

CIS 4930/6930-002

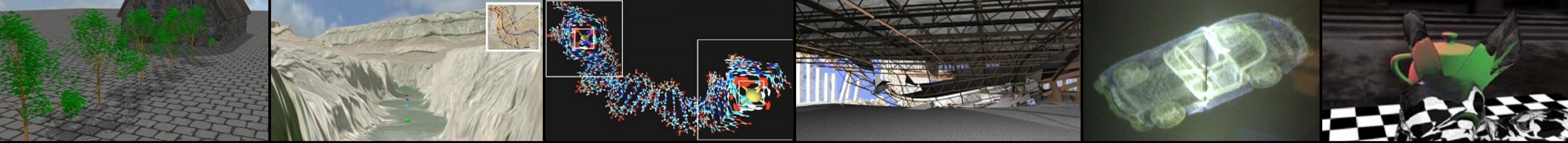
DATA VISUALIZATION



DATA ABSTRACTION AND VISUAL ENCODING

Paul Rosen
Assistant Professor
University of South Florida

slides credits Miriah Meyer (U of Utah)



REMINDERS...

Peer Reviews due next class

Contact me if you get your own submission to review

Make sure to give written feedback

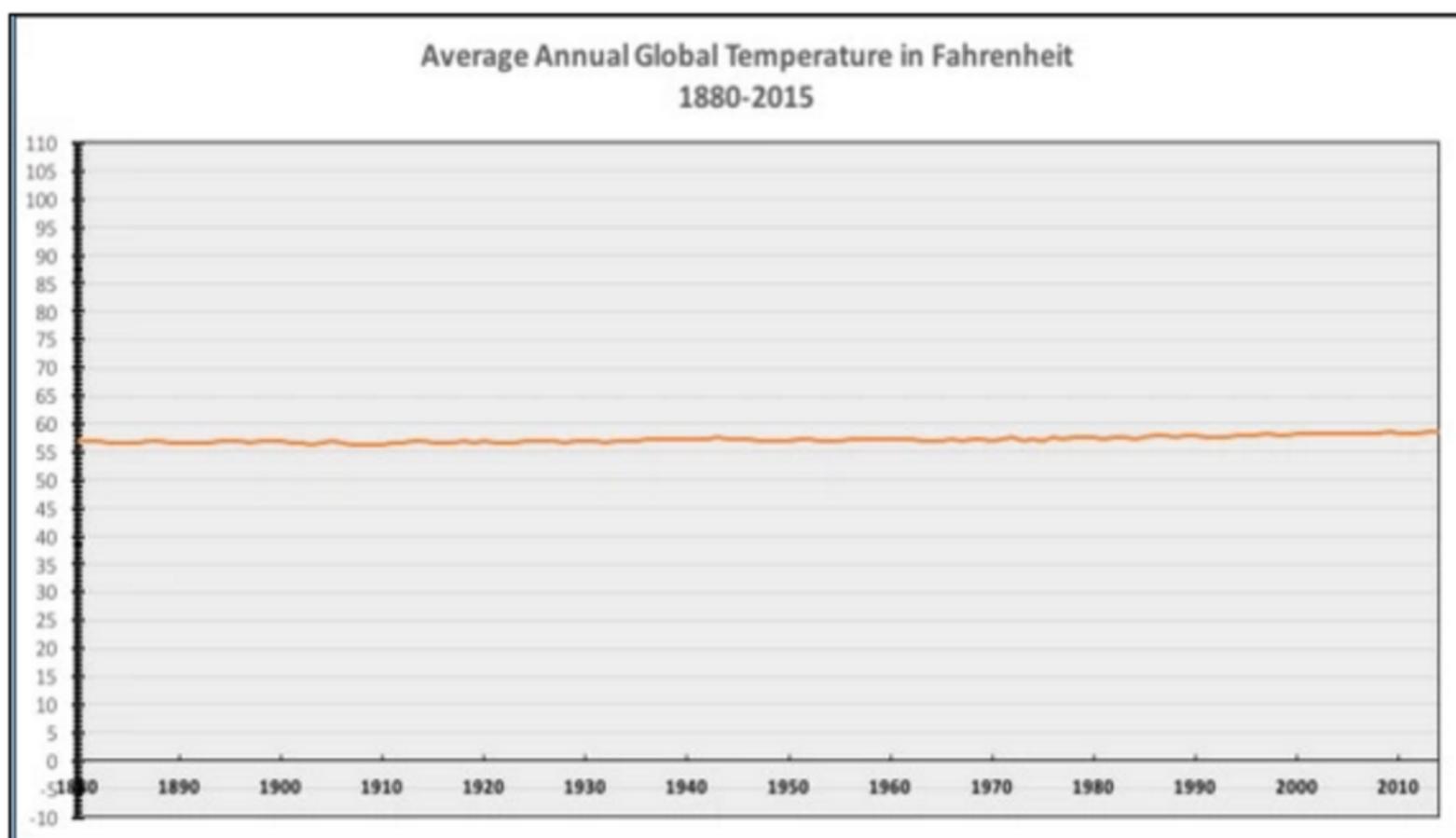
Project 2 due 1/29/18





The only #climatechange chart you need to see. natl.re/wPKpro

(h/t [@powerlineUS](#))



RETWEETS
408

LIKES
322



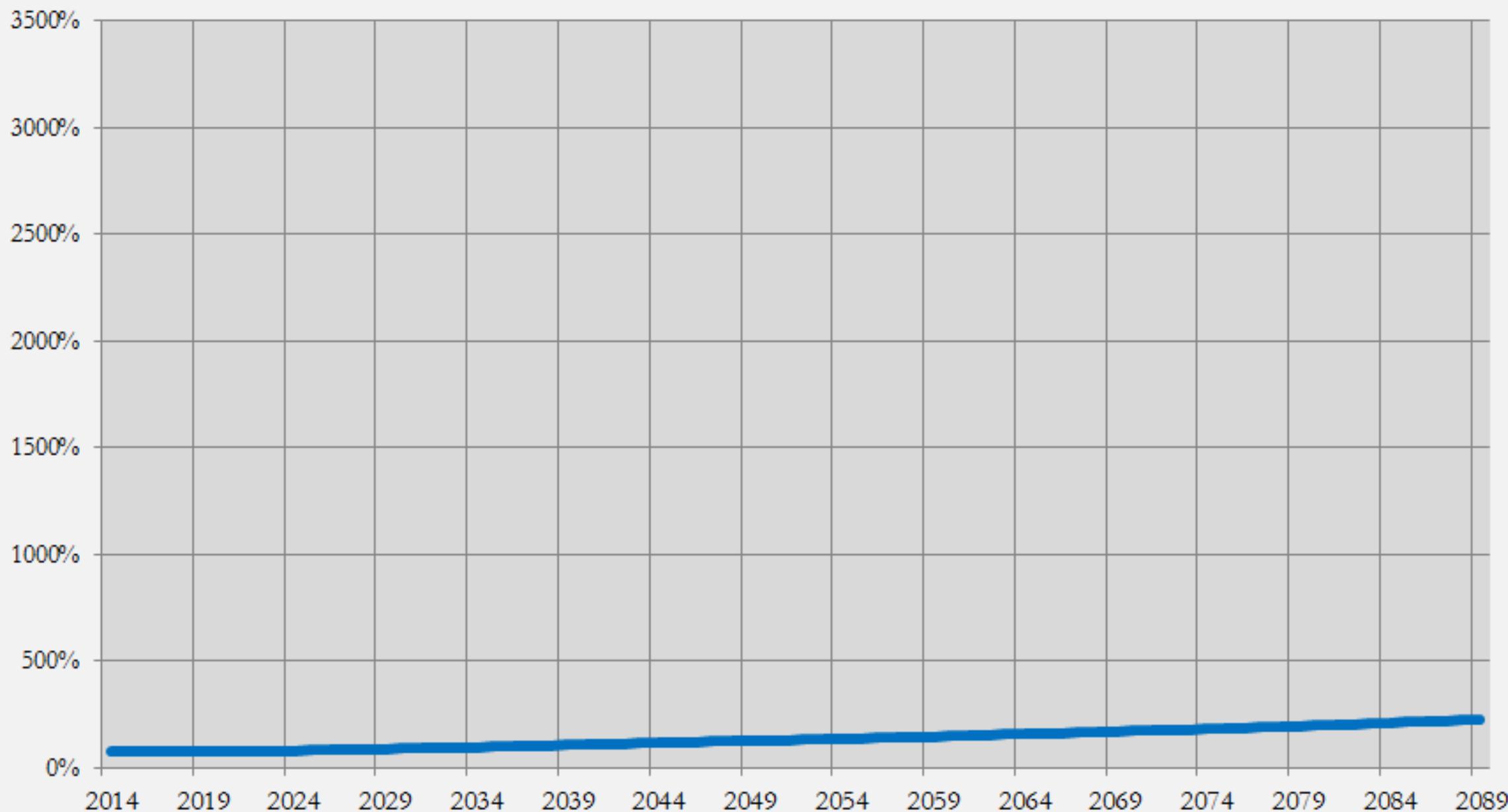
1:36 PM - 14 Dec 2015



...



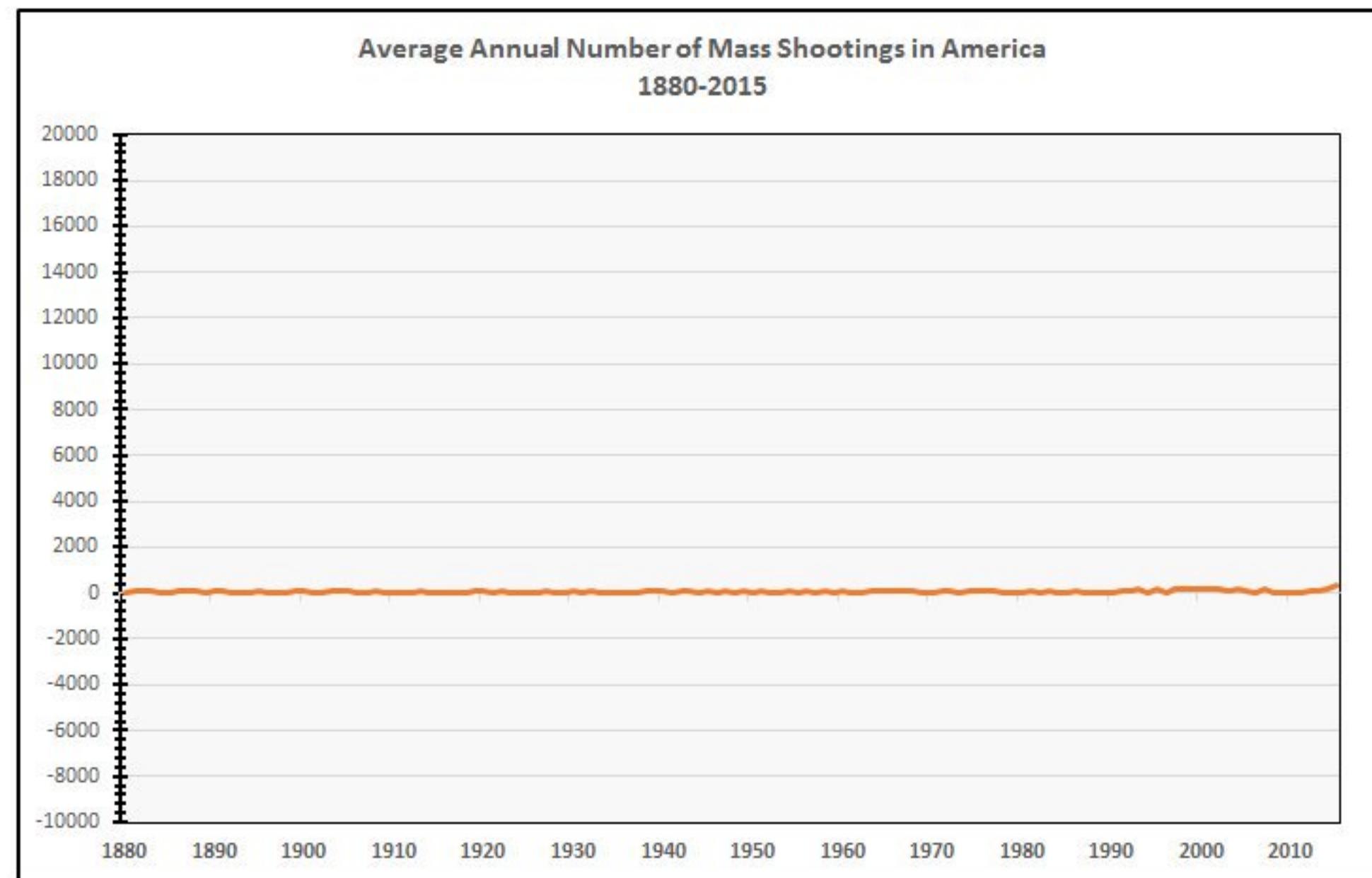
Federal Debt Held by the Public, as a share of GDP



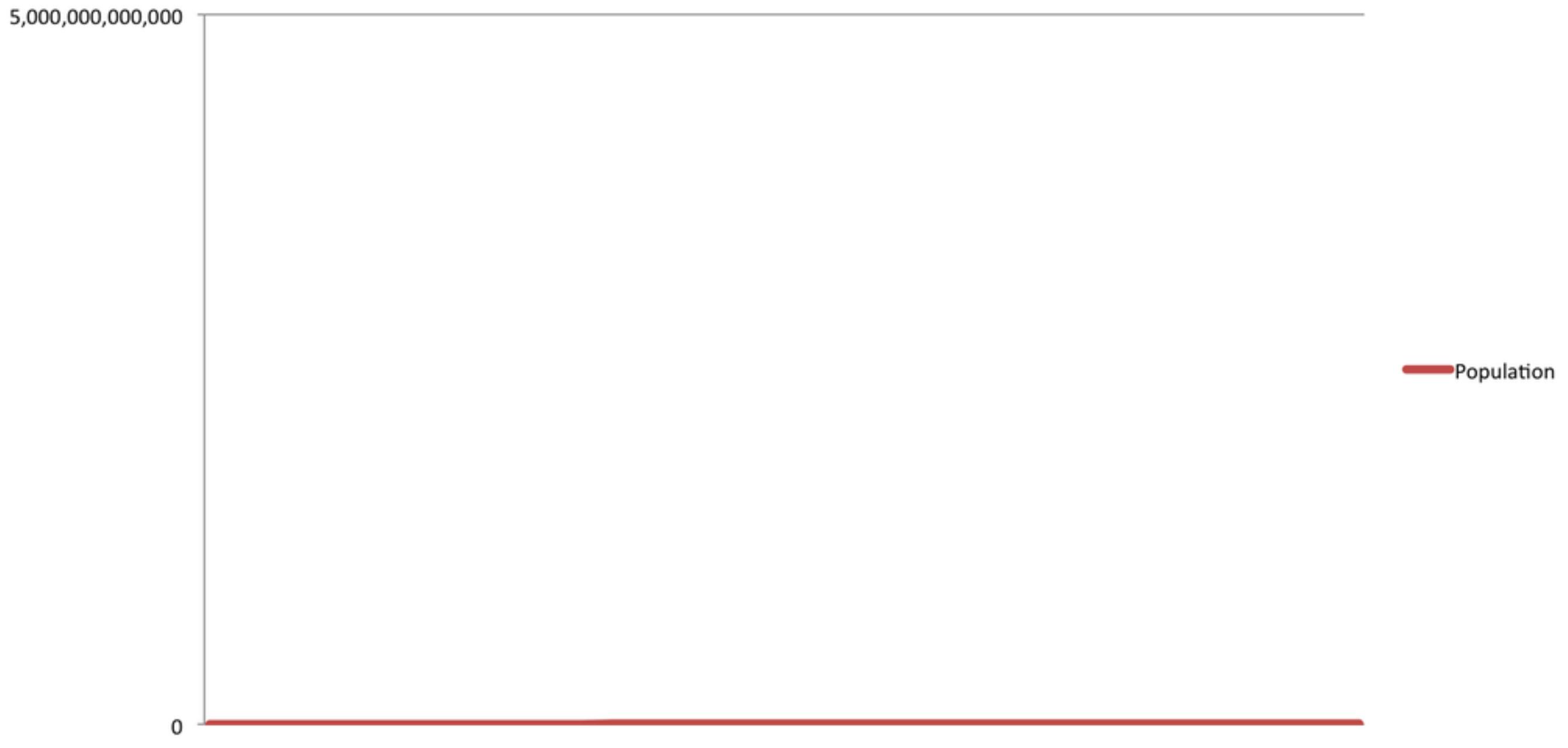
Source: CBO, 2014

@SeanMcElwee





World population from 10,000 BC to present



DATA ABSTRACTION

the *what* part of an analysis that pertains to the data
translation of domain-specific terms into words that
are as generic as possible



TYPE vs SEMANTIC



DATA TYPES

Items

Attributes

Links

Positions

Grids



DATASET TYPES

Tables

Items

Attributes



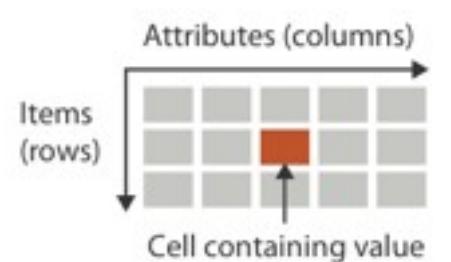
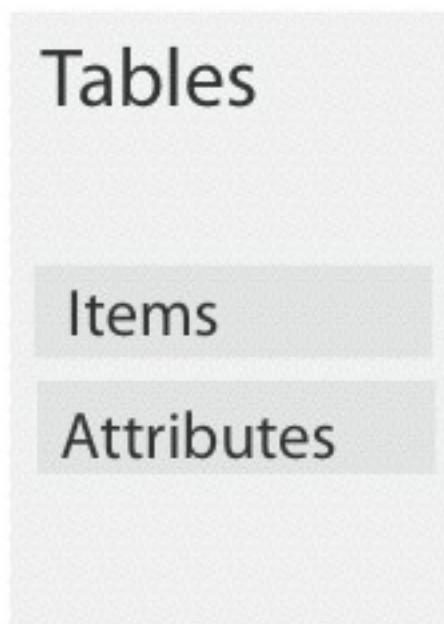
A	B	C	S	T	U
Order ID	Order Date	Order Priority	Product Container	Product Base Margin	Ship Date
3	10/14/06	5-Low	Large Box	0.8	10/21/06
6	2/21/08	4-Not Specified	Small Pack	0.55	2/22/08
32	7/16/07	2-High	Small Pack	0.79	7/17/07
32	7/16/07	2-High	Jumbo Box		7/17/07
32	7/16/07	2-High	Medium Box		7/18/07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

attribute

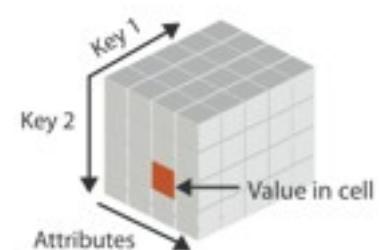
cell

item

DATASET TYPES



→ *Multidimensional Table*

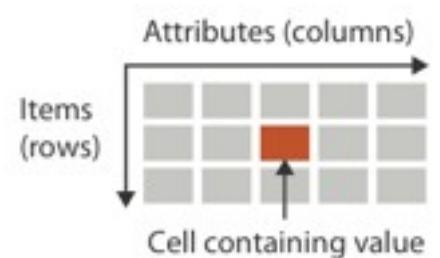


DATASET TYPES

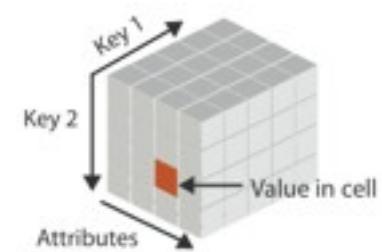
Tables

Items

Attributes



→ *Multidimensional Table*

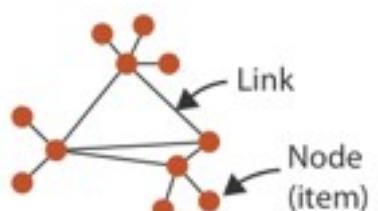


Networks & Trees

Items (nodes)

