CS-5630 / CS-6630 Visualization
Exam Review, Views Part II

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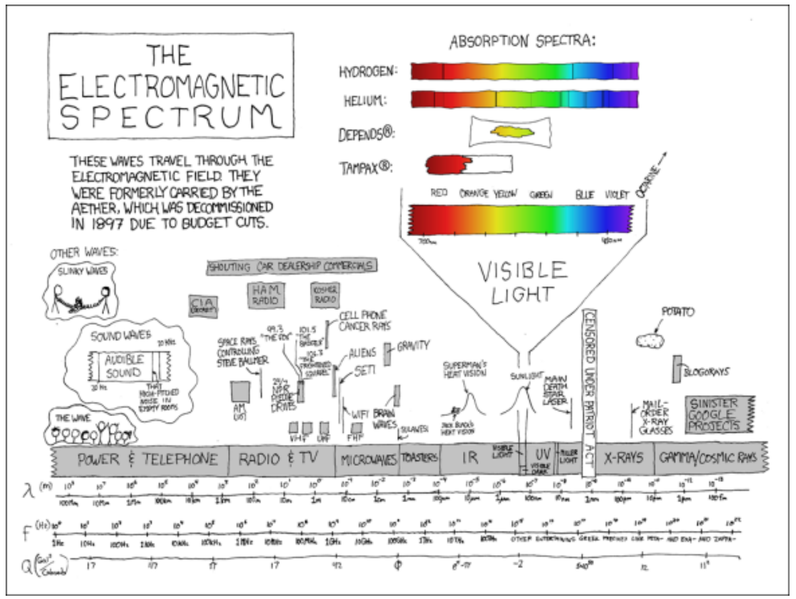
THE UNIVERSITY OF UTAH



[xkcd]

Exam Review

1. Selectors

Give at least three different ways to select the second rectangle in the following code. You can modify the html, but do not change the order or appearance of the elements.

```
<body>
<svg width="400" height="200">
  <rect x="10" y="10" width="20" height="10"/>
  <g>
    <rect x="50" y="50" width="20" height="100"/>
    <circle cx="200" cy="100" r="50"/>
  </g>
  <rect x="80" y="50" width="20" height="10"/>
  <rect x="120" y="50" width="40" height="20"/>
</svg>
</body>
```

add ID and class to the rect

Selectors

#myID

.myClass

g > rect

g rect

2. What is the difference between the DOM and an HTML file?

DOM

- hierarchical representation used by browser to render
- elements can be defined in html or manipulated dynamically
- manipulation via API or libraries

HTML

- a markup language (not a scripting language) used to structure documents.
- Can be interspersed with styling and scripting language to generate dynamic DOM content

3. D3

```
var svg = d3.select("svg")
svg.selectAll("rect")
        .data([127, 61, 256])
        .attr("x", 0)
        .attr("y", function(a,b) { return
b*90+50 })
        .attr("width", function(a,b) { return a; })
        .attr("height", 20)
        .style("fill", "steelblue");
```

I - values of a and b

a: 127, 61, 256

b: 0, 1, 2

II - What happens if svg is empty?

Nothing

Fix by .enter().append()

4. What is the idea behind scales in D3?

Scales are a function that map an input (the domain) to an output (the range).

They make it easy to map varying datasets to consistent results.

They make it easy to map data to color scales.

They work equally well for continuous and categorical data.

5. When is it not advisable to use visualization?

When we have well-defined questions on a well-defined dataset.

- Who is the tallest in this class? vs
- What is the distribution of heights in this class? Are there any interesting patterns?

When decision is needed in minimal time.

- Visualization needs a human in the loop. When a human is to slow, you can’t use visualization.

6. Data Types

Mark up the following things:

- Attributes
- Items
- Semantics
- Keys
- Data Types
  - Categorical
  - Ordinal
  - Quantitative

	A	B	C	S	T	U
1	Order ID	Order Date	Order Priority	Product Container	Product Base Margin	Ship Date
2	3	10/14/06	5-Low	Large Box	0.8	10/21/06
3	6	2/21/08	4-Not Specified	Small Pack	0.55	2/22/08
4	32	7/16/07	2-High	Small Pack	0.79	7/17/07
5	32	7/16/07	2-High	Jumbo Box	0.72	7/17/07
6	32	7/16/07	2-High	Medium Box	0.6	7/18/07
7	32	7/16/07	2-High	Medium Box	0.65	7/18/07
8	35	10/23/07	4-Not Specified	Wrap Bag	0.52	10/24/07
9	35	10/23/07	4-Not Specified	Small Box	0.58	10/25/07
10	36	11/3/07	1-Urgent	Small Box	0.55	11/3/07
11	65	3/18/07	1-Urgent	Small Pack	0.49	3/19/07
12	66	1/20/05	5-Low	Wrap Bag	0.56	1/20/05
13	69	6/4/05	4-Not Specified	Small Pack	0.44	6/6/05
14	69	6/4/05	4-Not Specified	Wrap Bag	0.6	6/6/05
15	70	12/18/06	5-Low	Small Box	0.59	12/23/06
16	70	12/18/06	5-Low	Wrap Bag	0.82	12/23/06
17	96	4/17/05	2-High	Small Box	0.55	4/19/05
18	97	1/29/06	3-Medium	Small Box	0.38	1/30/06
19	129	11/19/08	5-Low	Small Box	0.37	11/28/08
20	130	5/8/08	2-High	Small Box	0.37	5/9/08
21	130	5/8/08	2-High	Medium Box	0.38	5/10/08
22	130	5/8/08	2-High	Small Box	0.6	5/11/08
23	132	6/11/06	3-Medium	Medium Box	0.6	6/12/06
24	132	6/11/06	3-Medium	Jumbo Box	0.69	6/14/06
25	134	5/1/08	4-Not Specified	Large Box	0.82	5/3/08
26	135	10/21/07	4-Not Specified	Small Pack	0.64	10/23/07
27	166	9/12/07	2-High	Small Box	0.55	9/14/07
28	193	8/8/06	1-Urgent	Medium Box	0.57	8/10/06
29	194	4/5/08	3-Medium	Wrap Bag	0.42	4/7/08

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4	32	7/16/07	2-High	Small Pack	0.79	7/17/07
5	32	7/16/07	2-High	Jumbo Box	0.72	7/17/07
6	32	7/16/07	2-High	Medium Box	0.6	7/18/07
7	32	7/16/07	2-High	Medium Box	0.65	7/18/07
8	35	10/23/07	4-Not Specified	Wrap Bag		10/24/07
9	35	10/23/07	4-Not Specified	Small Box		10/25/07
10	36	11/3/07	1-Urgent	Small Box		11/3/07
11	65	3/18/07	1-Urgent	Small Pack		3/19/07
12	66	1/20/05	5-Low	Wrap Bag		1/20/05
13	69	6/4/05	4-Not Specified	Small Pack		6/6/05
14	69	6/4/05	4-Not Specified	Wrap Bag		6/6/05
15	70	12/18/06	5-Low	Small Box		12/23/06
16	70	12/18/06	5-Low	Wrap Bag		12/23/06
17	96	4/17/05	2-High	Small Box		4/19/05
18	97	1/29/06	3-Medium	Small Box	0.38	1/30/06
19	129	11/19/08	5-Low	Small Box	0.37	11/28/08
20	130	5/8/08	2-High	Small Box	0.37	5/9/08
21	130	5/8/08	2-High	Medium Box	0.38	5/10/08
22	130	5/8/08	2-High	Small Box	0.6	5/11/08
23	132	6/11/06	3-Medium	Medium Box	0.6	6/12/06
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25	134	5/1/08	4-Not Specified	Large Box	0.82	5/3/08
26	135	10/21/07	4-Not Specified	Small Pack	0.64	10/23/07
27	166	9/12/07	2-High	Small Box	0.55	9/14/07
28	193	8/8/06	1-Urgent	Medium Box	0.57	8/10/06
29	194	4/5/08	3-Medium	Wrap Bag	0.42	4/7/08

Item/Element/
(Independent)
Variable

	A	B	C	S	T	U
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2	3	10/14/06	5-Low	Large Box	0.8	10/21/06
3	6	2/21/08	4-Not Specified	Small Pack		2/22/08
4	32	7/16/07	2-High	Small Pack		7/17/07
5	32	7/16/07	2-High	Jumbo Box		7/17/07
6	32	7/16/07	2-High	Medium Box		7/18/07
7	32	7/16/07	2-High	Medium Box		7/18/07
8	35	10/23/07	4-Not Specified	Wrap Bag		10/24/07
9	35	10/23/07	4-Not Specified	Small Box		10/25/07
10	36	11/3/07	1-Urgent	Small Box		11/3/07
11	65	3/18/07	1-Urgent	Small Pack		3/19/07
12	66	1/20/05	5-Low	Wrap Bag		1/20/05
13	69	6/4/05	4-Not Specified	Small Pack	0.44	6/6/05
14	69	6/4/05	4-Not Specified	Wrap Bag	0.6	6/6/05
15	70	12/18/06	5-Low	Small Box	0.59	12/23/06
16	70	12/18/06	5-Low	Wrap Bag	0.82	12/23/06
17	96	4/17/05	2-High	Small Box	0.55	4/19/05
18	97	1/29/06	3-Medium	Small Box	0.38	1/30/06
19	129	11/19/08	5-Low	Small Box	0.37	11/28/08
20	130	5/8/08	2-High	Small Box	0.37	5/9/08
21	130	5/8/08	2-High	Medium Box	0.38	5/10/08
22	130	5/8/08	2-High	Small Box	0.6	5/11/08
23	132	6/11/06	3-Medium	Medium Box	0.6	6/12/06
24	132	6/11/06	3-Medium	Jumbo Box	0.69	6/14/06
25	134	5/1/08	4-Not Specified	Large Box	0.82	5/3/08
26	135	10/21/07	4-Not Specified	Small Pack	0.64	10/23/07
27	166	9/12/07	2-High	Small Box	0.55	9/14/07
28	193	8/8/06	1-Urgent	Medium Box	0.57	8/10/06
29	194	4/5/08	3-Medium	Wrap Bag	0.42	4/7/08

