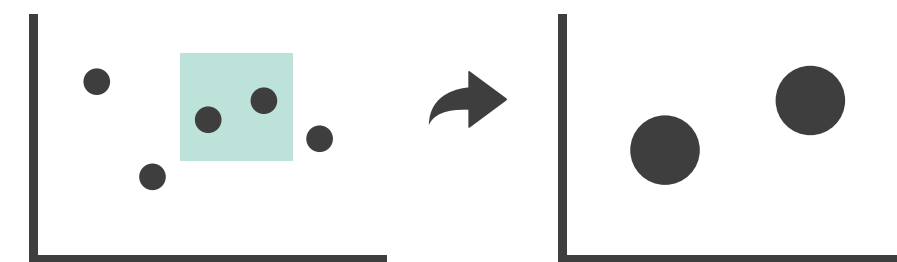


→ Navigate

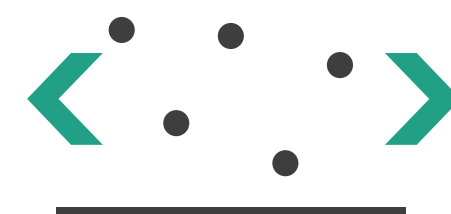
→ Item Reduction

→ Zoom

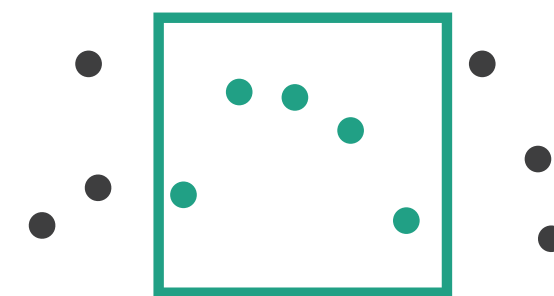
Geometric or *Semantic*



→ Pan/Translate

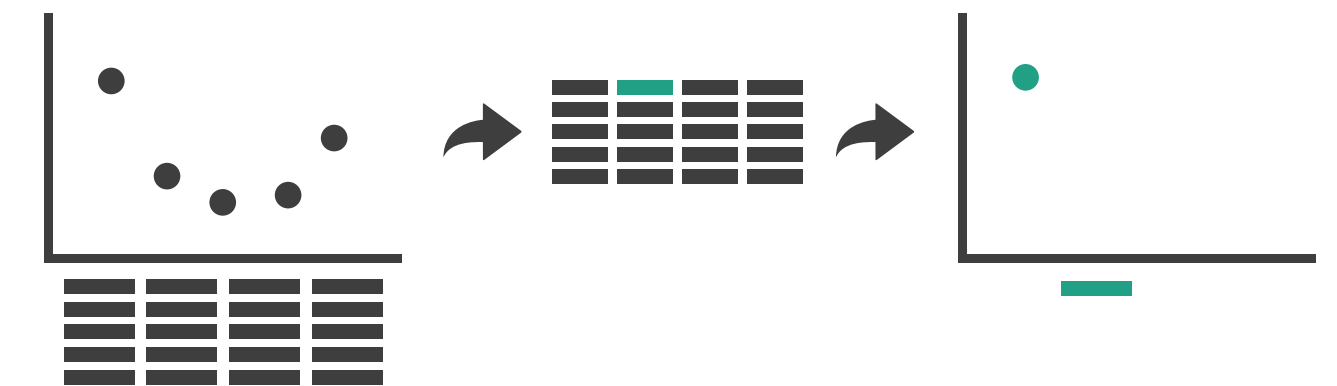


→ Constrained

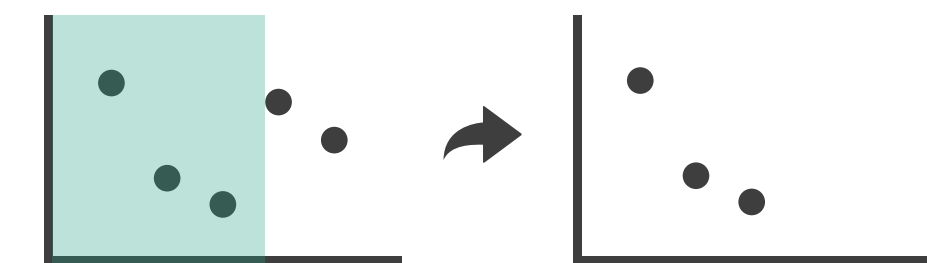


→ Attribute Reduction

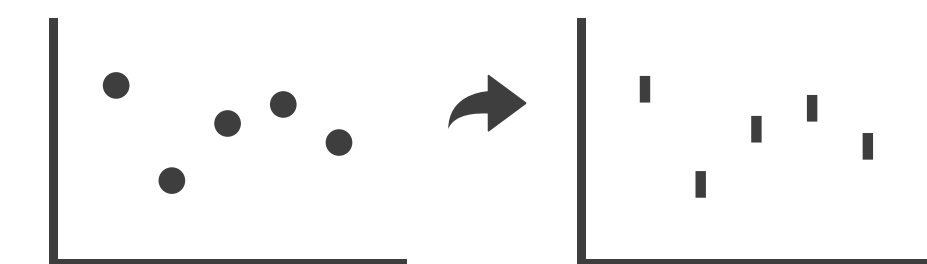
→ Slice



→ Cut

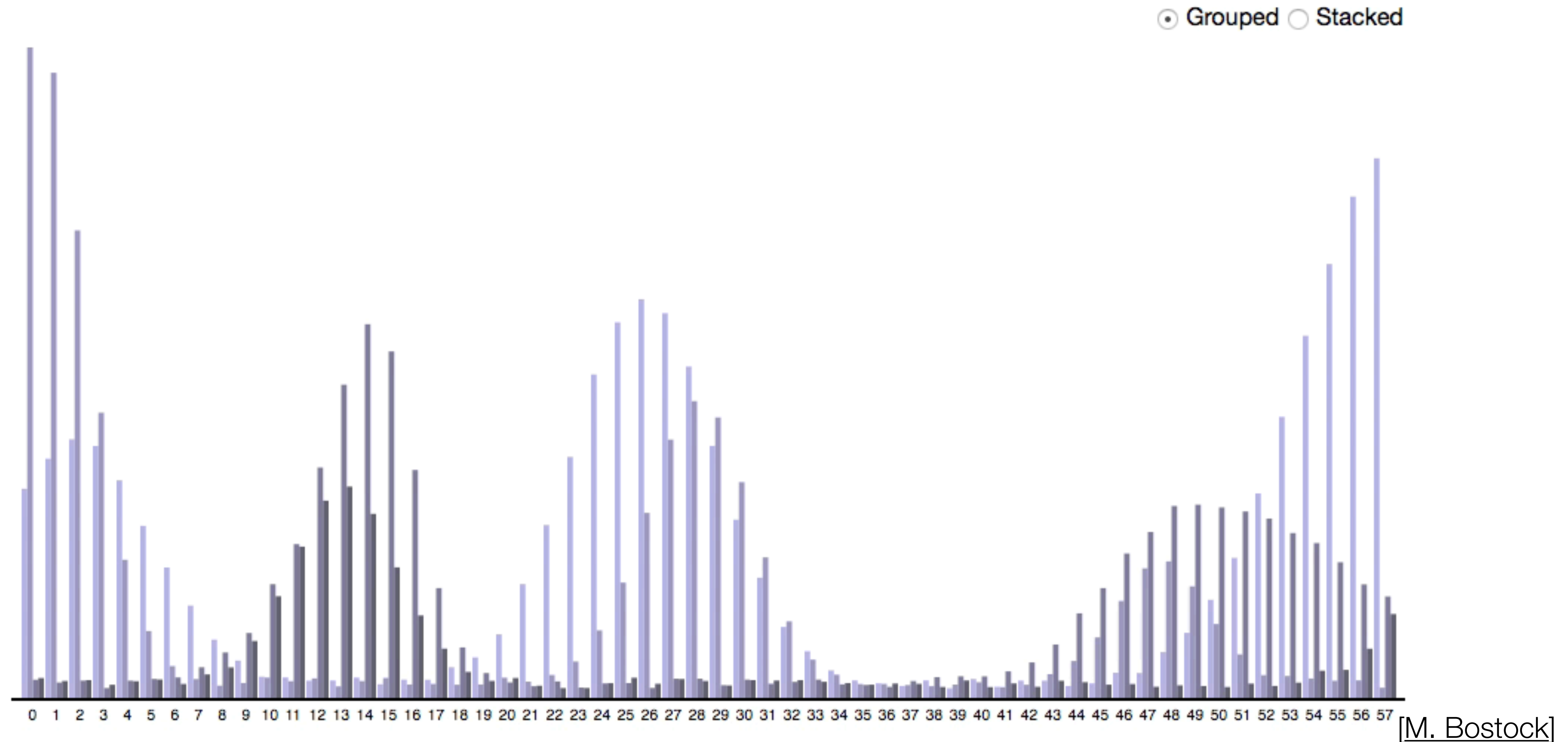


→ Project

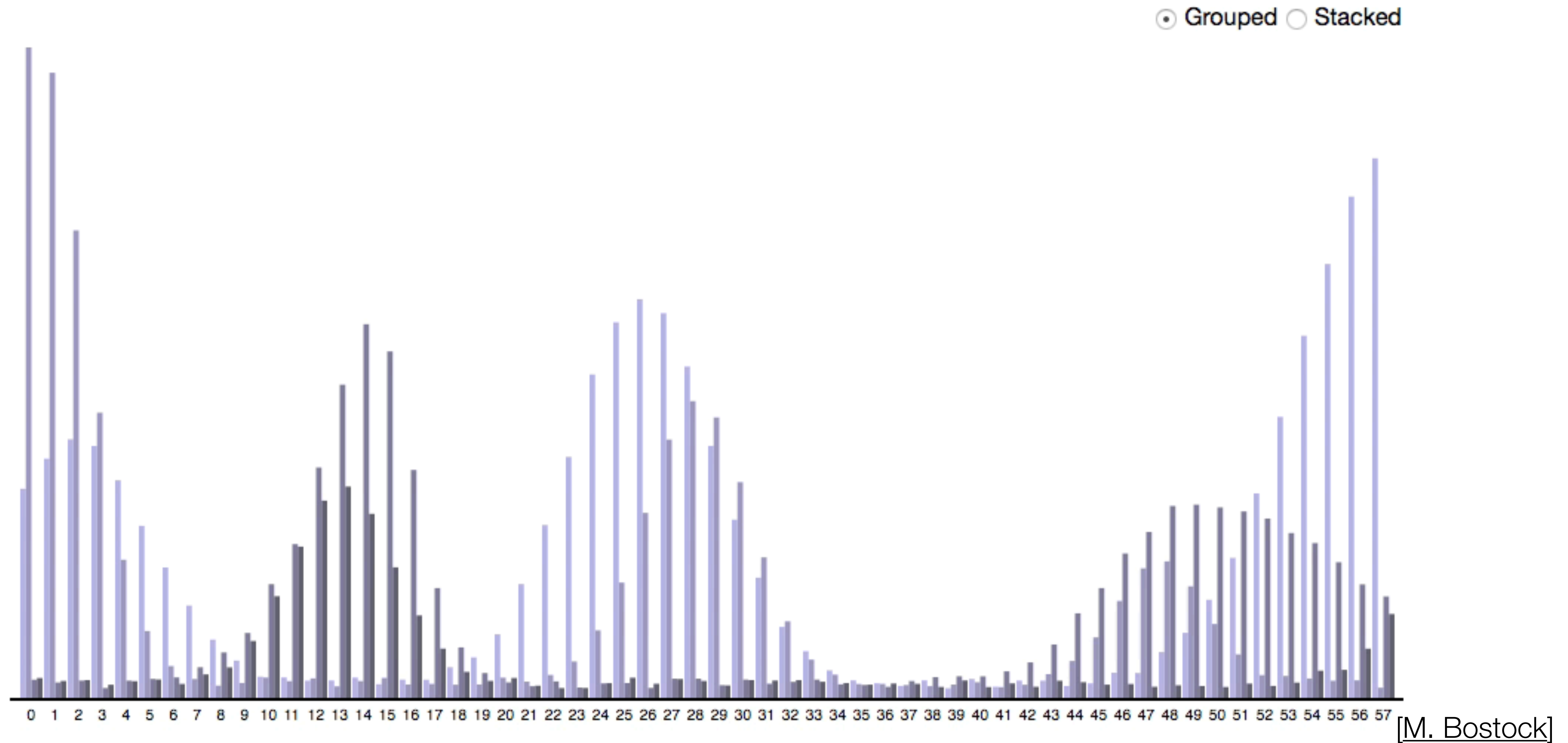


[Munzner (ill. Maguire), 2014]

Staged Animated Transitions



Staged Animated Transitions



