# Information Visualization

# 6 Human Computer Interaction

COMS21301

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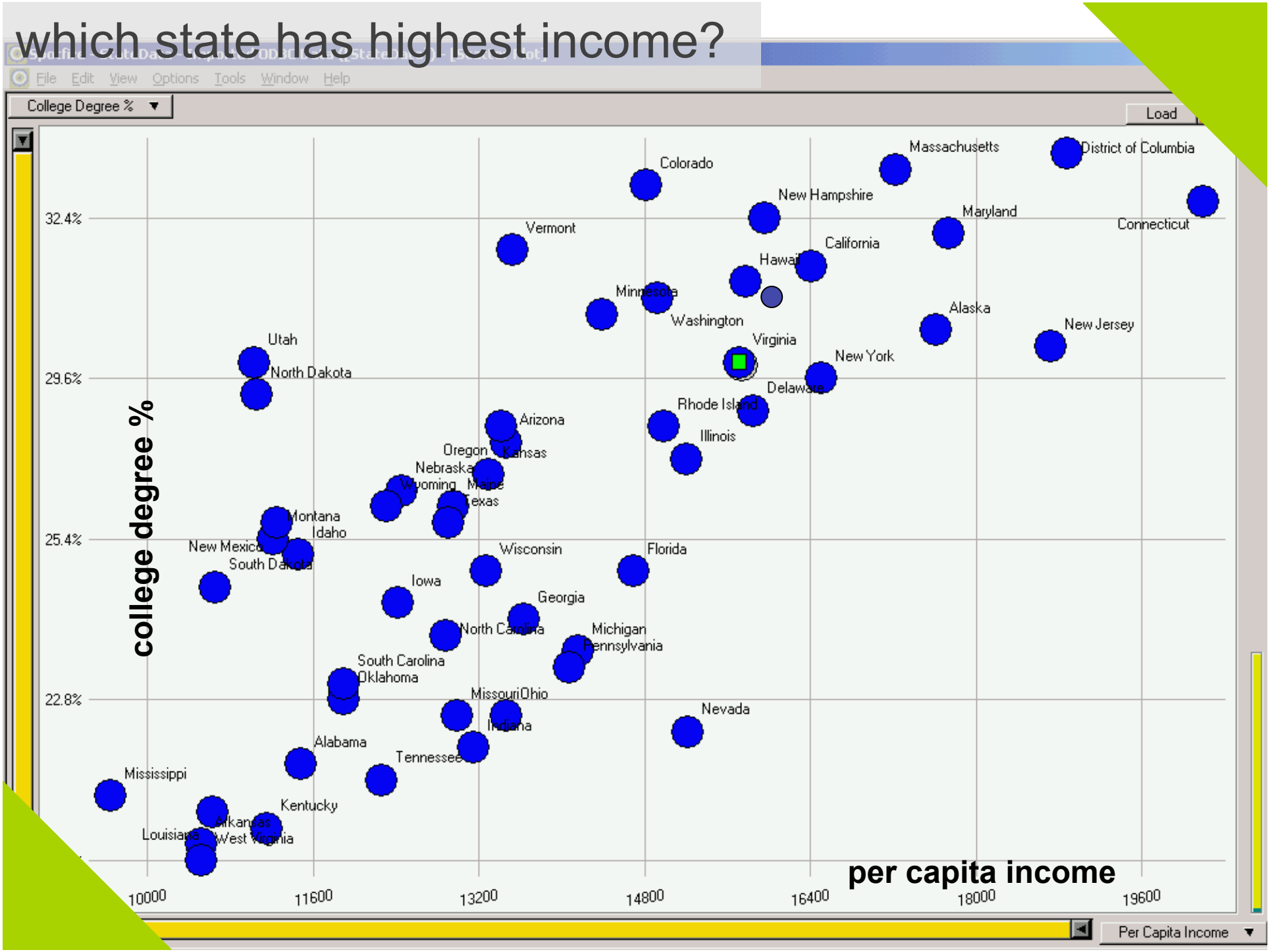
# which state has highest income?

Table - StateData ()

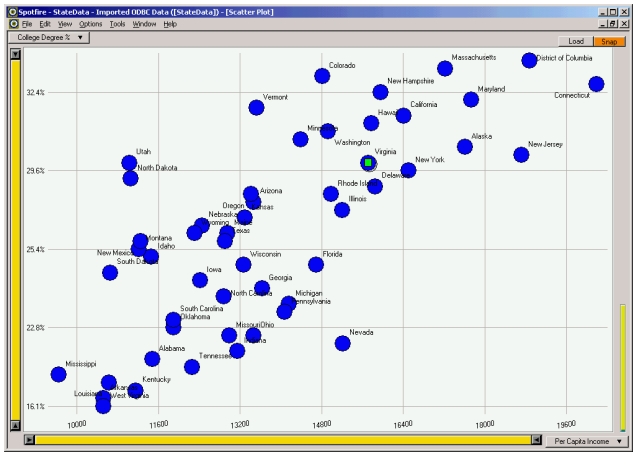
Load | Snap

| State | College Degree % | Per Capita Income |
|---|---|---|
| Alabama | 20.6% | 11486 |
| Alaska | 30.3% | 17610 |
| Arizona | 27.1% | 13461 |
| Arkansas | 17.0% | 10520 |
| California | 31.3% | 16409 |
| Colorado | 33.9% | 14821 |
| Connecticut | 33.8% | 20189 |
| Delaware | 27.9% | 15854 |
| District of Columbia | 36.4% | 18881 |
| Florida | 24.9% | 14638 |
| Georgia | 24.3% | 13631 |
| Hawaii | 31.2% | 15770 |
| Idaho | 25.2% | 11457 |
| Illinois | 26.8% | 15201 |
| Indiana | 20.9% | 13149 |
| Iowa | 24.5% | 12422 |
| Kansas | 26.5% | 13300 |
| Kentucky | 17.7% | 11153 |
| Louisiana | 19.4% | 10635 |
| Maine | 25.7% | 12957 |
| [illegible]yland | 31.7% | 17730 |
| [illegible]achusetts | 34.5% | 17224 |
| [illegible] | 24.1% | 14154 |
| [illegible] | 30.4% | 14389 |
| Minnesota | 30.4% | 14389 |
| Mississippi | 19.9% | 9648 |
| Missouri | 22.3% | 12989 |
| Montana | 25.4% | 11213 |
| Nebraska | 26.0% | 12452 |
| Nevada | 21.5% | 15214 |
| New Hampshire | 32.4% | 15959 |
| New Jersey | 30.1% | 18714 |
| New Mexico | 25.5% | 11246 |
| New York | 29.6% | 16501 |
| North Caroline | 24.2% | 12885 |
| North Dakota | 26.1% | 11051 |
| Ohio | 22.3% | 13461 |
| Oklahoma | 22.8% | 11893 |
| Oregon | 27.5% | 13418 |
| Pennsylvania | 23.2% | 14068 |
| Rhode Island | 27.5% | 14981 |
| South Caroline | 23.0% | 11897 |
| South Dakota | 24.6% | 10661 |
| Tennessee | 20.1% | 12255 |
| Texas | 25.5% | 12904 |
| Utah | 30.0% | 11029 |
| Vermont | 31.5% | 13527 |
| Virginia | 30.0% | 15713 |
| Washington | 30.9% | 14923 |
| West Virginia | 16.1% | 10520 |
| Wisconsin | 24.9% | 13276 |
| Wyoming | 25.7% | 12311 |

# which state has highest income?




hides data
hampers knowledge
nothing learned
no insight




reveals data
reveals knowledge that is
not necessarily “stored”
in the data
insight!

**representation matters**


Western world
Long life in small family
Third world
Short life in large family
So this is what I could display
here. I put fertility rate here:
number of children per woman:


Chart
Map
How to use
Share graph
Full screen
[Hans rosling]
2012
Color
Geographic regions
Select
Children per woman (total fertility)
Size
Population, total
Play

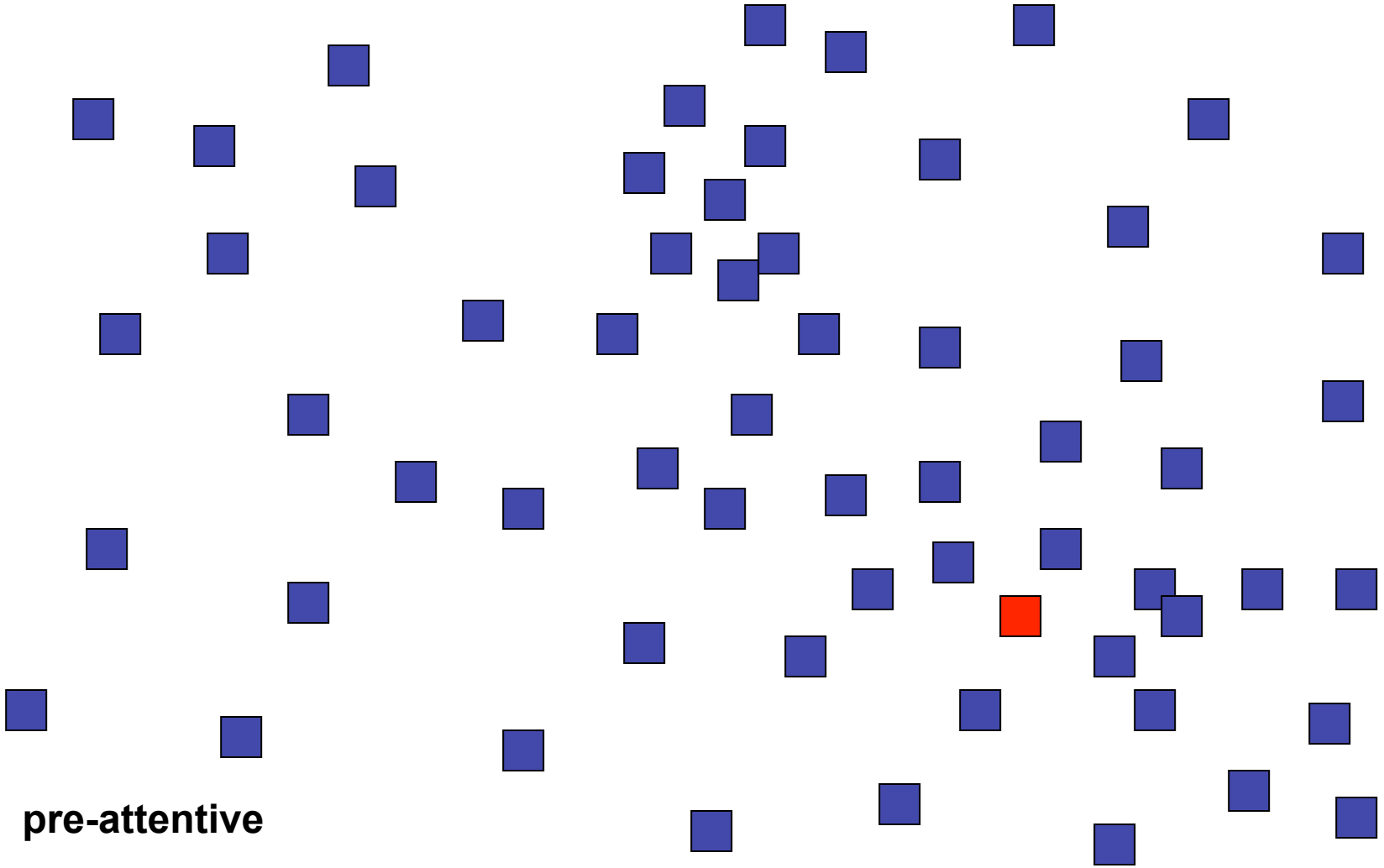
# visualization::

the purpose of visualization is to convey information to people through graphical means

# visual perception

# find the red square:

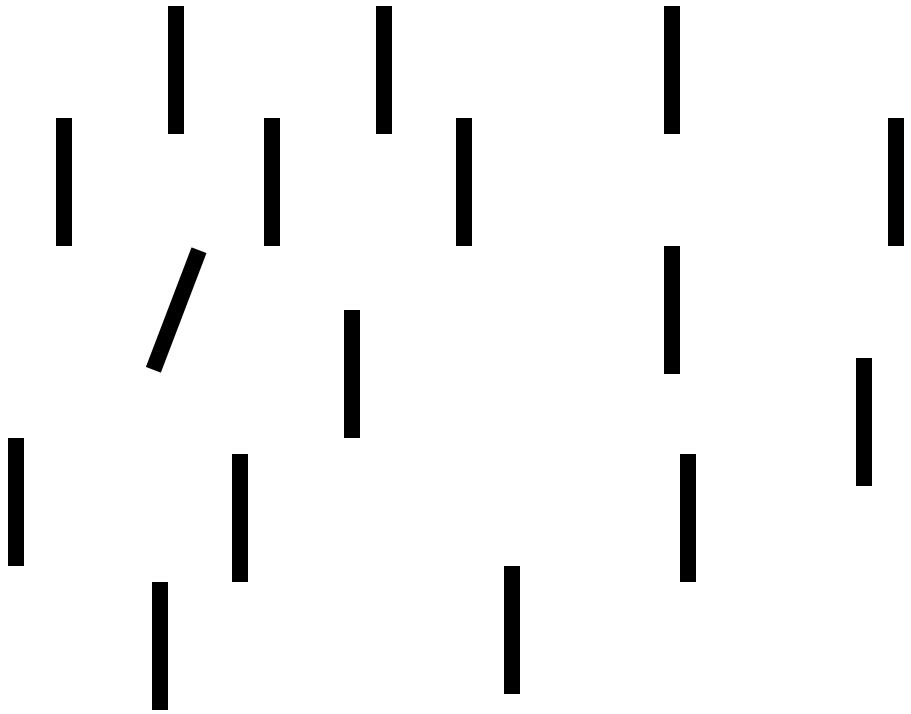
# find the red square:



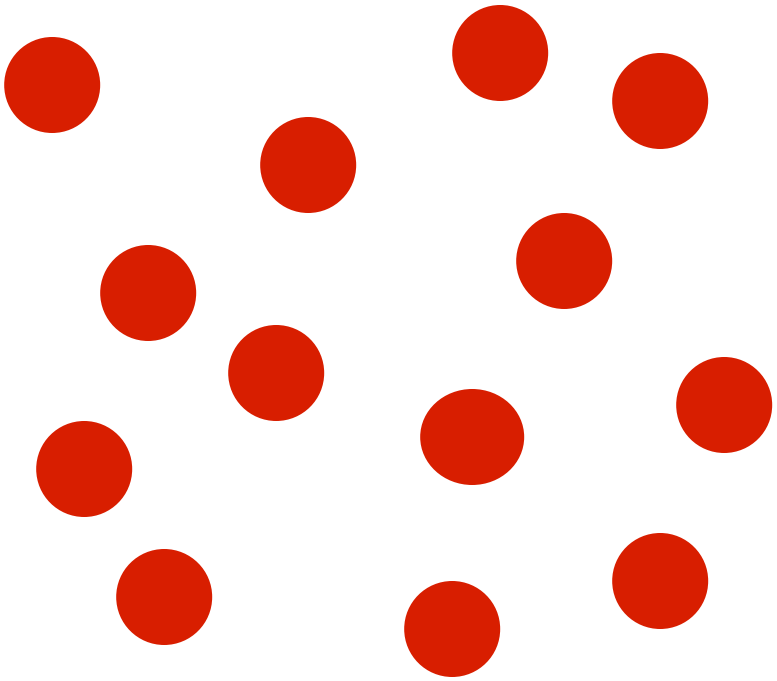
pre-attentive

# find different orientation

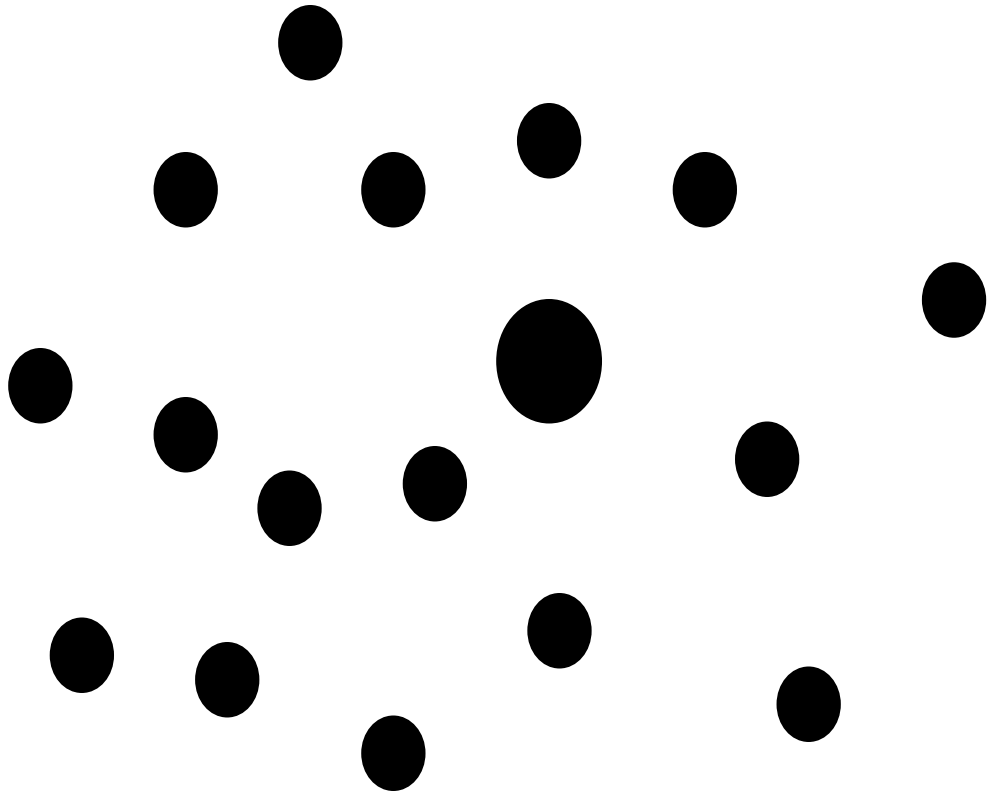
# find different orientation



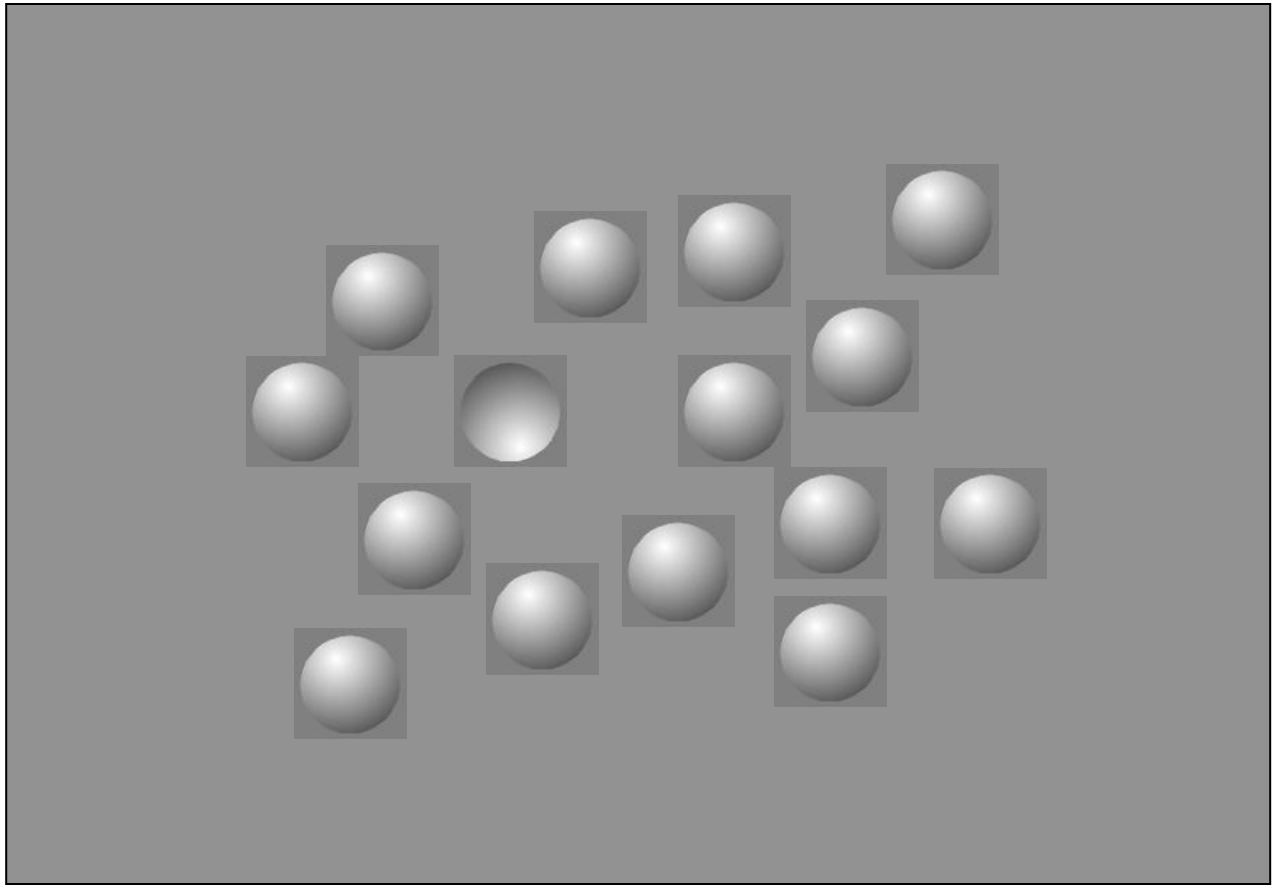
# motion



# size



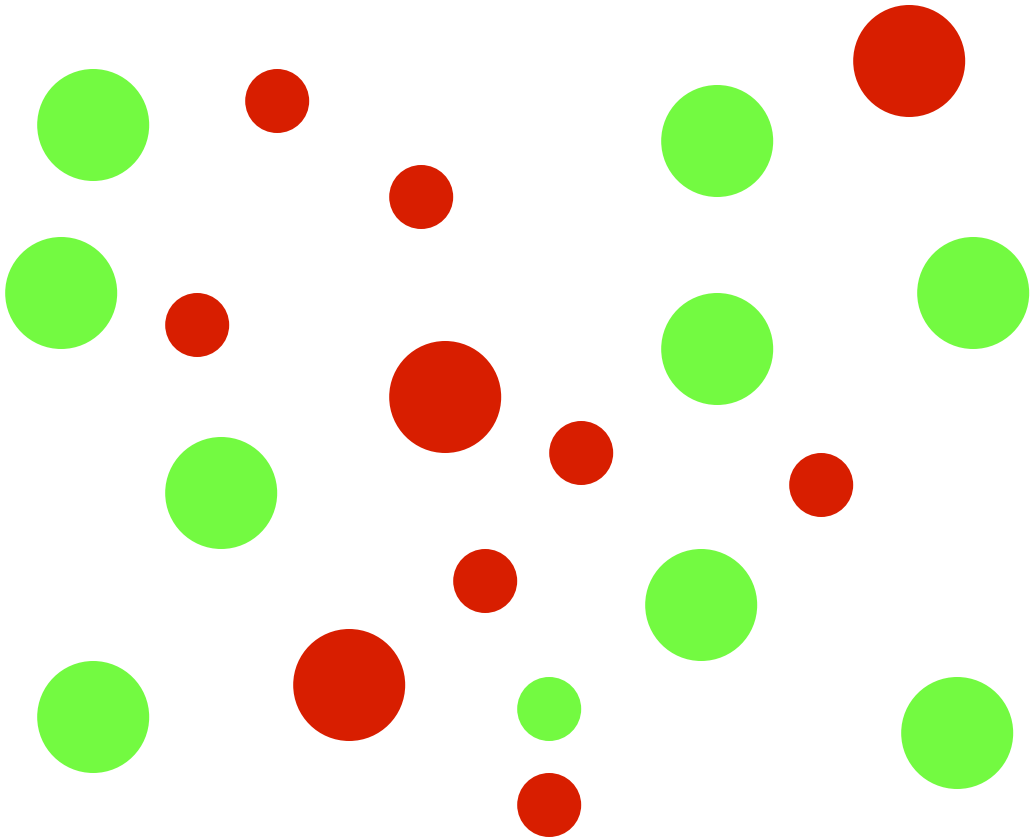
# lighting



# conjunction does not pop-out

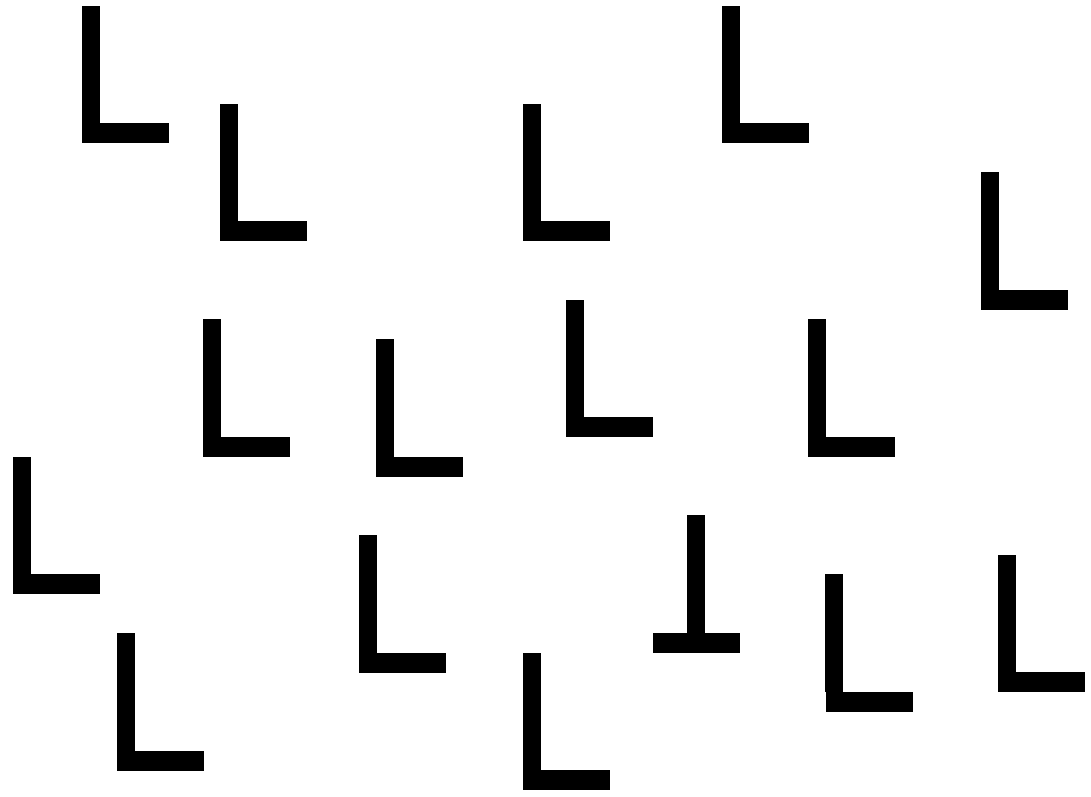
where is the small green circle?