Attribute/
Dimension/
(Dependent)
Variable/
Feature

Sheets Charts SmartArt Graphics WordArt

	A	B	C	S	T	U
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3	6	2/21/08	4-Not Specified	Small Pack	5	2/22/08
4	32	7/16/07	2-High	Small Pack	9	7/17/07
5	32	7/16/07	2-High	Jumbo Box	0.72	7/17/07
6	32	7/16/07	2-High	Medium Box	0.6	7/18/07
7	32	7/16/07	2-High	Medium Box	0.65	7/18/07
8	35	10/23/07	4-Not Specified	Wrap Bag	0.52	10/24/07
9	35	10/23/07	4-Not Specified	Small Box	0.58	10/25/07
10	36	11/3/07	1-Urgent	Small Box	0.55	11/3/07
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28	193	8/8/06	1-Urgent	Medium Box	0.57	8/10/06
29	194	4/5/08	3-Medium	Wrap Bag	0.42	4/7/08

Semantics

	A	B	C	S	T	U
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2	3	10/14/06	5-Low	Large Box	0.8	10/21/06
3	6	2/21/08	4-Not Specified	Small Pack	0.55	2/22/08
4	32	7/16/07	2-High	Small Pack	0.79	7/17/07
5	32	7/16/07	2-High	Jumbo Box	0.72	7/17/07
6	32	7/16/07	2-High	Medium Box	0.6	7/18/07
7	32	7/16/07	2-High	Medium Box		7/18/07
8	35	10/23/07	4-Not Specified	Wrap Bag		10/24/07
9	35	10/23/07	4-Not Specified	Small Box	0.58	10/25/07
10	36	11/3/07	1-Urgent	Small Box	0.55	11/3/07
11	65	3/18/07	1-Urgent	Small Pack	0.49	3/19/07
12	66	1/20/05	5-Low	Wrap Bag	0.56	1/20/05
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14	69	6/4/05	4-Not Specified	Wrap Bag	0.6	6/6/05
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16	70	12/18/06	5-Low	Wrap Bag	0.82	12/23/06
17	96	4/17/05	2-High	Small Box	0.55	4/19/05
18	97	1/29/06	3-Medium	Small Box	0.38	1/30/06
19	129	11/19/08	5-Low	Small Box	0.37	11/28/08
20	130	5/8/08	2-High	Small Box	0.37	5/9/08
21	130	5/8/08	2-High	Medium Box	0.38	5/10/08
22	130	5/8/08	2-High	Small Box	0.6	5/11/08
23	132	6/11/06	3-Medium	Medium Box	0.6	6/12/06
24	132	6/11/06	3-Medium	Jumbo Box	0.69	6/14/06
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26	135	10/21/07	4-Not Specified	Small Pack	0.64	10/23/07
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28	193	8/8/06	1-Urgent	Medium Box	0.57	8/10/06
29	194	4/5/08	3-Medium	Wrap Bag	0.42	4/7/08

Keys?

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7	32	7/16/07	2-High	Medium Box	0.65	7/18/07
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11	65	3/18/07	1-Urgent	Small Pack	0.49	3/19/07
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13	69	6/4/05	4-Not Specified	Small Pack	0.44	6/6/05
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19	129	11/19/08	5-Low	Small Box	0.37	11/28/08
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21	130	5/8/08	2-High	Medium Box	0.38	5/10/08
22	130	5/8/08	2-High	Small Box		5/11/08
23	132	6/11/06	3-Medium	Medium Box		6/12/06
24	132	6/11/06	3-Medium	Jumbo Box		6/14/06
25	134	5/1/08	4-Not Specified	Large Box		5/3/08
26	135	10/21/07	4-Not Specified	Small Pack		10/23/07
27	166	9/12/07	2-High	Small Box	0.55	9/14/07
28	193	8/8/06	1-Urgent	Medium Box	0.57	8/10/06
29	194	4/5/08	3-Medium	Wrap Bag	0.42	4/7/08

Attribute Types?

	A	B	C	S	T	U
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2	3	10/14/06	5-Low	Large Box	0.8	10/21/06
3	6	2/21/08	4-Not Specified	Small Pack	0.55	2/22/08
4	32	7/16/07	2-High	Small Pack	0.79	7/17/07
5	32	7/16/07	2-High	Jumbo Box	0.72	7/17/07
6	32	7/16/07	2-High	Medium Box	0.6	7/18/07
7	32	7/16/07	2-High	Medium Box	0.65	7/18/07
8	35	10/23/07	4-Not Specified	Wrap Bag	0.52	10/24/07
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11	65	3/18/07	1-Urgent	Small Pack	0.49	3/19/07
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19	129	11/19/08	5-Low	Small Box	0.37	11/28/08
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24	132	6/11/06	3-Medium	Jumbo Box		
25	134	5/1/08	4-Not Specified	Large Box		
26	135	10/21/07	4-Not Specified	Small Pack		
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28	193	8/8/06	1-Urgent	Medium Box		
29	194	4/5/08	3-Medium	Wrap Bag		

Categorical

Ordinal

Quantitative

7. Datatype Examples & Properties

	Ordinal	Interval	Ratio
Example	Shirt Sizes	Temp in C Date	Length, Pressure, Counts
=	Y	Y	Y
≠	Y	Y	Y
<	Y	Y	Y
>	Y	Y	Y
+	N	Y	Y
-	N	Y	Y
×	N	N	Y
÷	N	N	Y
Is Zero Arbitrary?	N/A	N	N

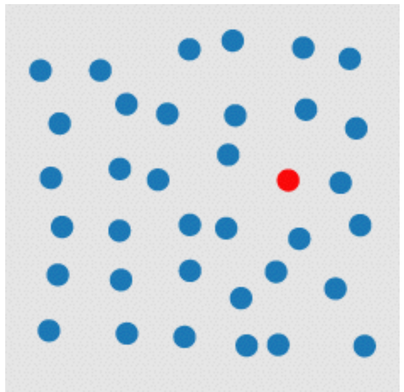
8. What is preattentive processing? Which properties are preattentive? How can it be used in visualization?

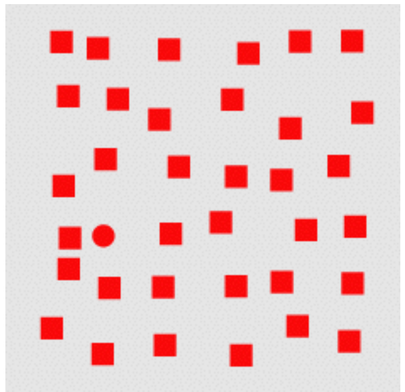
The perception that detects elements very rapidly

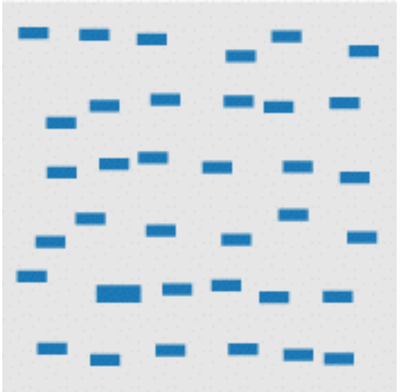
happens before focused attention

Hue, Shape, Size, Orientation, Curvature, Density, ….

Can be used to draw attention to areas of interest and to express similarity and group memberships.







9. What distinguishes magnitude (MC) and identity channels (IC). List and sort in order of effectiveness.

MC are used for ordinal and quantitative data

IC are used for categorical data.

MC can express a quantity and an order.

IC can only identify elements and inform about equality.