Links

Attributes



→ *Trees*

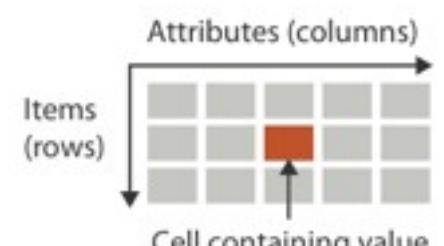


DATASET TYPES

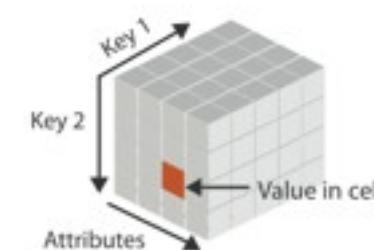
Tables

Items

Attributes



→ *Multidimensional Table*

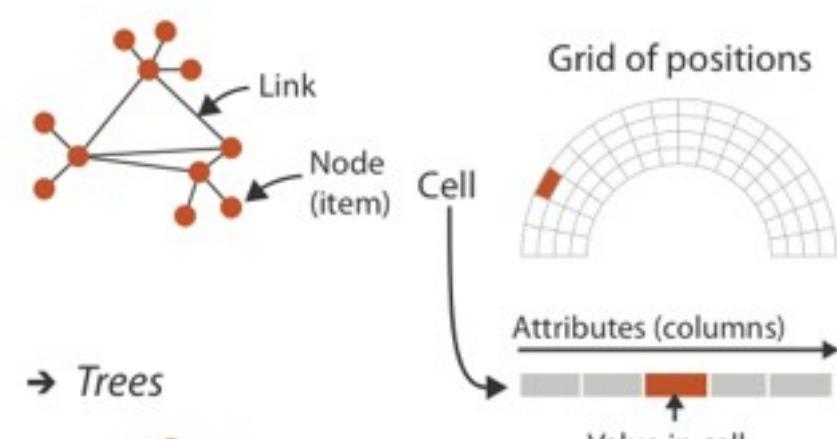


Networks & Trees

Items (nodes)

Links

Attributes

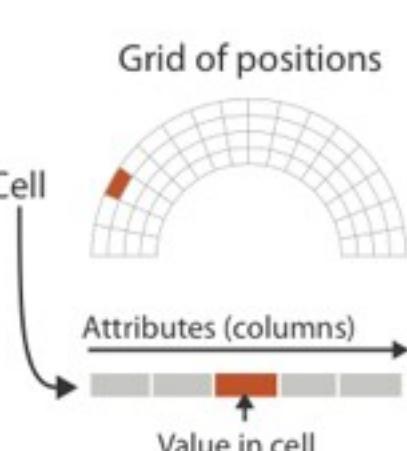


Fields

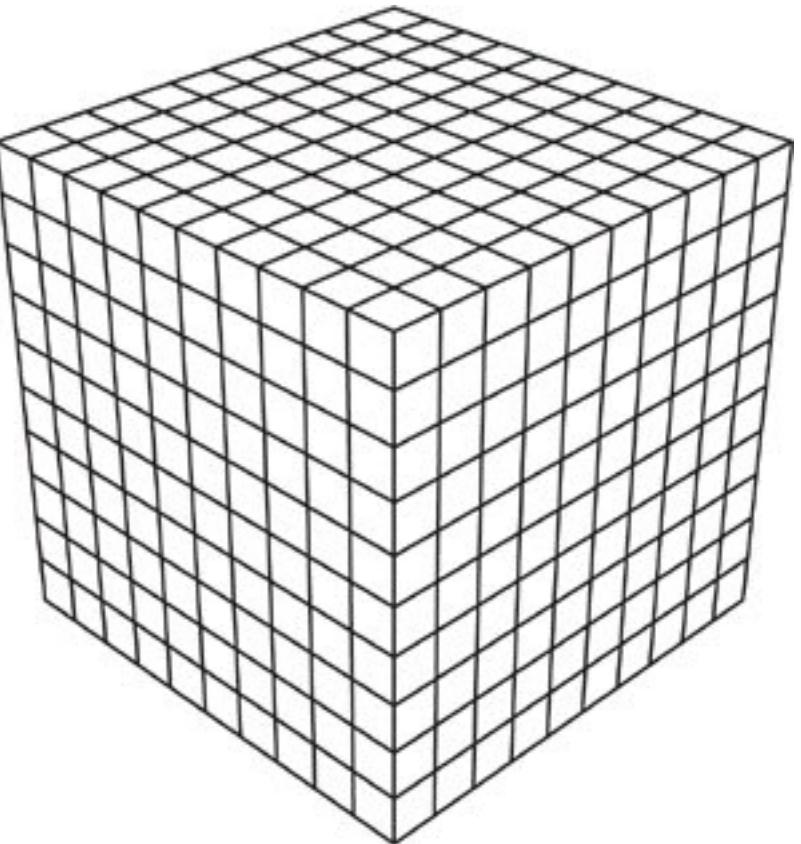
Grids

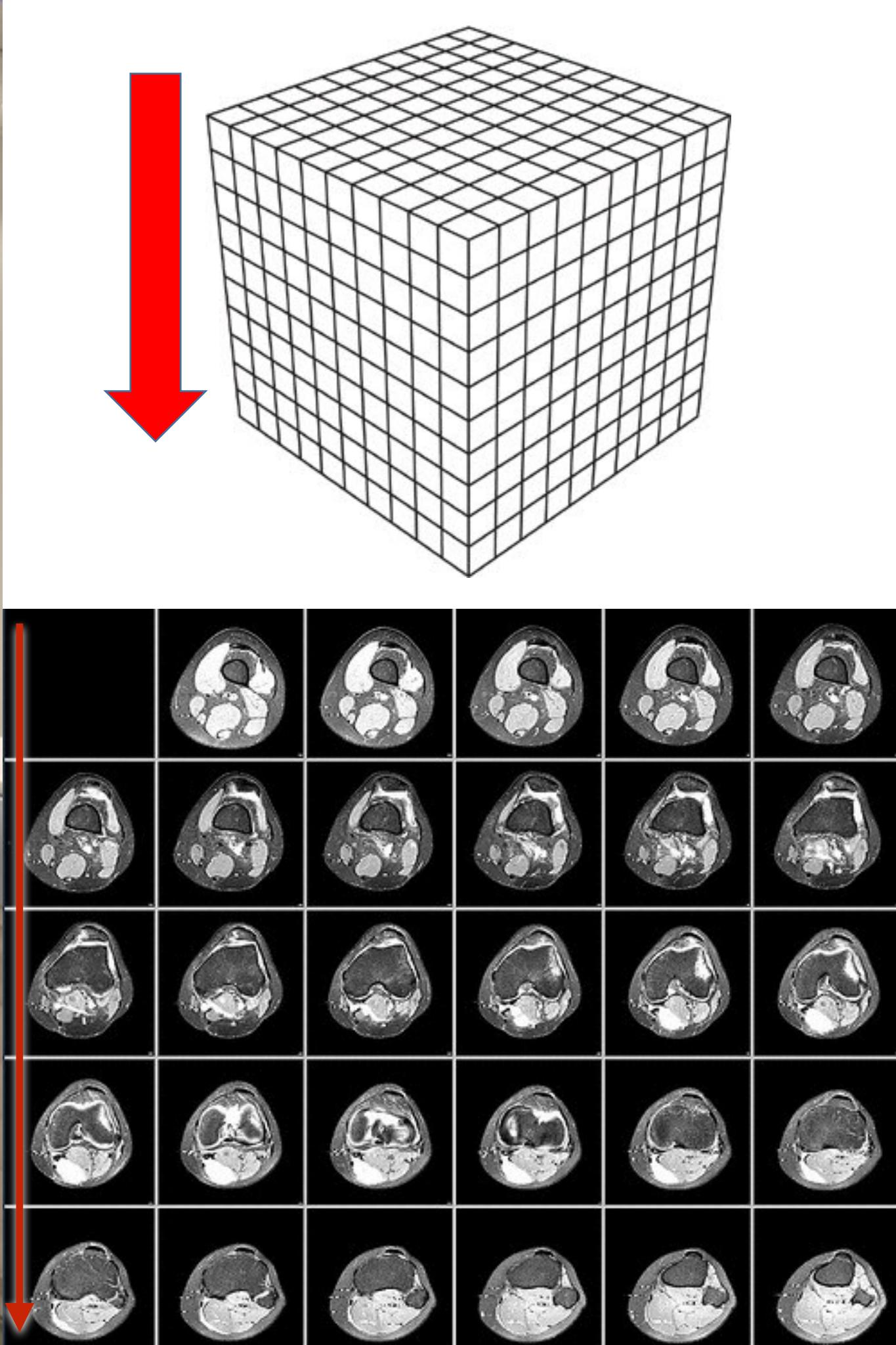
Positions

Attributes

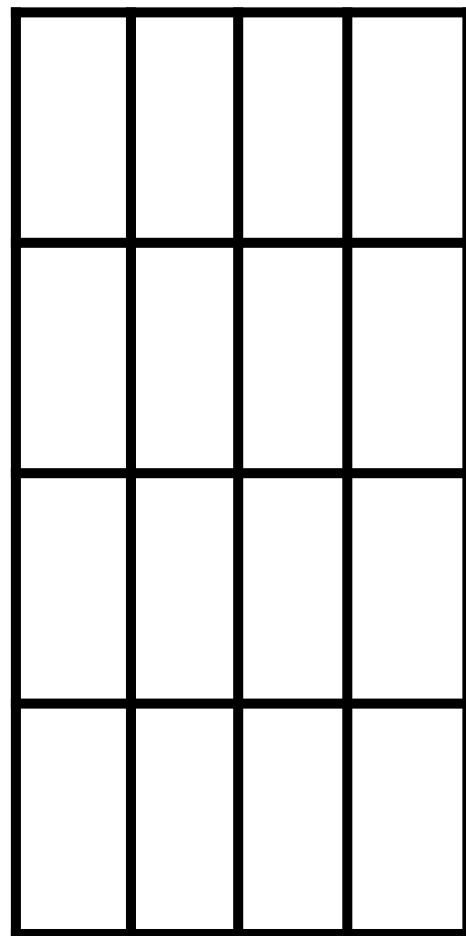




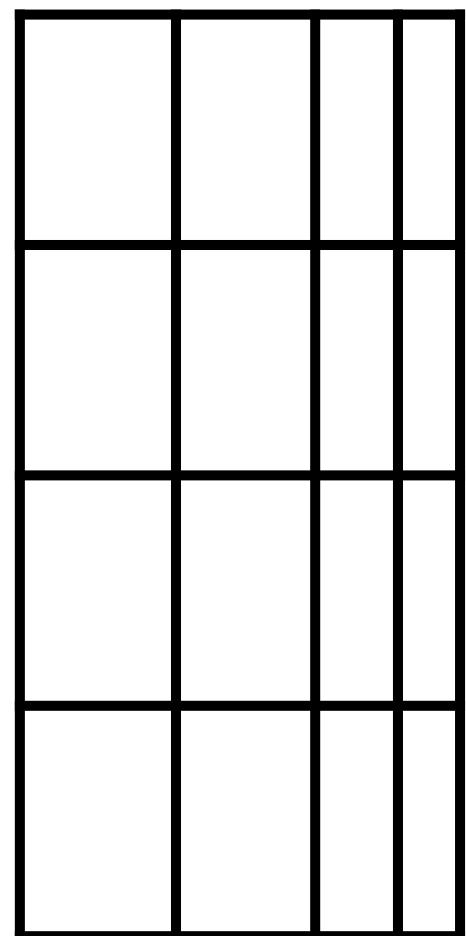




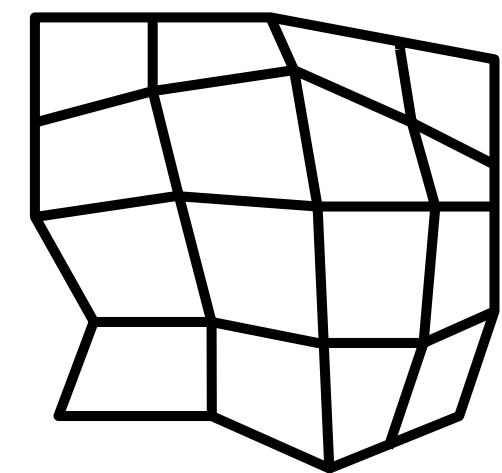
GRID TYPES



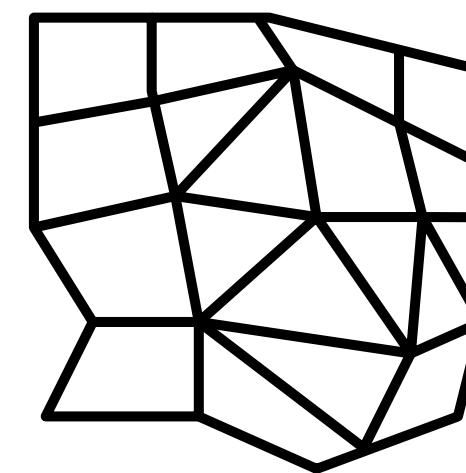
uniform



rectilinear



structured



unstructured

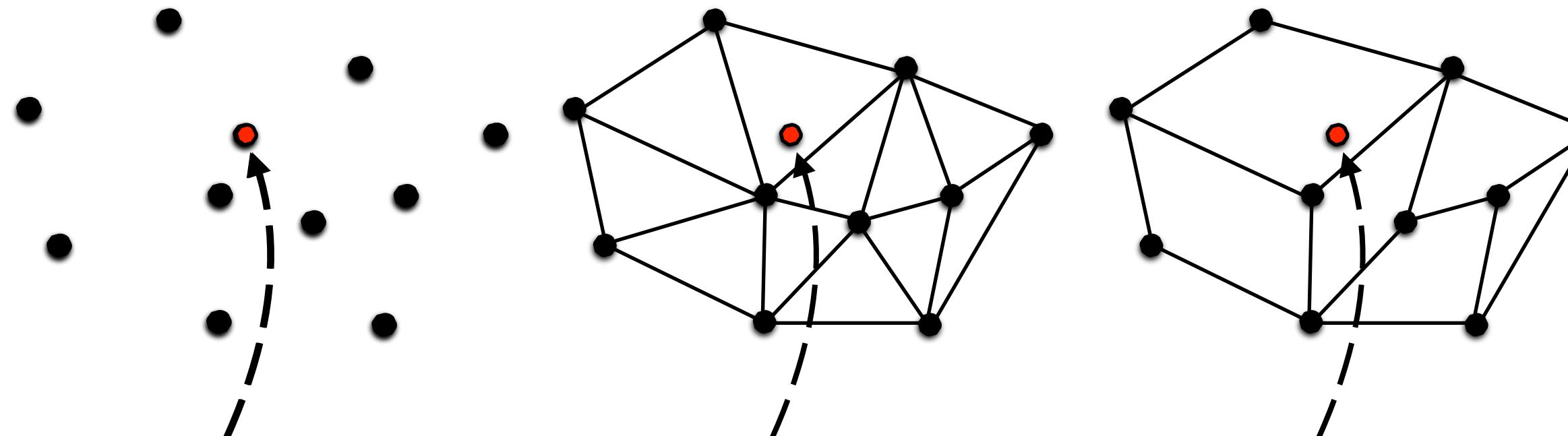


GRID CHOICES IMPACT HOW CONTINUOUS DATA IS INTERPRETED

two key considerations:

Sampling – the choice of where attributes are measured

Interpolation – how to model the attributes in the rest of space

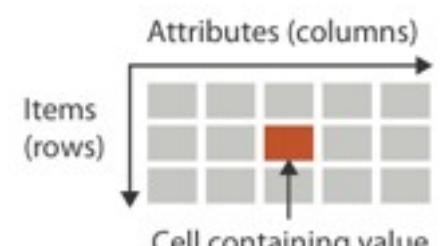


DATASET TYPES

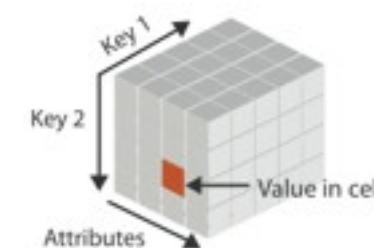
Tables

Items

Attributes



→ *Multidimensional Table*

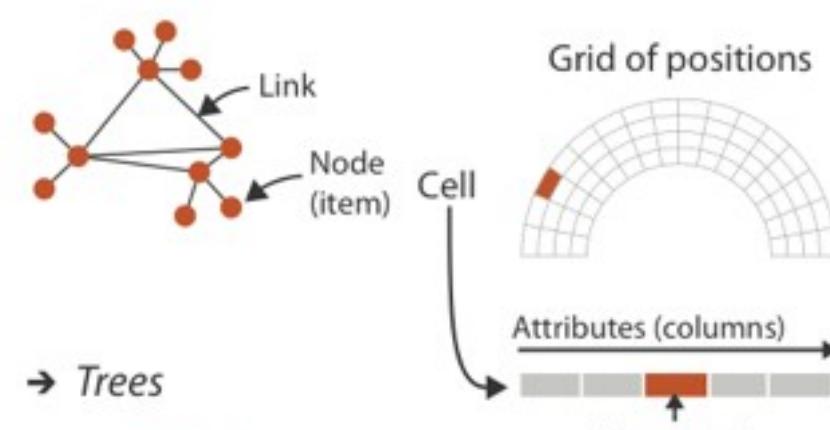


Networks & Trees

Items (nodes)

Links

Attributes

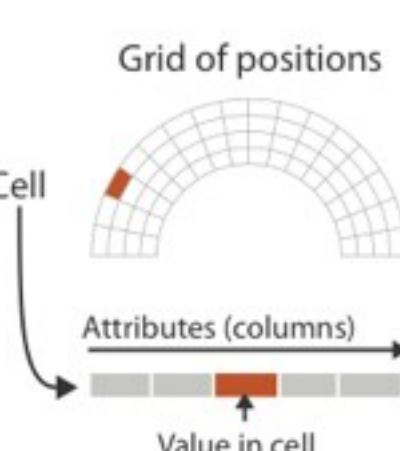


Fields

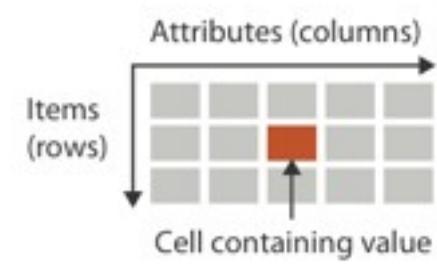
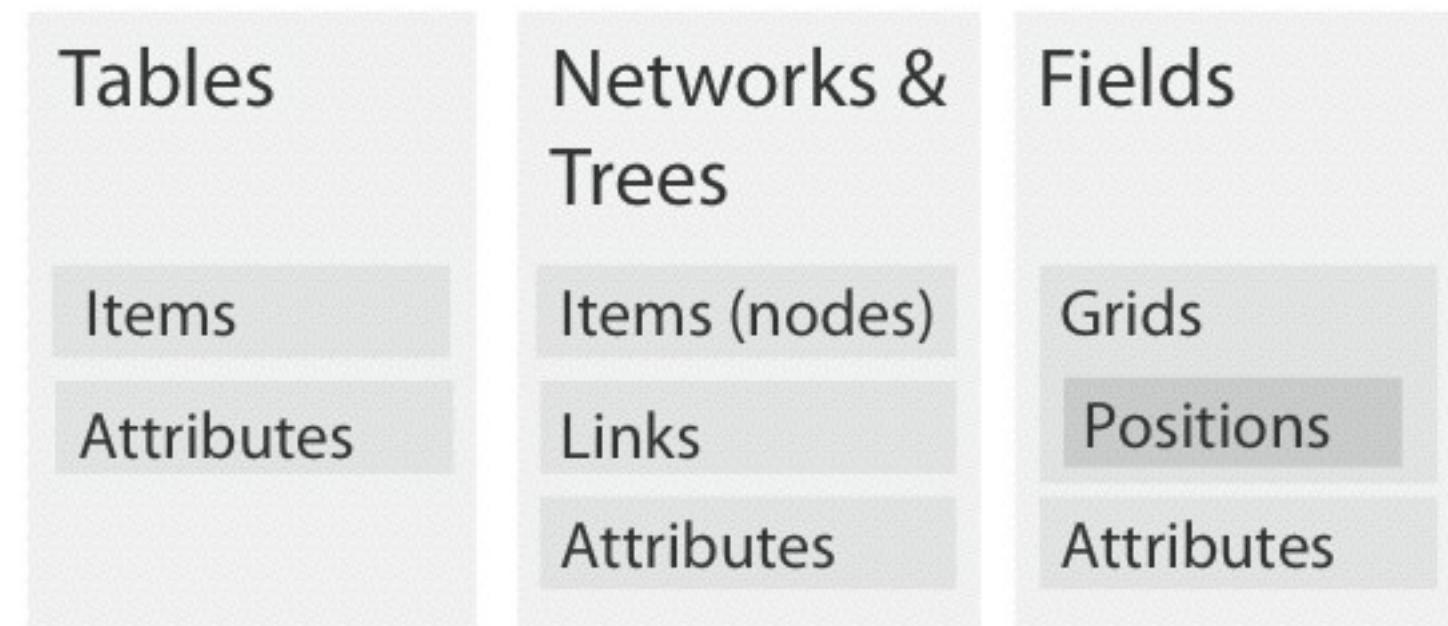
Grids