Multiple Views

➔ Juxtapose and Coordinate Multiple Side-by-Side Views

➔ Share Encoding: Same/Different

➔ *Linked Highlighting*

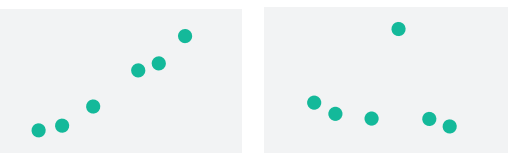


➔ Share Data: All/Subset/None

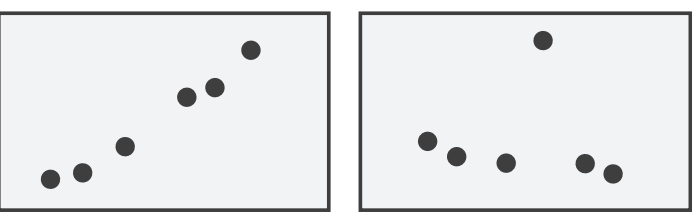


➔ Share Navigation

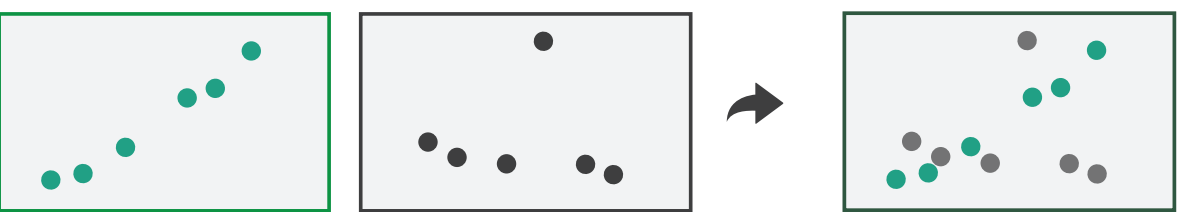


		Data		
		All	Subset	None
Encoding	Same	Redundant	 Overview/ Detail	 Small Multiples
	Different	 Multiform	 Multiform, Overview/ Detail	No Linkage

➔ Partition into Side-by-Side Views



➔ Superimpose Layers



[Munzner (ill. Maguire), 2014]