Channels: Expressiveness Types and Effectiveness Ranks

Magnitude Channels: Ordered Attributes

- Position on common scale
- Position on unaligned scale
- Length (1D size)
- Tilt/angle
- Area (2D size)
- Depth (3D position)
- Color luminance
- Color saturation
- Curvature
- Volume (3D size)

Most ▲ Effectiveness ▼ Least

Same (Color luminance, Color saturation)

Same (Curvature, Volume (3D size))

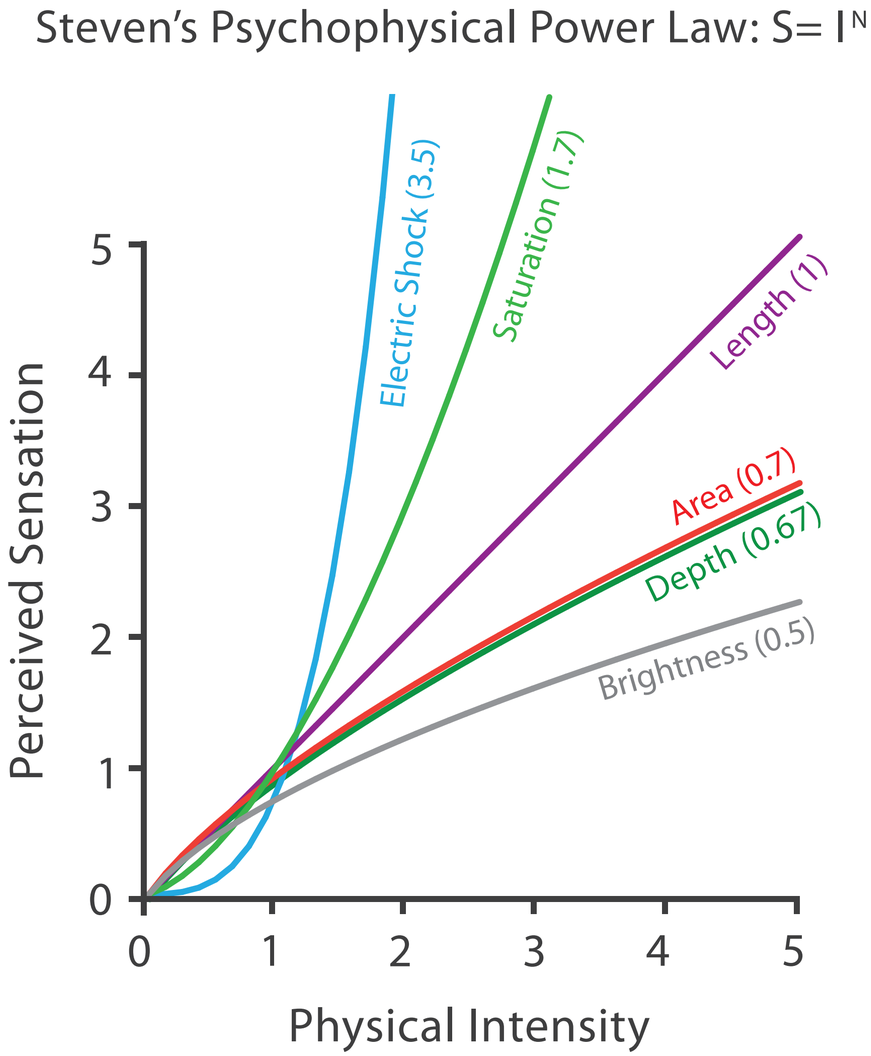
Identity Channels: Categorical Attributes

- Spatial region
- Color hue
- Motion
- Shape

10. Steven's Psychophysical Power Law describes a relationship between two things – what are they? Why is the Law important for visualization?

It characterizes the relationship between physical intensity of a signal and the perceived sensation.

This is important because, except for length, the relationship between intensity and perception is not linear, i.e., we under or over-estimate things like saturation or area size.



11. Are small multiples an example of same or multiform views? What is the difference between the two?

Small Multiples are same views.

Same Views

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

Mutiform Views

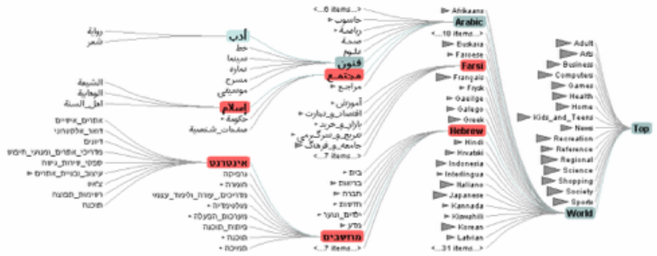
difference visual encodings are used between the views

rational:
single, monolithic view has strong limits on the number of attributes that can be shown simultaneously

15. What is a Degree of Interest Function, what is it used for?
DOI(x) = API(x) - D(x,y)
What are the two terms in that function?

A degree of interest function assigns each element (x) in a dataset an a priori interest [API(x)], i.e., a global importance, and a distance from a current focus (y) [D(x, y)]

Together, they determine which elements in a focus +context display should be visible, preferring globally important elements and elements in the neighborhood of the local selection.



Design Critique

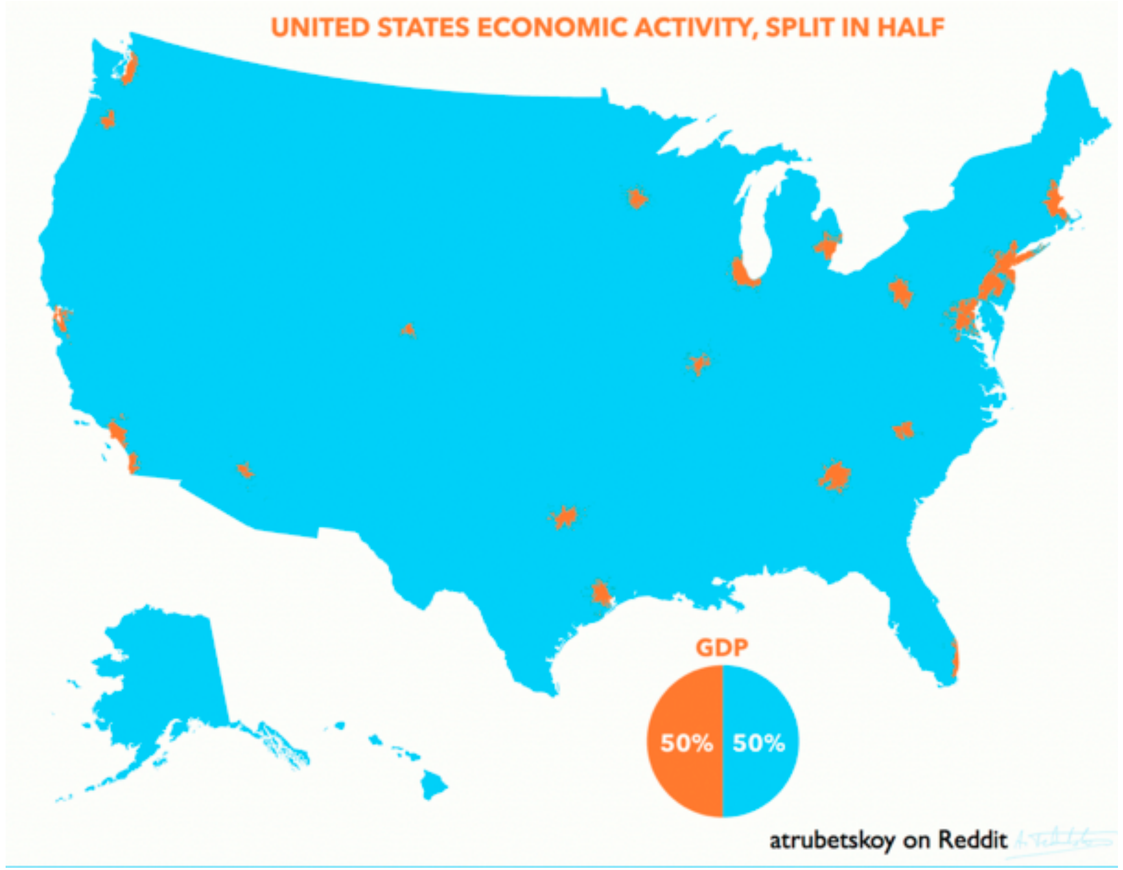
What is the data shown in the visualization?

Which marks and channels are used?

Are there any ethical implications of this chart?

Do you think this is a fair depiction?

Do you find the visualization effective?



Administrativa

Homework 5 / Project

Due this Friday

Take it serious - it will help your project immensely

Next Tuesday: Project Peer Review

- MANDATORY attendance

Homework 6

Due next Friday

Don’t panic! Thursday lecture will be tremendously helpful.

Will answer questions about:

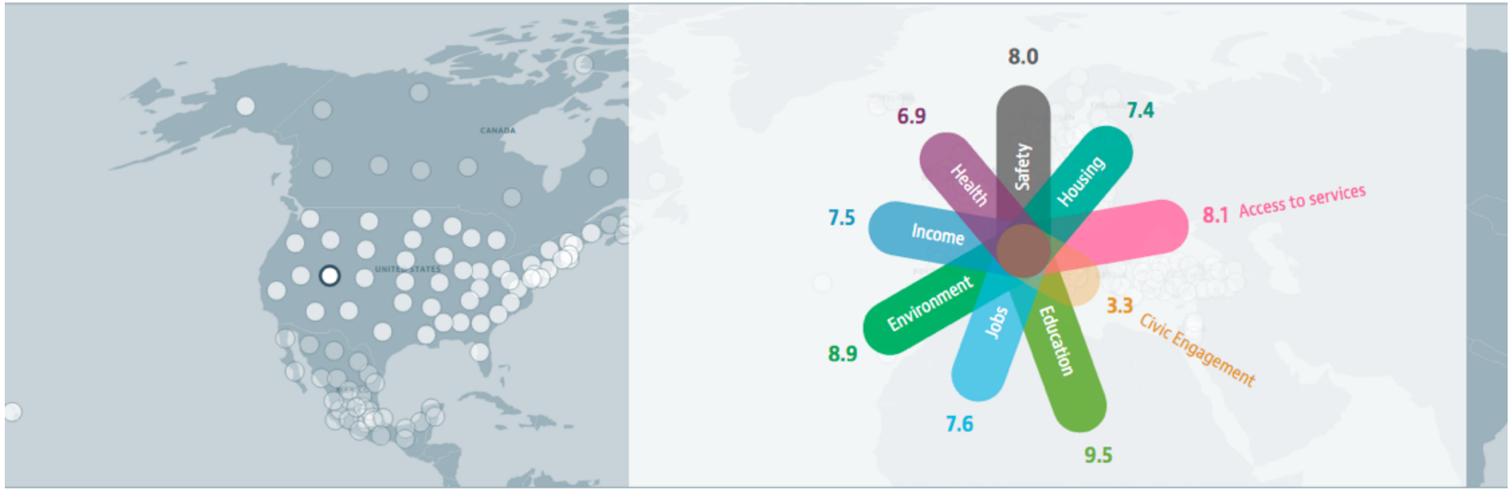
- Volume Rendering Algorithms
- What is a transfer function? Why do I care?
- Brief GLSL HowTo

Design Critique

OECD Regional Well-Being

OECD countries / United States

Utah



Explore the map to find out how life is across OECD regions and discover regions with similar well-being.