# conjunction does not pop-out



where is the small green circle?

# compound features do not pop-out



where is the inverted T?

# human vision

highest bandwidth sense

fast, parallel

pattern recognition

pre-attentive

extends memory and cognitive capacity

(Multiplication test)

people think visually

brain = 8 lbs,  vision = 3 lbs

Impressive.  Let's use it!

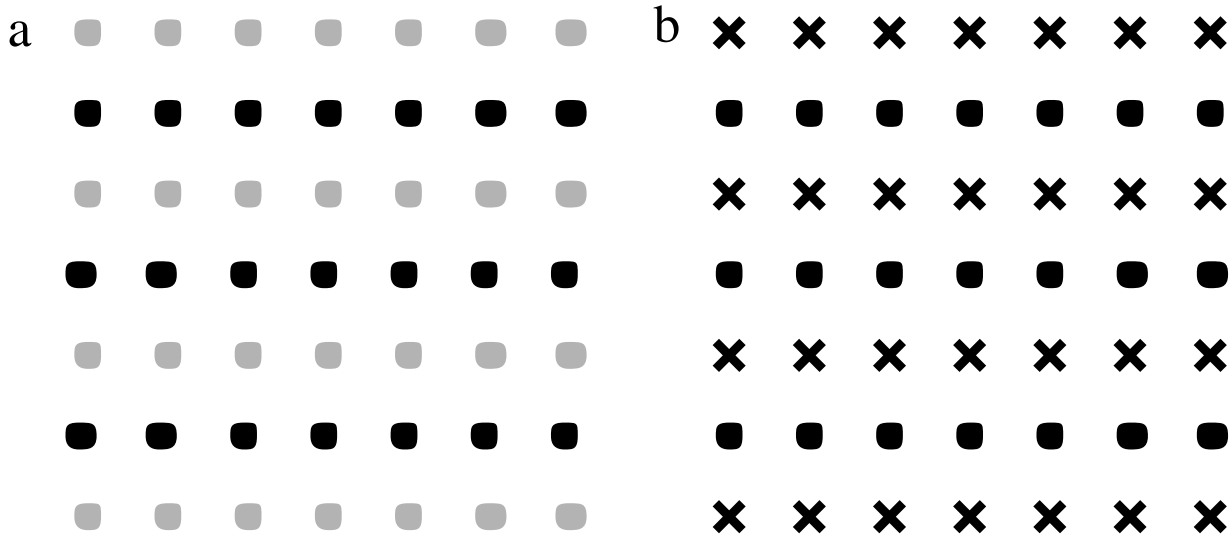
# gestalt laws::

*Gestalt* is a psychology term which means "unified whole". It refers to theories of **visual perception** developed by psychologists in the 1920s. Describe how people tend to organize visual elements into **groups** or *unified wholes* when certain principles are applied. These principles are:

[Max Westheimer, Kurt Koffka, and Wolfgang Kohler (1912)]

# similarity

when objects look similar to one another, people often perceive them as a group or pattern.



# similarity

when objects look similar to one another, people often perceive them as a group or pattern.

# continuity

occurs when the eye is compelled to move through one object and continue to another object.

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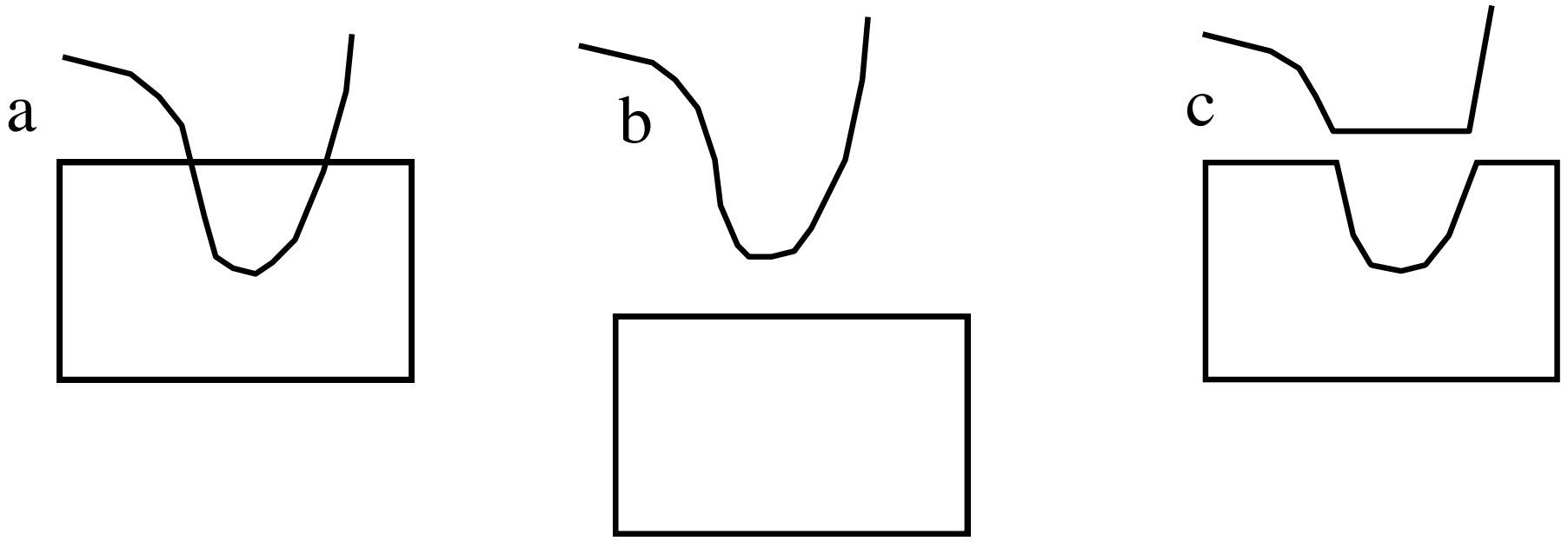

# closure

occurs when an object is *incomplete* or a space is not *completely enclosed*. If enough of the shape is indicated, people percieve the whole by filling in the missing infomation.

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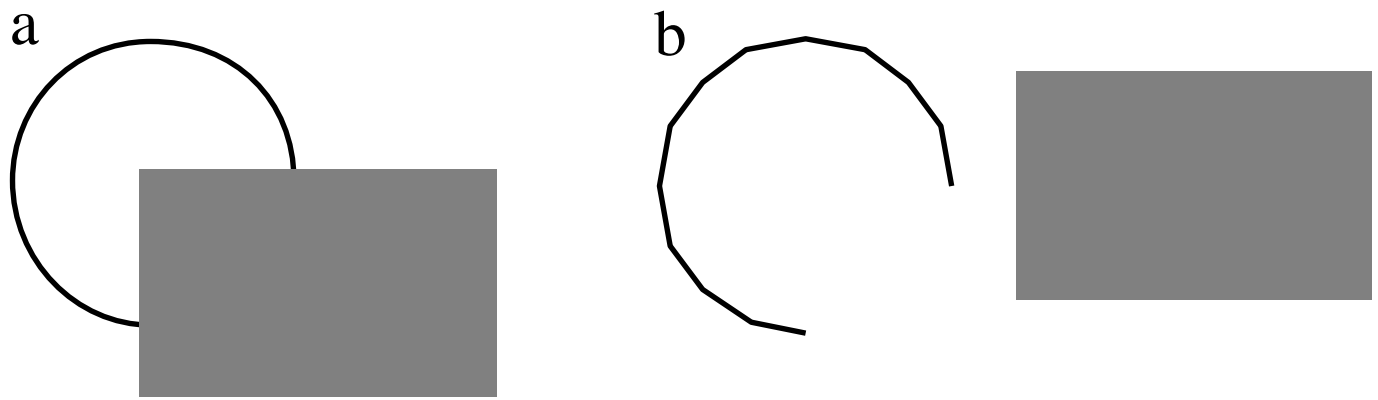
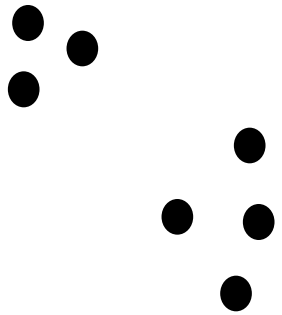
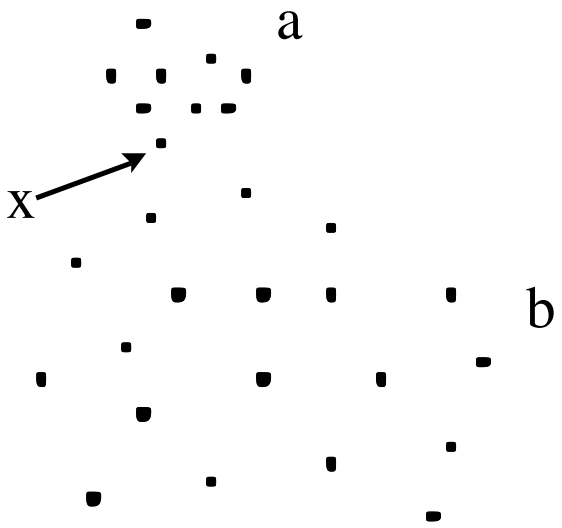


# proximity

elements placed close together tend to be perceived as a group.





# figure and ground

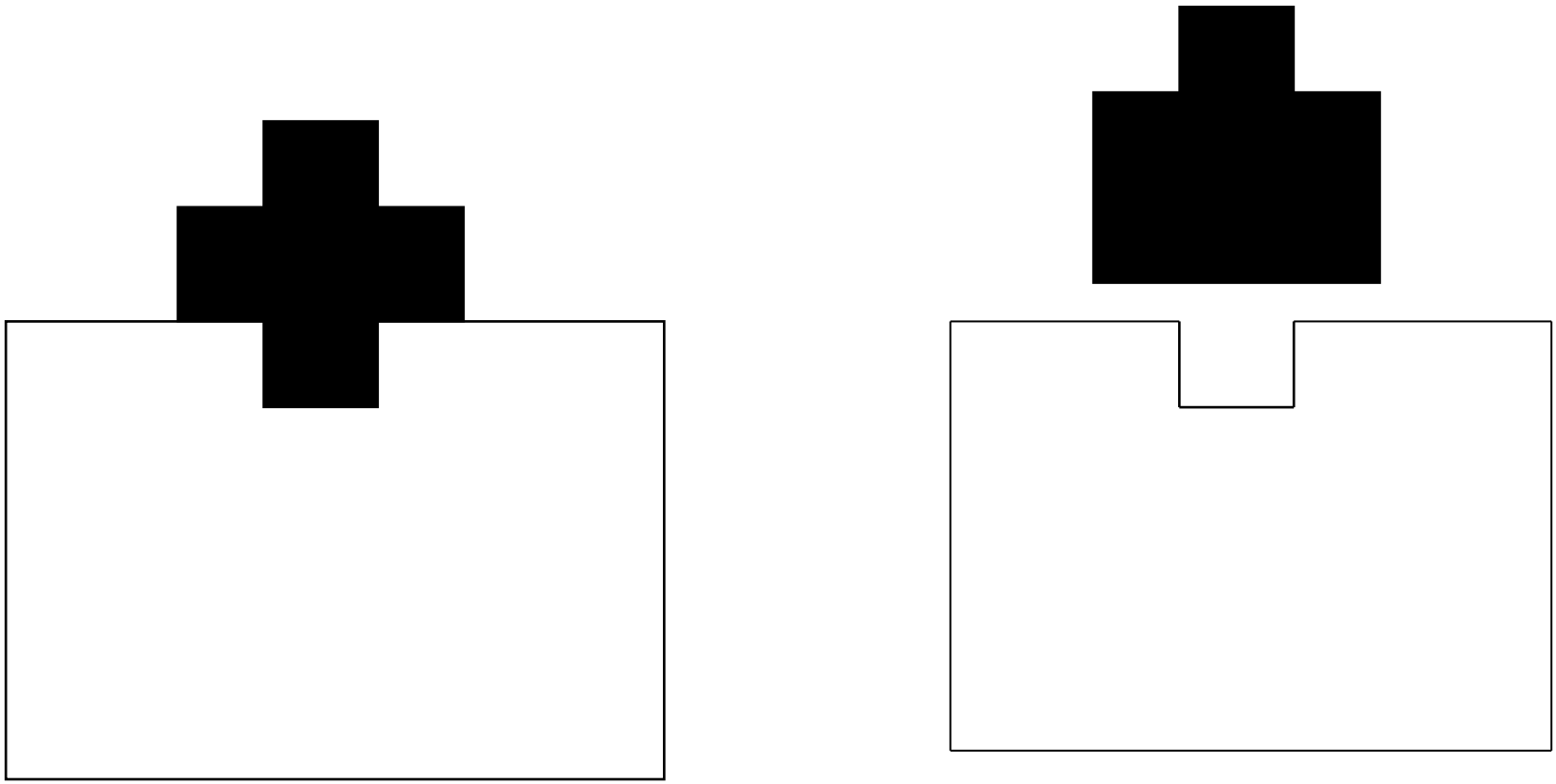
the eye differentiates an object form its surrounding area. a form, silhouette, or shape is naturally perceived as figure (object), while the surrounding area is perceived as ground (background).