Filtering and Aggregation

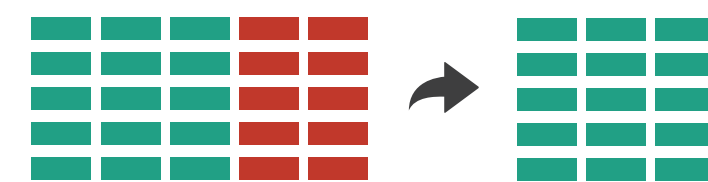
Reducing Items and Attributes

➔ Filter

➔ Items

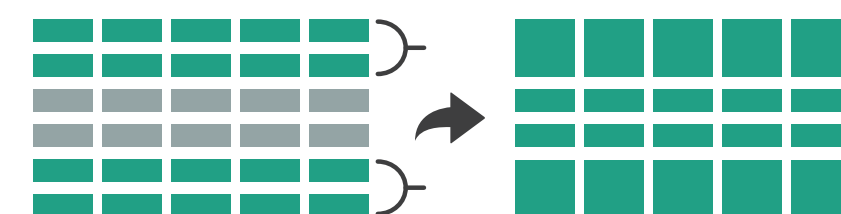


➔ Attributes

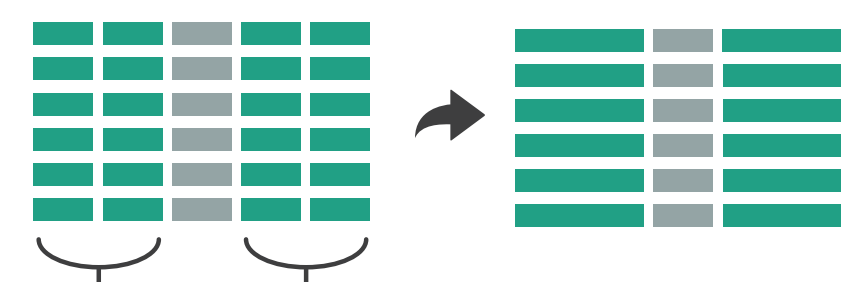


➔ Aggregate

➔ Items



➔ Attributes



Reduce

➔ Filter



➔ Aggregate



➔ Embed



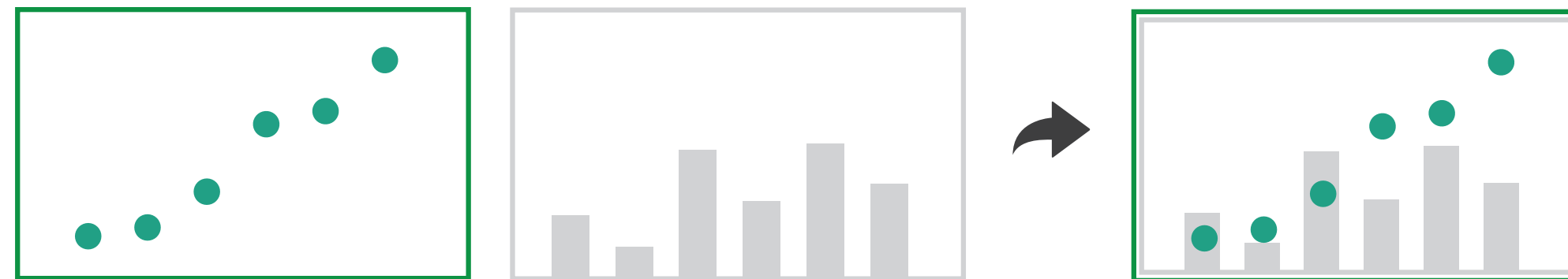
Focus+Content