Each region is measured in nine topics important for well-being. The values of the indicators are expressed as a score between 0 and 10. A high score indicates better performance relative to the other regions.

Help

Regions with similar well-being *in other countries*

Canada
British Columbia

United Kingdom
North East England

Germany
Saxony-Anhalt

Ireland
Southern and Eastern

Well-being in detail

Access to services

Utah reaches **8.1** / 10 points in **Access to services.**

0 · · · · 5 · · · · 10

This puts the region in position **7** / 51 regions in United States.

Civic Engagement

Utah reaches **3.3** / 10 points in **Civic Engagement.**

0 · · · · 5 · · · · 10

This puts the region in position **44** / 51 regions in United States.

Education

Utah reaches **9.5** / 10 points in **Education.**

0 · · · · 5 · · · · 10

This puts the region in position **9** / 51 regions in United States.

https://goo.gl/gaF2sT

Recap: Views

Multiple Views

Eyes over Memory:

Trade-off of display space and working memory

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 lined together such that actions in one view affect the others.

Linked Views Options

encoding: same or multiform

dataset: share all, subset, or none

highlighting: to link, or not

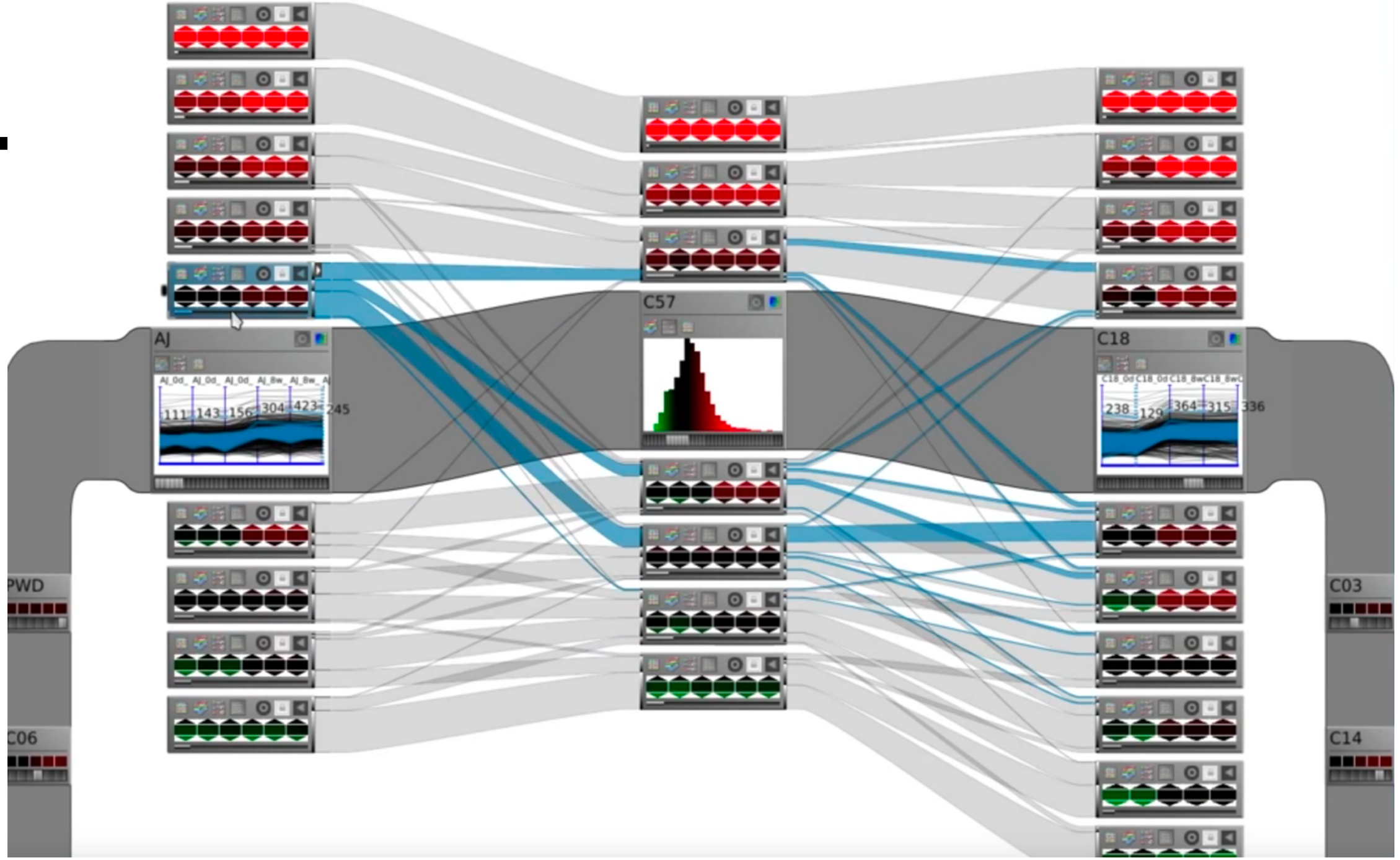
navigation: to share, or not

Multiform

difference visual encodings are used between the views

rational:
single, monolithic view has strong limits on the number of attributes that can be shown simultaneously

L



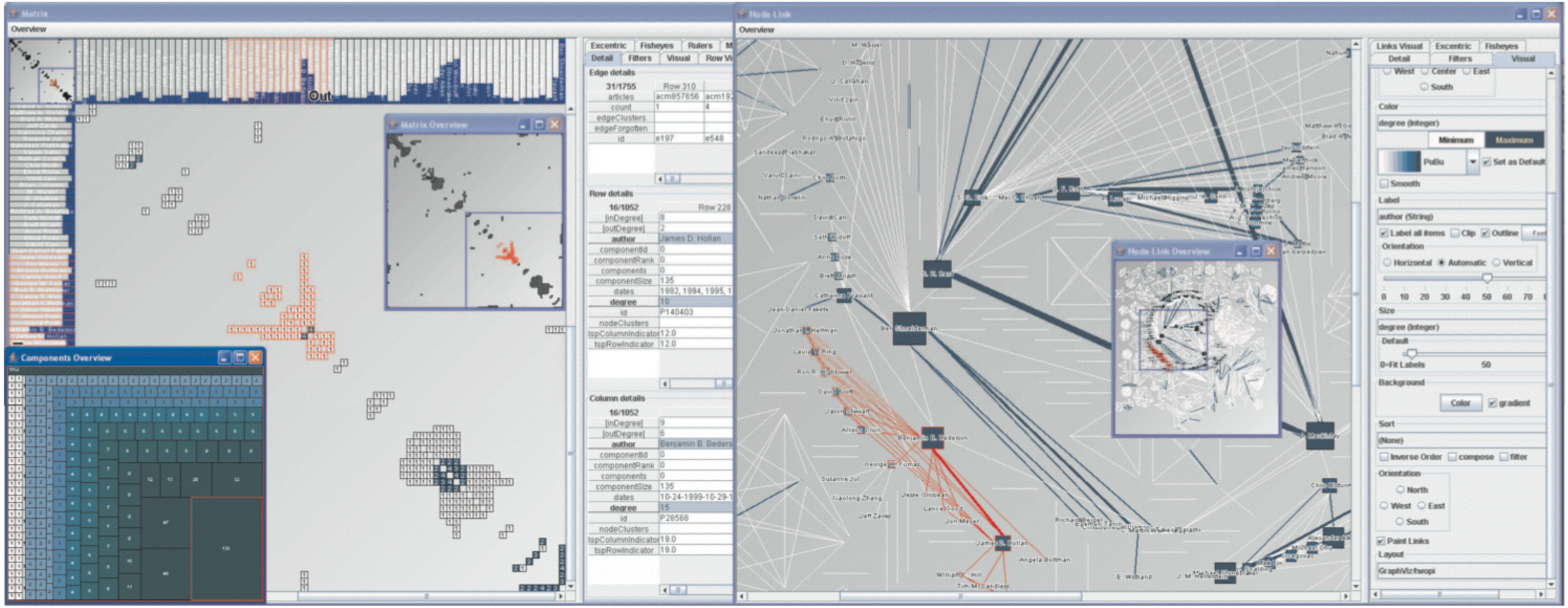
SHARED-DATA

showing all data in each view, but with different encoding schemes

rational

different views support different tasks

MatrixExplorer



Same Data - Different Idioms (Multiform)