Positions

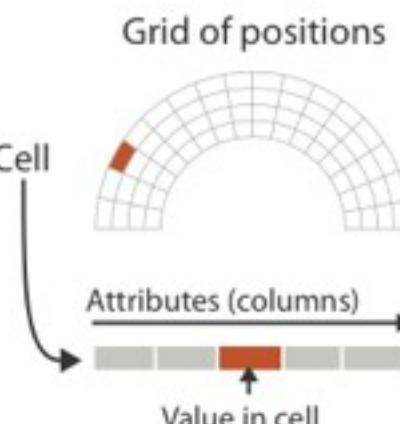
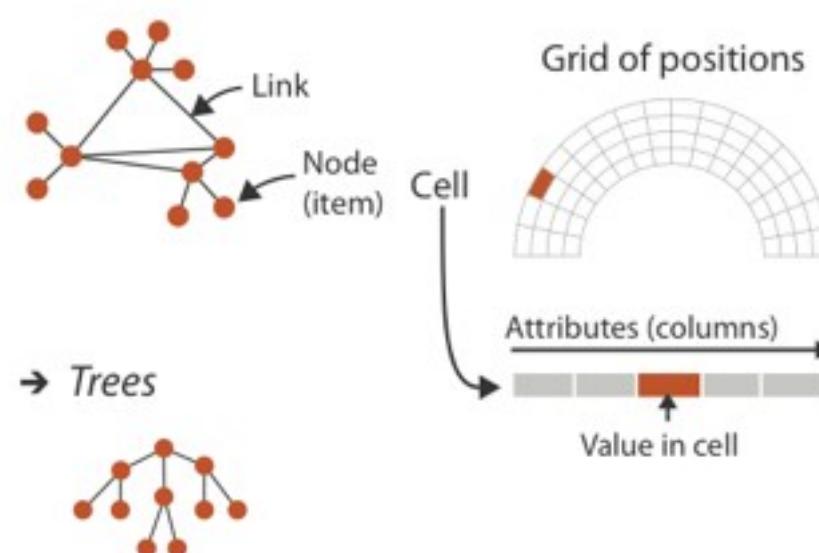
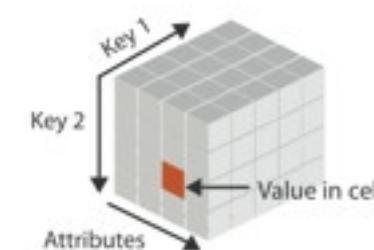
Attributes



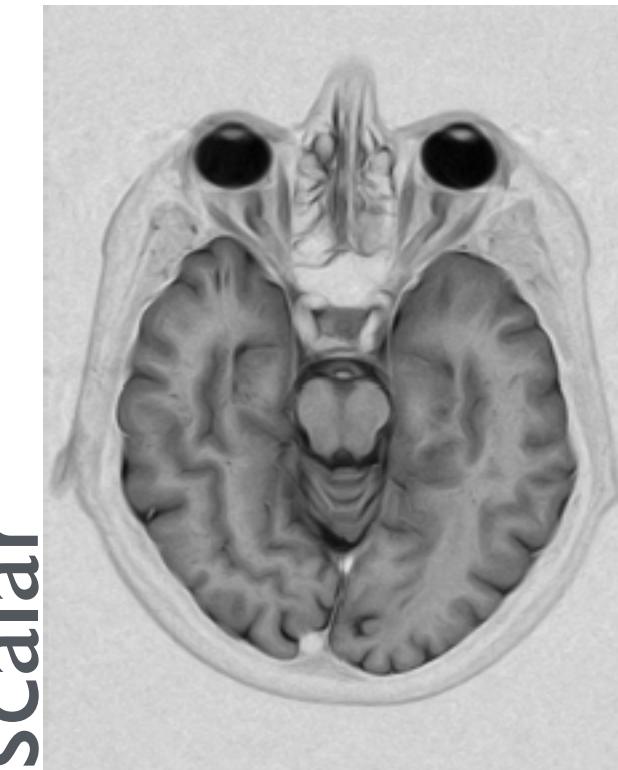
DATASET TYPES



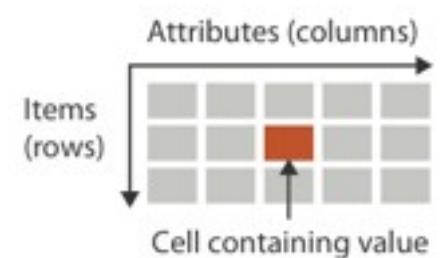
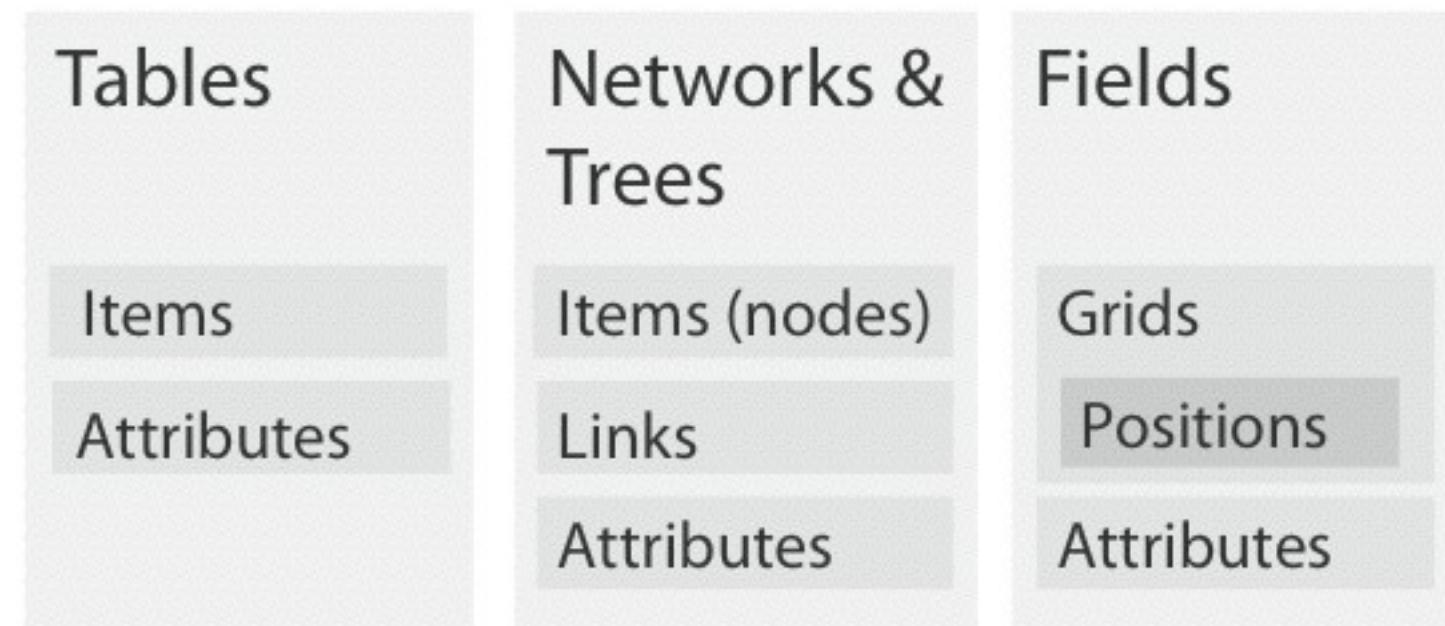
→ *Multidimensional Table*



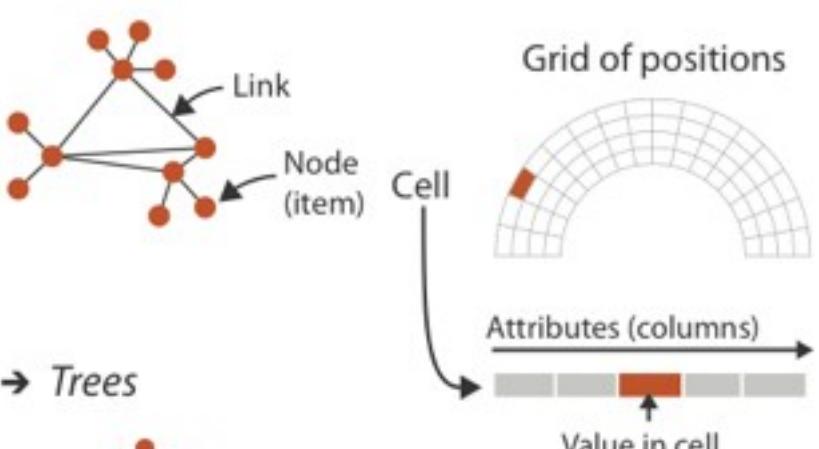
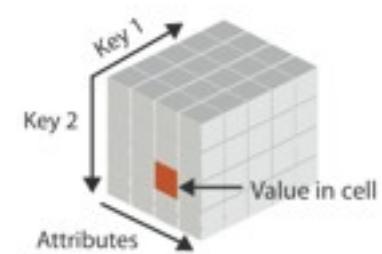
scalar



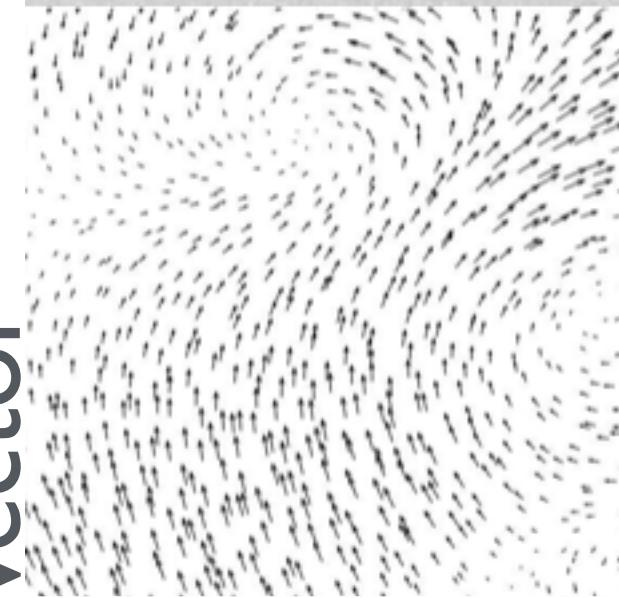
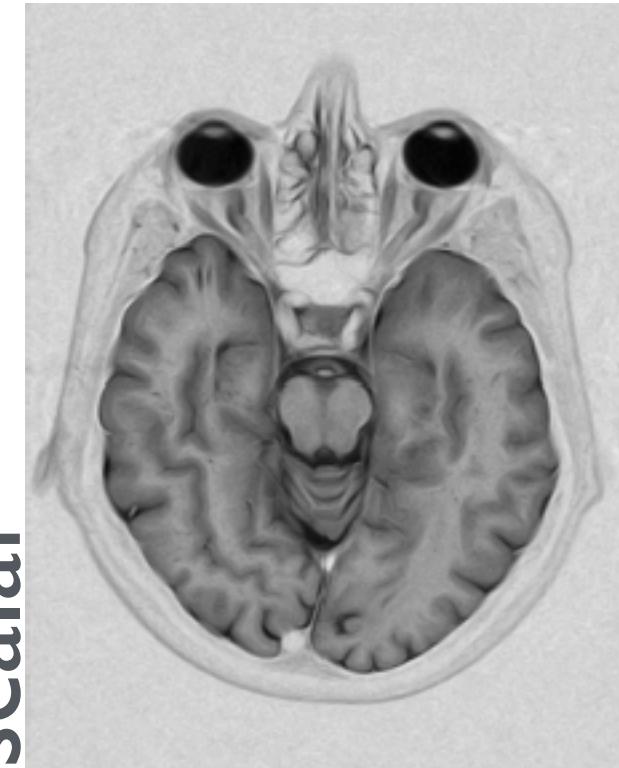
DATASET TYPES



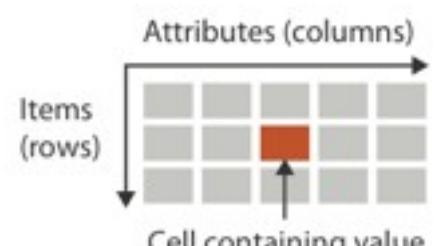
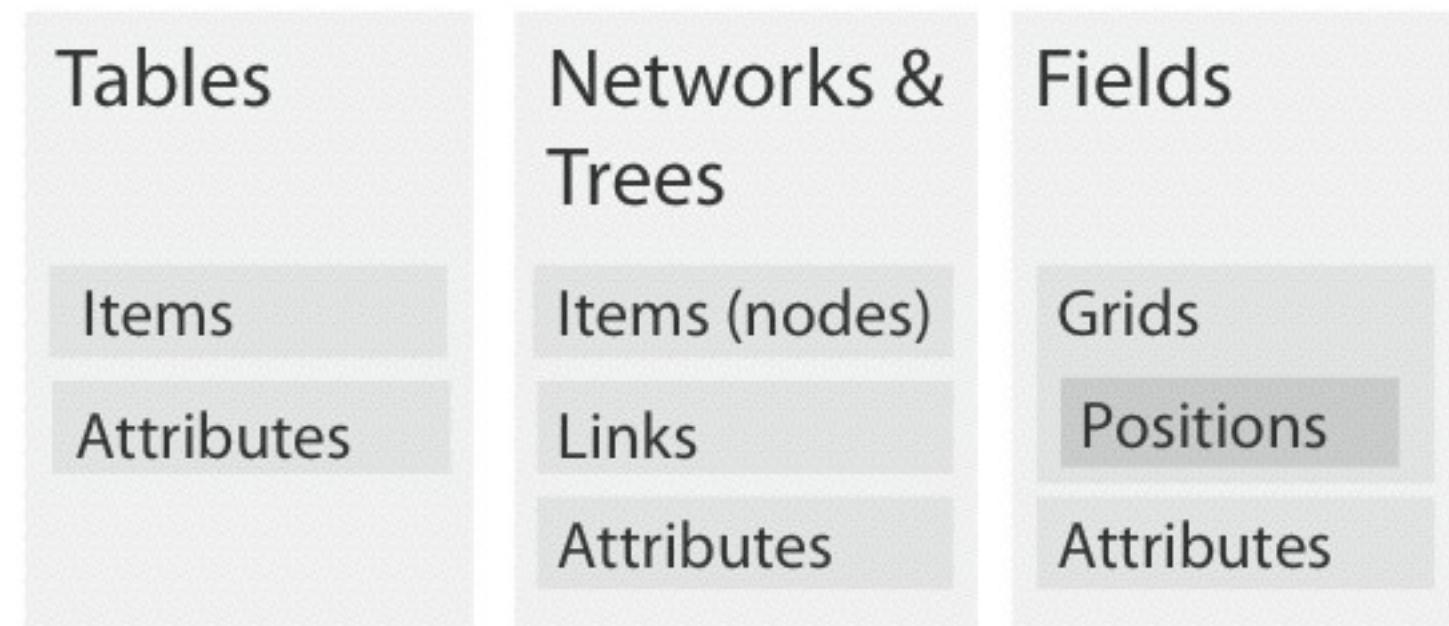
→ *Multidimensional Table*



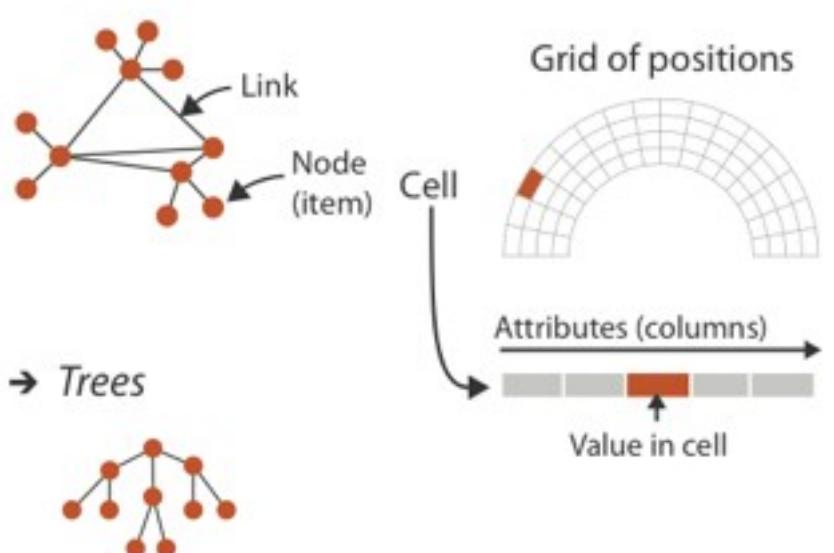
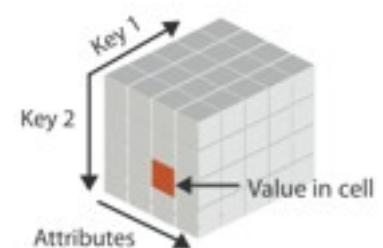
scalar
vector



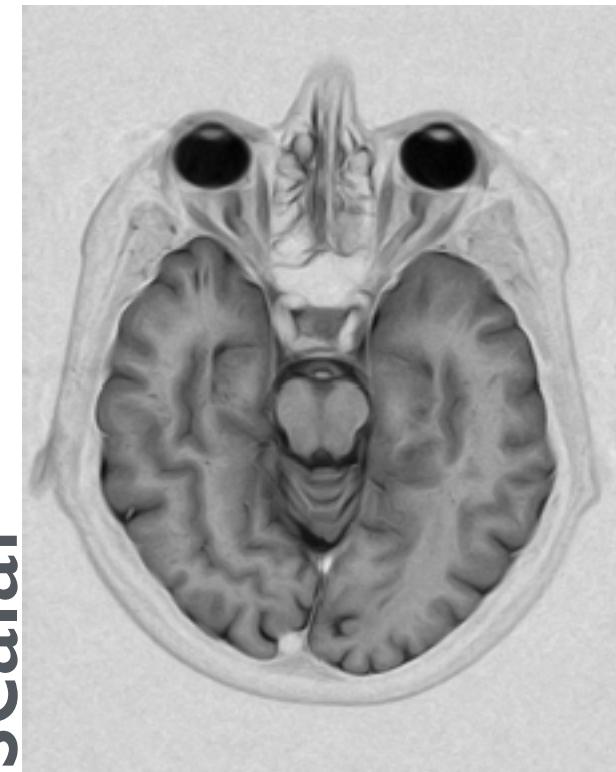
DATASET TYPES



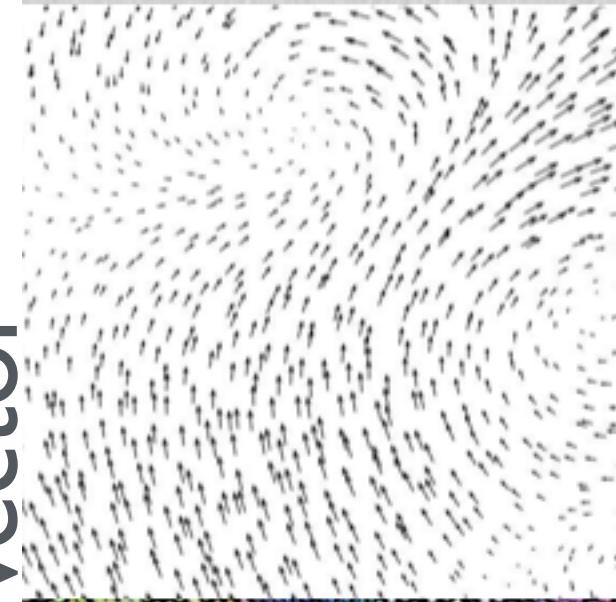
→ *Multidimensional Table*



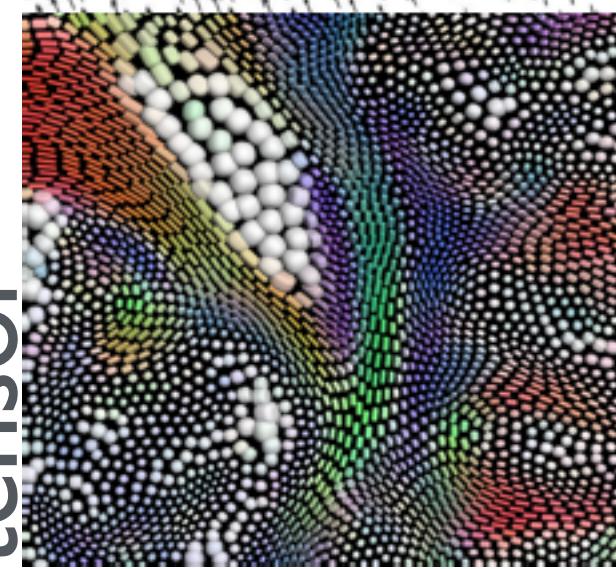
scalar



vector



tensor

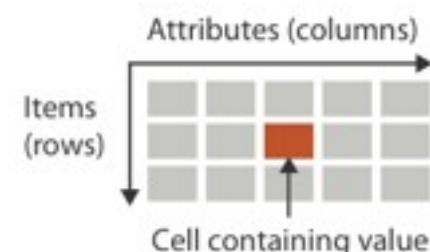


DATASET TYPES

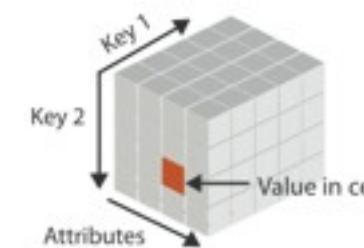
Tables

Items

Attributes



→ *Multidimensional Table*

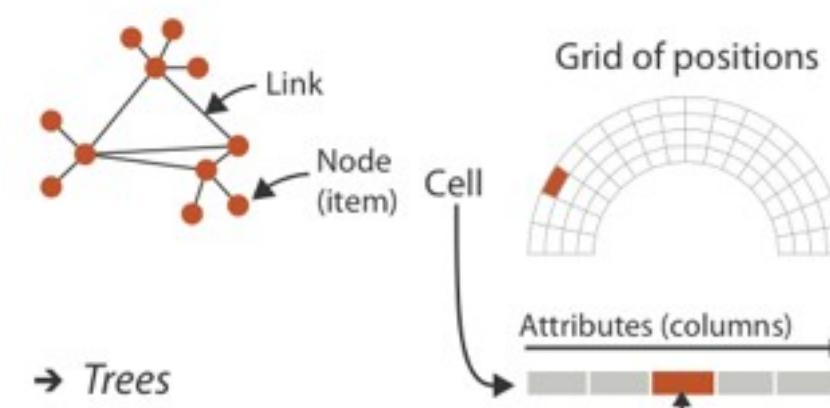


Networks & Trees

Items (nodes)