➔ Embed

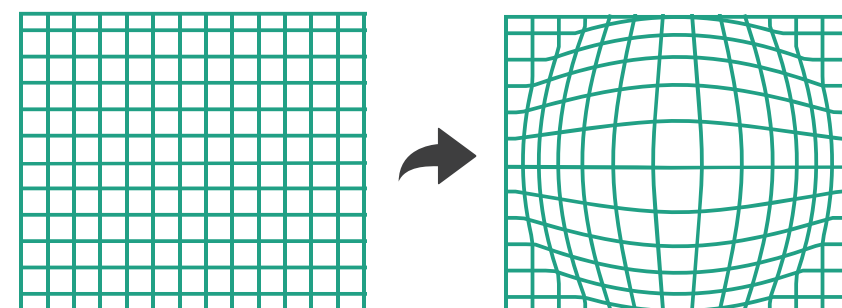
➔ Elide Data



➔ Superimpose Layer



➔ Distort Geometry



Reduce

➔ Filter



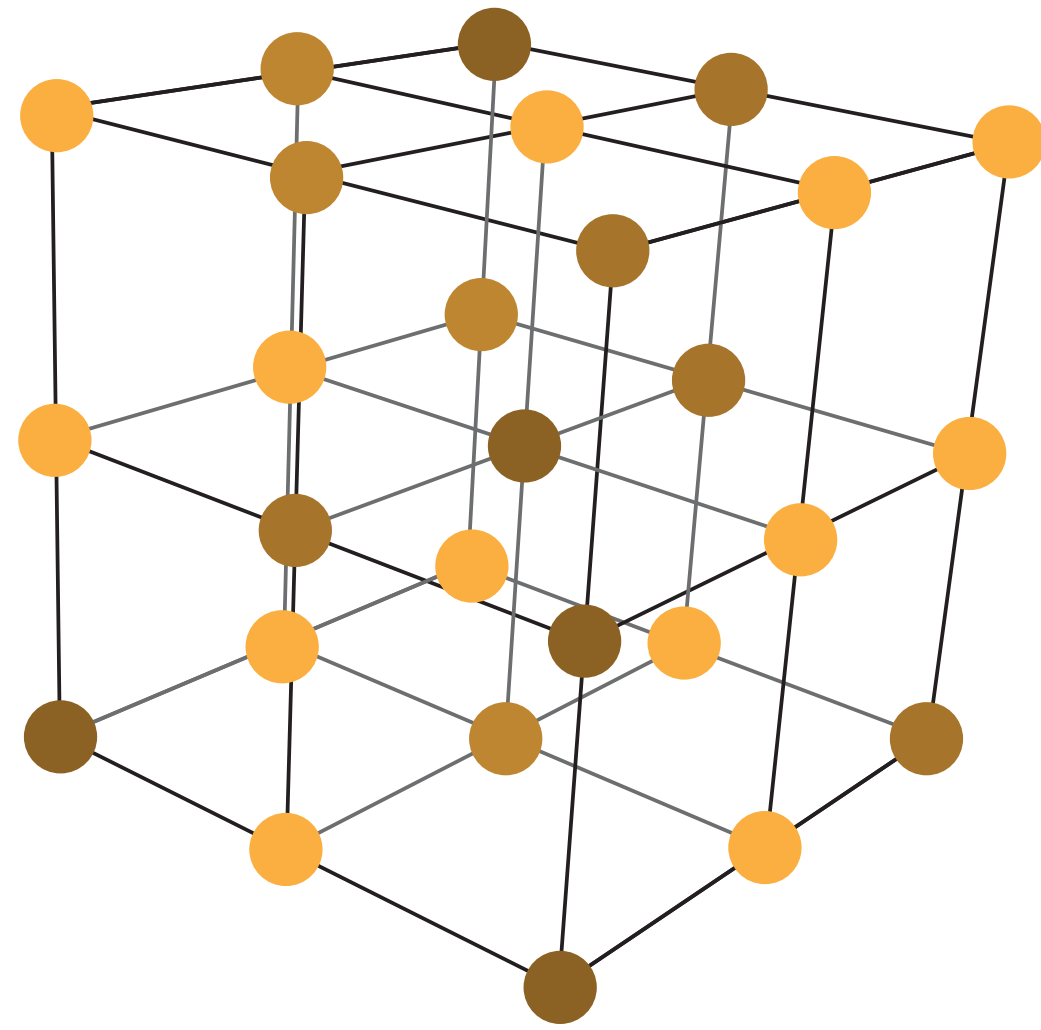
➔ Aggregate



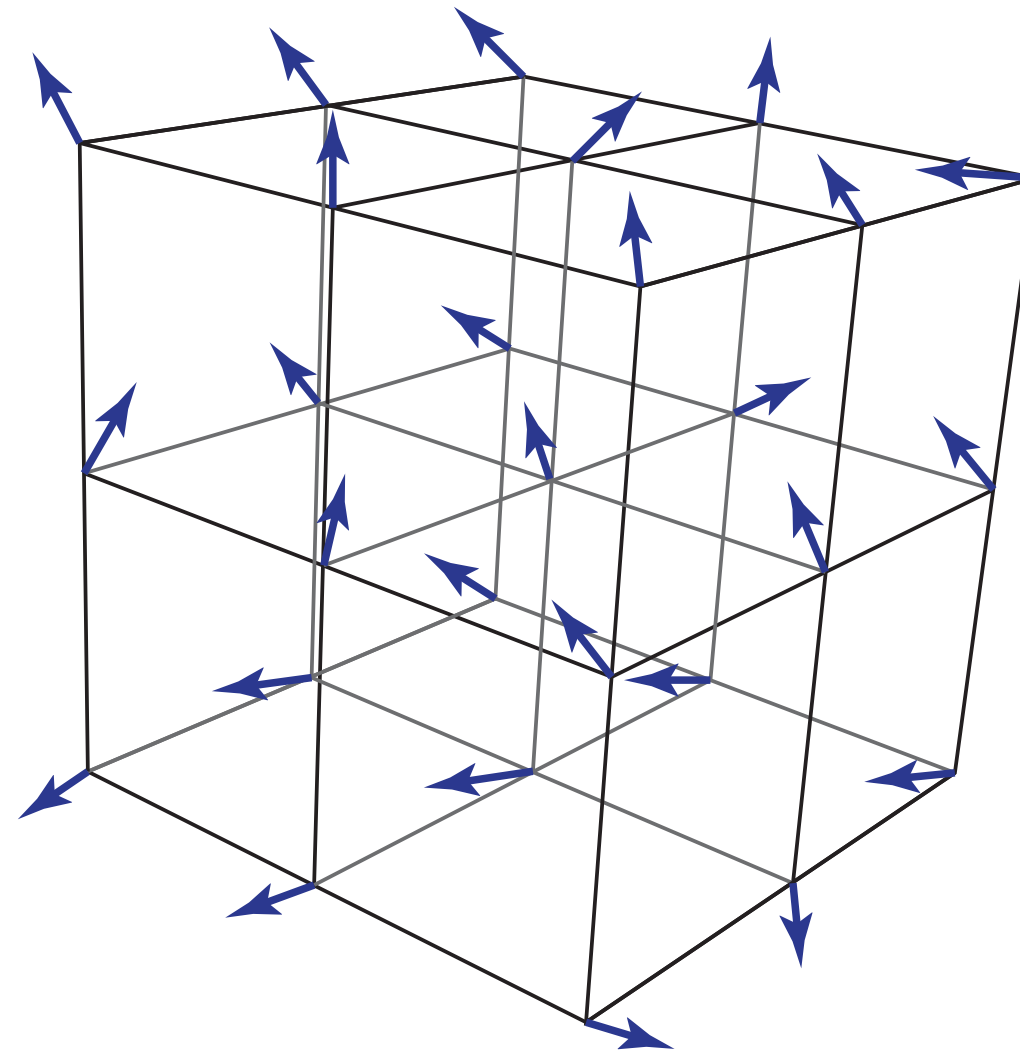
➔ Embed



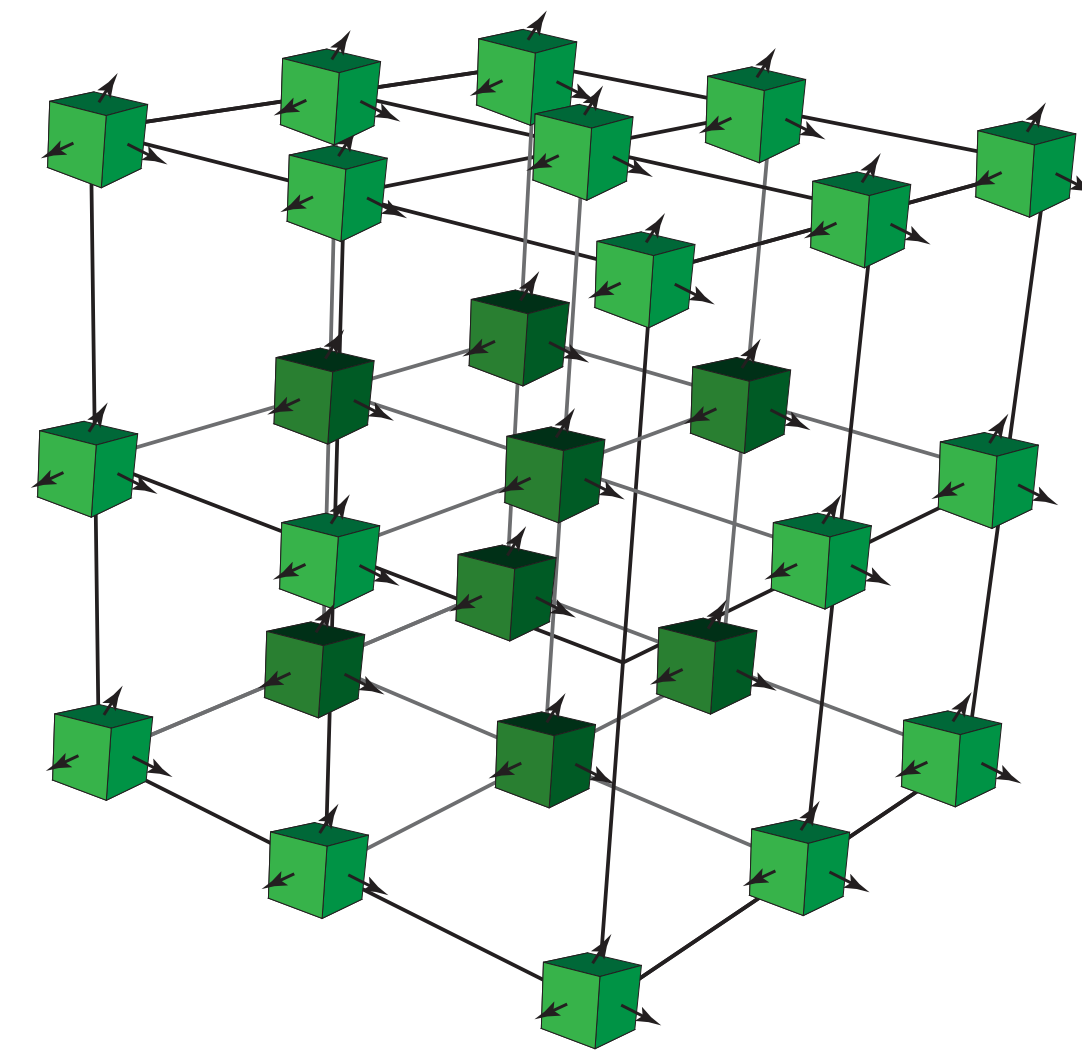
Fields in Visualization



Scalar Fields



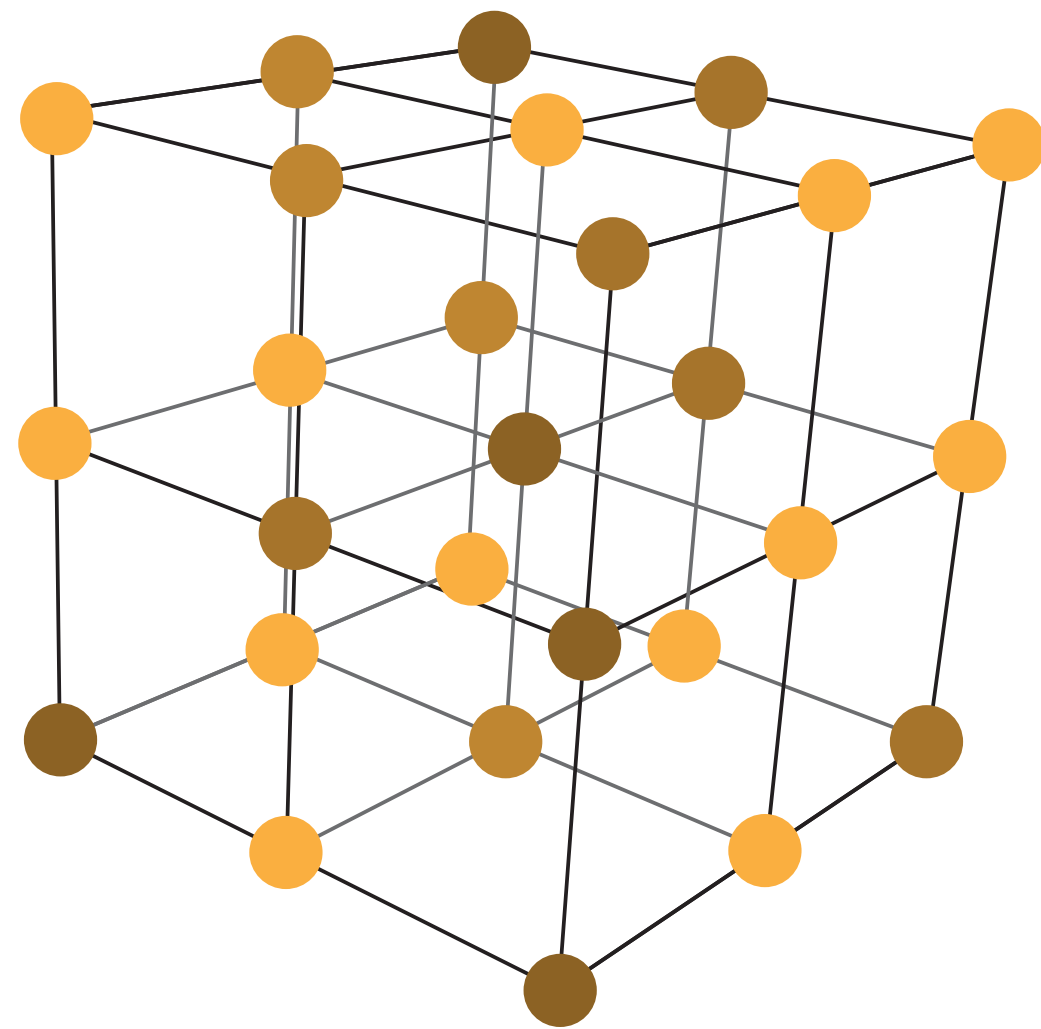