Henry 2006

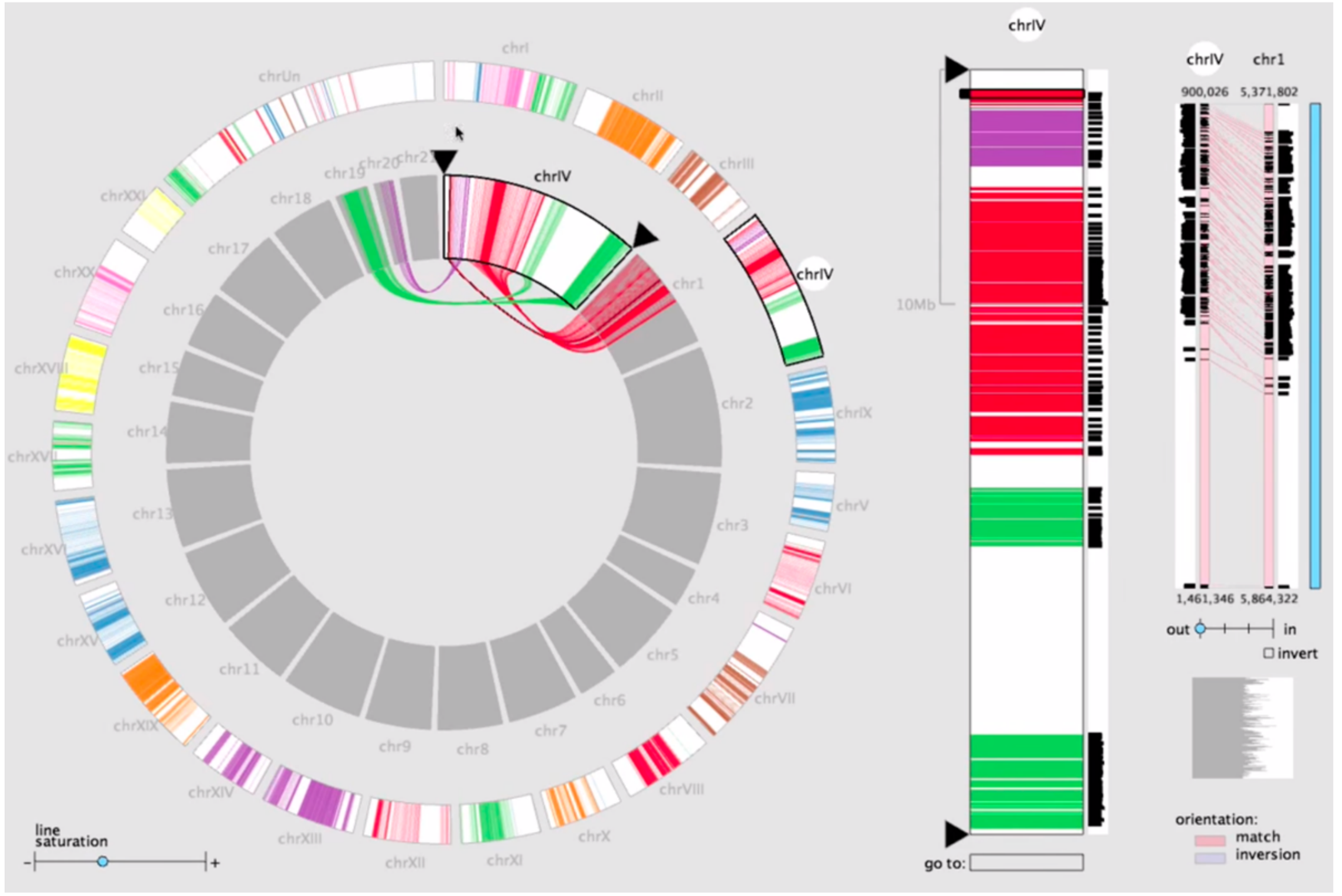
OVERVIEW + DETAIL

one view shows (often summarized) information about 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

MizBee



[Meyer 2009]

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

Small Multiples for Graph Attributes

[Barsky, InfoVis 2008]

Partitioning

PARTITIONING

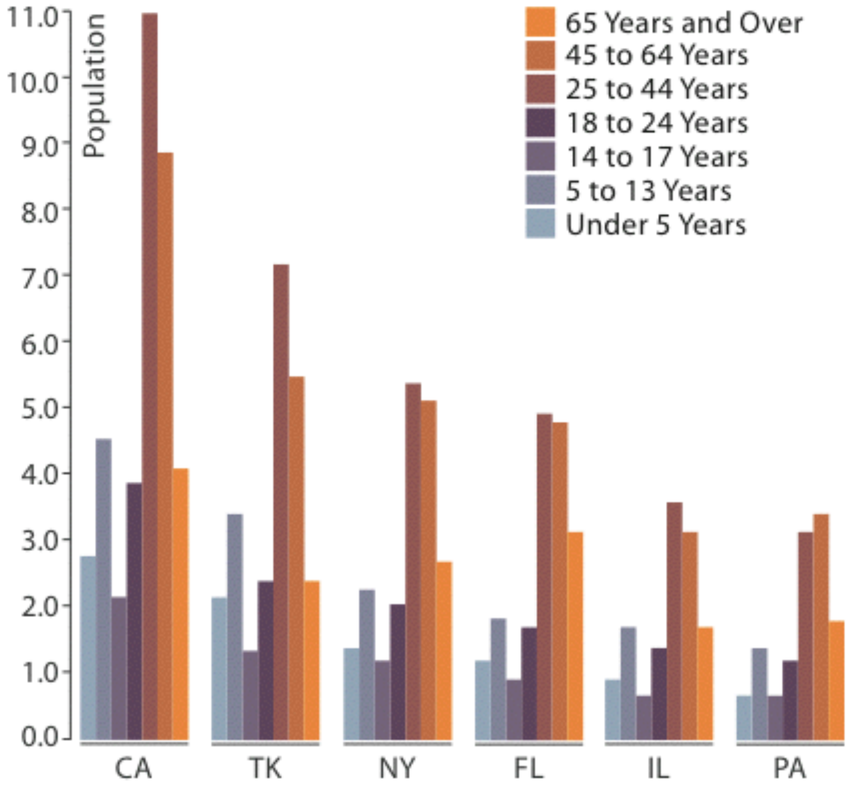
action on the dataset that **separates the data into groups**