Links

Attributes



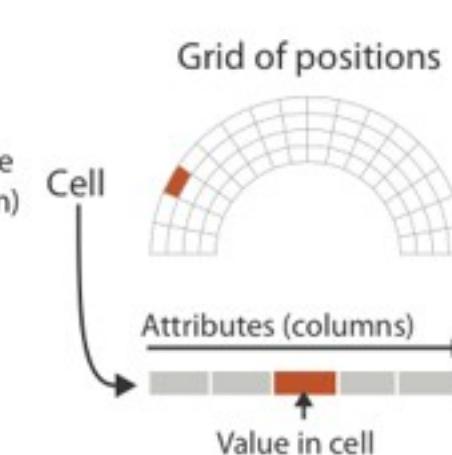
→ *Trees*

Fields

Grids

Positions

Attributes

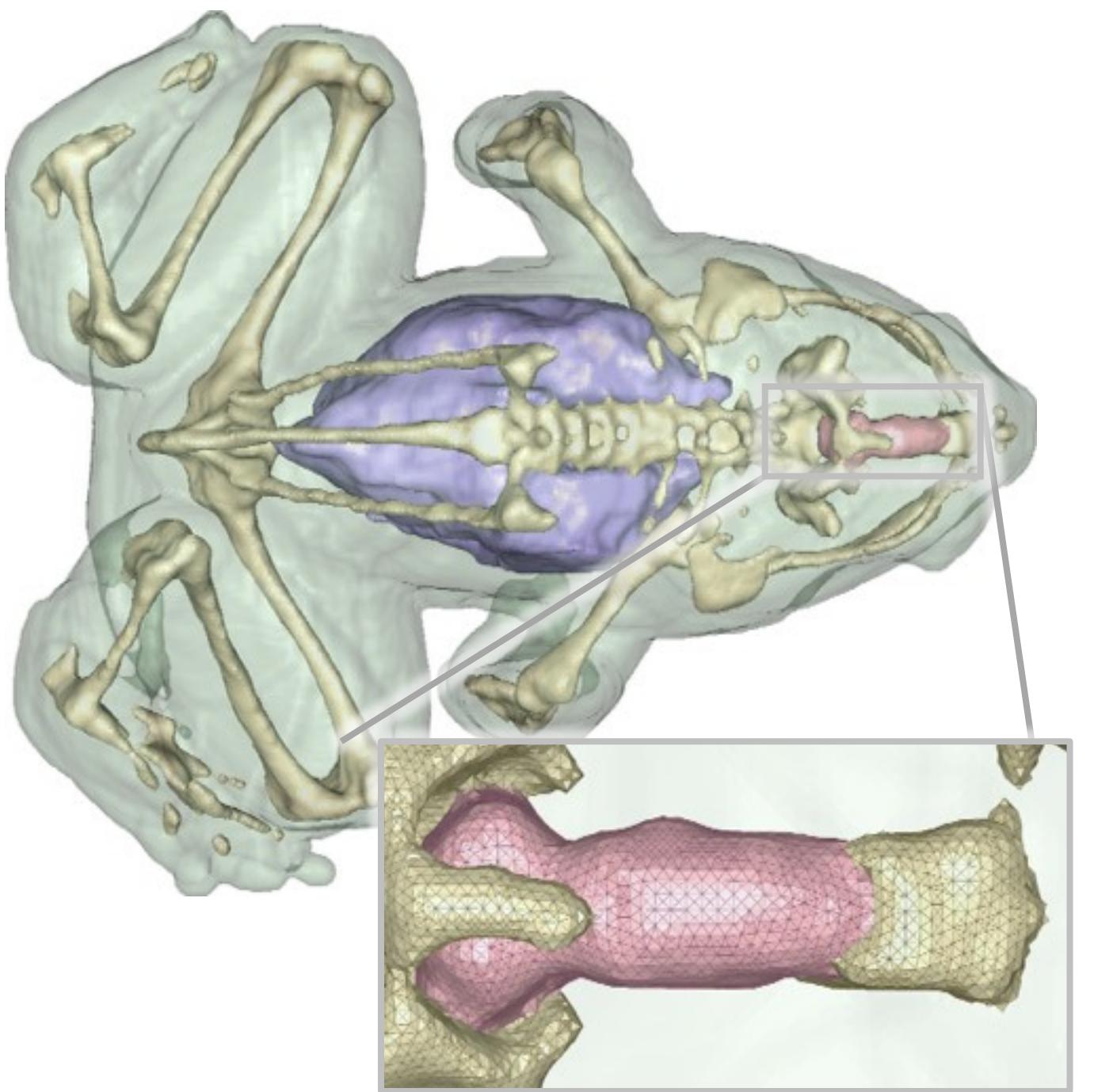


Geometry

Items

Positions



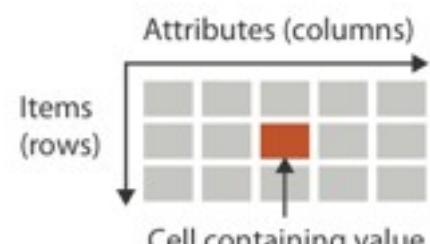


DATASET TYPES

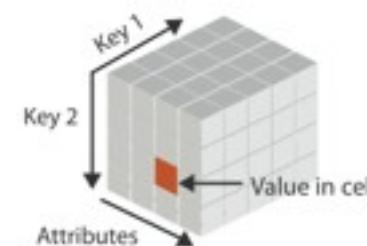
Tables

Items

Attributes



→ *Multidimensional Table*

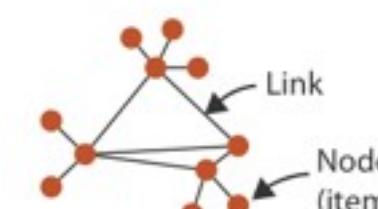


Networks & Trees

Items (nodes)

Links

Attributes



→ *Trees*

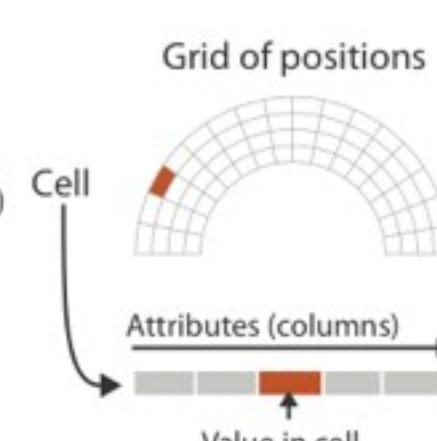


Fields

Grids

Positions

Attributes



Geometry

Items

Positions



Clusters, Sets, Lists

Items



ATTRIBUTE TYPES

Categorical

no implicit ordering



ATTRIBUTE TYPES

Categorical

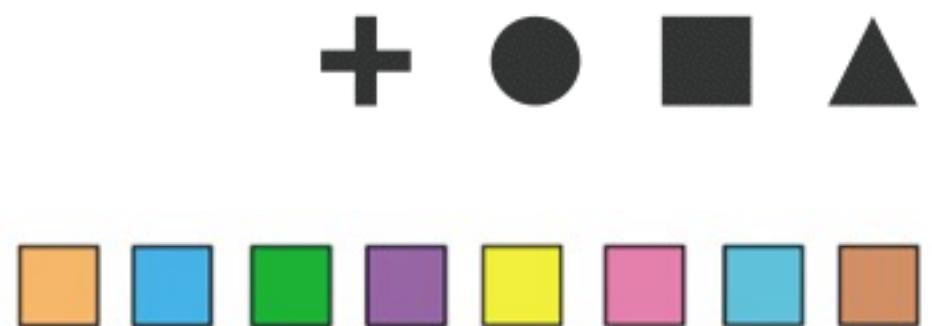
no implicit ordering



ATTRIBUTE TYPES

Categorical

no implicit ordering



Ordered

Ordinal

Quantitative



ATTRIBUTE TYPES

Categorical

no implicit ordering



Ordered

Ordinal

Quantitative

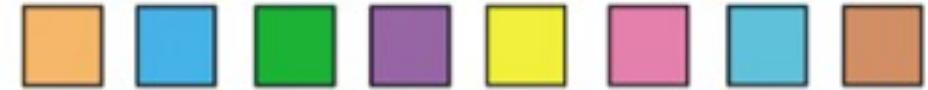
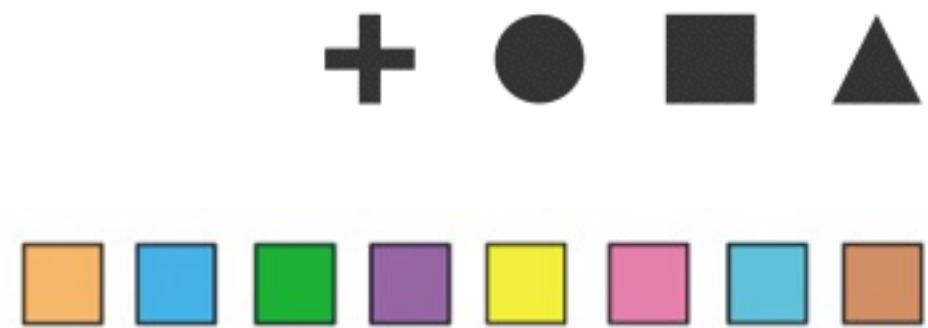
meaningful magnitude
(can do arithmetic)



ATTRIBUTE TYPES

Categorical

no implicit ordering



Ordered

Ordinal



Quantitative

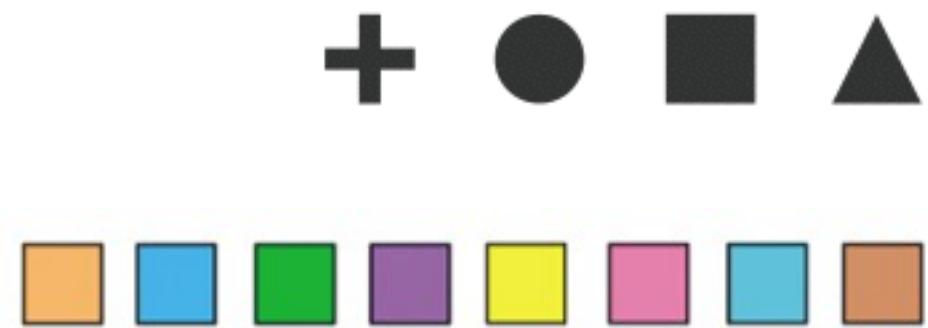
meaningful magnitude
(can do arithmetic)



ATTRIBUTE TYPES

Categorical

no implicit ordering



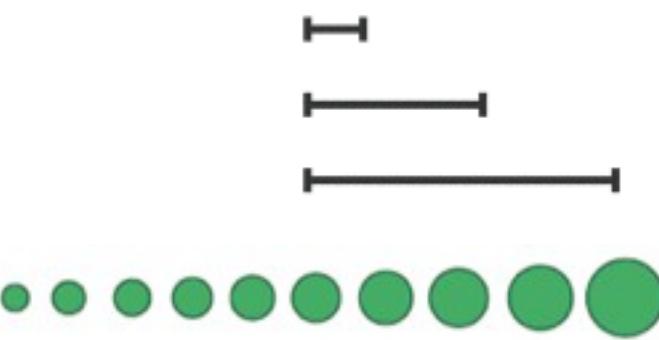
Ordered

Ordinal



Quantitative

meaningful magnitude
(can do arithmetic)



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

quantitative
ordinal
categorical



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

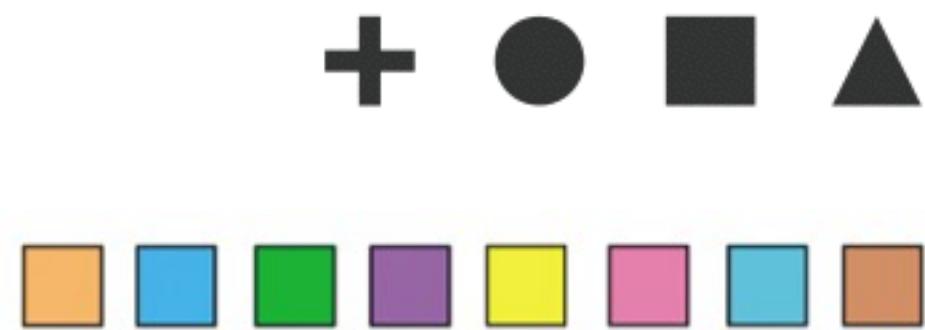
quantitative
ordinal
categorical



ATTRIBUTE TYPES

Categorical

no implicit ordering



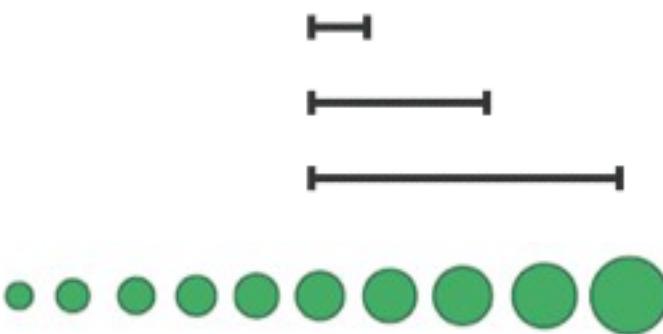
Ordered

Ordinal



Quantitative

meaningful magnitude
(can do arithmetic)



Sequential



Divergent



Cyclic



DERIVED ATTRIBUTES

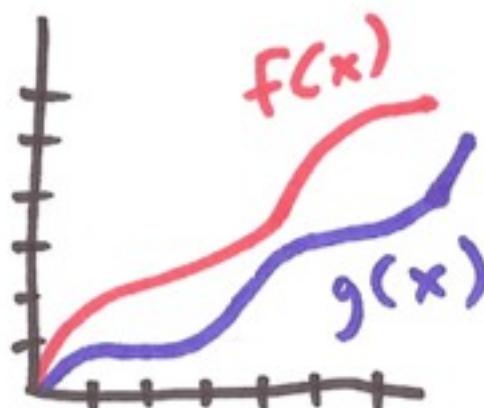
derived attribute: computed from originals

simple change of type

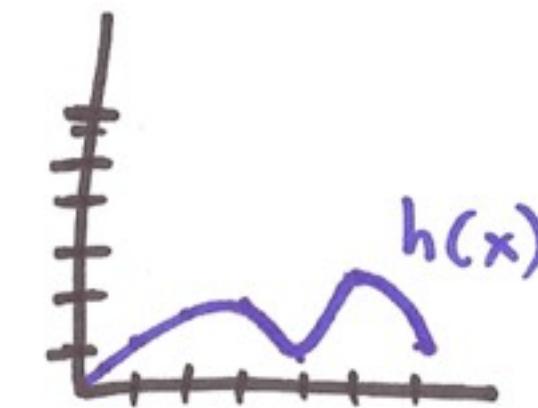
acquire additional data

complex transformation

transformation is abstraction choice



original data



$h(x) = f(x) - g(x)$
derived data



DATA MODEL vs CONCEPTUAL MODEL

data model: mathematical abstraction (data abstraction)

set with operations, e.g. floats with * / - +

conceptual model: mental construction (semantics)

includes semantics, supports reasoning

conceptual model motivates data abstraction choices



EXAMPLE

from data model ...

- 32.52, 54.06, -17.35, ... (floats)

using conceptual model ...

temperature

to new data abstraction...

continuous to 2 significant figures (quantitative)

hot, warm, cold (ordinal)

above freezing, below freezing (categorical)



ABSTRACTION EXERCISE ...

COFFEE, ESPRESSO & HOT TEA			
	8oz. SMALL	12oz. MEDIUM	16oz. LARGE
GUATEMALA CASI CIELO <small>floral, lemon & cocoa</small>	1.50	1.70	1.90
GUATEMALA CASI CIELO de-caf <small>floral, lemon & cocoa</small>	1.50	1.70	1.90
SUMATRA <small>Spicy, herbal & earthy</small>	1.50	1.70	1.90
ESPRESSO	1.45	1.70	1.85
AMERICANO	1.60	1.80	2.00
CAFÉ LATTE	2.15	2.75	3.20
CAPPUCINO	2.15	2.75	3.20
CAFÉ MOCHA	2.65	3.05	3.55
ORGANIC BREAKFAST	1.70	1.90	2.10
ORGANIC LONG LIFE GREEN TEA	1.70	1.90	2.10
MONSOON CHAI	1.70	1.90	2.10
CHAI TEA LATTE	2.40	2.95	3.35
BLACK TEA LATTE	2.20	2.55	3.20
HOT CHOCOLATE	2.50	2.75	3.00
HOMEMADE SYRUP FLAVORS	.50 each		



CIS 4930/6930-002

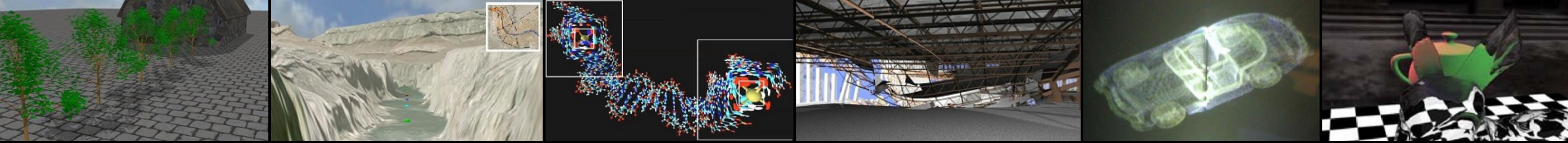
DATA VISUALIZATION



VISUAL ENCODING

Paul Rosen
Assistant Professor
University of South Florida

slides credits Miriah Meyer (U of Utah)



REMINDERS...