# figure and ground

# figure and ground

# symmetry

the mind perceives objects as being symmetrical and forming around a center point



# symmetry

the mind perceives objects as being symmetrical and forming around a center point

ok now how do we use these to represent data?

# encoding data

# data types

27
4.1
102
3.14
-0.1
16

arguably the most common

numerical data

Monday
Wednesday
Tuesday
Thursday

ordinal data

things that are naturally ordered

categorical data

things without order

# visual properties


| NUMERICAL | ORDINAL | CATEGORICAL |
|---|---|---|
| Position | Position | Position |
| Length | Density | Color Hue |
| Angle | Color Saturation | Texture |
| Slope | Color Hue | Connection |
| Area | Texture | Containment |
| Volume | Connection | Density |
| Density | Containment | Color Saturation |
| Color Saturation | Length | Shape |
| Color Hue | Angle | Length |

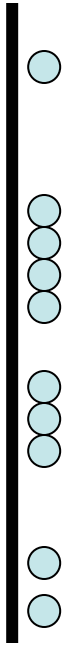
# 1D

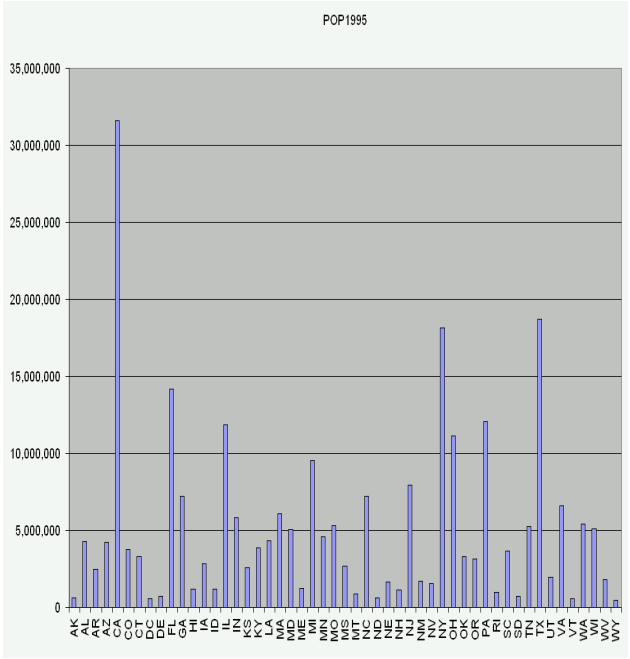
Dot plot

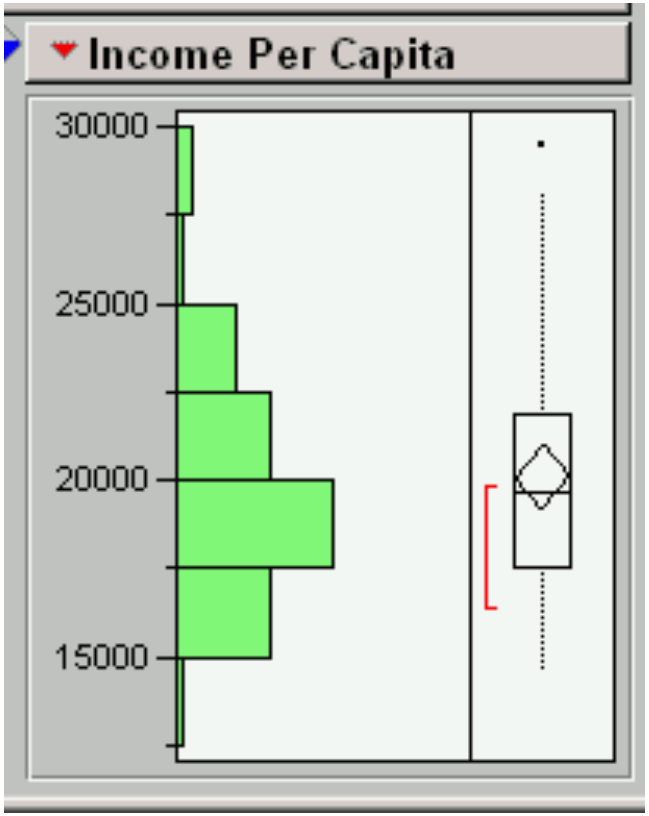
Bar chart  (item vs. attribute)