Vector Fields



Tensor Fields

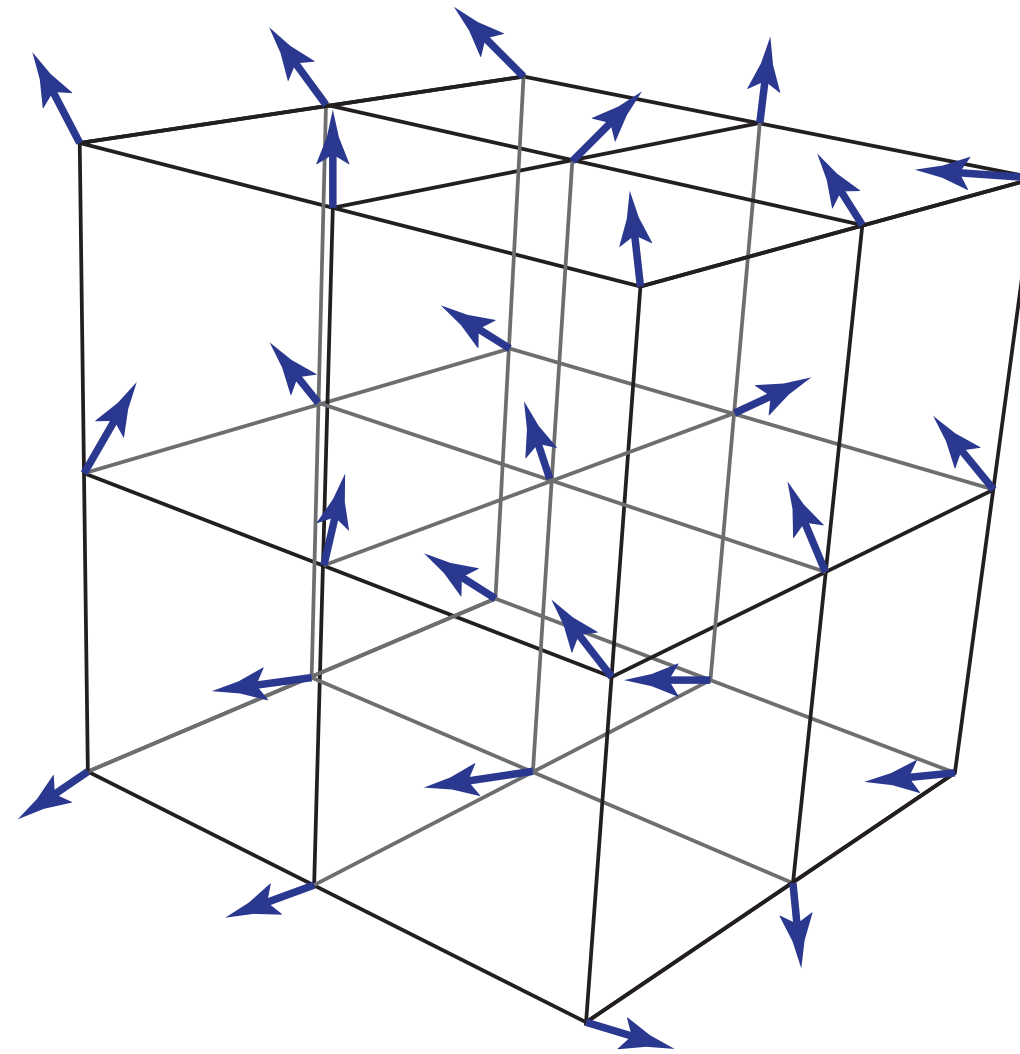
Each point in space has an associated...

Fields in Visualization



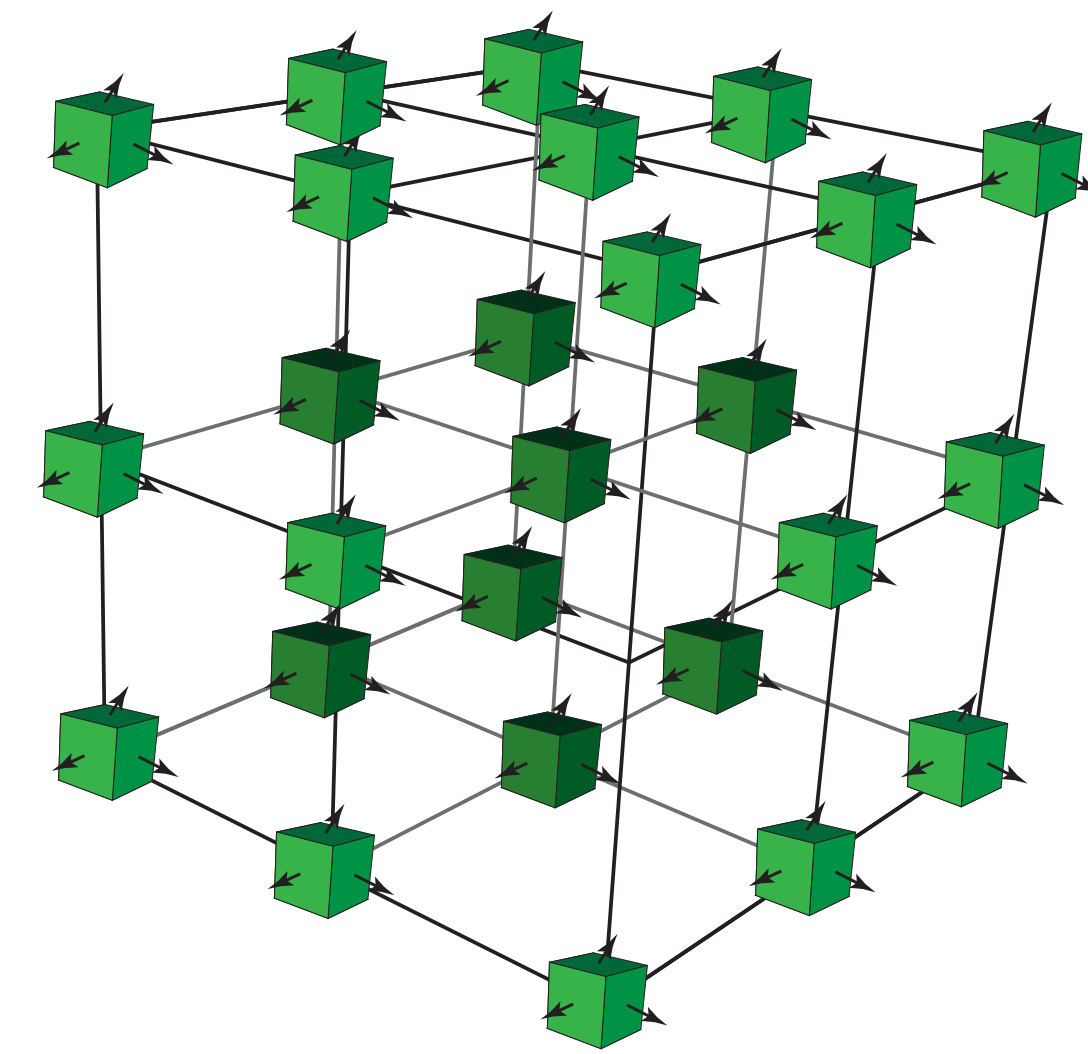
Scalar Fields

(Order-0 Tensor Fields)



Vector Fields

(Order-1 Tensor Fields)



Tensor Fields

(Order-2+)

Each point in space has an associated...