1/30/2017 - Project #2 due



VISUAL ENCODING

marks and channels

planar position

time

color



MARKS

graphical element in an image
classified according to number of spatial dimensions
required



points (0D)



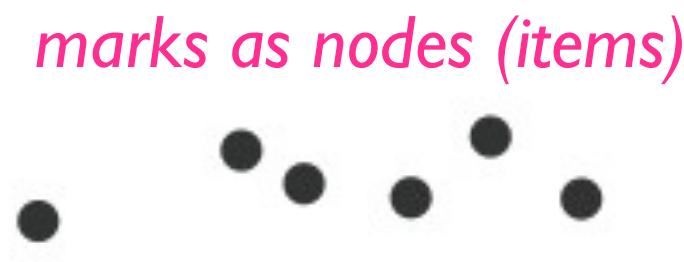
lines (1D)



areas (2D)



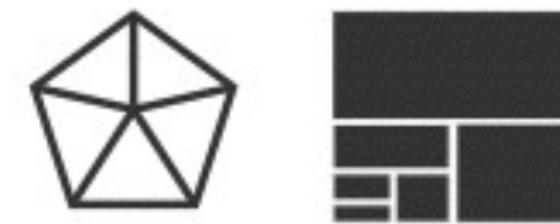
MARKS



points (0D)

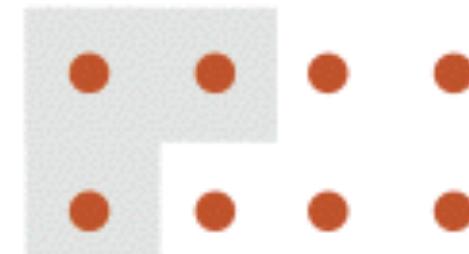


lines (1D)

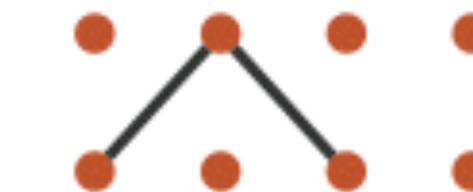


areas (2D)

marks as links



containment



connection



CHANNELS

parameters that control the appearance of marks

④ Position

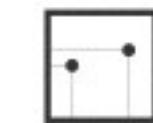
→ Horizontal



→ Vertical



→ Both



④ Color



④ Shape



④ Tilt



④ Size

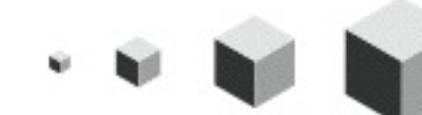
→ Length



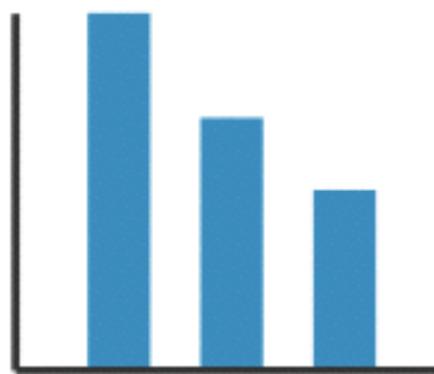
→ Area



→ Volume



NAME THAT MARK AND CHANNEL



CHANNEL TYPES

identity (what or where)

magnitude (how much)

④ Position

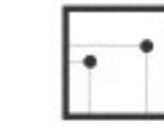
→ Horizontal



→ Vertical



→ Both



④ Color



④ Shape



④ Tilt



④ Size

→ Length



→ Area



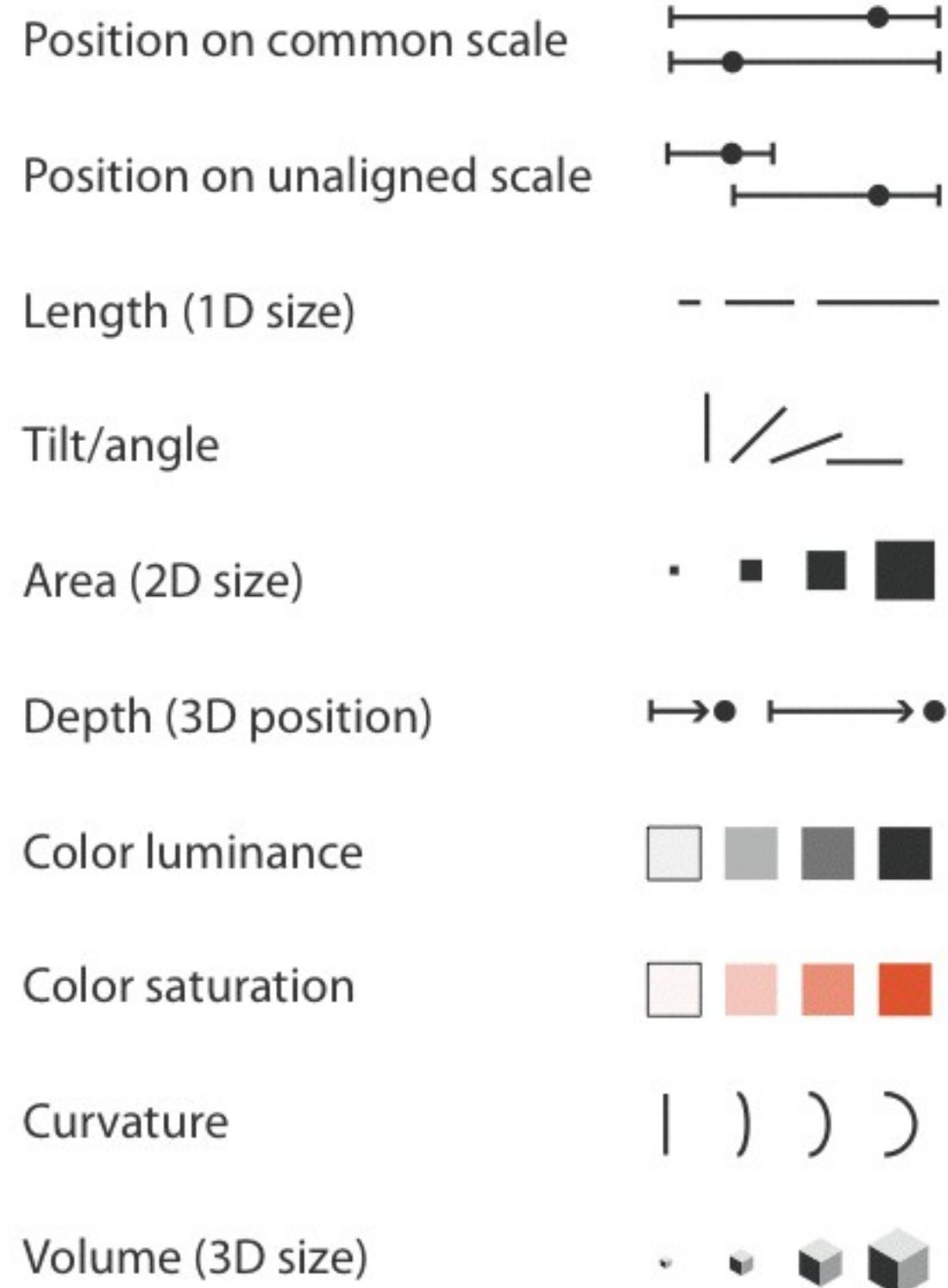
→ Volume



EXPRESSIVENESS & EFFECTIVENESS



④ **Magnitude Channels: Ordered Attributes**



Length (1D size)

Tilt/angle

Area (2D size)

Depth (3D position)

Color luminance

Color saturation

Curvature

Volume (3D size)

(*how much*)

④ **Identity Channels: Categorical Attributes**



Color hue

Motion

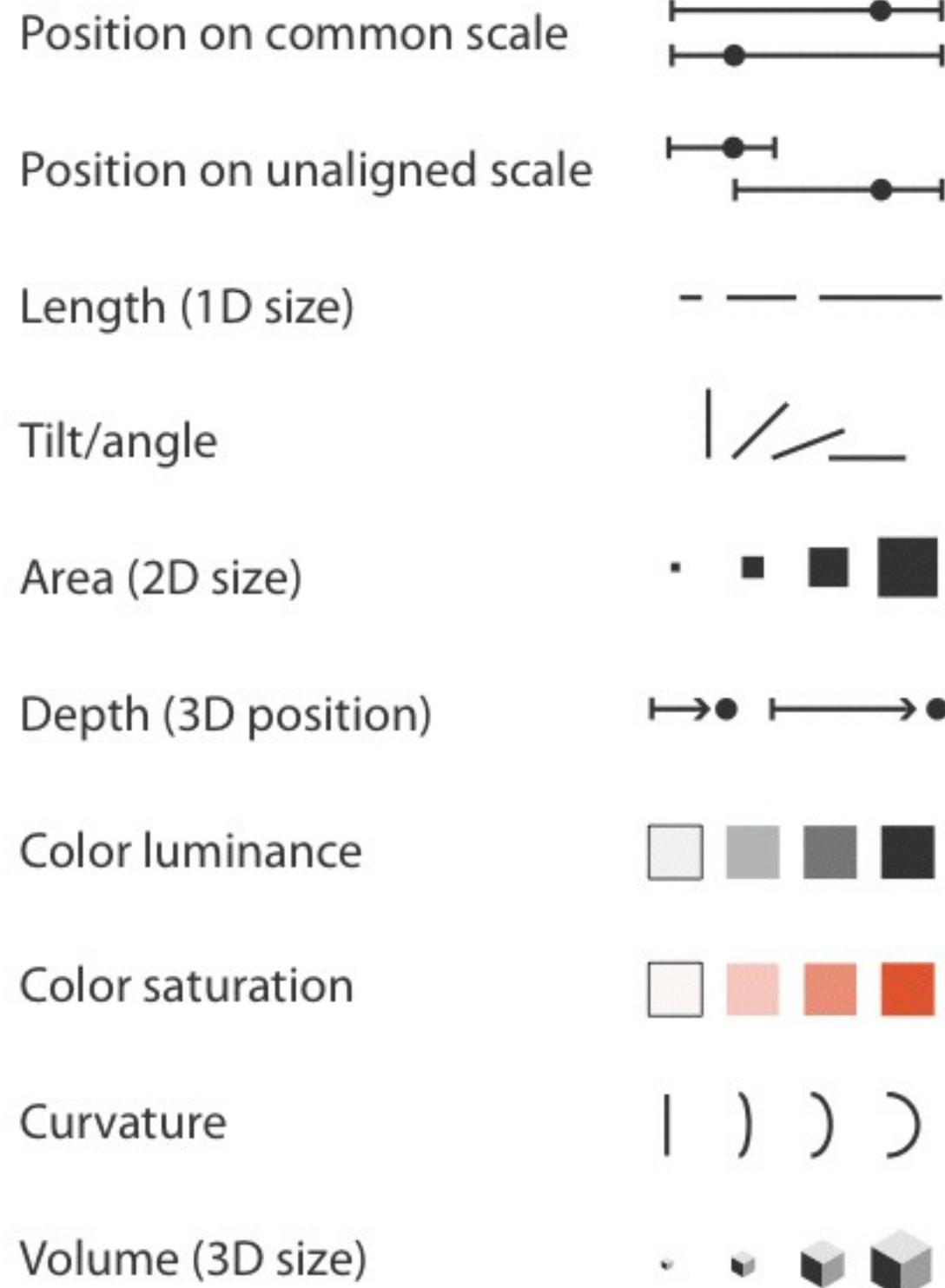
Shape

(*what or where*)

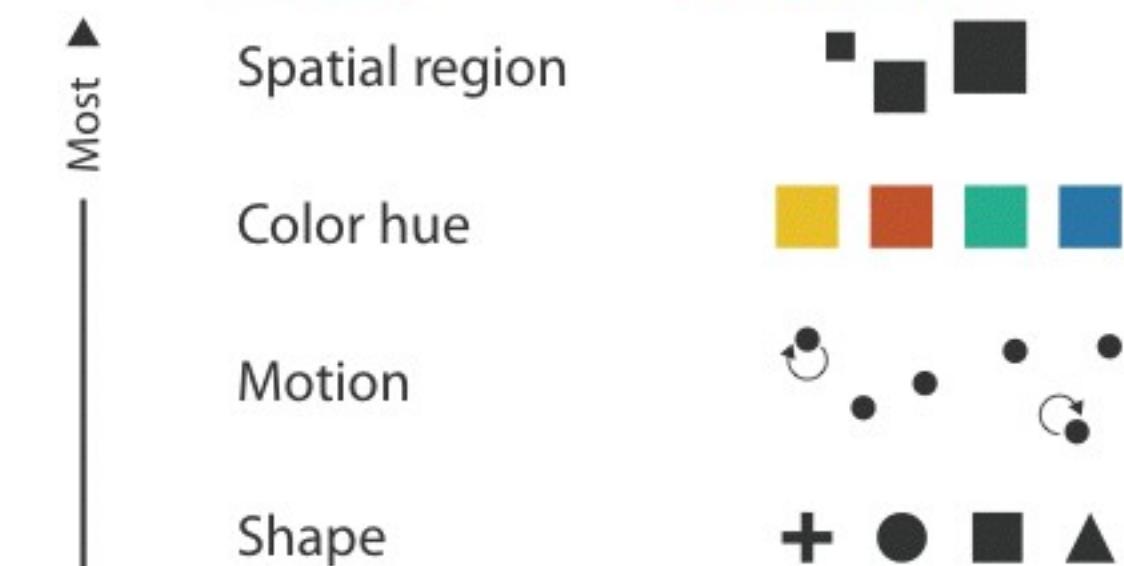
EXPRESSIVENESS



→ **Magnitude Channels: Ordered Attributes**



→ **Identity Channels: Categorical Attributes**



EFFECTIVENESS



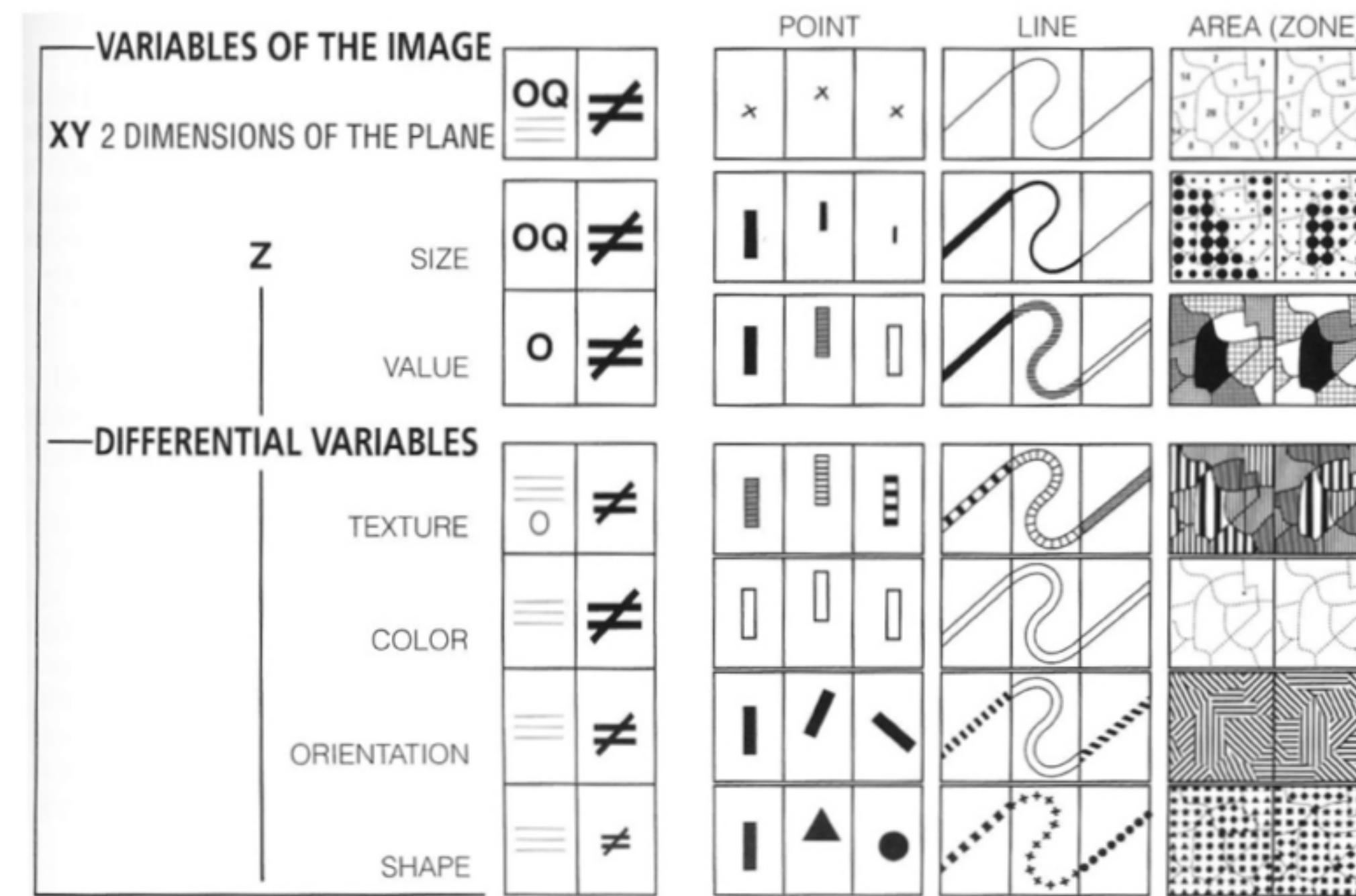
WHERE DO RANKINGS COME FROM?



BERTIN, "SEMOLOGY OF GRAPHICS", 1967

O = Ordinal, Q = Quantitative

≠ = Differences ≡ = Similarities



CLEVELAND & MCGILL, "GRAPHICAL PERCEPTION AND GRAPHICAL METHODS FOR ANALYZING SCIENTIFIC DATA", 1985

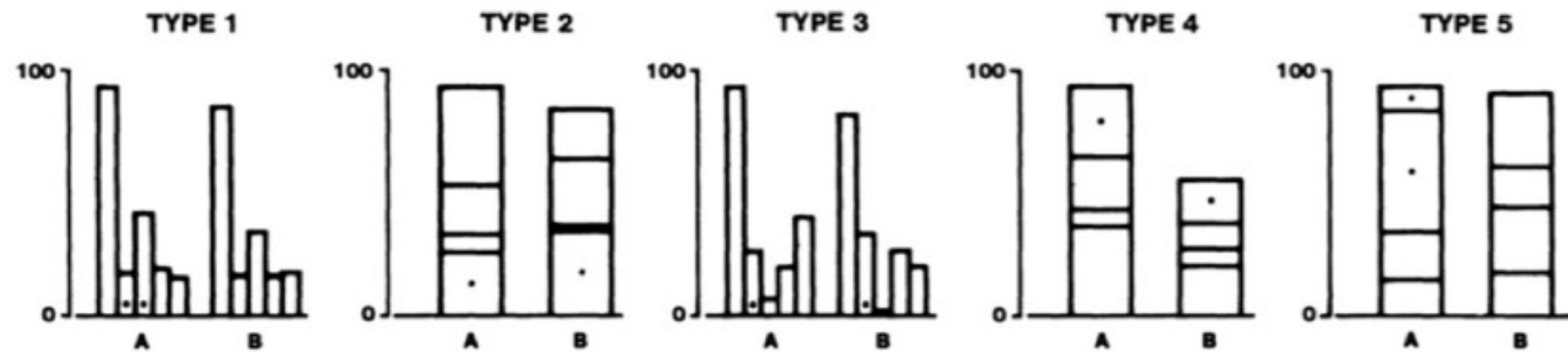


Figure 4. Graphs from position-length experiment.

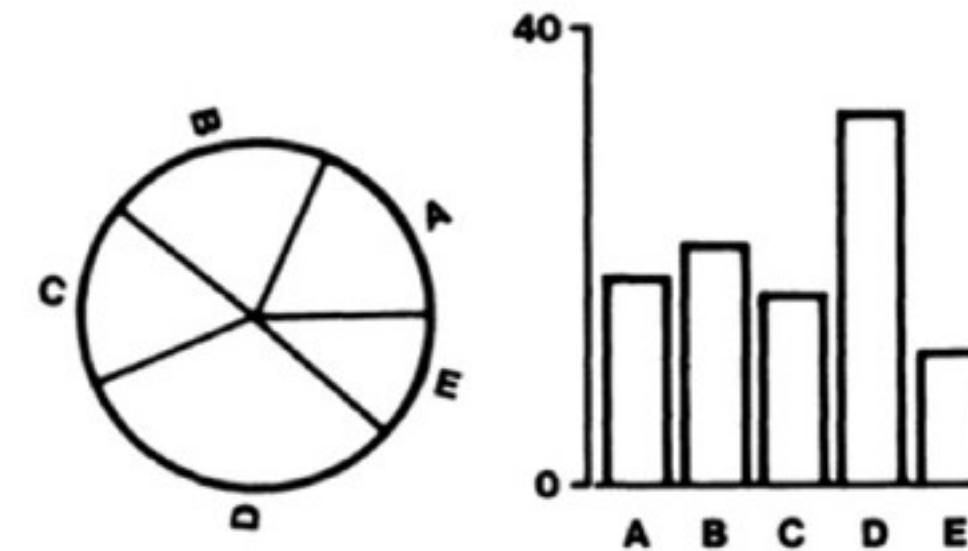
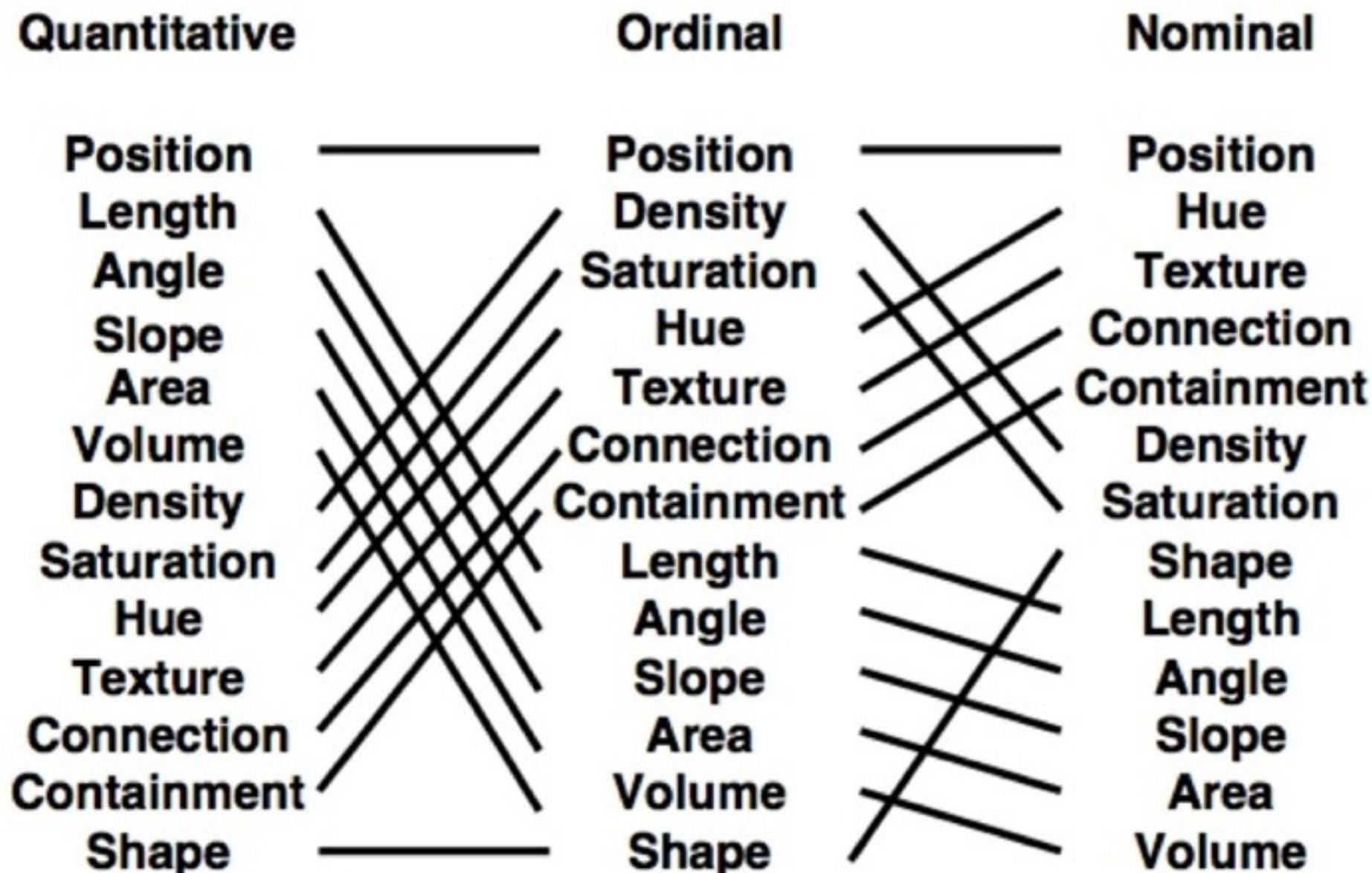


Figure 3. Graphs from position-angle experiment.