Tukey box plot

Histogram

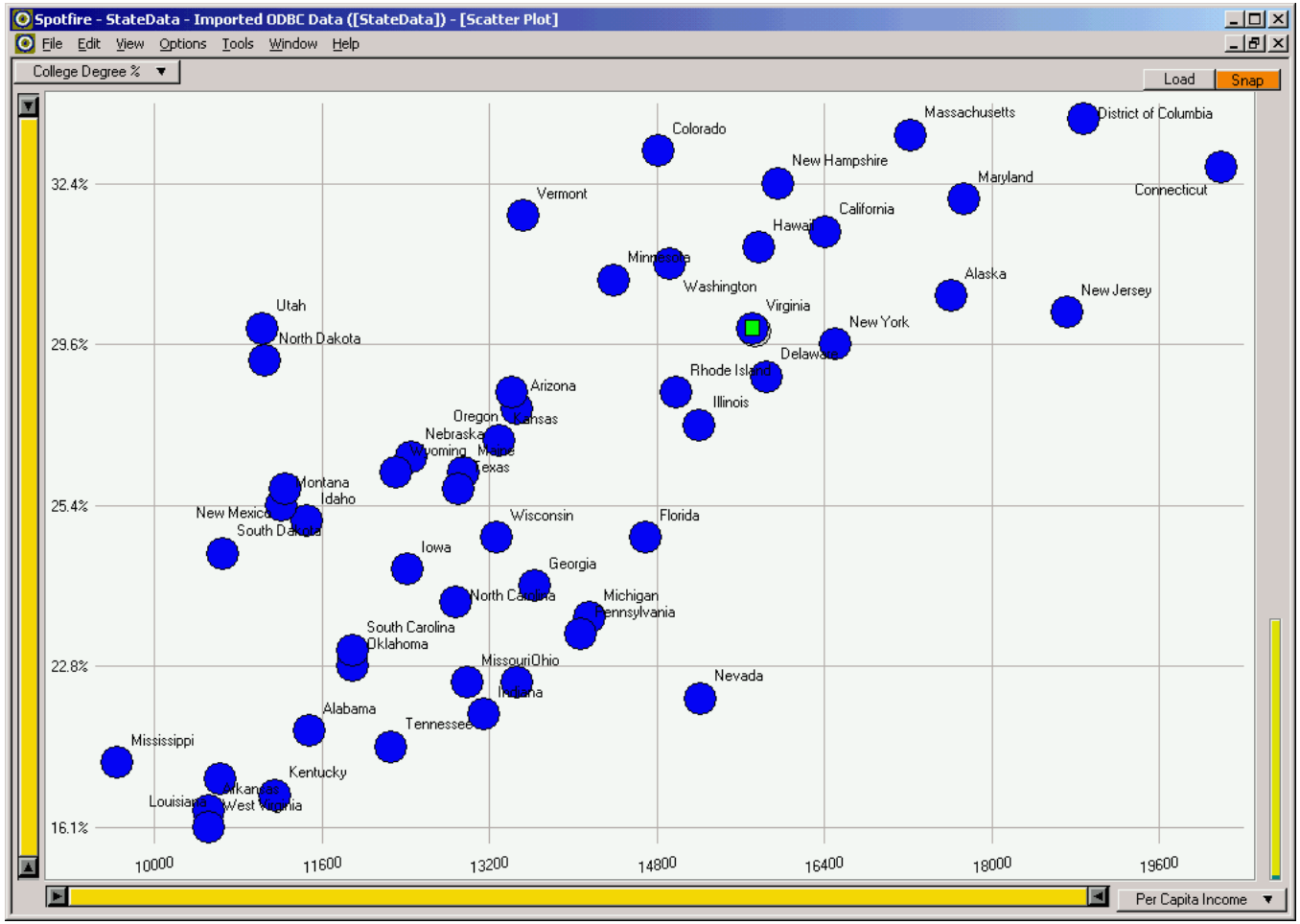




# scatterplot

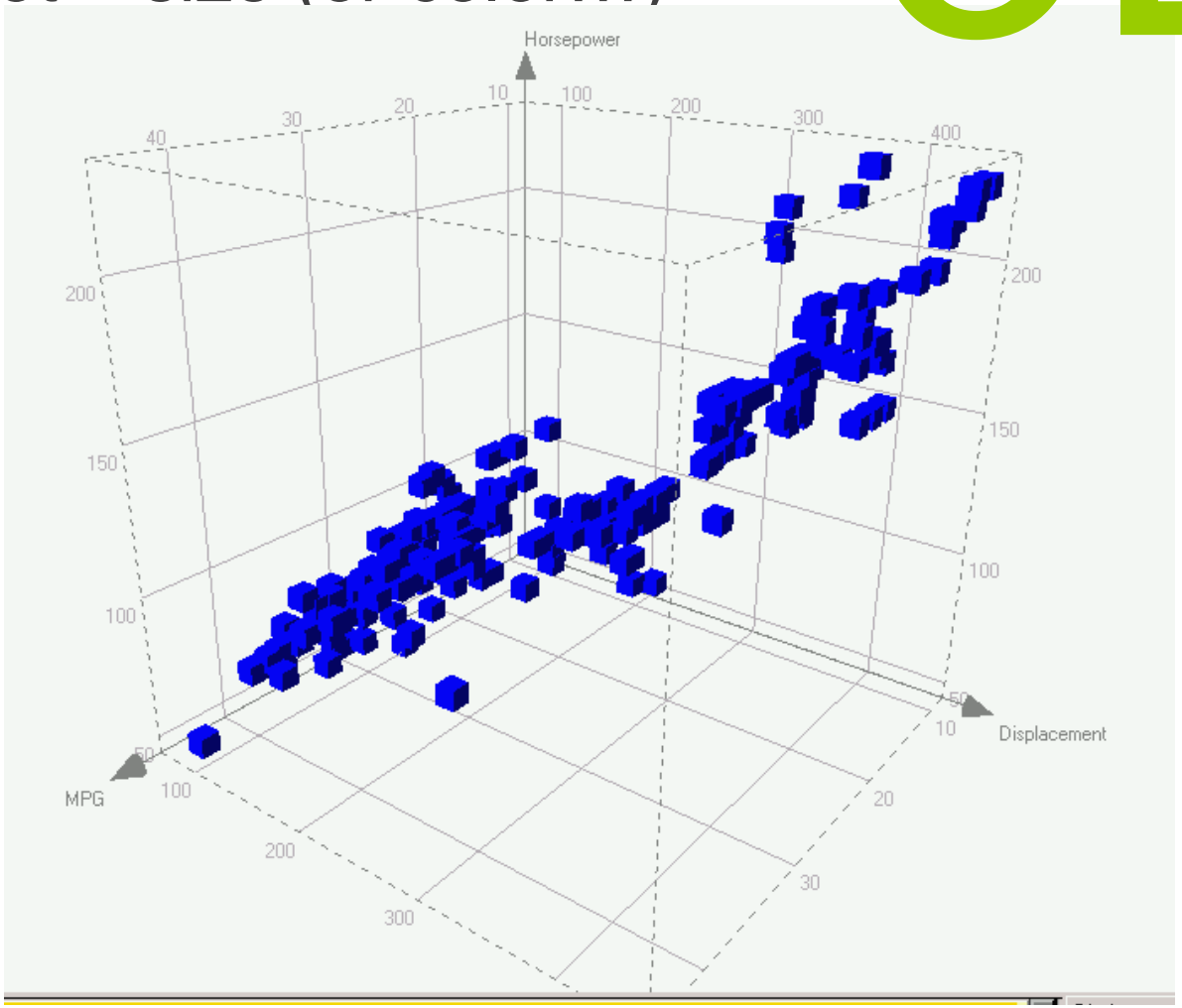
# 2D



# trivariate

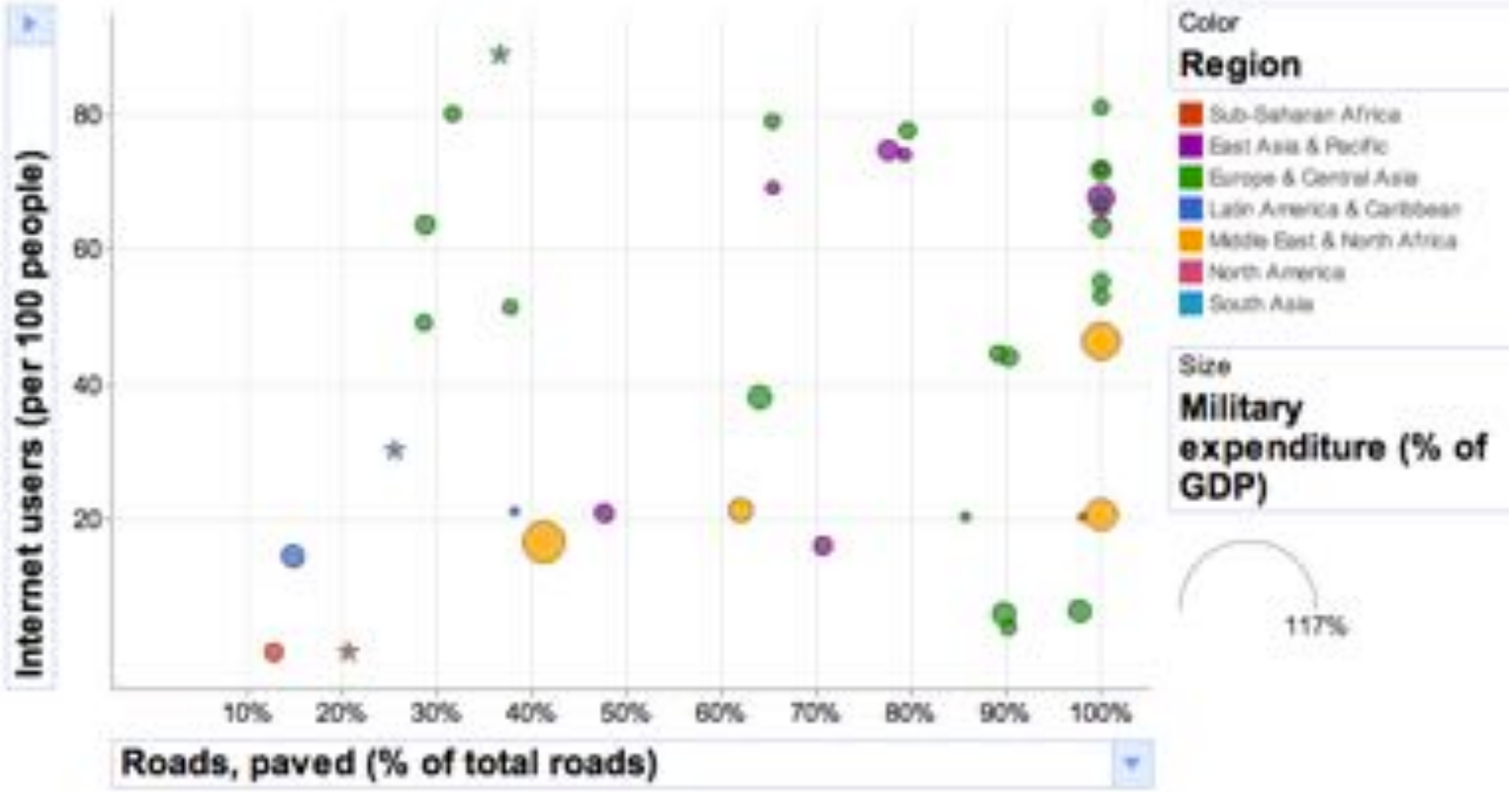
- 3D scatterplot, spin plot
- 2D plot + size (or color…)