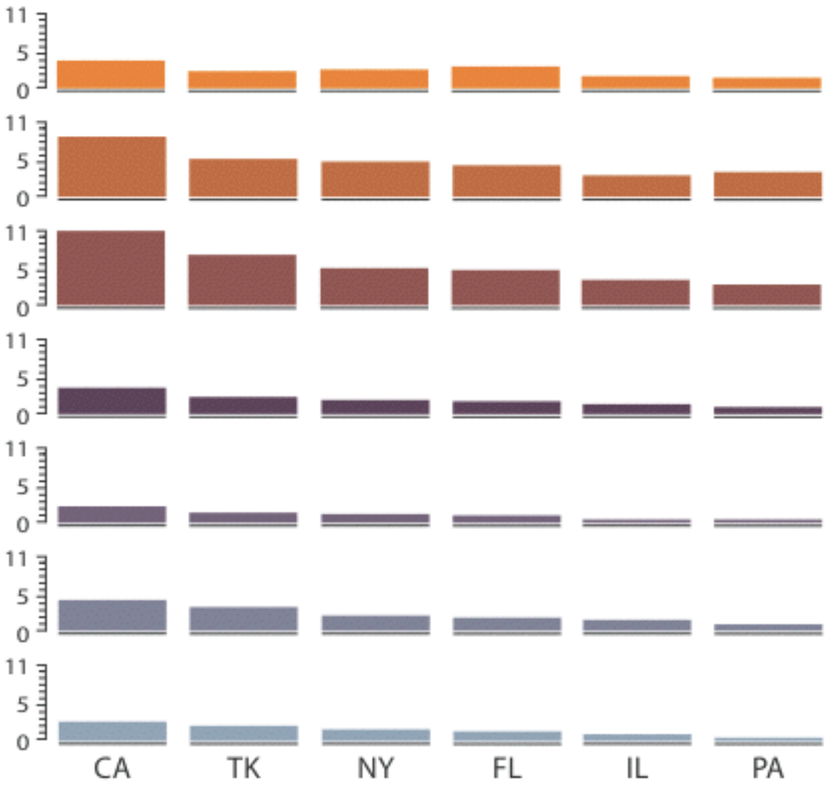
design choices

- 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

TRELLIS

panel variables

attributes encoded in individual views

partitioning variables

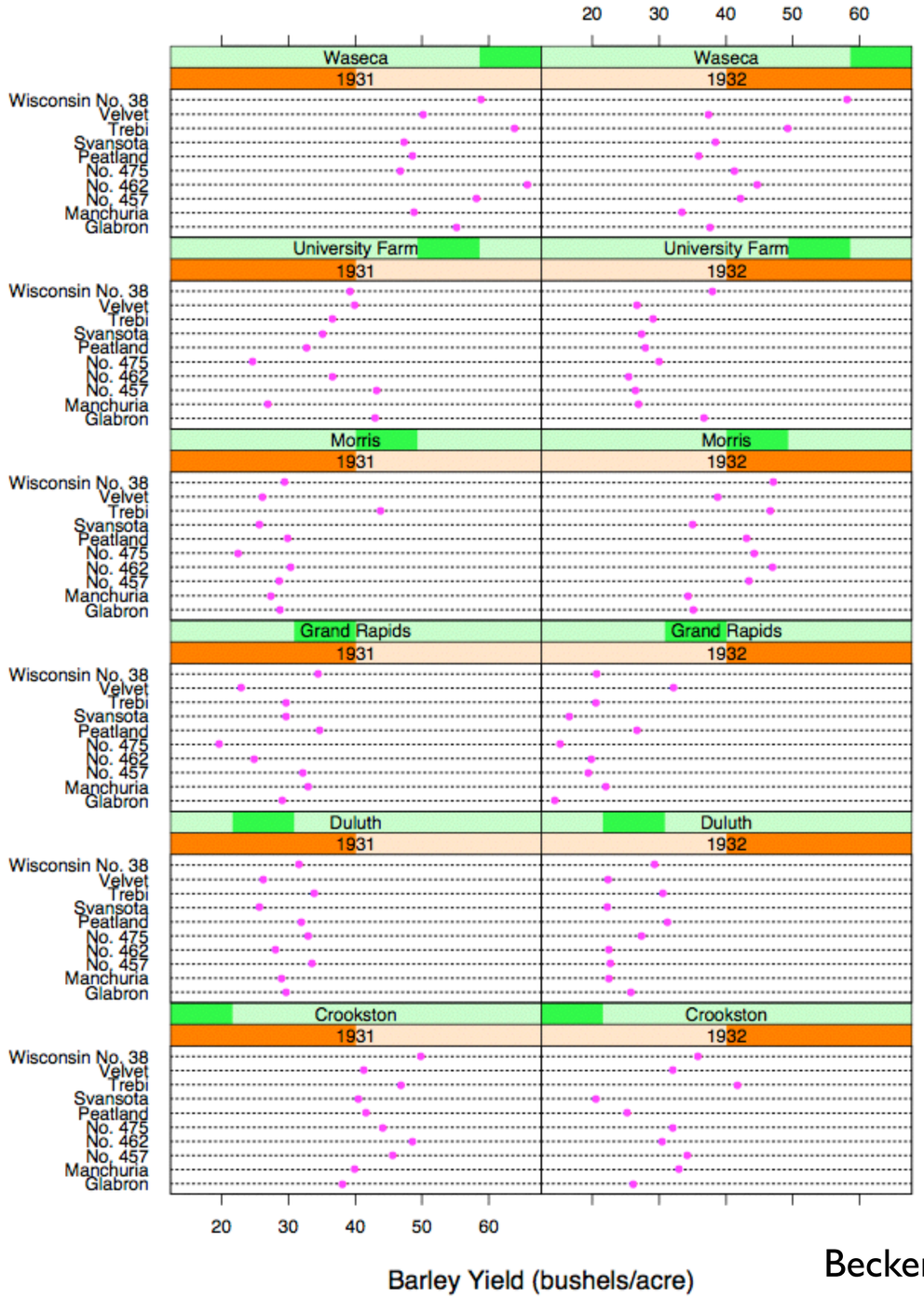
partitioning attributes assigned to columns, rows, and pages

main-effects ordering

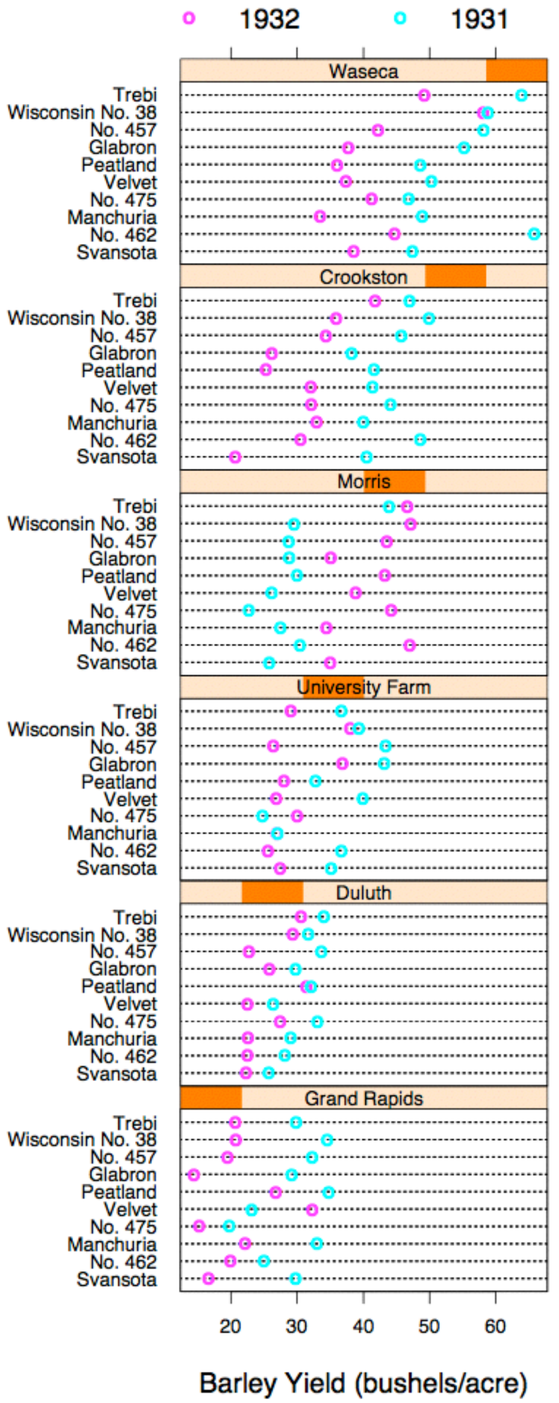
order partitioning variable levels/states based on derived data

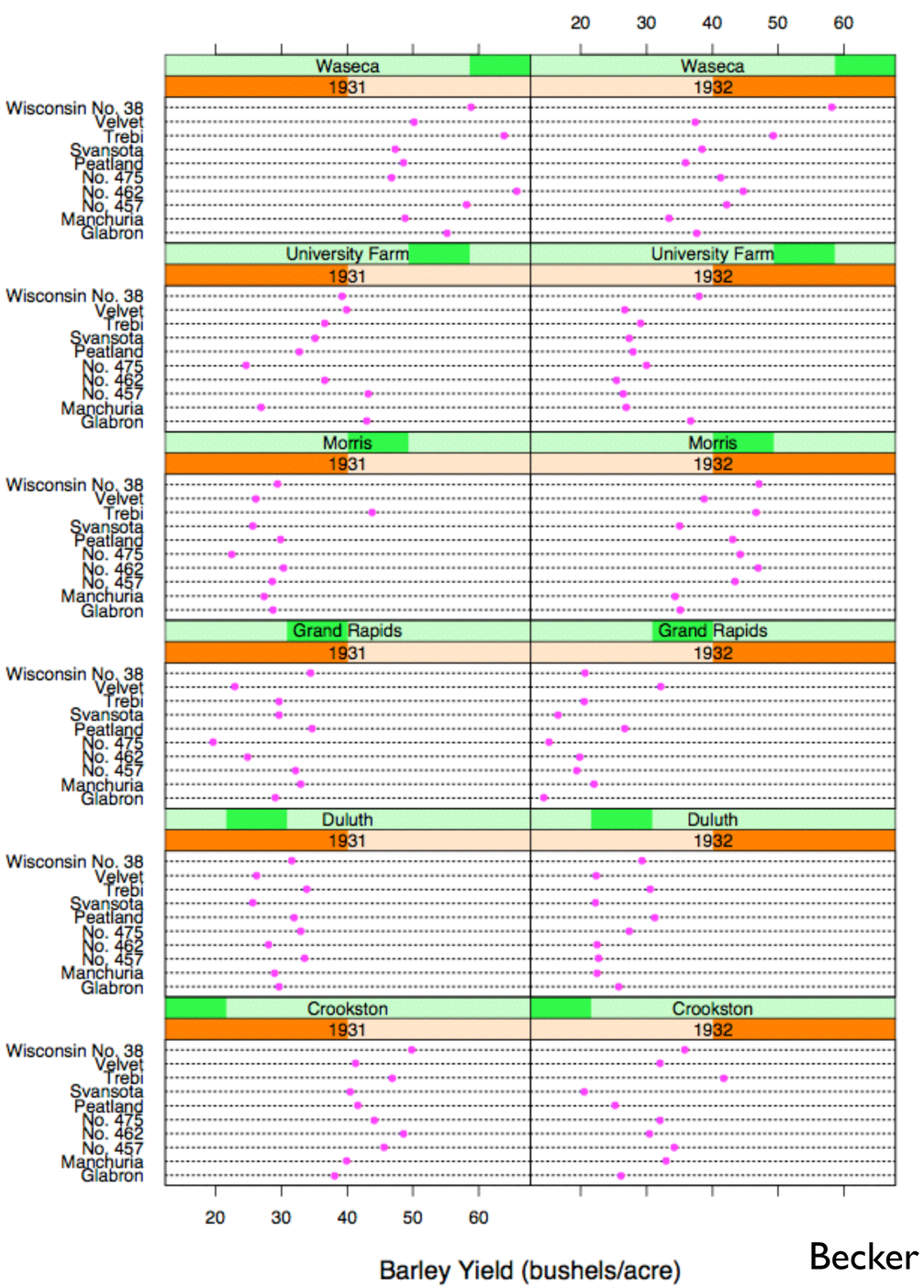
support perception of trends and structure in data

sort by group medians



Becker 1996


1932
1931
Waseca
Trebi
Wisconsin No. 38
No. 457
Glabron
Peatland
Velvet
No. 475
Manchuria
No. 462
Svansota
Crookston
Morris
University Farm
Duluth
Grand Rapids
20
30
40
50
60
Barley Yield (bushels/acre)