MACKINLAY, "AUTOMATING THE DESIGN OF GRAPHICAL PRESENTATIONS OF RELATIONAL INFORMATION", 1986



HEER & BOSTOCK, “CROWDSOURCING GRAPHICAL PERCEPTION: USING MECHANICAL TURK TO ASSESS VISUALIZATION DESIGN”, 2010

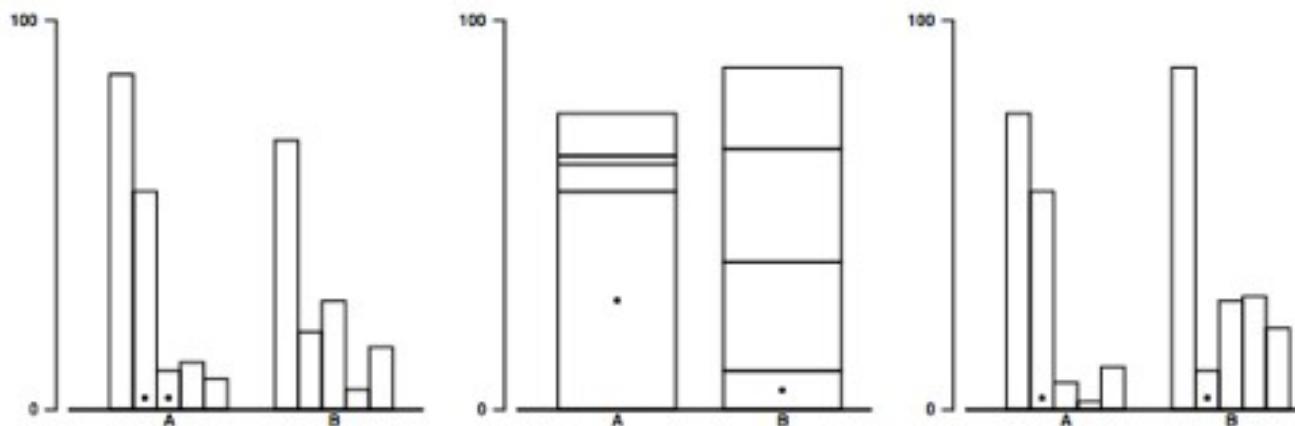


Figure 1: Stimuli for judgment tasks T1, T2 & T3. Subjects estimated percent differences between elements.

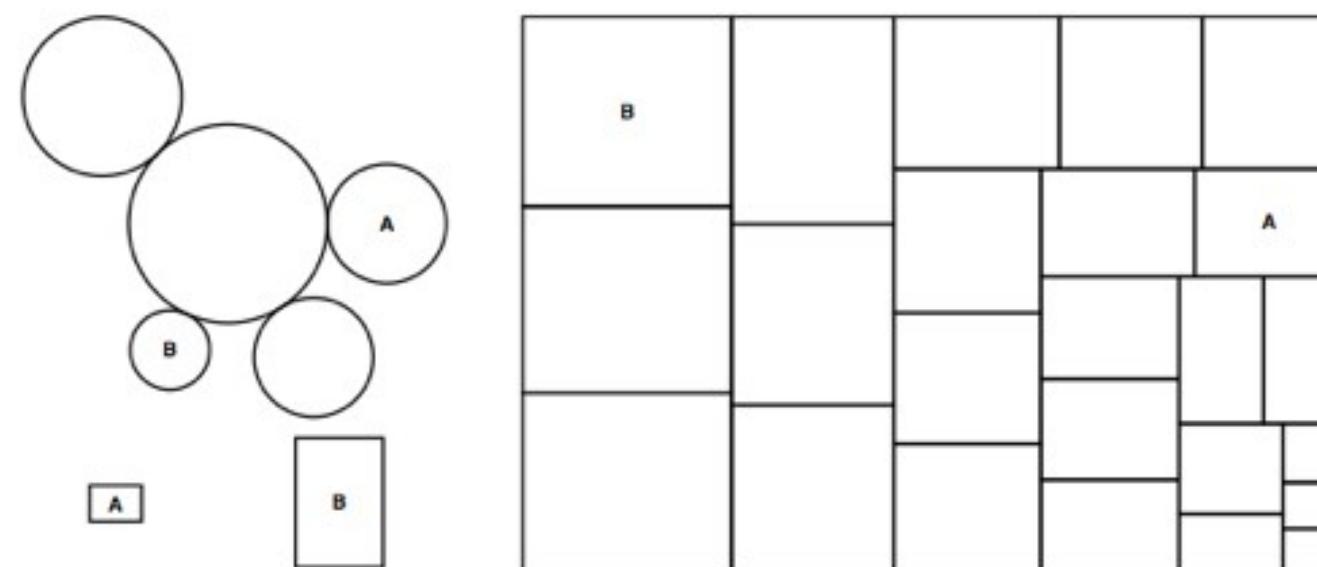
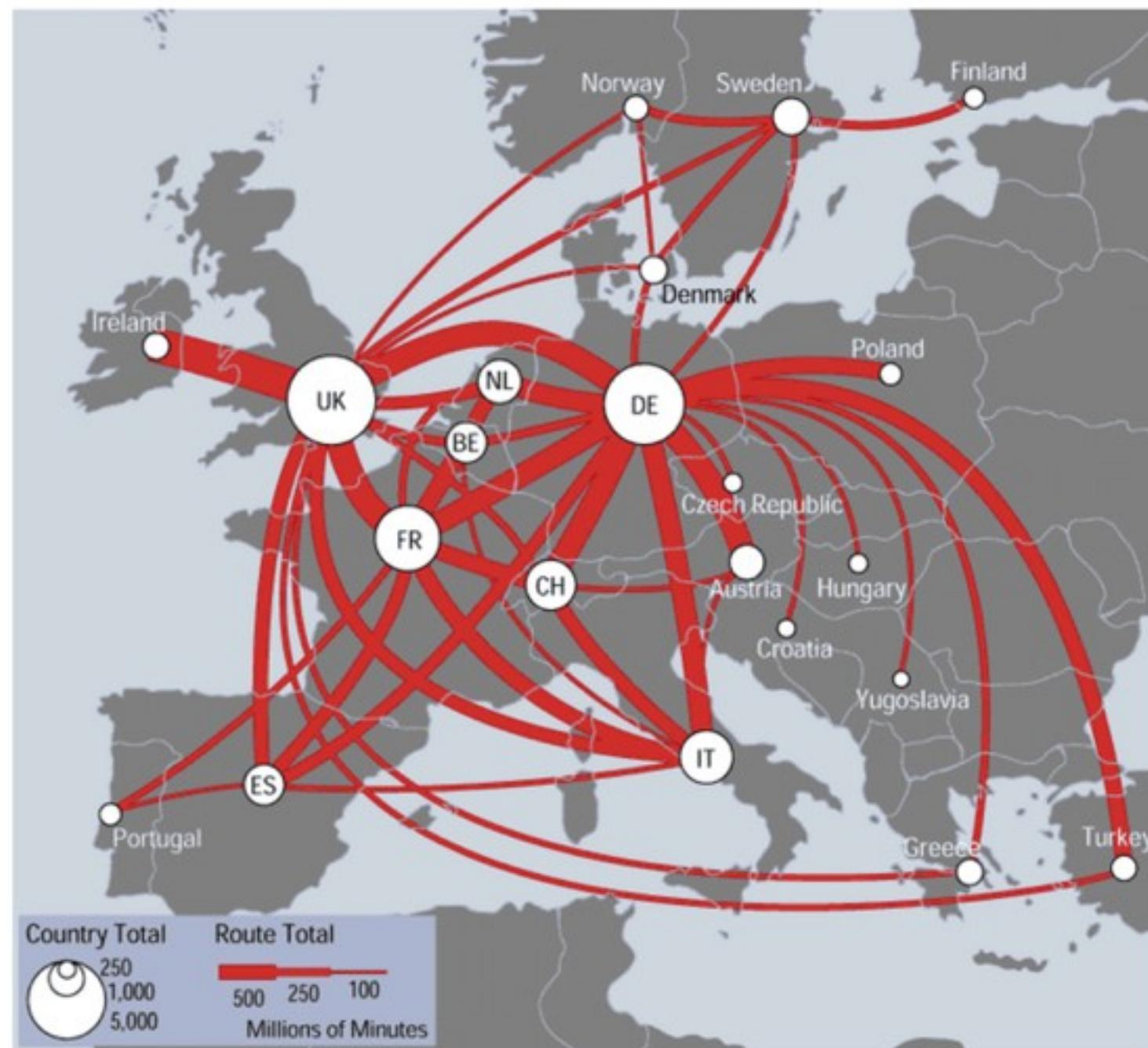


Figure 2: Area judgment stimuli. Top left: Bubble chart (T7), Bottom left: Center-aligned rectangles (T8), Right: Treemap (T9).



DISCRIMINABILITY

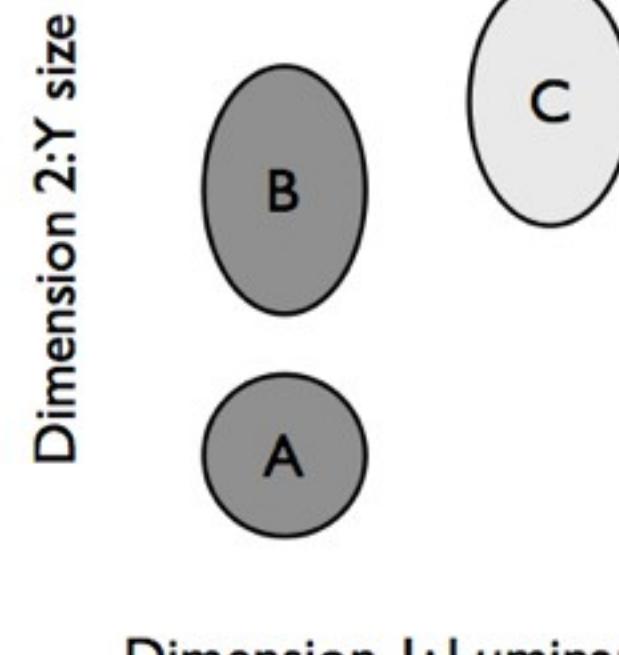


SEPARABLE vs INTEGRAL

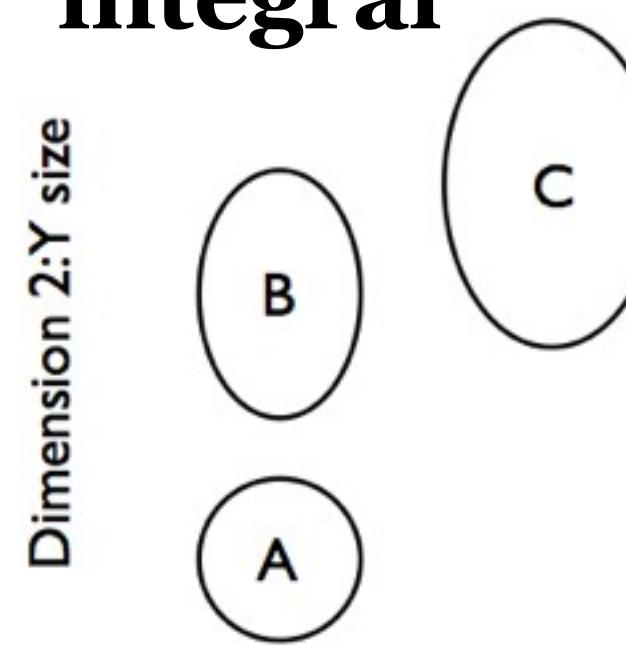
separable: can judge each channel individually

integral: two channels are viewed holistically

separable



integral



SEPARABLE vs INTEGRAL

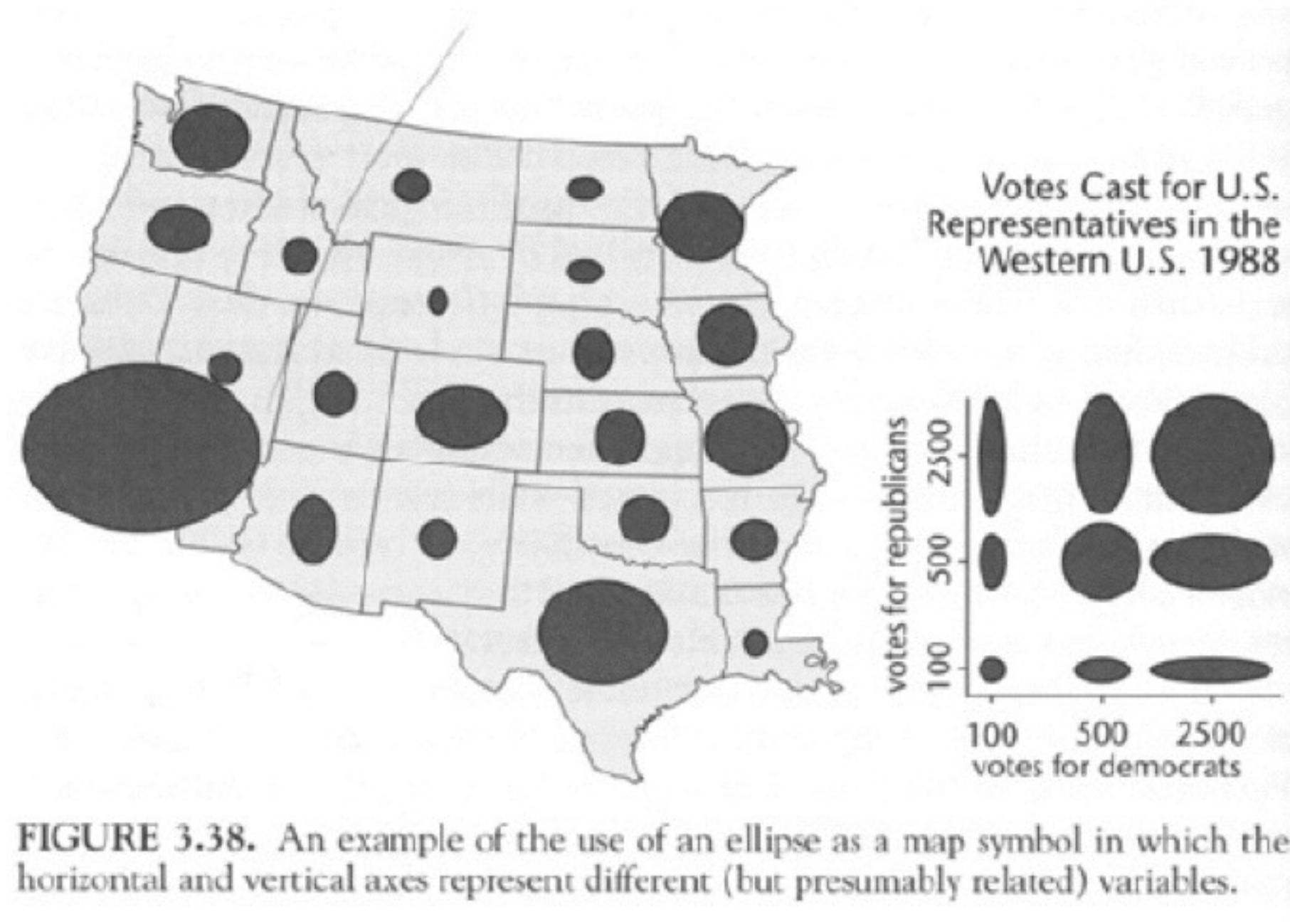
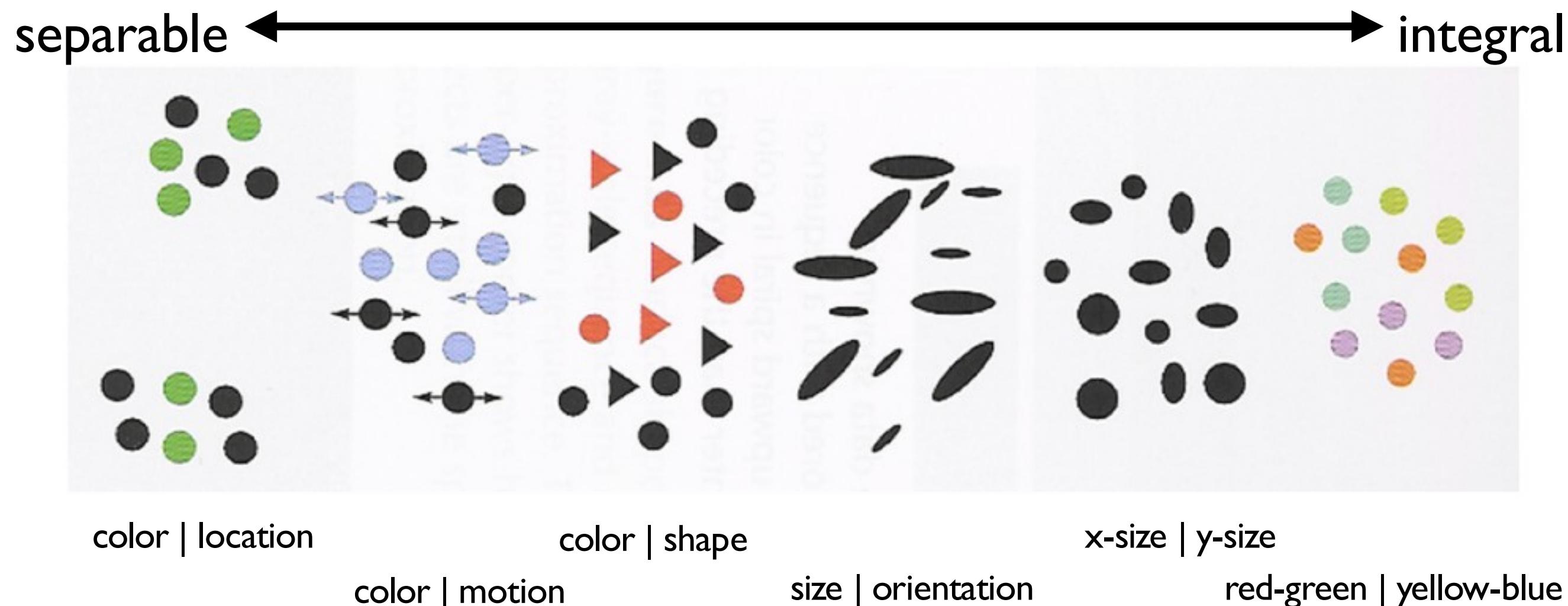


FIGURE 3.38. An example of the use of an ellipse as a map symbol in which the horizontal and vertical axes represent different (but presumably related) variables.



SEPARABLE vs INTEGRAL



READING, WRITING, AND EARNING MONEY

The latest data from the U.S. Census's American Community Survey paints a fascinating picture of the United States at the county level. We've looked at the educational achievement and the median income of the entire nation, to see where people are going to school, where they're earning money, and if there is any correlation.