3D



# multi-D scatterplot

nD

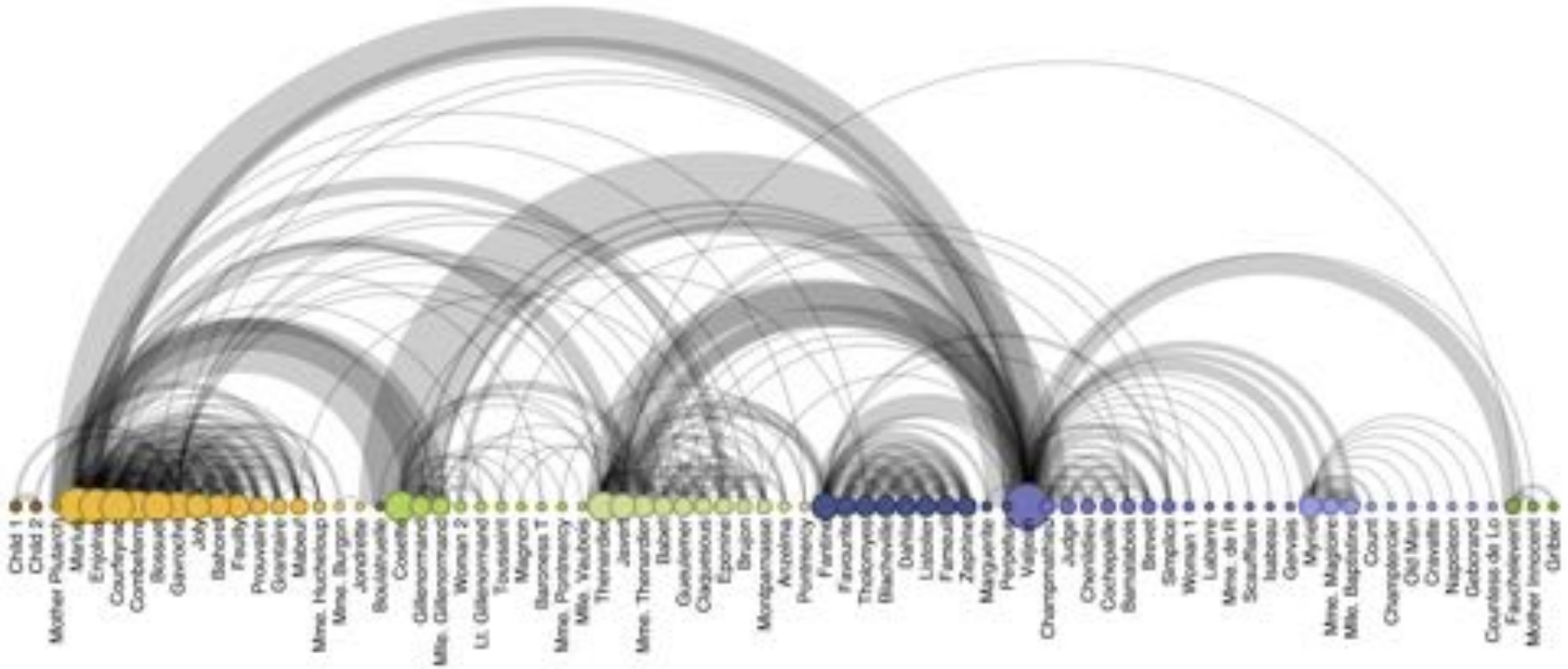


# a few examples

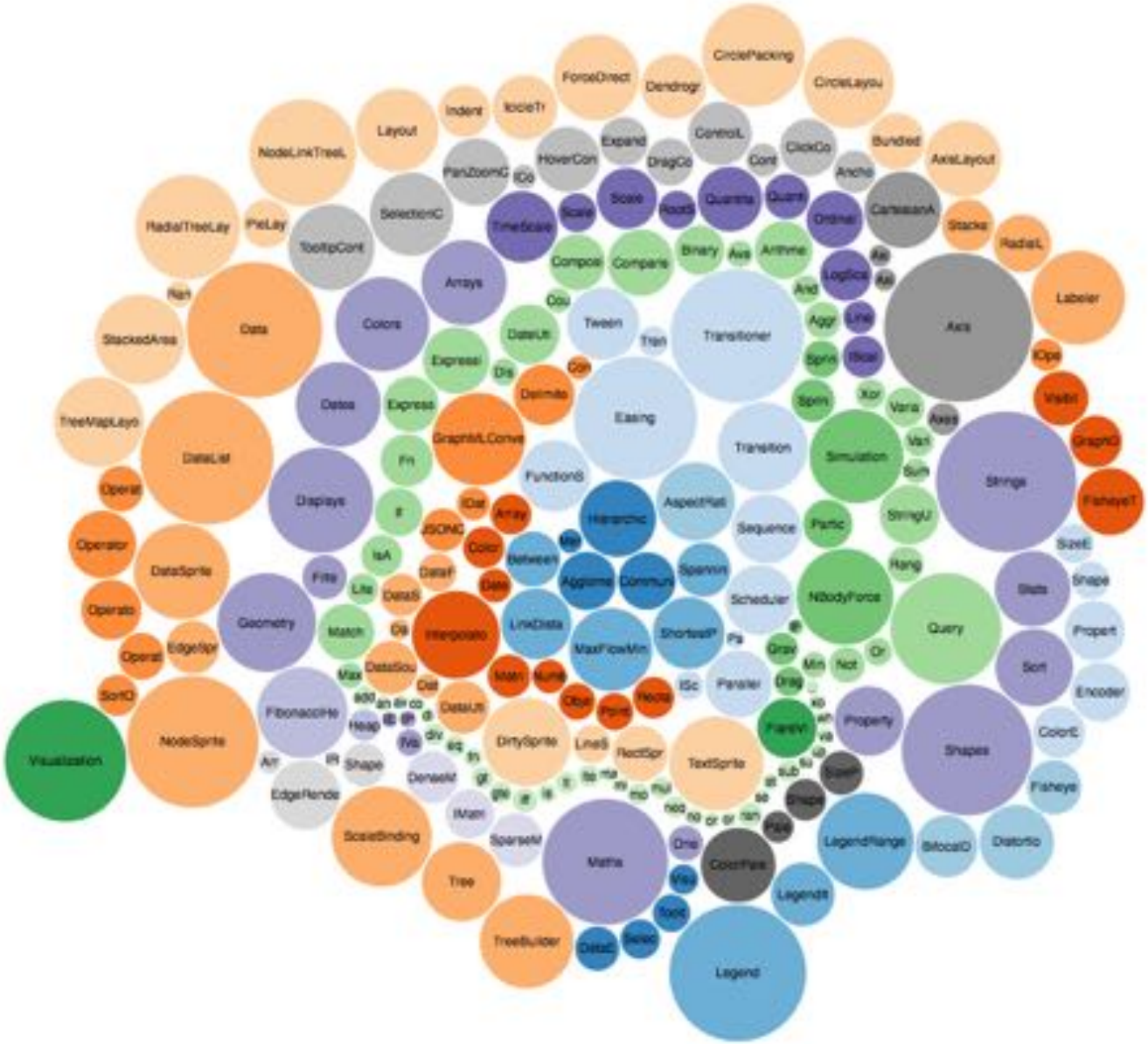
# cartogram

CO2 emission

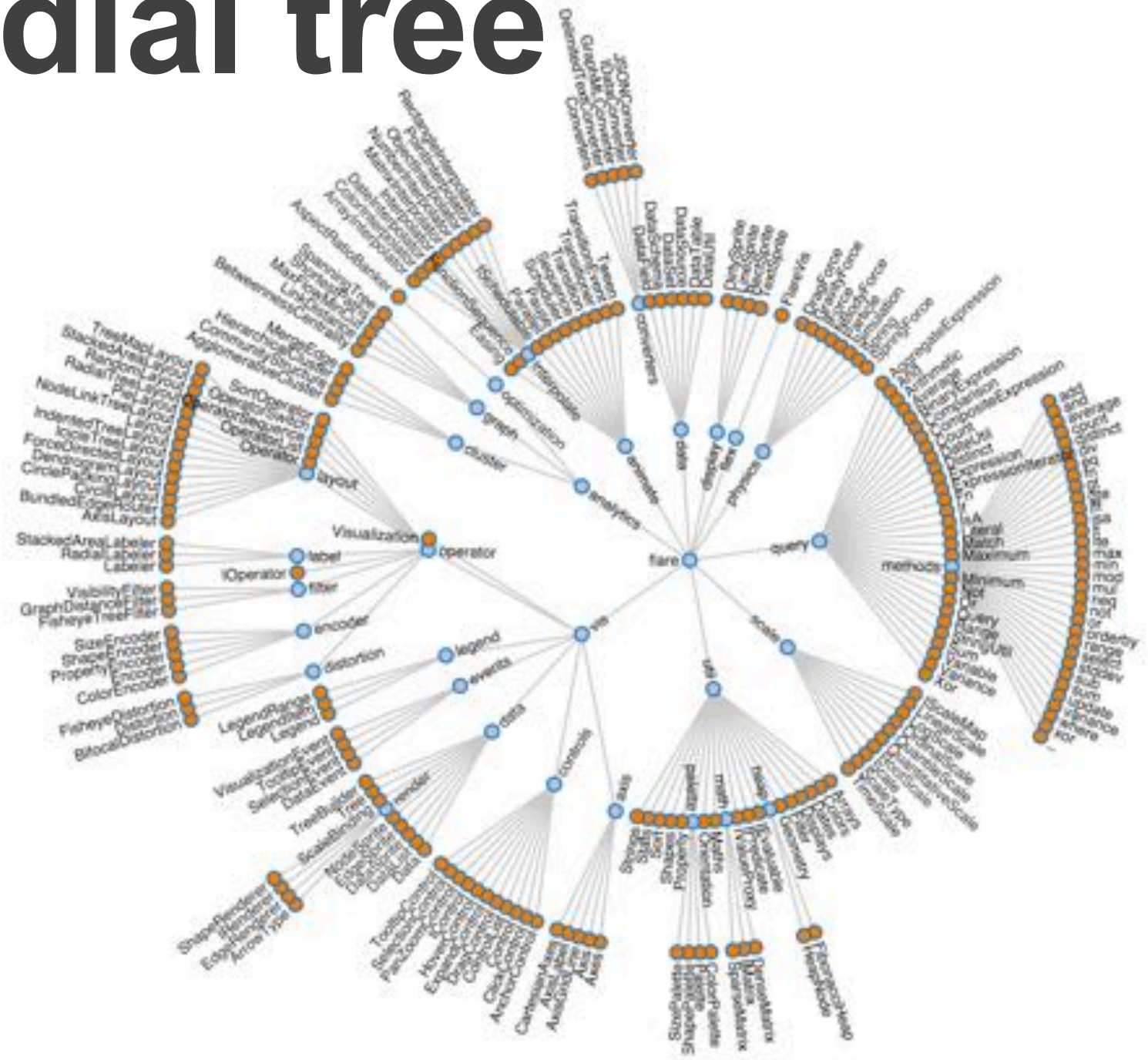
# arc diagram


Child 1
Child 2
Mme. Hucheloup
Mme. Burgon
Woman 2
Lt. Gillenormand
Toussaint
Magnon
Baroness T
Mme. Pontmercy
Mlle. Vaubois
Mme. Thenardier
Babet
Gueulemer
Claquesous
Brujon
Montparnasse
Anzelma
Pontmercy
Judge
Champmathieu
Chenildieu
Cochepaille
Brevet
Simplice
Woman 1
Scaufflaire
Isabeau
Gervais
Mme. Magloire
Mlle. Baptistine
Count
Champtercier
Old Man
Napoleon
Deborand
Countess de Lo
Fauchelevent
Mother Innocent
Orbier

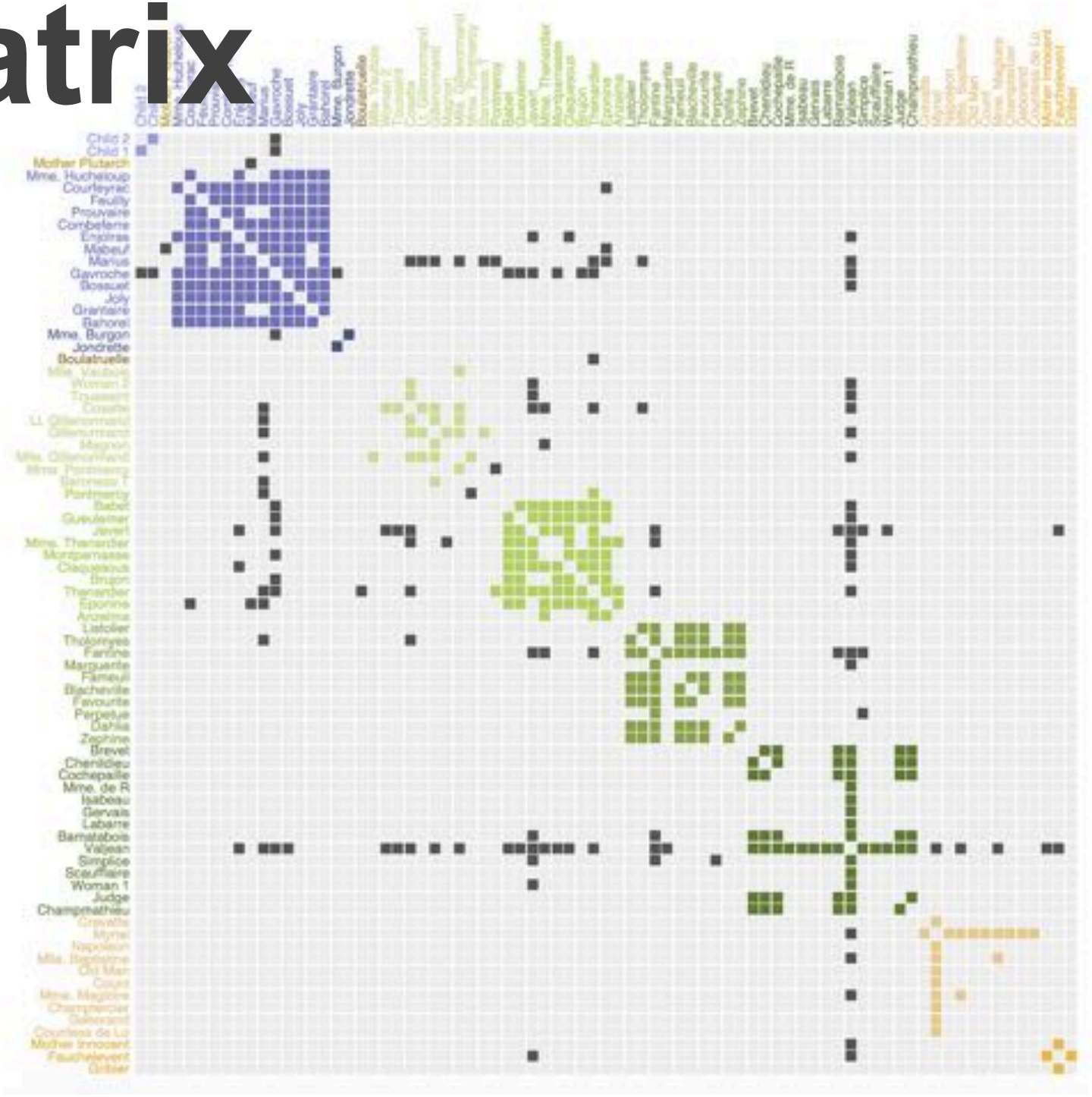
# bubble cloud



# radial tree


Visualization
operator
label
IOperator
filter
encoder
distortion
legend
events
data
controls
axis
scale
vis
flare
query
methods
graph
cluster
optimization
animate
analytics
data
converters
display
flex
physics
layout
Operator
Maximum
Minimum
Not
Or
Query
Range
StringUtil
Sum
Variable
Xor
Variance
Legend
Axis

# matrix


Child 2
Child 1
Mother Plutarch
Mme. Hucheloup
Courfeyrac
Feuilly
Prouvaire
Combeferre
Enjolras
Mabeuf
Marius
Gavroche
Bossuet
Joly
Grantaire
Bahorel
Mme. Burgon
Jondrette
Boulatruelle
Mlle. Vaubois
Woman 2
Toussaint
Cosette
Lt. Gillenormand
Gillenormand
Magnon
Mlle. Gillenormand
Mme. Pontmercy
Sergeant
Pontmercy
Babet
Gueulemer
Javert
Mme. Thenardier
Montparnasse
Claquesous
Brujon
Thenardier
Eponine
Anzelma
Listolier
Tholomyes
Fantine
Marguerite
Fameuil
Blacheville
Favourite
Perpetue
Dahlia
Zephine
Brevet
Chenildieu
Cochepaille
Mme. de R
Isabeau
Gervais
Labarre
Barmatabois
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Simplice
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Mlle. Baptistine
Old Man
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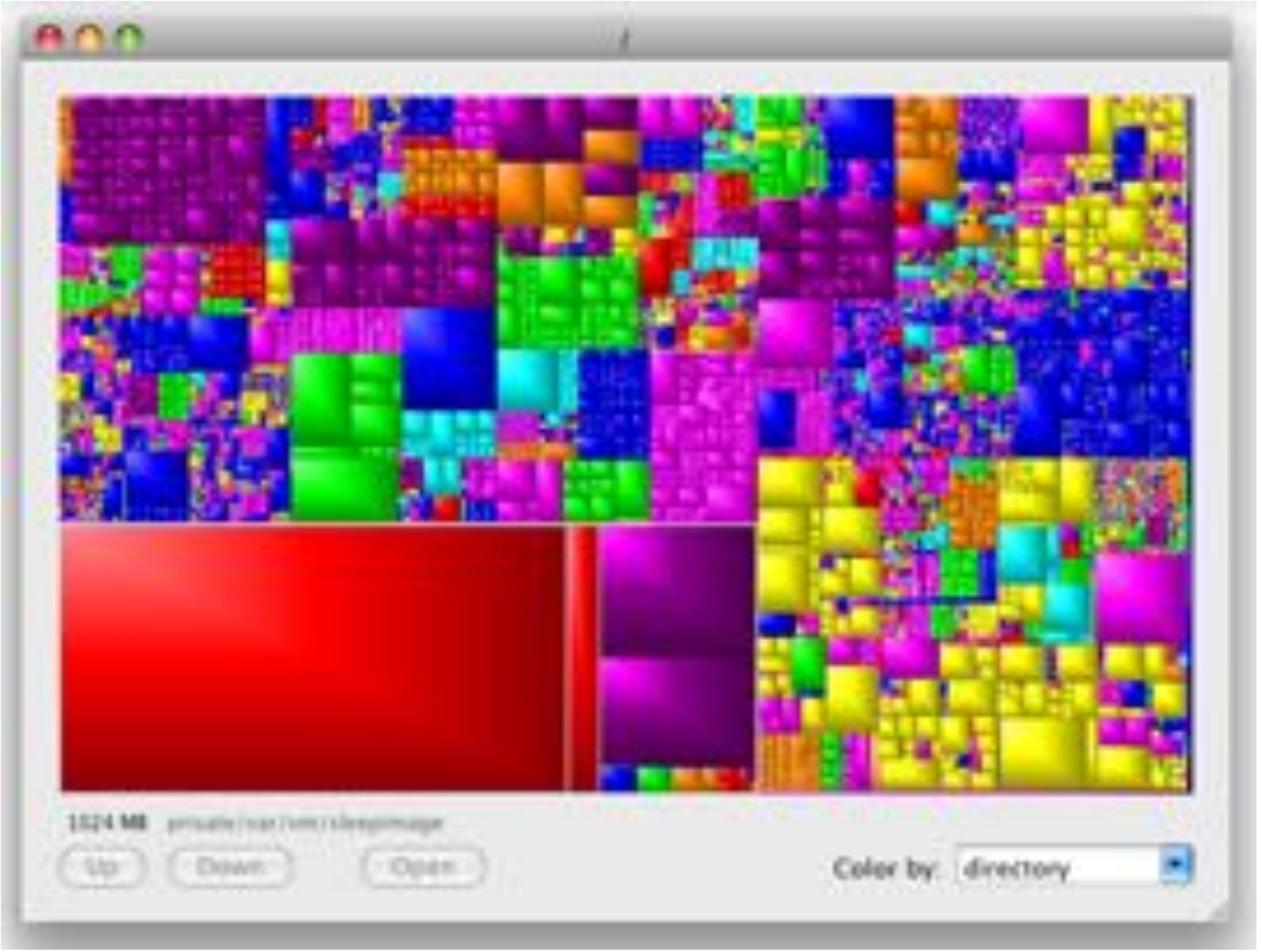
Mme. Magloire
Champtercier
Geborand
Countess de Lo
Mother Innocent
Fauchelevent
Gribier