s_0

Scalar

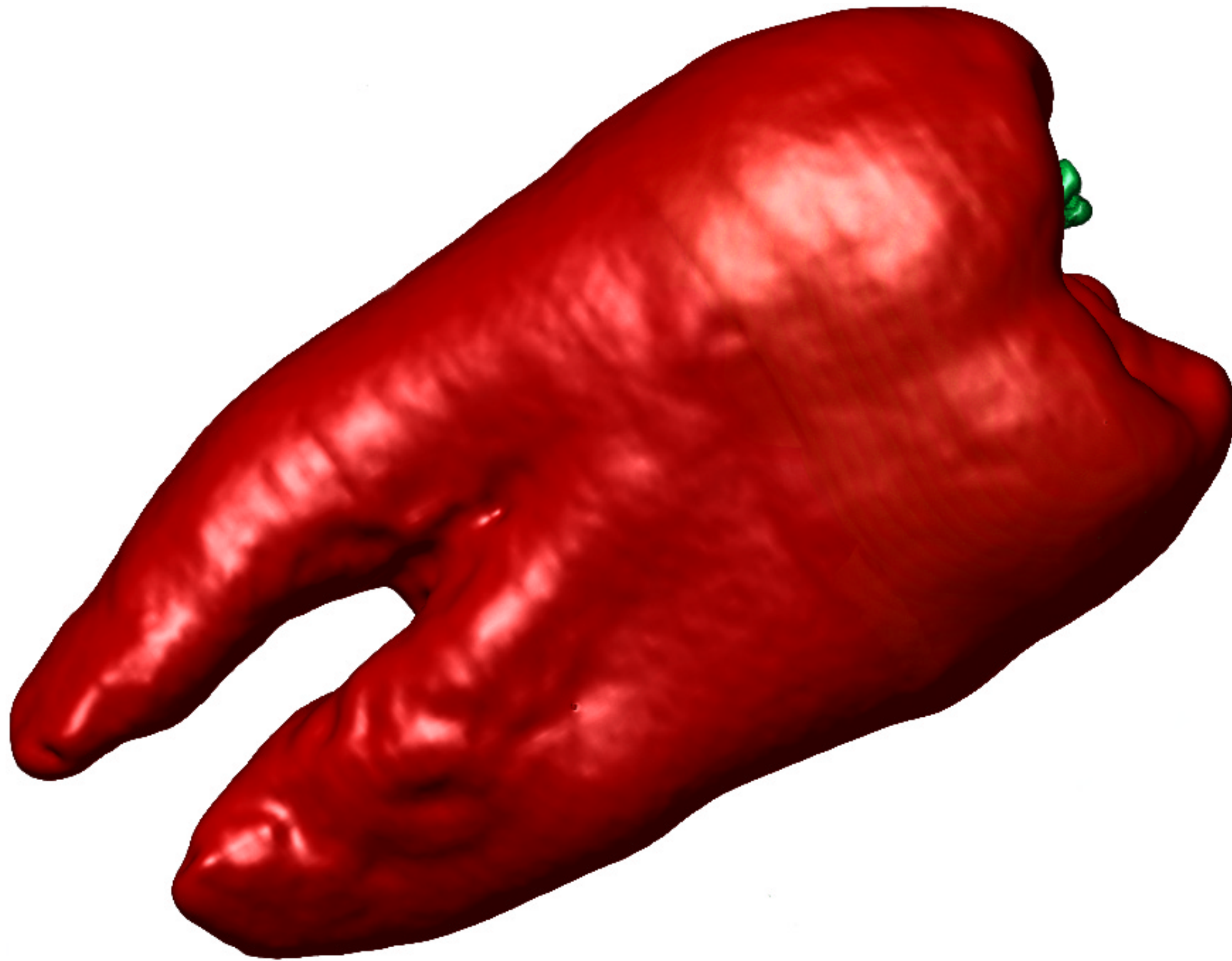
$$\begin{bmatrix} v_0 \\ v_1 \\ v_2 \end{bmatrix}$$

Vector

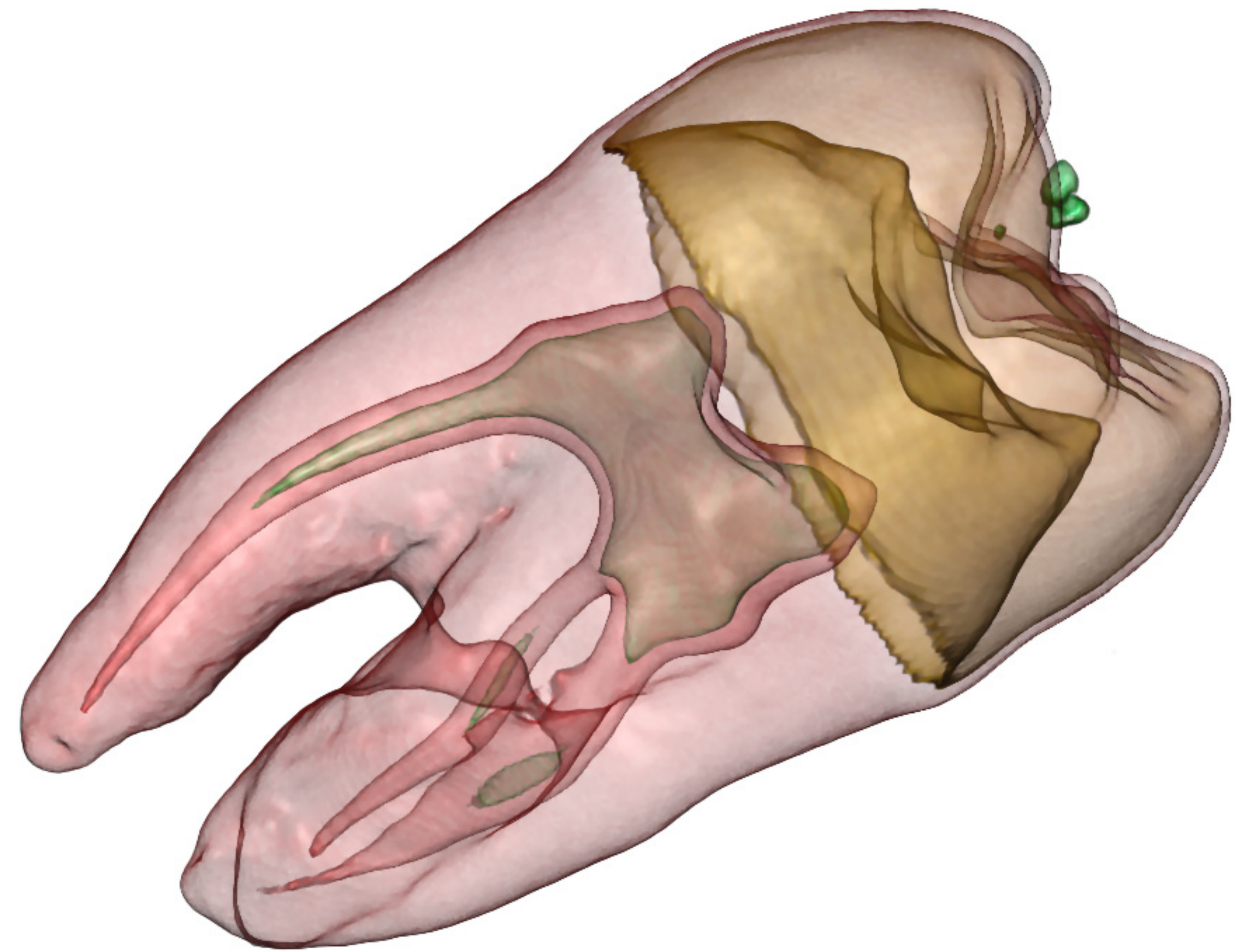
$$\begin{bmatrix} \sigma_{00} & \sigma_{01} & \sigma_{02} \\ \sigma_{10} & \sigma_{11} & \sigma_{12} \\ \sigma_{20} & \sigma_{21} & \sigma_{22} \end{bmatrix}$$