20
30
40
50
60
Waseca
1931
1932
Wisconsin No. 38
Velvet
Trebi
Svansota
Peatland
No. 475
No. 462
No. 457
Manchuria
Glabron
University Farm
Morris
Grand Rapids
Duluth
Crookston
Barley Yield (bushels/acre)

Becker 1996

HiVE: Hierarchical Visual Expression

partitioning: transform data attributes into a hierarchy

reconfigure partitioning hierarchies to explore data space

use treemaps as spacefilling rectangular layouts

Slingsby 2009

HiVE: Hierarchical Visual Expression

partitioning: transform multidimensional data into a hierarchy

reconfigure partitioning hierarchies to explore data space

use treemaps as spacefilling rectangular layouts

- each rectangle is a partitioned subset
- nested graphical summaries
  - size, shape, color used to show subset properties
  - containment ordering by partition variables

HiVE example: London property

partitioning attributes

house type
neighborhood
sale time

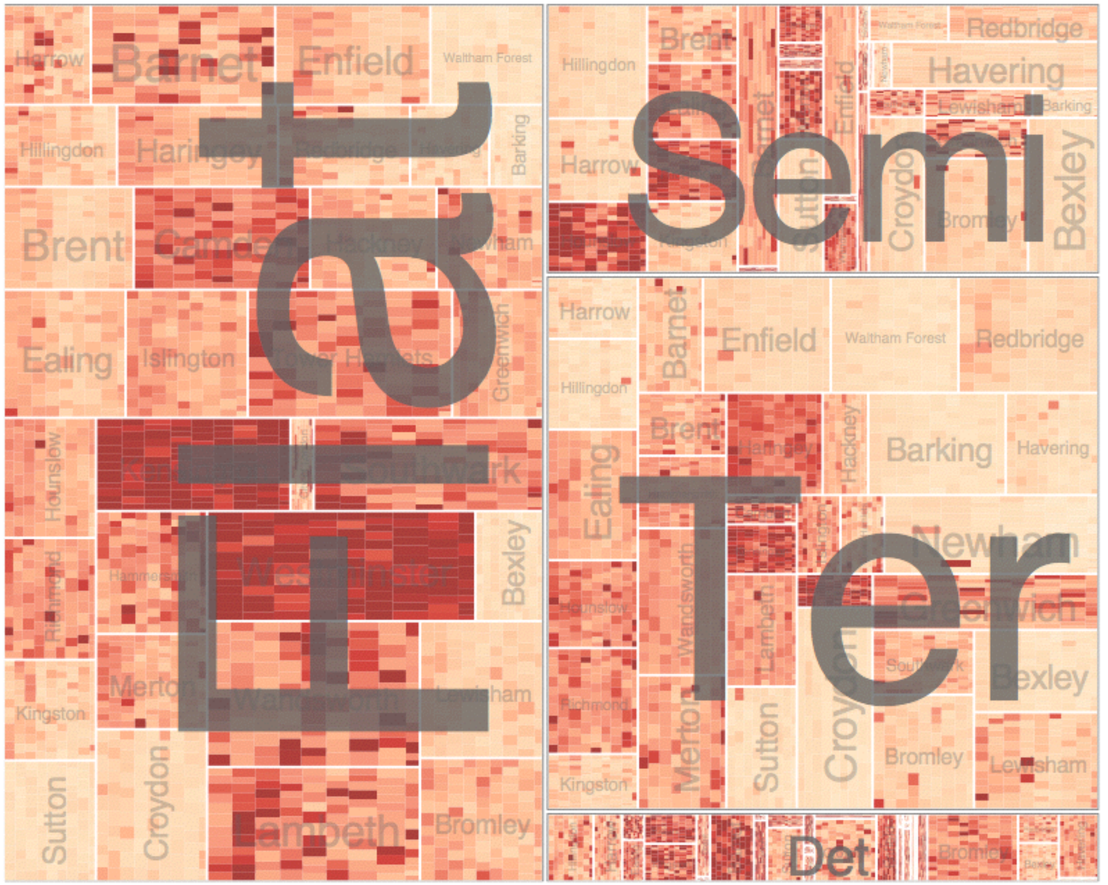
encoding attributes

average price (color)
number of sales (size)

results

between neighborhoods, different housing distributions

within neighborhoods, similar prices



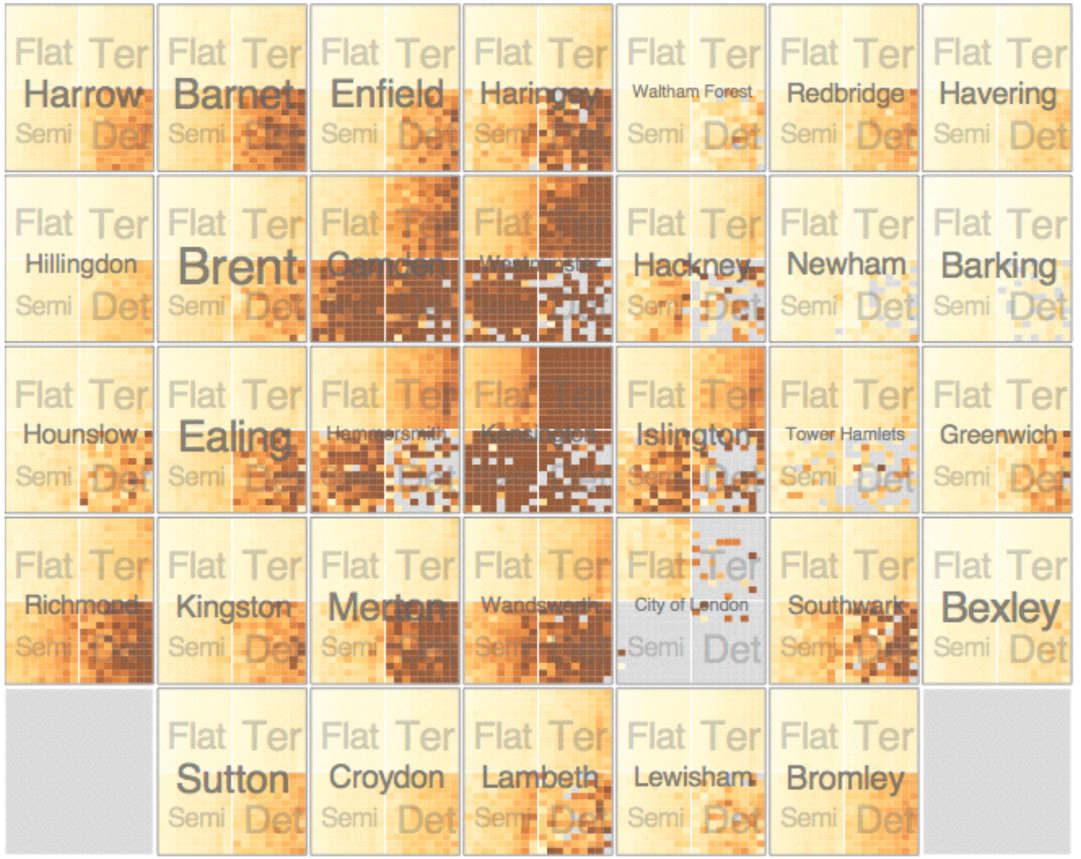
Slingsby 2009

HiVE example: London property

partitioning attributes
neighborhood location
neighborhood
house type
sale time (year)
sale time (month)

encoding attributes
average price (color)
n/a (size)

results
expensive neighborhoods
near center of city



Slingsby 2009

Configuring Hierarchical Layouts to Address Research Questions

Aidan Slingsby, Jason Dykes and Jo Wood
giCentre, Department of Information Science, City University London
http://www.gicentre.org/hierarchical_layouts/