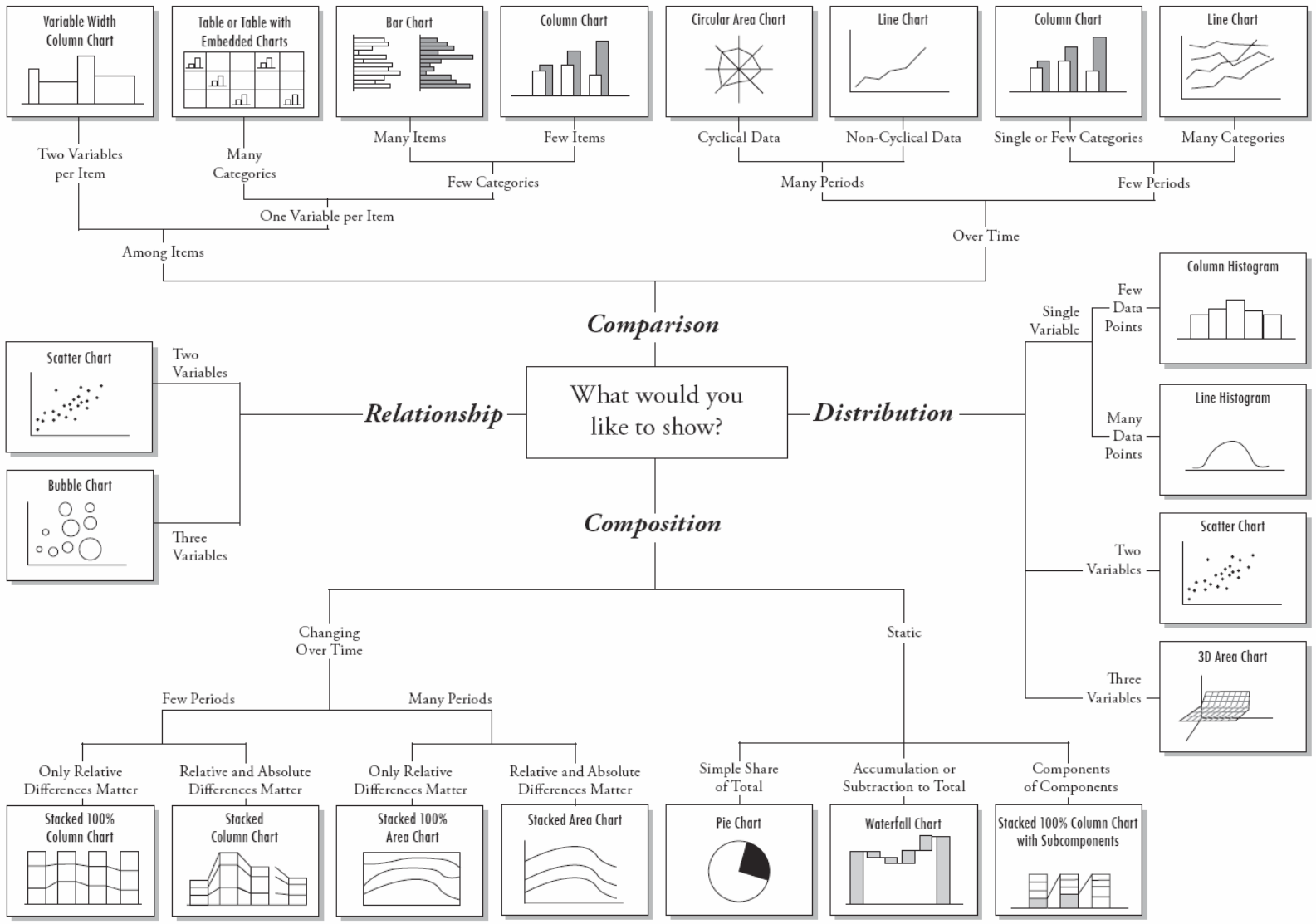
# treemap



what about interaction?

a good interface = “Overview, zoom & filter, details on demand” (ben shneiderman)

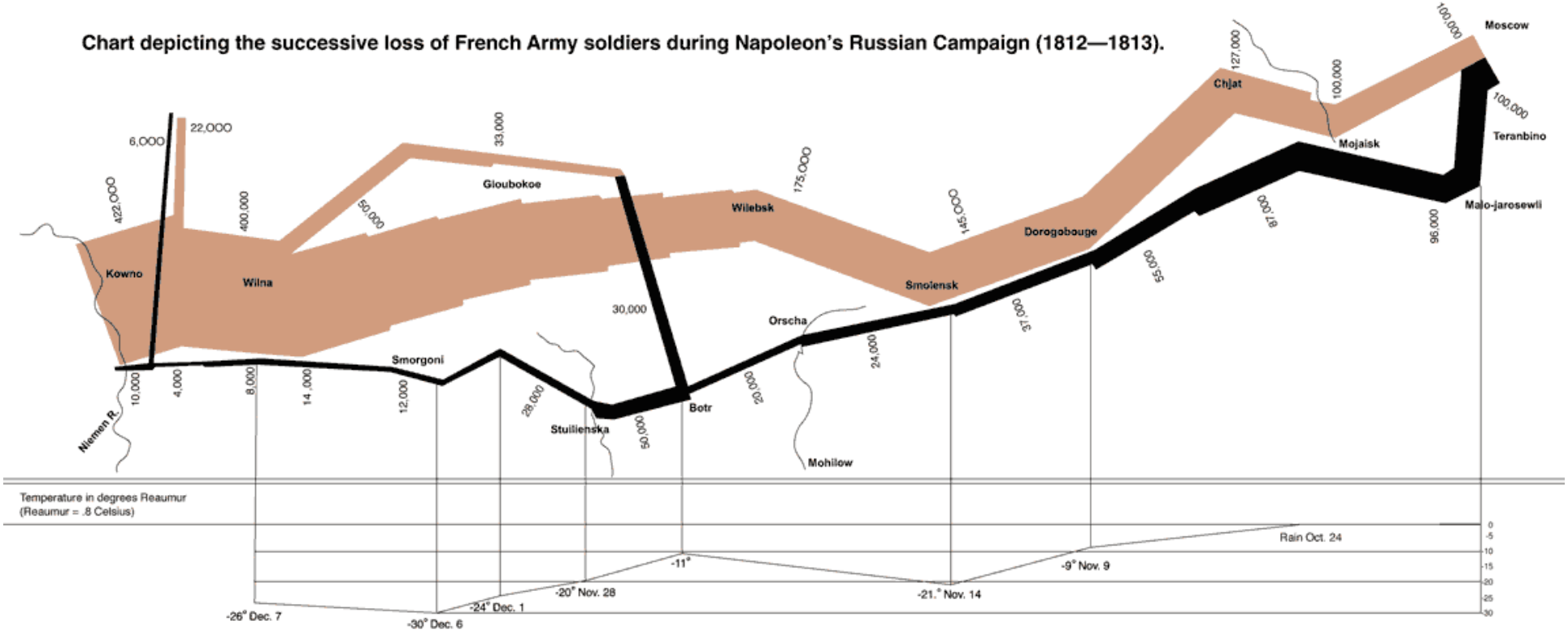
# why visualization?




many data = many representation to **convey meanings**

[Andrew Abela]

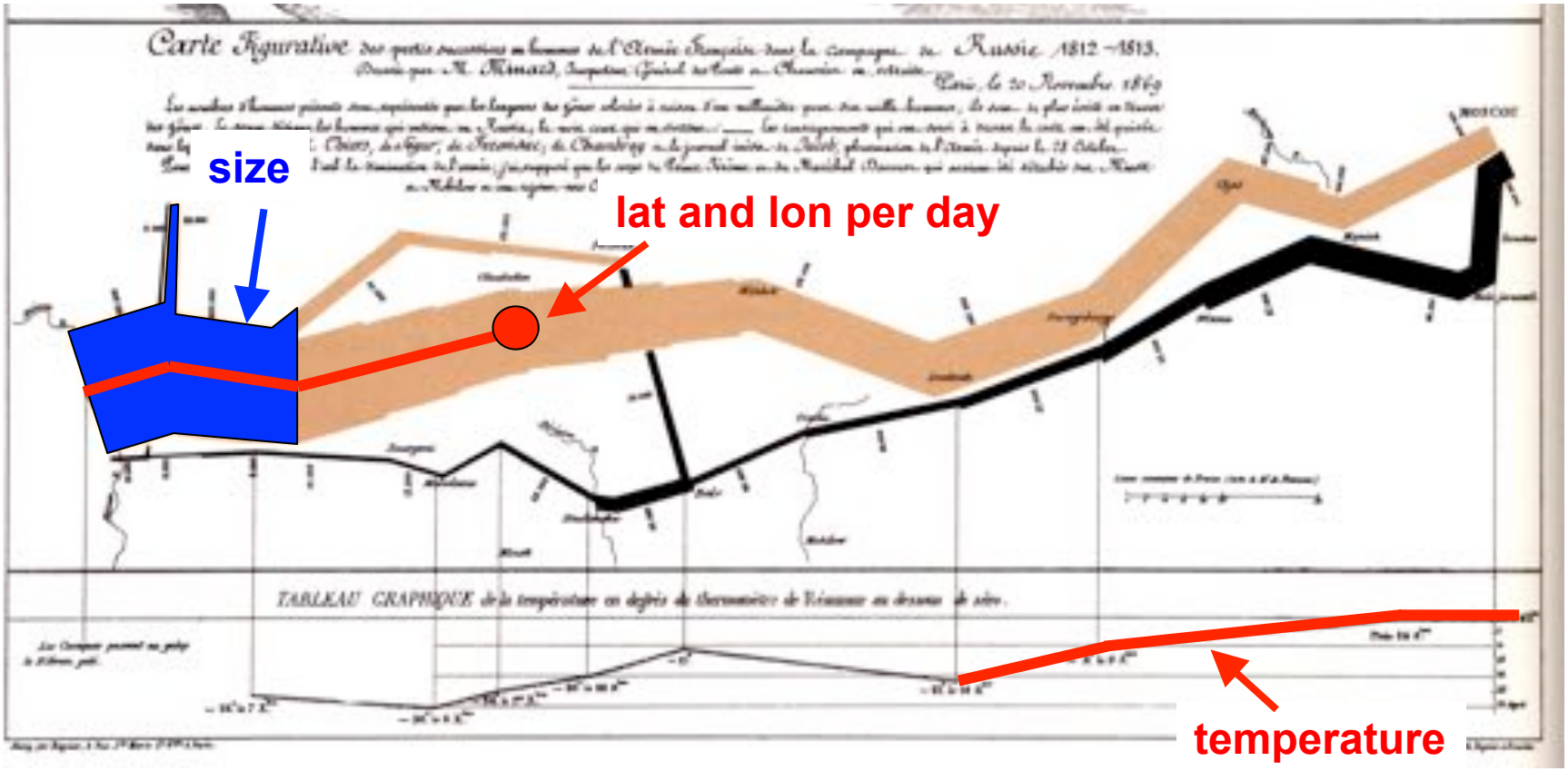
# history: static graphics




[Minard, 1869]

1. time
2. temperature
3. longitude
4. latitude
5. army size
6. direction

six variables are plotted
in this two dimensional graphic!



some consider that this graphic is the best ever!

# snow's cholera map

Dr. John Snow's use of graphical tool to locate source of cholera outbreak (Soho, 1845)

● cholera victim

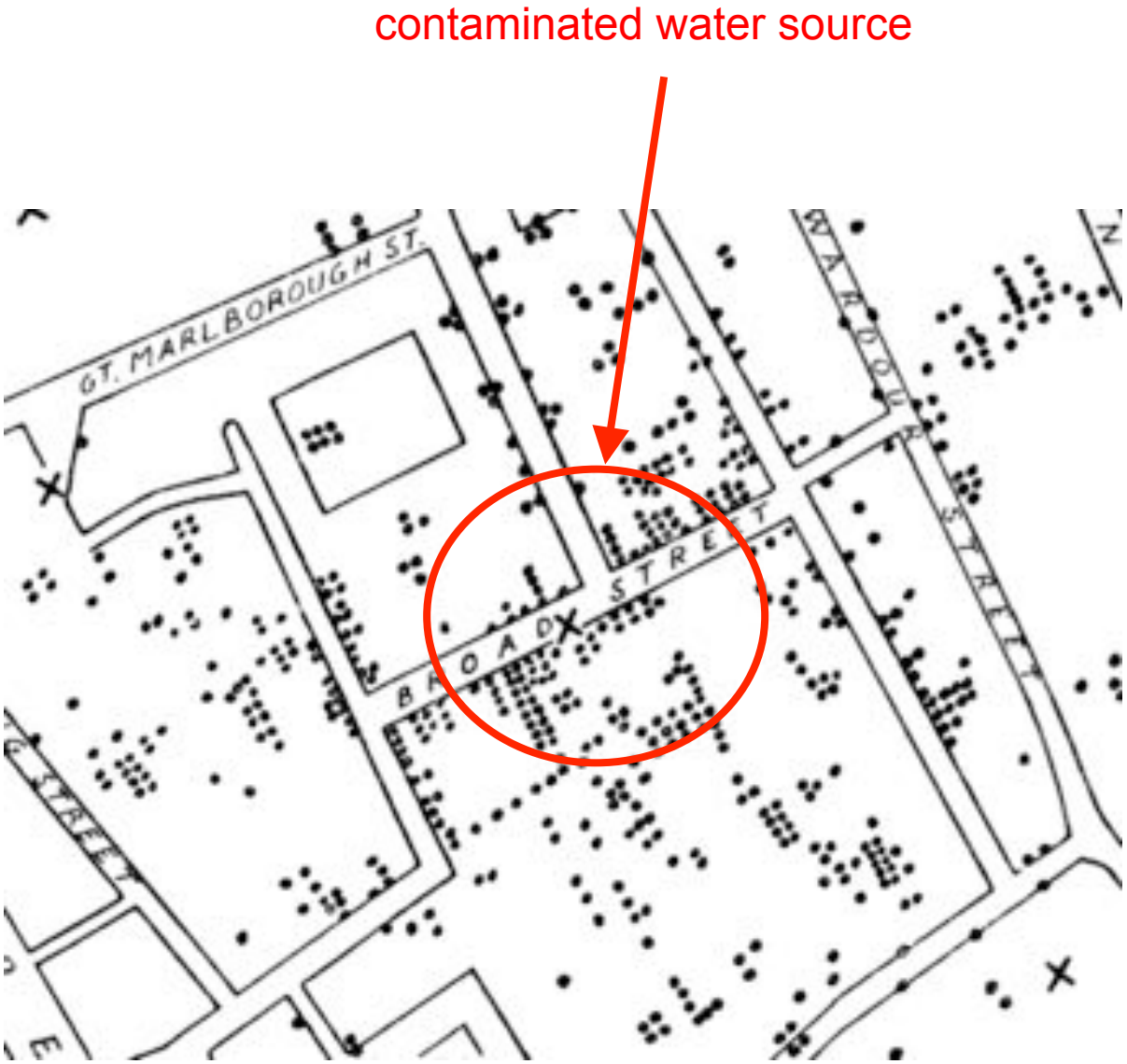
╳ water pump


[Source: Tufte, *The Visual Display of Quantitative Information*, 1983.]