Tensor

Isosurfacing



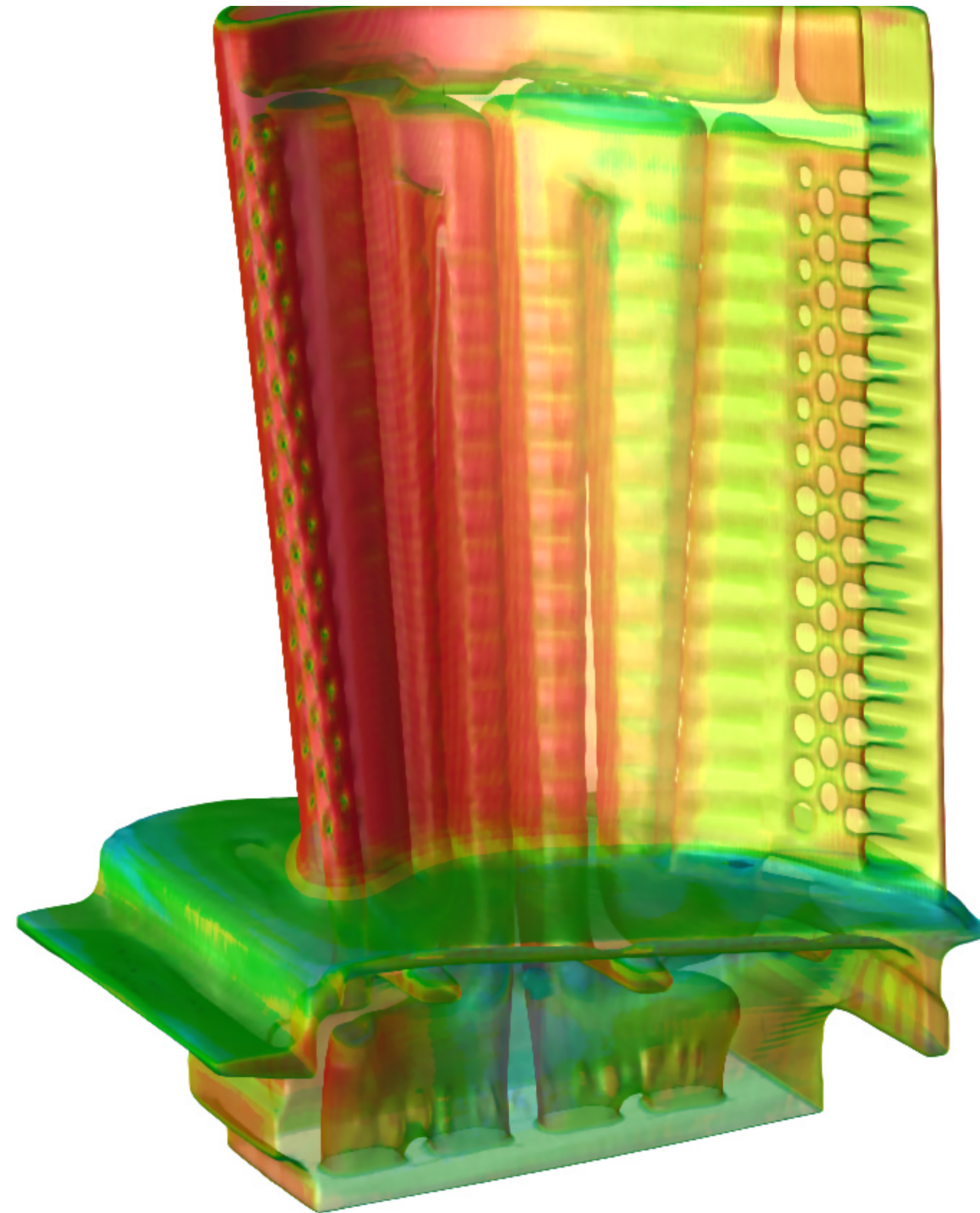
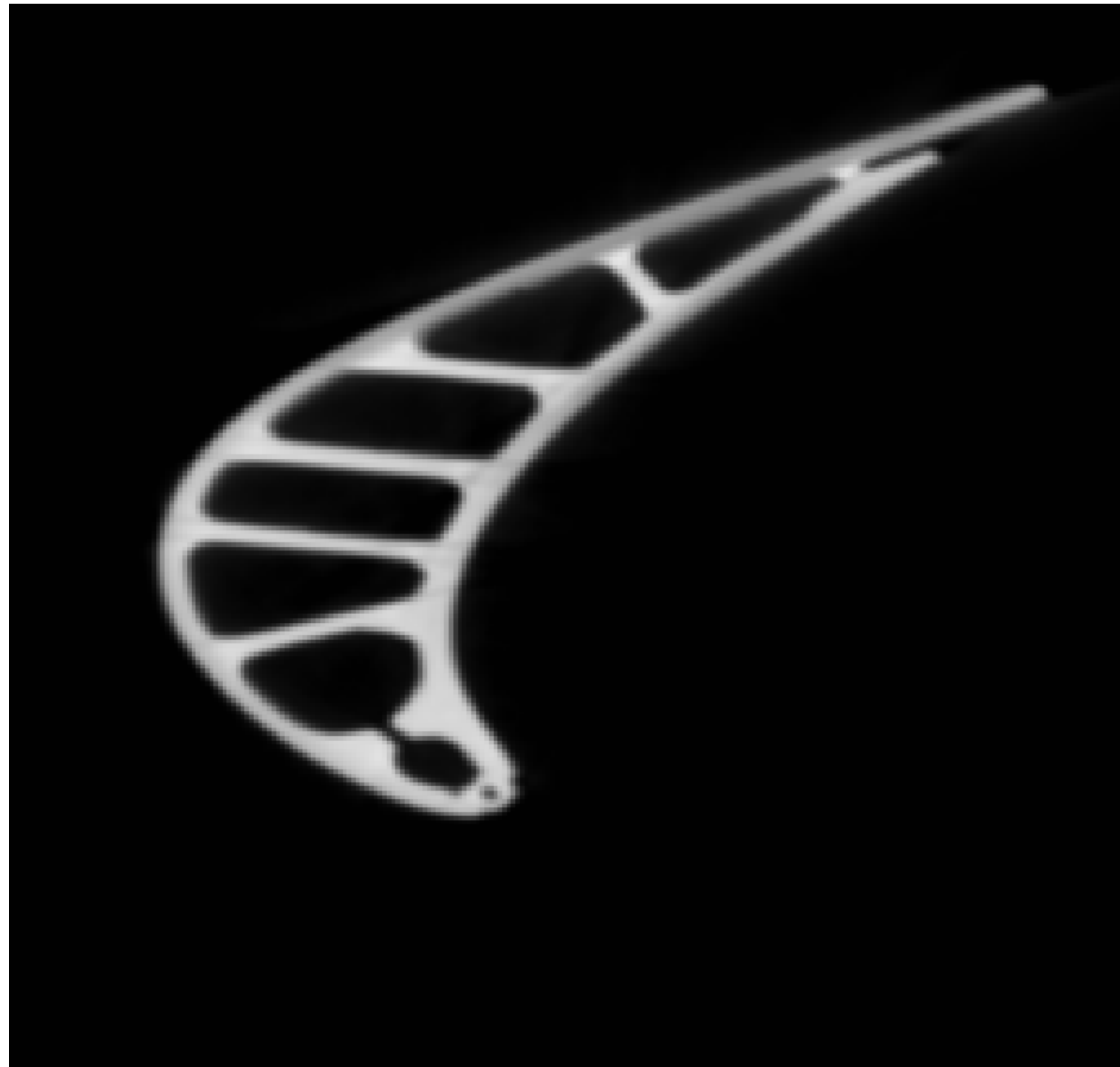
(a) An isosurfaced tooth.



(b) Multiple isosurfaces.

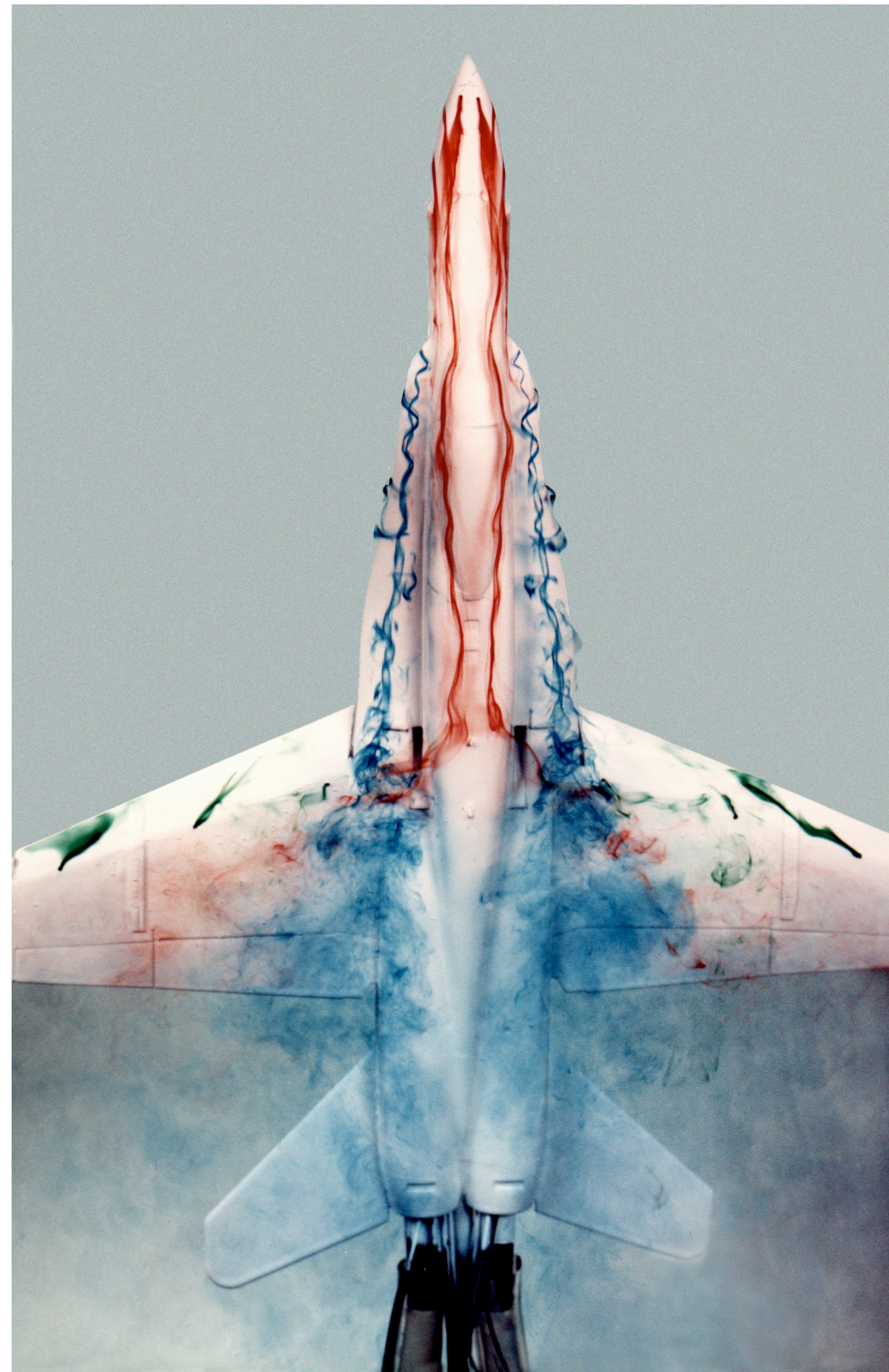
[J. Kniss, 2002]