(1) HIGH SCHOOL GRADUATES
60% 70% 80% 88%



(2) COLLEGE GRADUATES
10% 20% 30% 40%

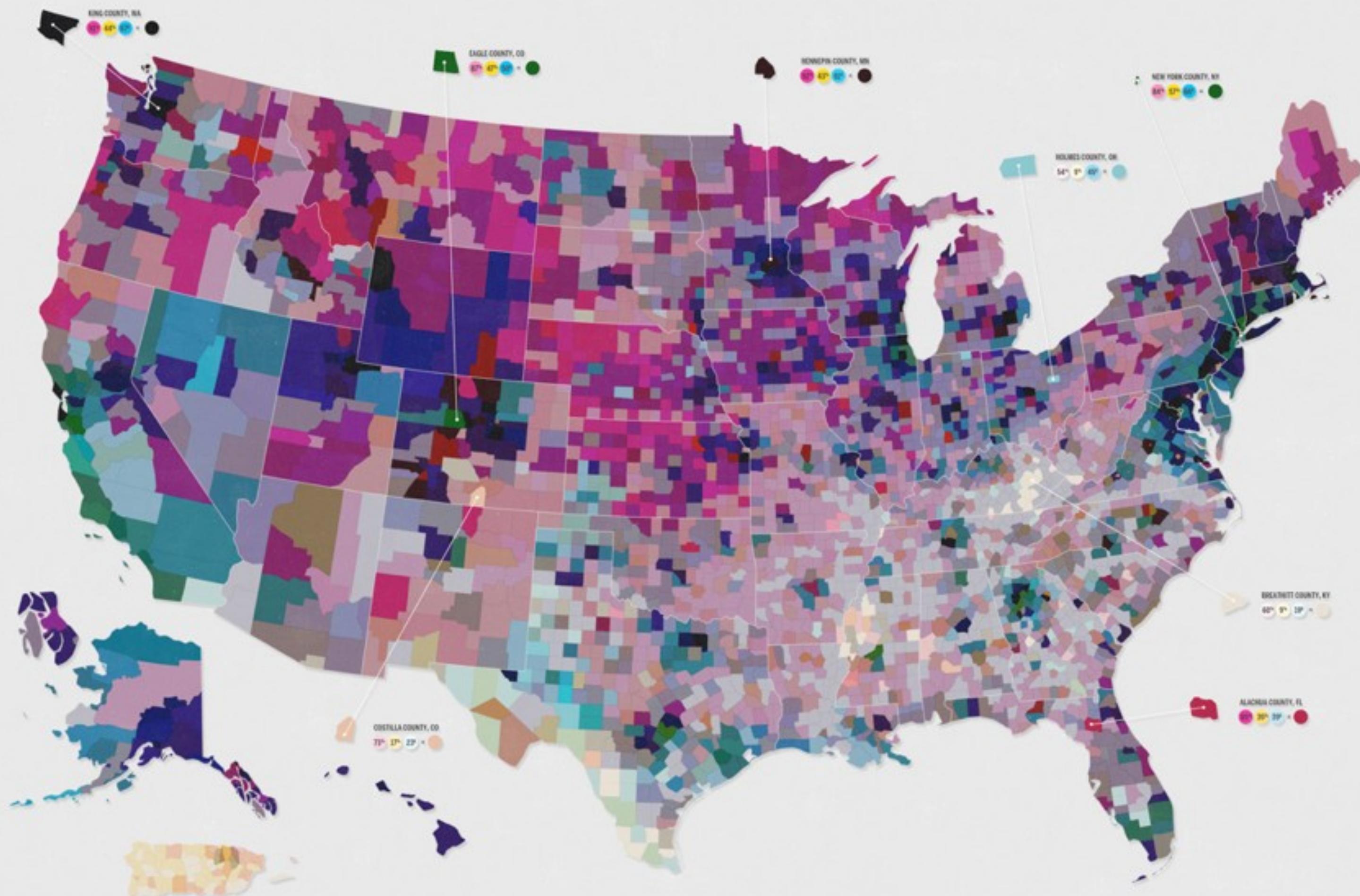


(3) MEDIAN HOUSEHOLD INCOME
20k 30k 40k 50k

The map at right is a product of overlaying the three sets of data. The variation in hue and value has been produced from the data shown above. In general, darker counties represent a more educated, better paid population while lighter areas represent communities with fewer graduates and lower incomes.



A collaboration between 60606 and Gregory Richarck.
SOURCE: U.S. Census



ENCODING SEMANTICS

Graphical Code	Semantics
Small shapes defined by closed contour, texture, color, shaded solid.	 Object, idea, entity, node.
Spatially ordered graphical objects.	 Related information or a sequence. In a sequence the left-to-right ordering convention borrows from the western convention for written language.
Graphical objects in proximity.	 Similar concepts, related information.
Graphical objects having the same shape, color, or texture.	 Similar concepts, related information.
Size of graphical object Height of graphical object.	 Magnitude, quantity, importance.
Shapes connected by contour.	 Related entities, path between entities.
Thickness of connecting contour.	 Strength of relationship.
Color and texture of connecting contour.	 Type of relationship.
Shapes enclosed by a contour, or a common texture, or a common color.	 Contained entities. Related entities.
Nested regions, partitioned regions.	 Hierarchical concepts.
Attached shapes.	 Parts of a conceptual structure.



+ PERCEPTUAL EFFECTS WE WILL
DISCUSS NEXT CLASS

pop-out

steven's power law

weber's law

gestalt principles



PLANAR POSITION

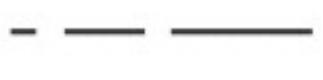
what's so special about the plane?

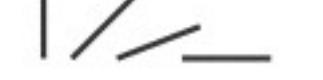


④ **Magnitude Channels: Ordered Attributes**

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) 

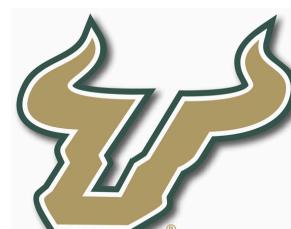
④ **Identity Channels: Categorical Attributes**

Spatial region 

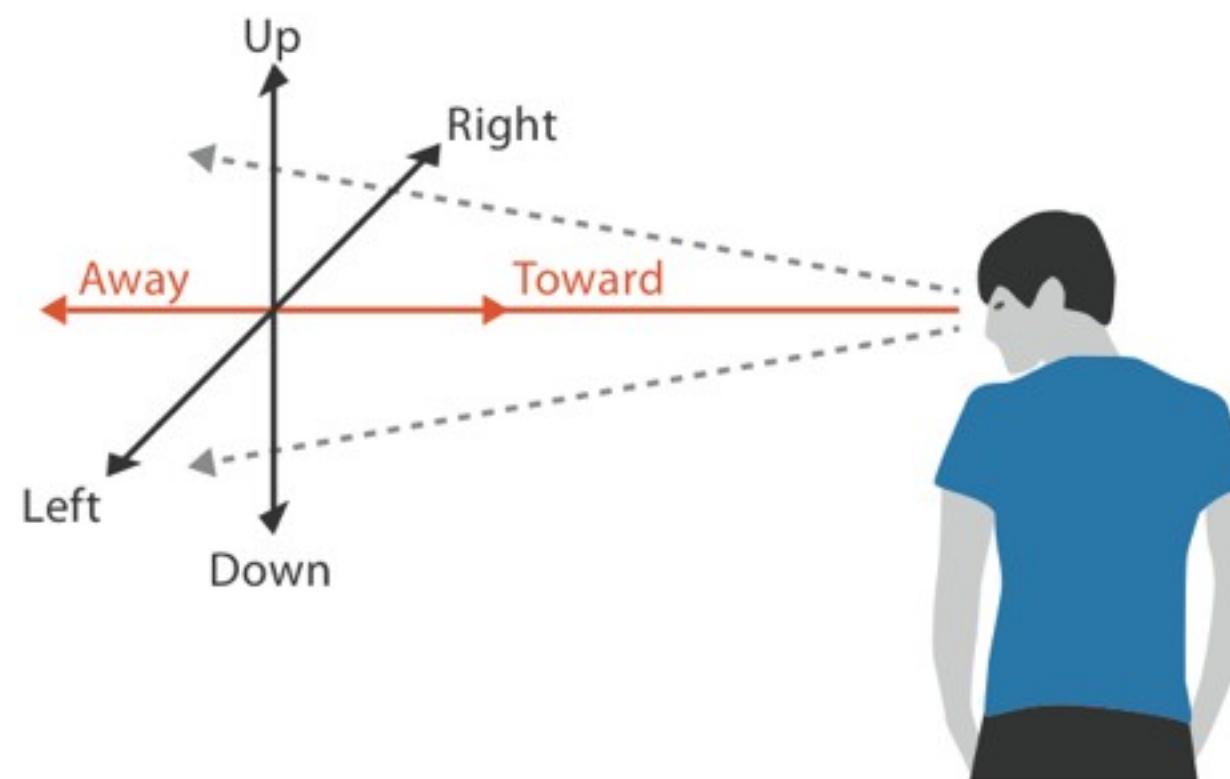
Color hue 

Motion 

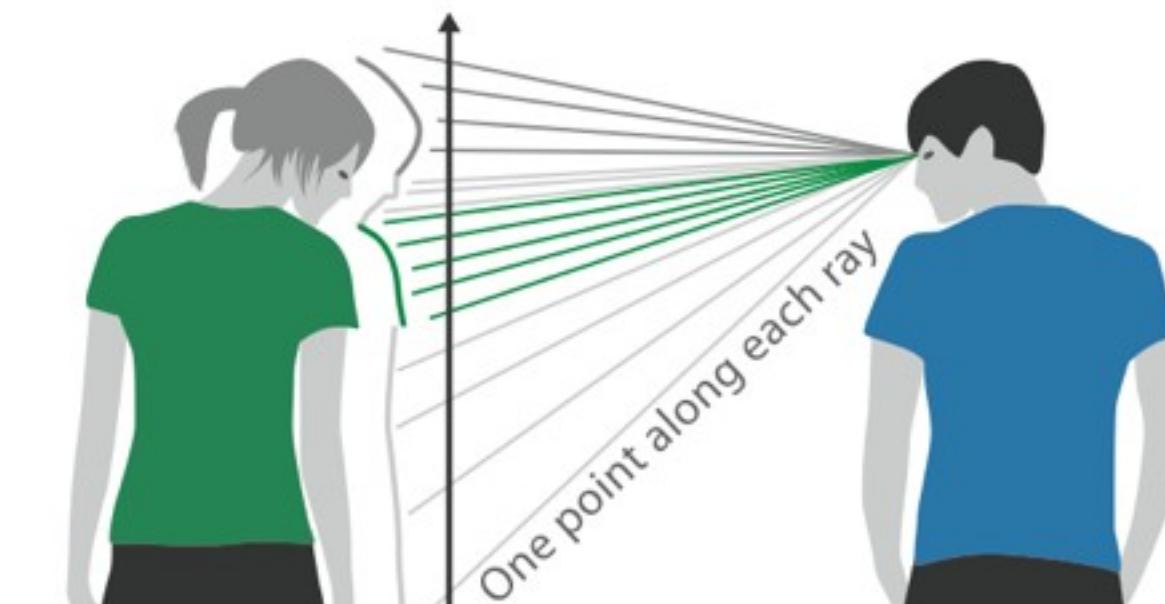
Shape 



WE SEE THE WORLD AS A ~~2.5D~~ SPACE



Thousands of points up/down and left/right



We can only see the outside shell of the world



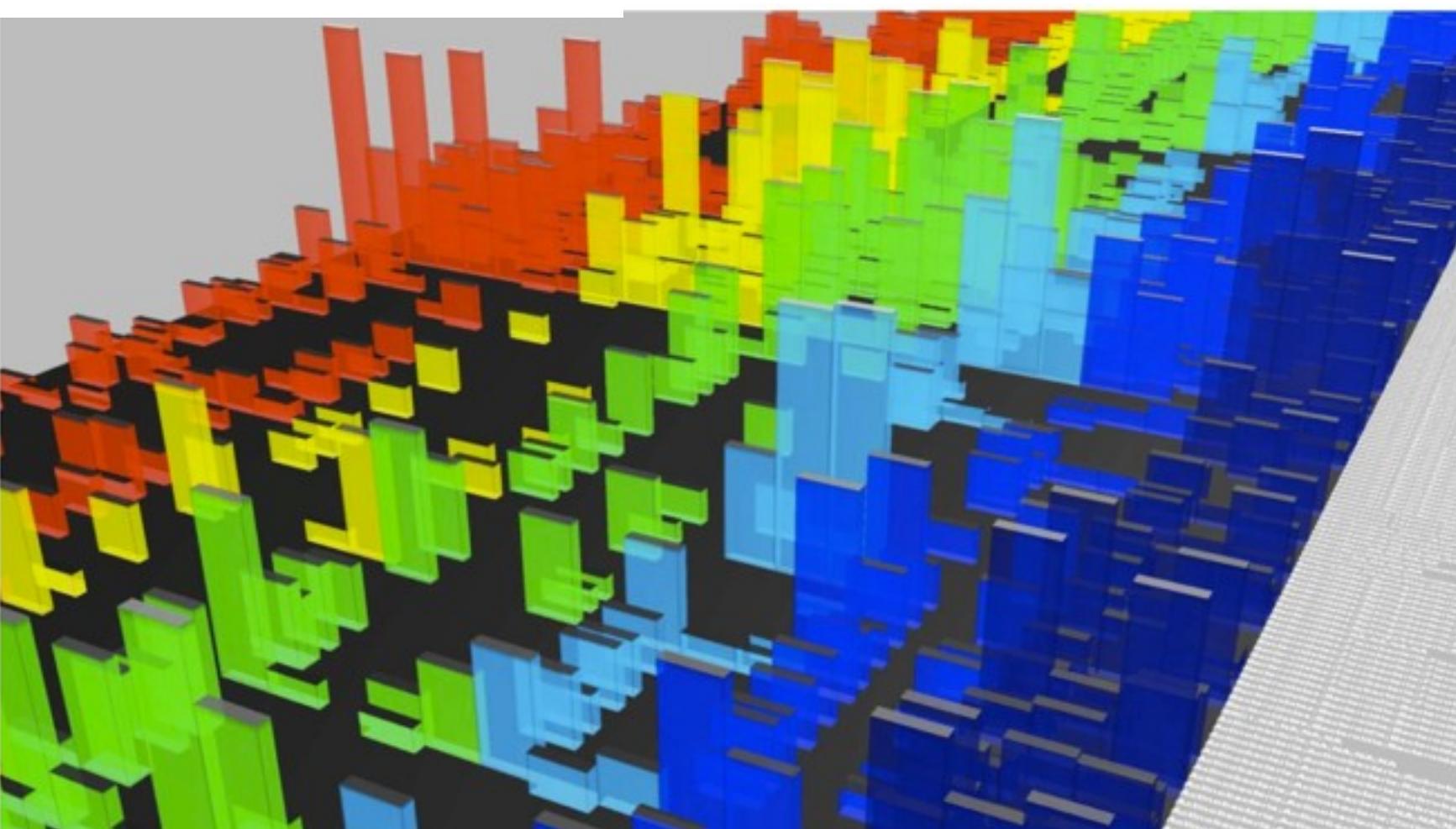
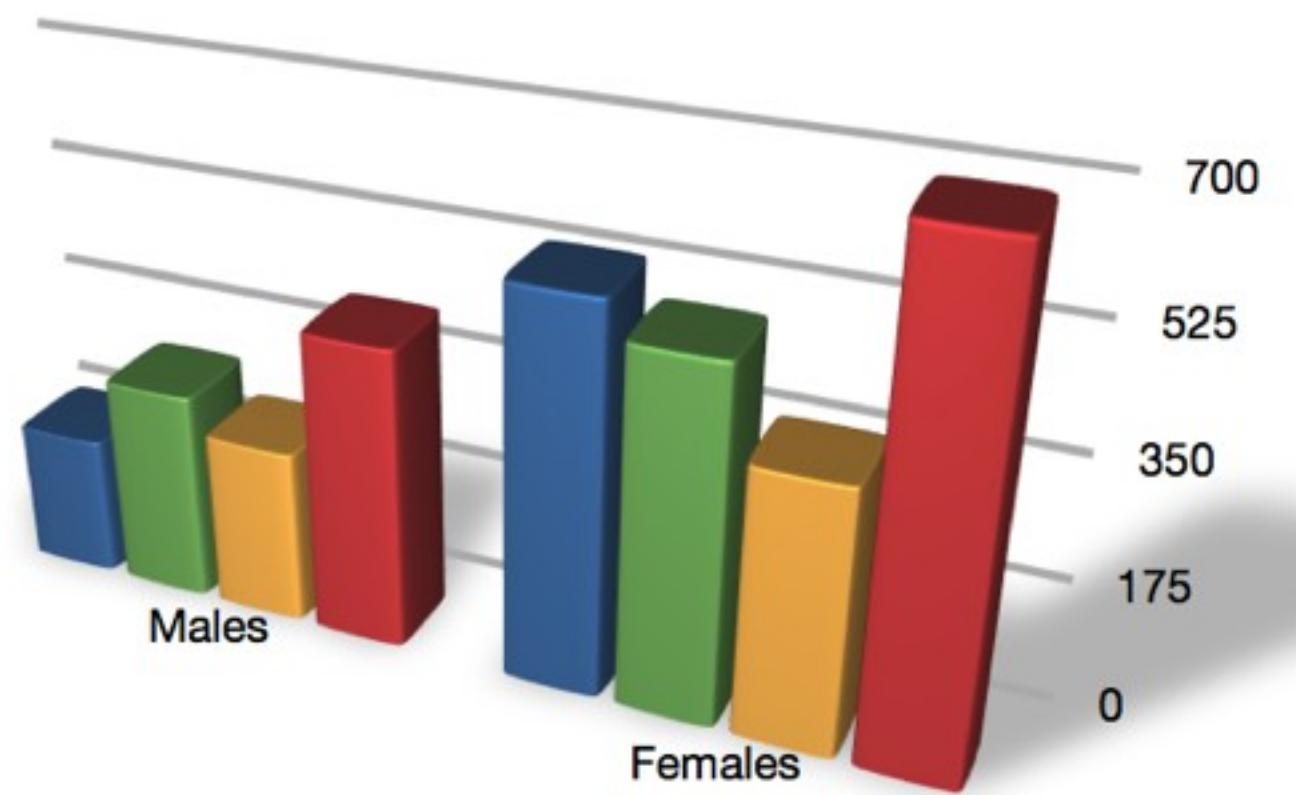
POWER DOES NOT EXTEND TO 3D

**perspective cues
interfere with color and size channels**

occlusion of data

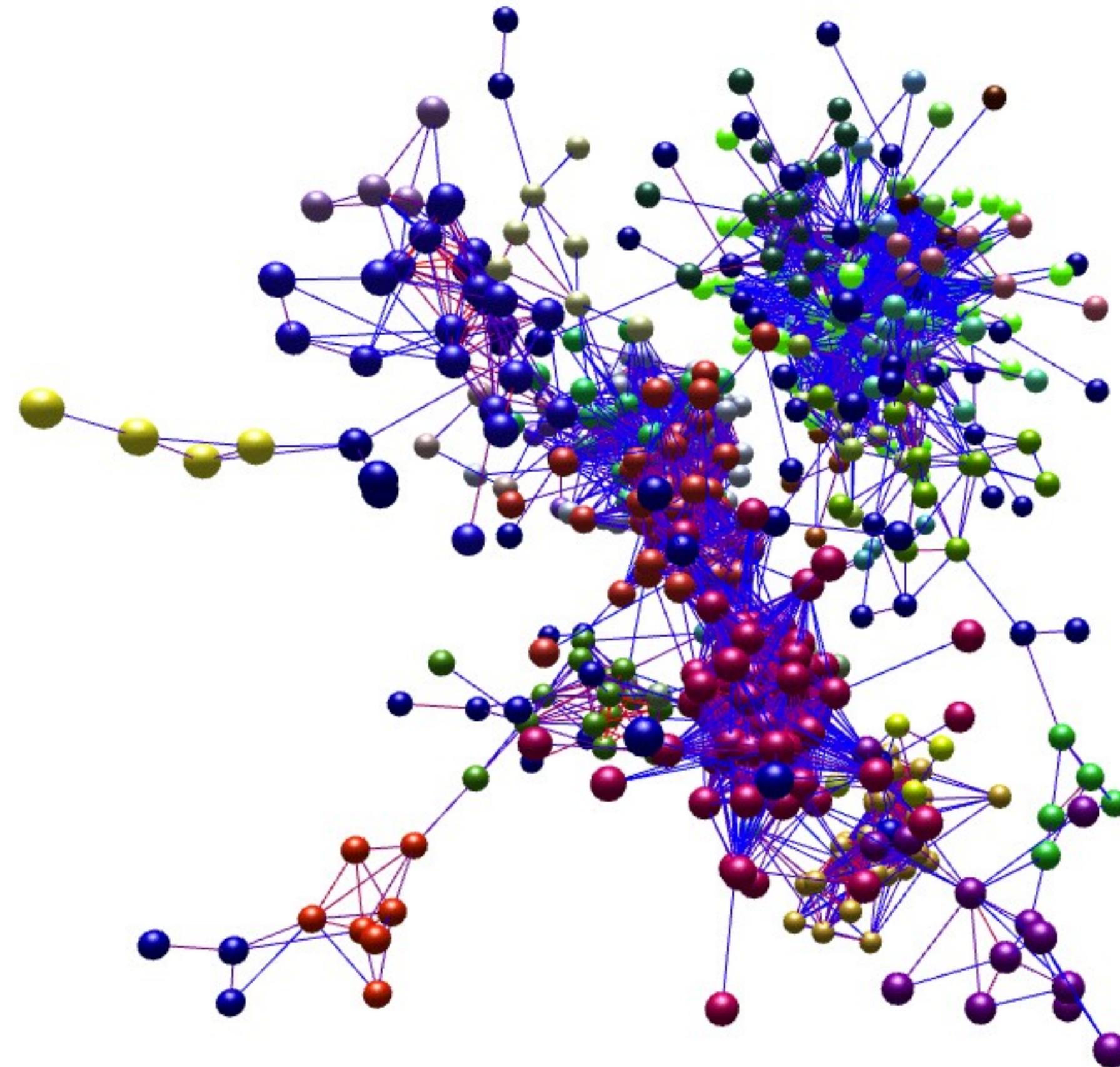
text legibility





MOORE 2011





TIME



VISUALIZATION

uses perception to point out interesting things.

uses pictures to enhance working memory



TIME AS ENCODING CHANNEL

external versus internal memory

easy to compare views by moving eyes

hard to compare view to memory of what you saw



CowParrot

by Bonnie J. Malcolm

Can you spot 12 differences between these pictures?



www.comparotpuzzles.com © 2001 Bonnie J. Malcolm



CowParrot

by Bonnie J. Malcolm

Can you spot 12 differences between these pictures?



www.cowparotpuzzles.com © 2001 Bonnie J. Malcolm



ComParrot

by Bonnie J. Malcolm

Can you spot 12 differences between these pictures?



www.comparropuzzles.com © 2001 Bonnie J. Malcolm

Solution: 1. Top tree leaf removed. 2. Nose line on left giraffe removed. 3. Shadow on lower left coconut removed. 4. Leaf vein below gecko removed. 5. Ear line on left giraffe removed. 6. Bottom spot on right giraffe colored in. 7. Small leaf at right of tree colored in. 8. Horn on right giraffe moved. 9. Spots on left giraffe moved. 10. Branch on left side shorter. 11. Giraffe tail longer. 12. Gekko eye missing.