LAYERING

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

rational

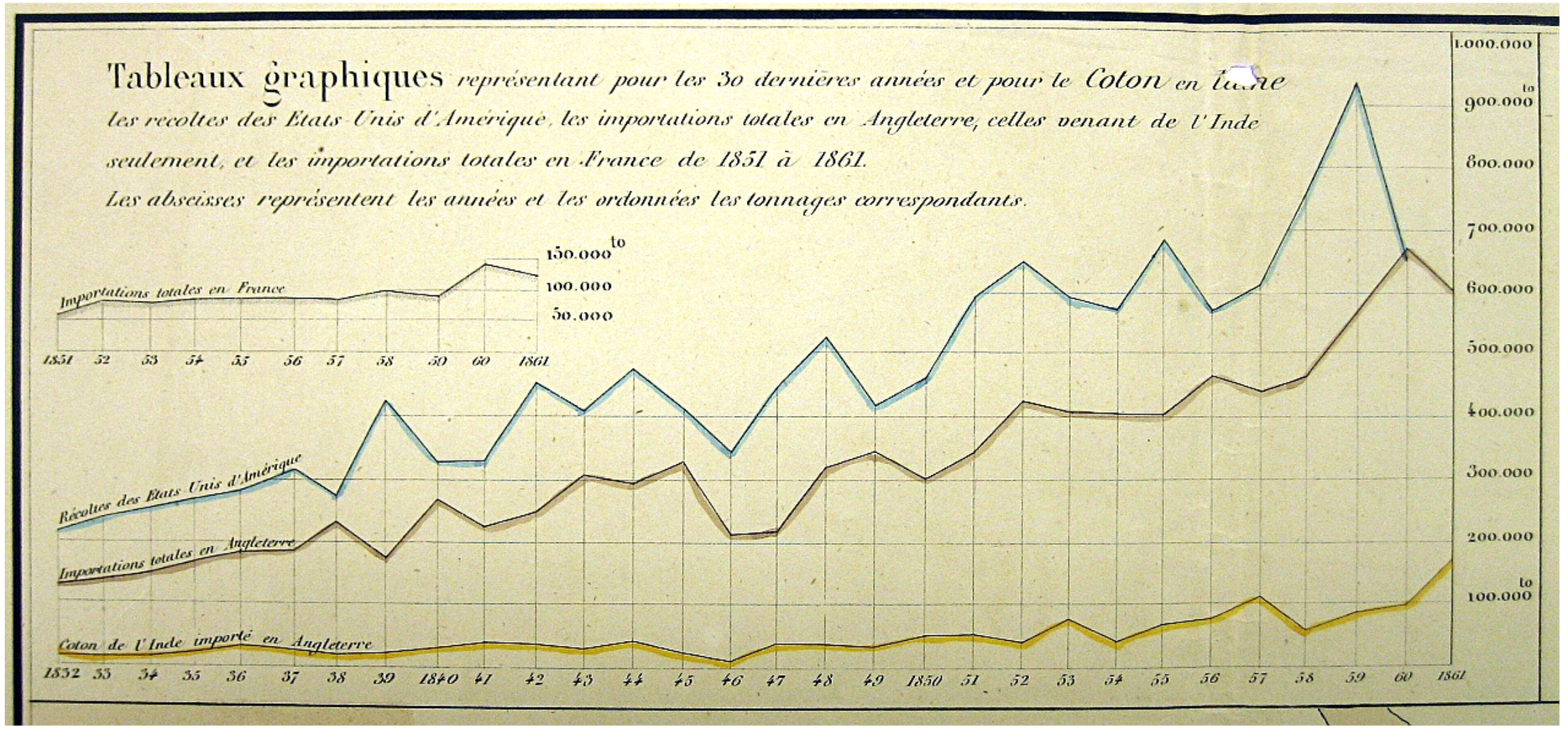
supports a larger, more detailed view than using multiple views

trade-off

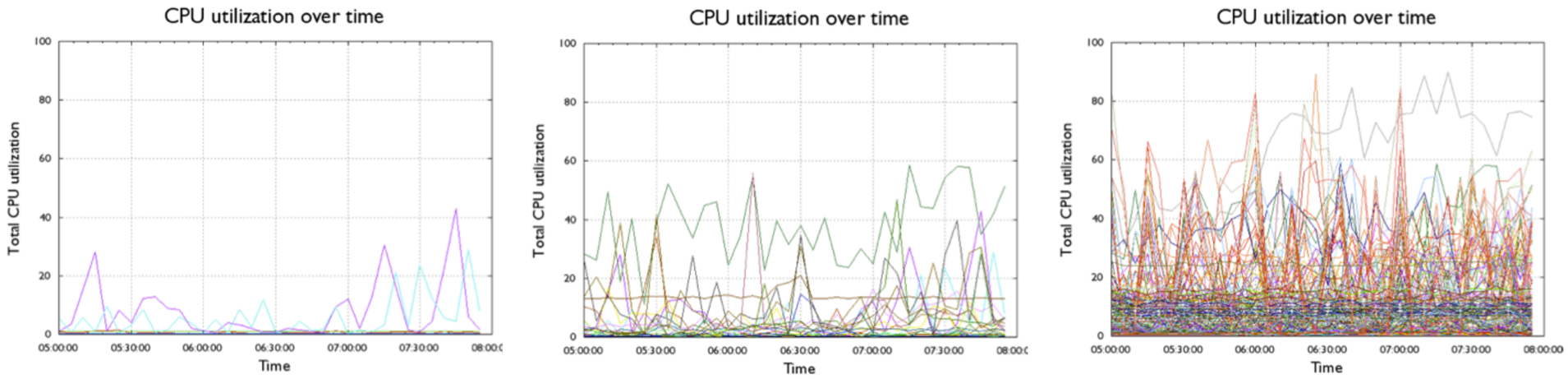
layering imposes constraints on visual encoding choice as well as number of layers that can be shown

JOSEPH MINARD

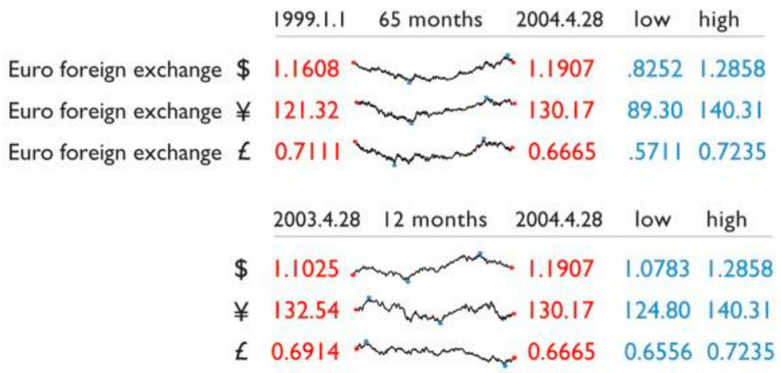
1781-1870



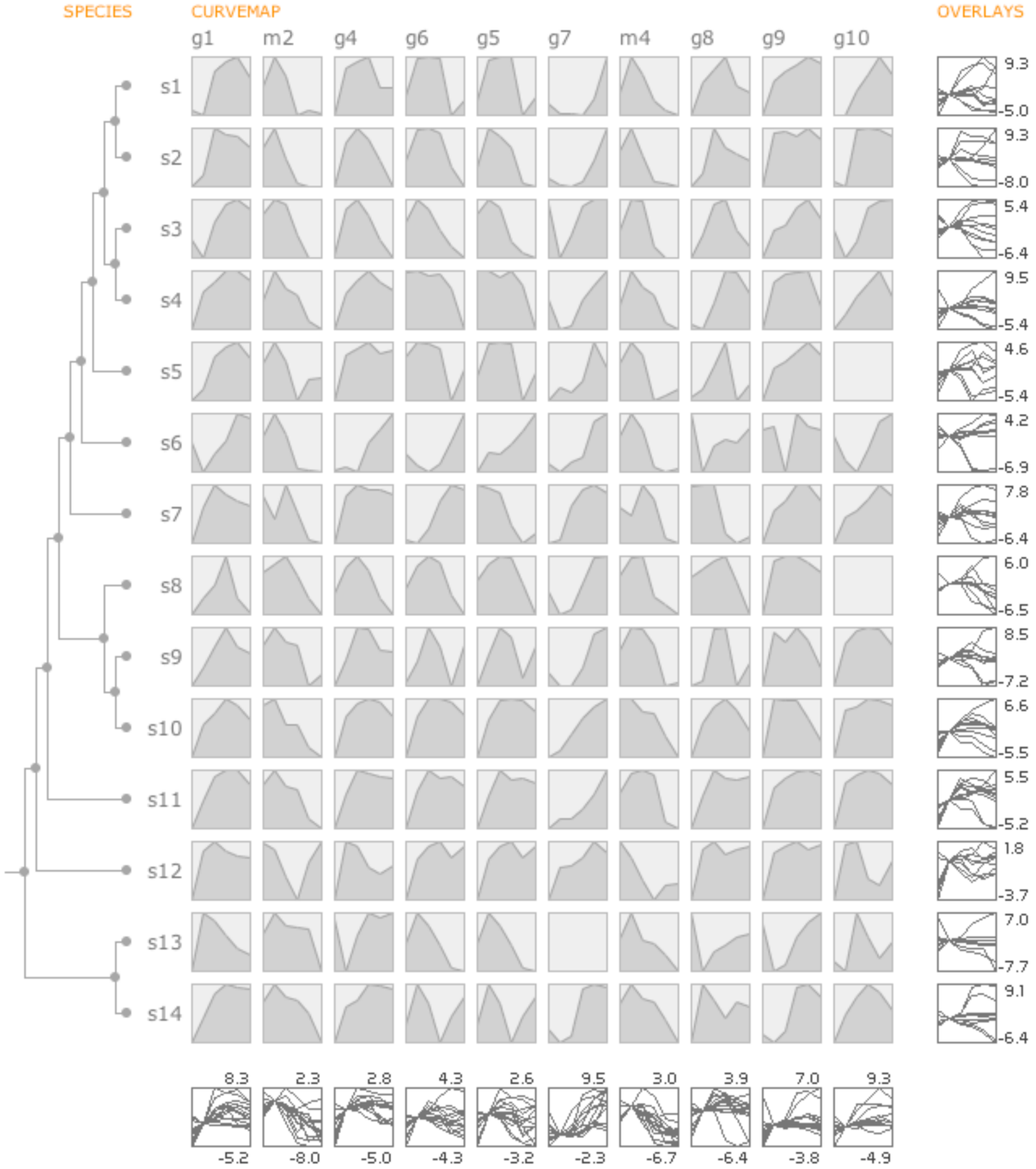
Overlays



Compare to Small Multiples - Sparklines



highlighting



MCV to the Max