Volume Rendering



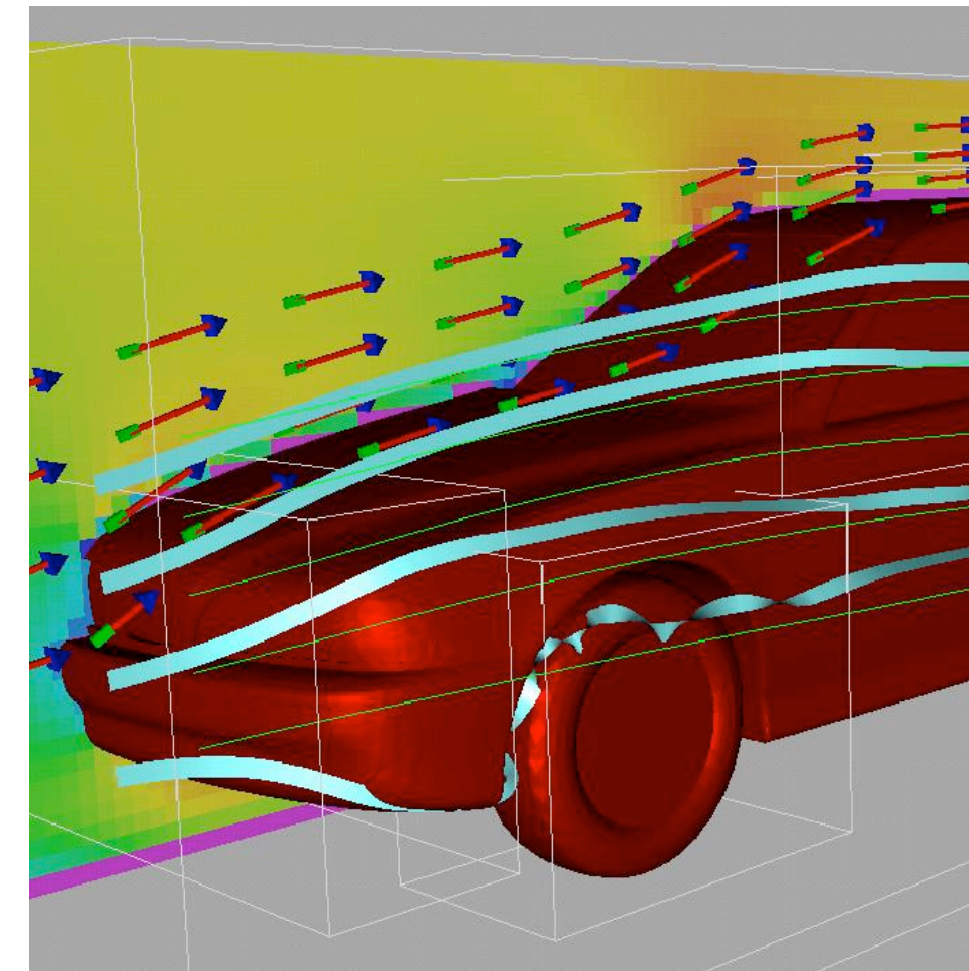
[J. Kniss, 2002]

Vector Fields

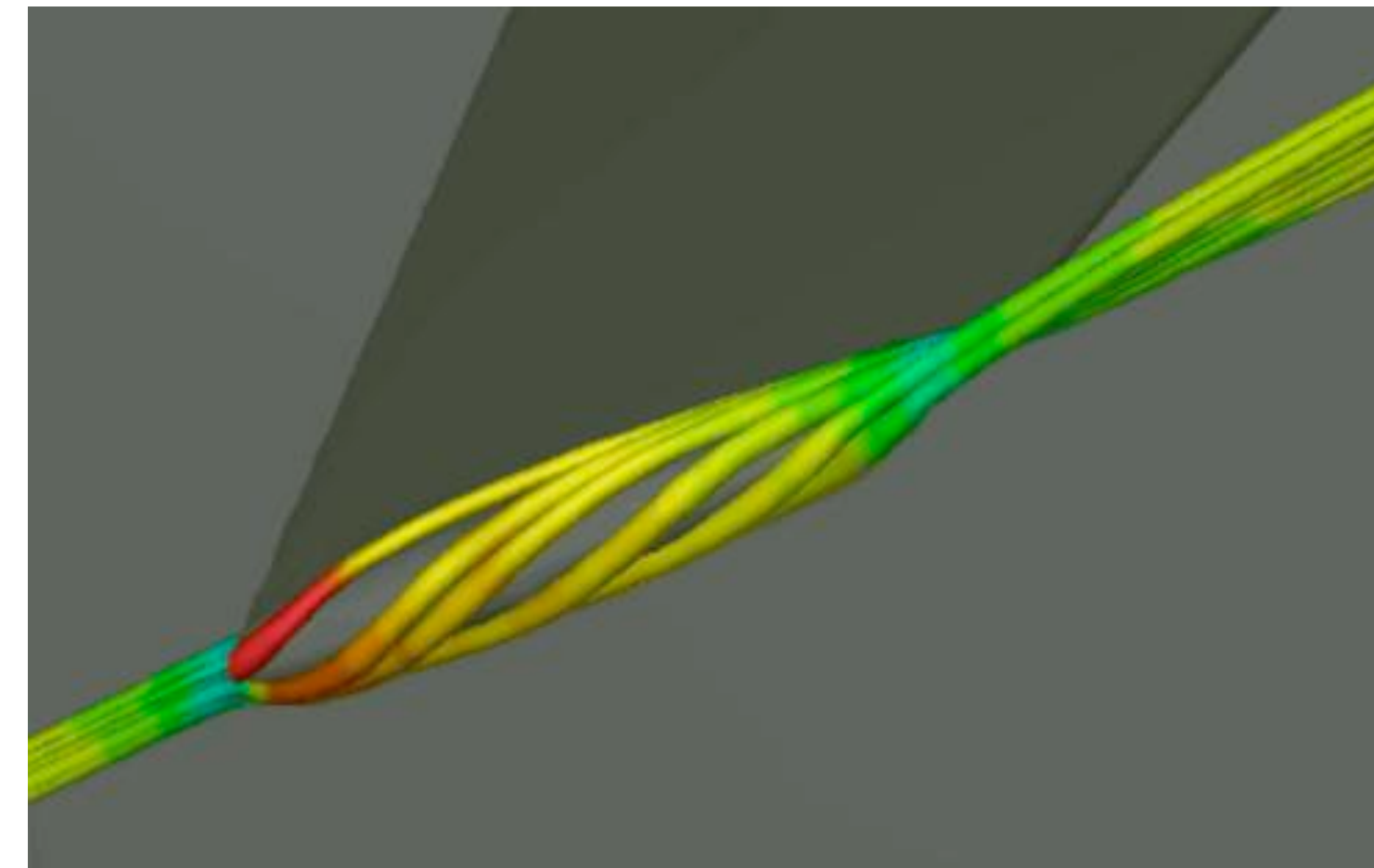


NASA Dryden Flight Research Center Photo Collection
<http://www.dfrc.nasa.gov/gallery/photo/index.html>
NASA Photo: ECN-33298-03 Date: 1985
1/48-scale model of an F-18 aircraft in Flow Visualization Facility (FVF)

Streaklines [NASA]



Stream Ribbons [Weiskopf/Machiraju/Möller]



Stream Tubes [Weiskopf/Machiraju/Möller]

The purpose of computing is about insight, not numbers

– R. W. Hamming

The purpose of visualization is about **insight**, not pictures

– Card, Mackinlay, Schneiderman

Projects Thursday