ComParrot

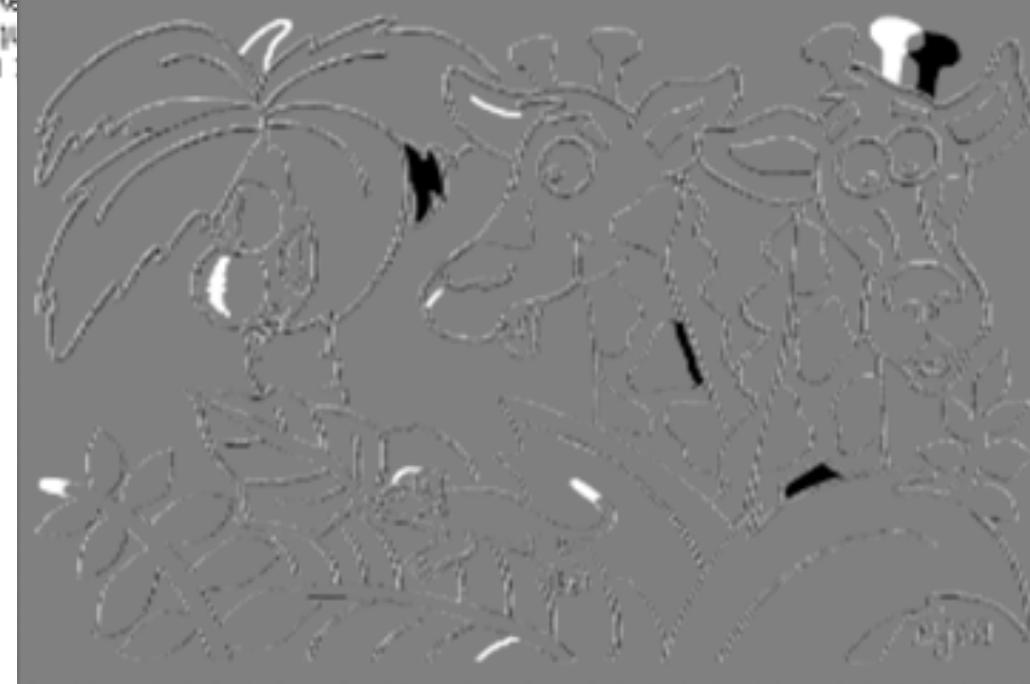
by Bonnie J. Malcolm

Can you spot 12 differences between these pictures?



www.comparropuzzles.com © 2001 Bonnie J. Malcolm

Solution: 1. Top tree leaf removed. 2. Ear line on left giraffe removed. 3. Horn on right giraffe moved. 4. Leaf vein below gecko removed. 5. Ear line on left giraffe re-added. 6. Tree colored in. 7. Leaf on right giraffe moved. 8. Spots on left giraffe removed. 9. Leaf on right giraffe missing. 10. Leaf on right giraffe moved. 11. Leaf on right giraffe re-added. 12. Leaf on right giraffe moved again.



WHEN TO USE ANIMATION?



GOOD: STORYTELLING

Hans Rosling shows the best stats you've ever seen | Video on TED.com

http://www.ted.com/talks/hans_rosling_shows_the_best_stats_you_ve_ever_seen.html

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Talks TED Conferences TED Conversations NEW About TED
Speakers TEDx Events TED Community TED Blog
Themes TED Prize TED Initiatives
Translations TED Fellows

Q Search

TALKS

Hans Rosling shows the best stats you've ever seen

TED2006, Filmed Feb 2006; Posted Jun 2006



3,471,109 Views [Like](#) 33k

INTERACTIVE TRANSCRIPT

ABOUT THE SPEAKER

ABOUT THIS TALK

You've never seen data presented like this. With the drama and urgency of a sportscaster, statistics guru Hans Rosling debunks myths about the so-called "developing world."

THE ROLEX ARTS INITIATIVE PAIRS ESTABLISHED MENTORS WITH EMERGING PROTÉGÉS FOR A YEAR OF CREATIVE COLLABORATION

WHAT TO WATCH NEXT

Hans Rosling's new insights on



GOOD: TRANSITIONS

Hans Rosling shows the best stats you've ever seen | Video on TED.com

http://www.ted.com/talks/hans_rosling_shows_the_best_stats_you_ve_ever_seen.html

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Q Search

TALKS

Hans Rosling shows the best stats you've ever seen

TED2006, Filmed Feb 2006; Posted Jun 2006



gapminder.org

3,471,109 Views [Like](#) 33k

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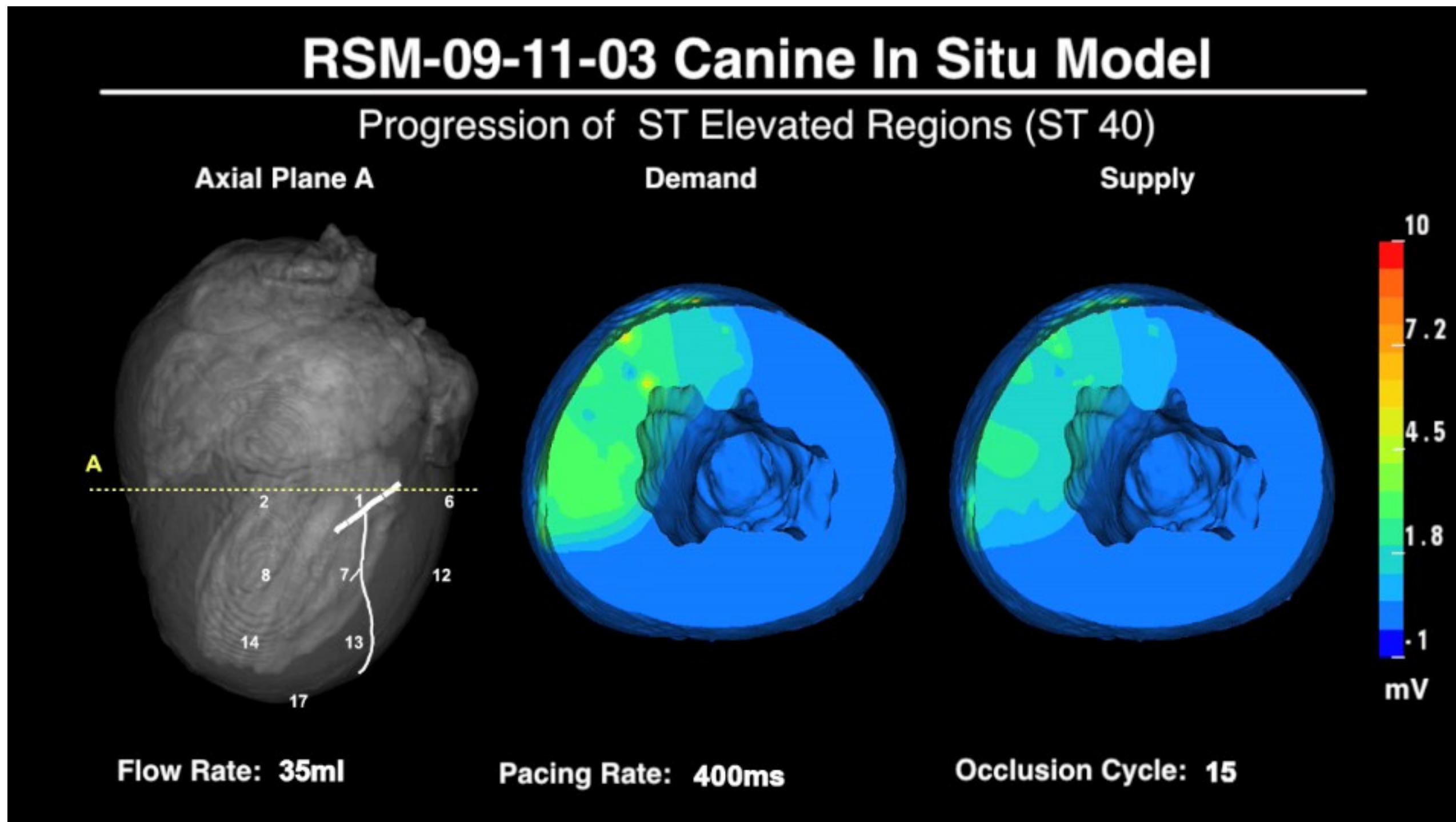
THE ROLEX ARTS INITIATIVE PAIRS ESTABLISHED MENTORS WITH EMERGING PROTÉGÉS FOR A YEAR OF CREATIVE COLLABORATION

WHAT TO WATCH NEXT

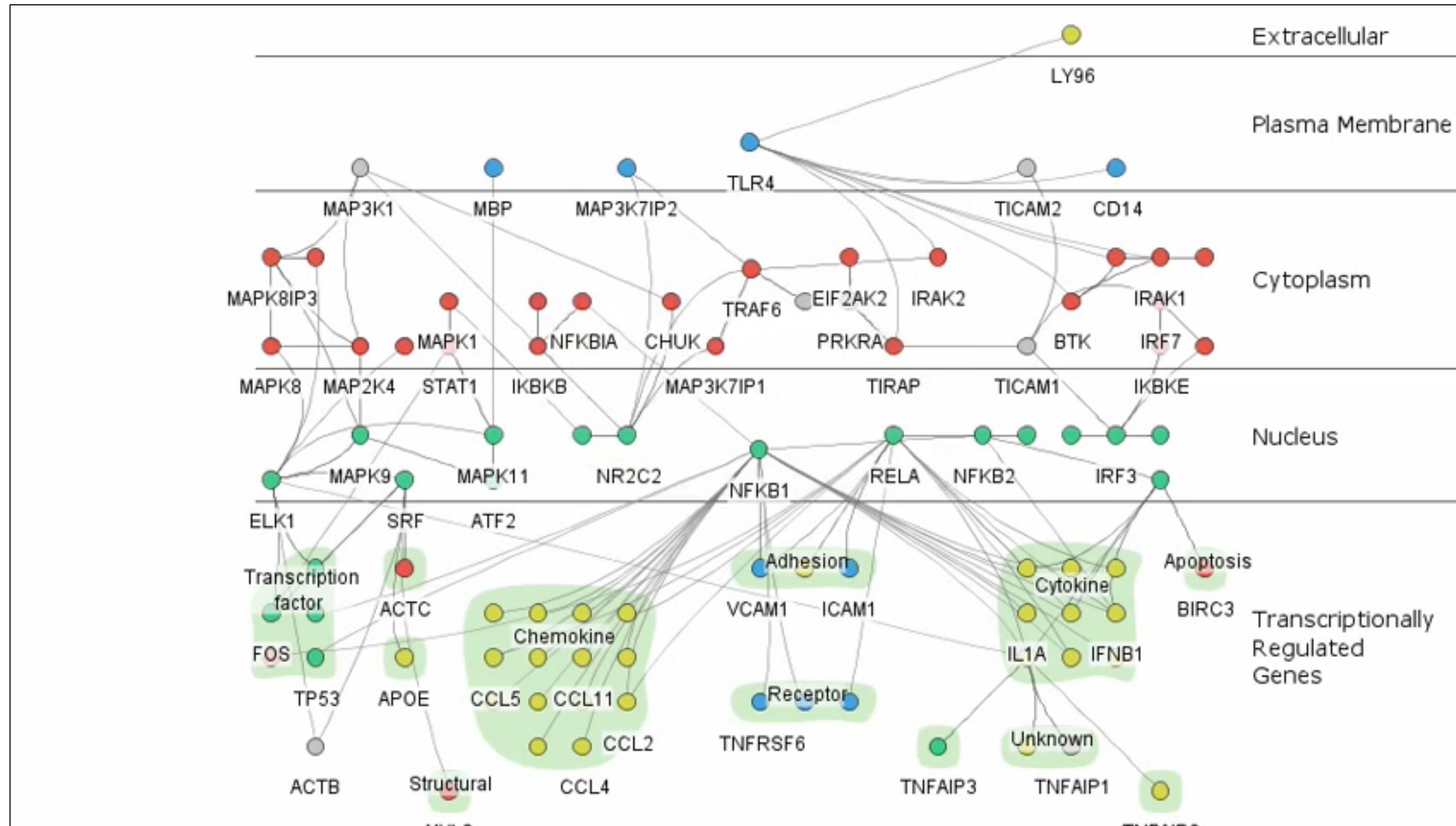
Hans Rosling's new insights on



BAD: COMPARING COMPLEX STATE CHANGES OVER TIME

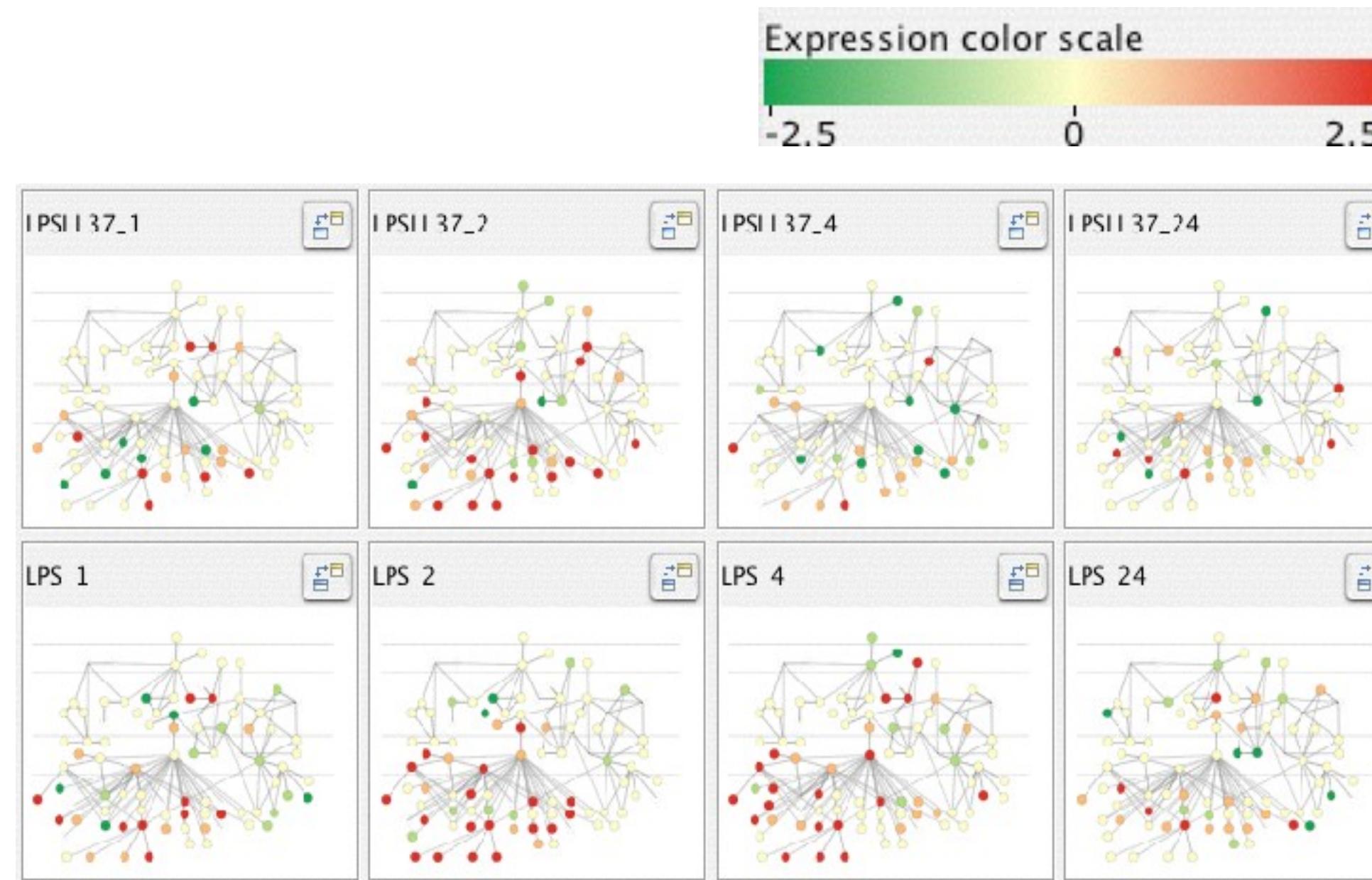


BAD: MULTIPLE STATES WITH MULTIPLE CHANGES



BAD: MULTIPLE STATES WITH MULTIPLE CHANGES

alternative: small multiples



COLOR



GET IT RIGHT IN BLACK AND WHITE

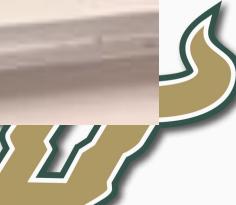
Maureen Stone



VISUAL ENCODING EXERCISE ...

COFFEE ESPRESSO & HOT TEA			
	8oz SMALL	12oz MEDIUM	16oz LARGE
GUATEMALA CASI CIELO <small>floral, lemon & cocoa</small>	1.50	1.70	1.90
GUATEMALA CASI CIELO de-caf <small>floral, lemon & cocoa</small>	1.50	1.70	1.90
SUMATRA <small>spicy, herbal & earthy</small>	1.50	1.70	1.90
ESPRESSO	1.45	1.70	1.85
AMERICANO	1.60	1.80	2.00
CAFÉ LATTE	2.15	2.75	3.20
CAPPUCCINO	2.15	2.75	3.20
CAFÉ MOCHA	2.65	3.05	3.55
ORGANIC BREAKFAST	1.70	1.90	2.10
ORGANIC LONG LIFE GREEN TEA	1.70	1.90	2.10
MONSOON CHAI	1.70	1.90	2.10
CHAI TEA LATTE	2.40	2.95	3.35
BLACK TEA LATTE	2.20	2.55	3.20
HOT CHOCOLATE	2.50	2.75	3.00
HOMEMADE SYRUP FLAVORS	.50 each		

Organic = S
 Size = S & G DEP
 Cost = Q
 price/cost - Q
 price/size - Q
 Caf. - Q
 Caf/0 - Q
 milk - C
 Cal - Q
 sugar - C
 taste - C
 flavor - C
 Caf. - C
 temp - C 20
 cost a/tax - Q



VISUAL ENCODING EXERCISE ...

COFFEE ESPRESSO & HOT TEA			
	8oz SMALL	12oz MEDIUM	16oz LARGE
GUATEMALA CASI CIELO <small>floral, lemon & cocoa</small>	1.50	1.70	1.90
GUATEMALA CASI CIELO de-caf <small>floral, lemon & cocoa</small>	1.50	1.70	1.90
SUMATRA <small>spicy, herbal & earthy</small>	1.50	1.70	1.90
ESPRESSO	1.45	1.70	1.85
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CAFÉ LATTE	2.15	2.75	3.20
CAPPUCCINO	2.15	2.75	3.20
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ORGANIC BREAKFAST	1.70	1.90	2.10
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CHAI TEA LATTE	2.40	2.95	3.35
BLACK TEA LATTE	2.20	2.55	3.20
HOT CHOCOLATE	2.50	2.75	3.00
HOMEMADE SYRUP FLAVORS	.50 each		

Size – O / Q

Derived

Cost – Q

Cost w/ tax – Q

Beverage type – C

Cost/ounce – Q

Name – C

Cost/size – Q

Taste – C

Caffeine – Q

Flavor – C

Milk – C

Caf/Decaf – C

Calories – Q

Temperature – C / O

Sugar – Q & C

Organic – C

O – Ordinal

Q – Quantitative

C – Categorical



Guatemala			
Guatemala			
Sumatra			

Espresso			
Americano			
Latte			
Cappuccino			
Mocha			

Organic Breakfast				
Organic Green				
Chai				
Chai Latte				
Black Latte				

Hot Chocolate					
---------------	---------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------



RECOMMENDED READING

Visualization Analysis & Design: Chapter 2 (pp. 20-41)
& Chapter 5 (pp. 94-115)