Dr. John Snow's use of graphical tool to locate source of cholera outbreak (Soho, 1845)

● cholera victim

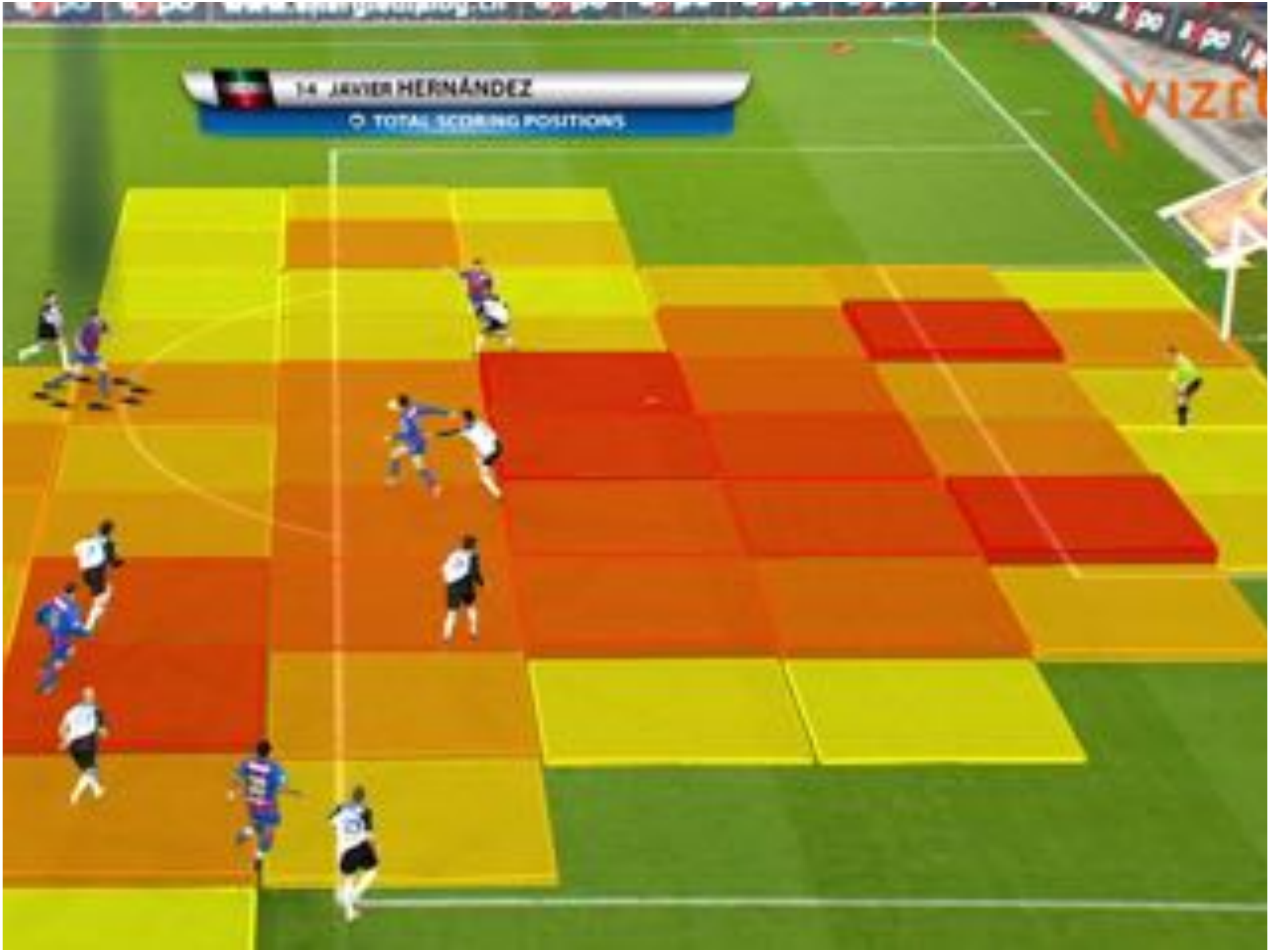
X water pump

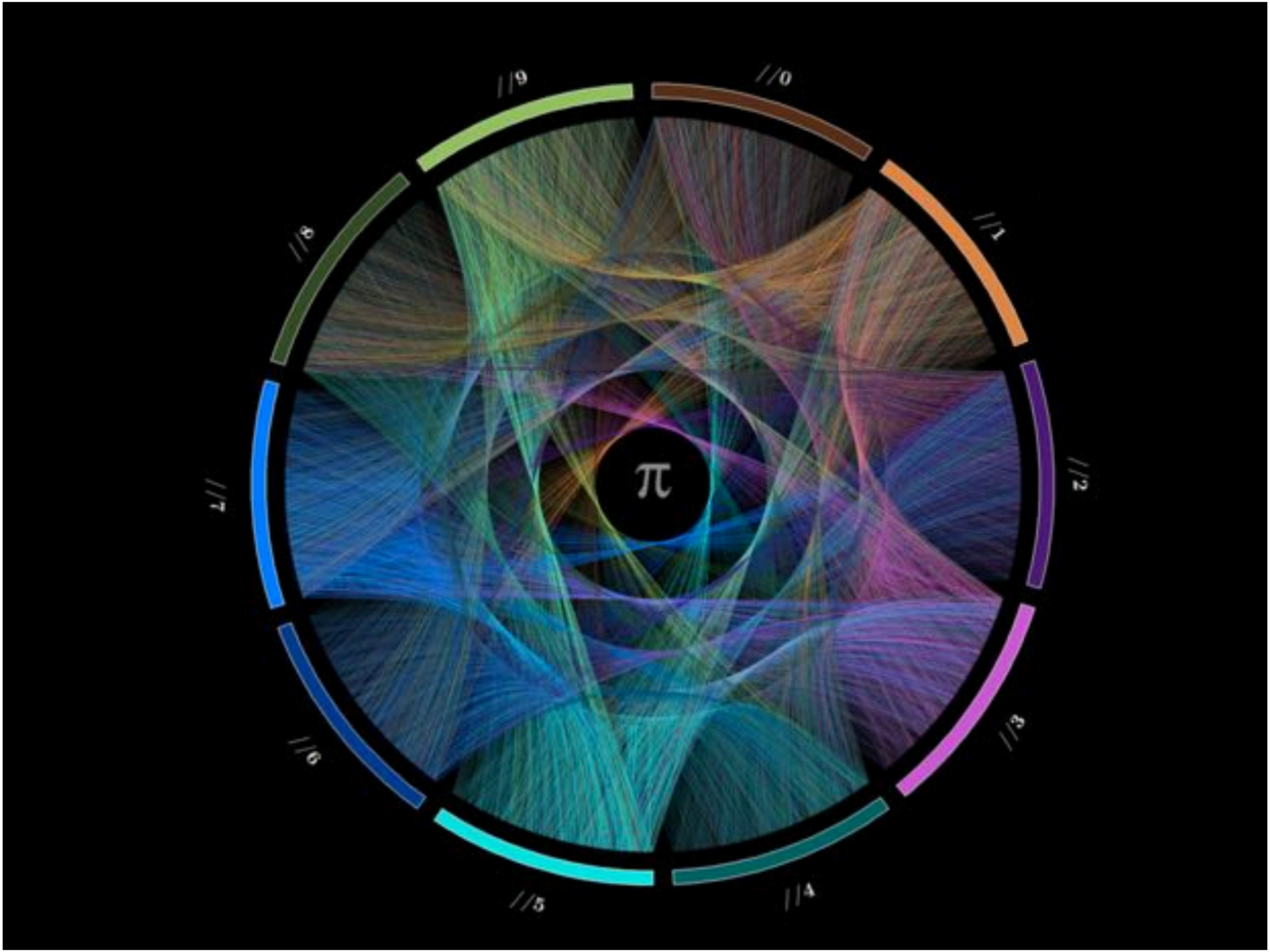


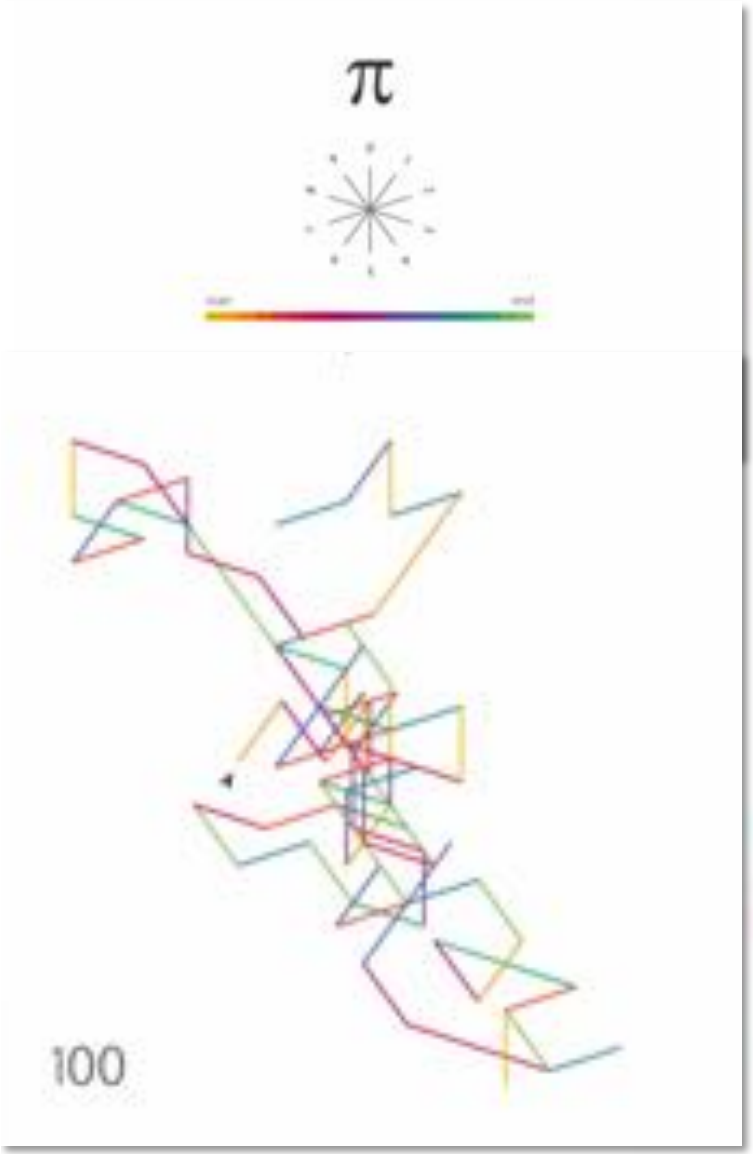

**[Source: Tufte, *The Visual Display of Quantitative Information*, 1983.]**

# heatmap


Germany 4 1 England
Game is over.
LINEUPS
PASSES
HEAT MAP
OVERVIEW
Orange shows area of play, by minute
1st HALF MIN. 1
HALF
GERMANY
ENGLAND
Goal
Shot
Player rankings in this game
Touches
Barry 73
Gerrard 72
Lampard 72
Cole 66
Terry 65
Lahm 63
Ozil 60
Boateng 54
Johnson 54
Upson 53
Khedira 51
Podolski 50
Rooney 50
Neuer 44


14 JAVIER HERNÁNDEZ
TOTAL SCORING POSITIONS


π
0
1
2
3
4
5
6
7
8
9


π
100


1000000

coming through AT&T's data and revealing itself.

Aaron kobling


2007-08-13
and then we can bring it into three-dimensional life.
Deb Roy

# we have a lot of data

"90% of all the data in the world has been generated over the last two years

In 2000, 75% of all information was in analog format

In 2007, 94% of our global technological memory consisted of digital bits and bytes

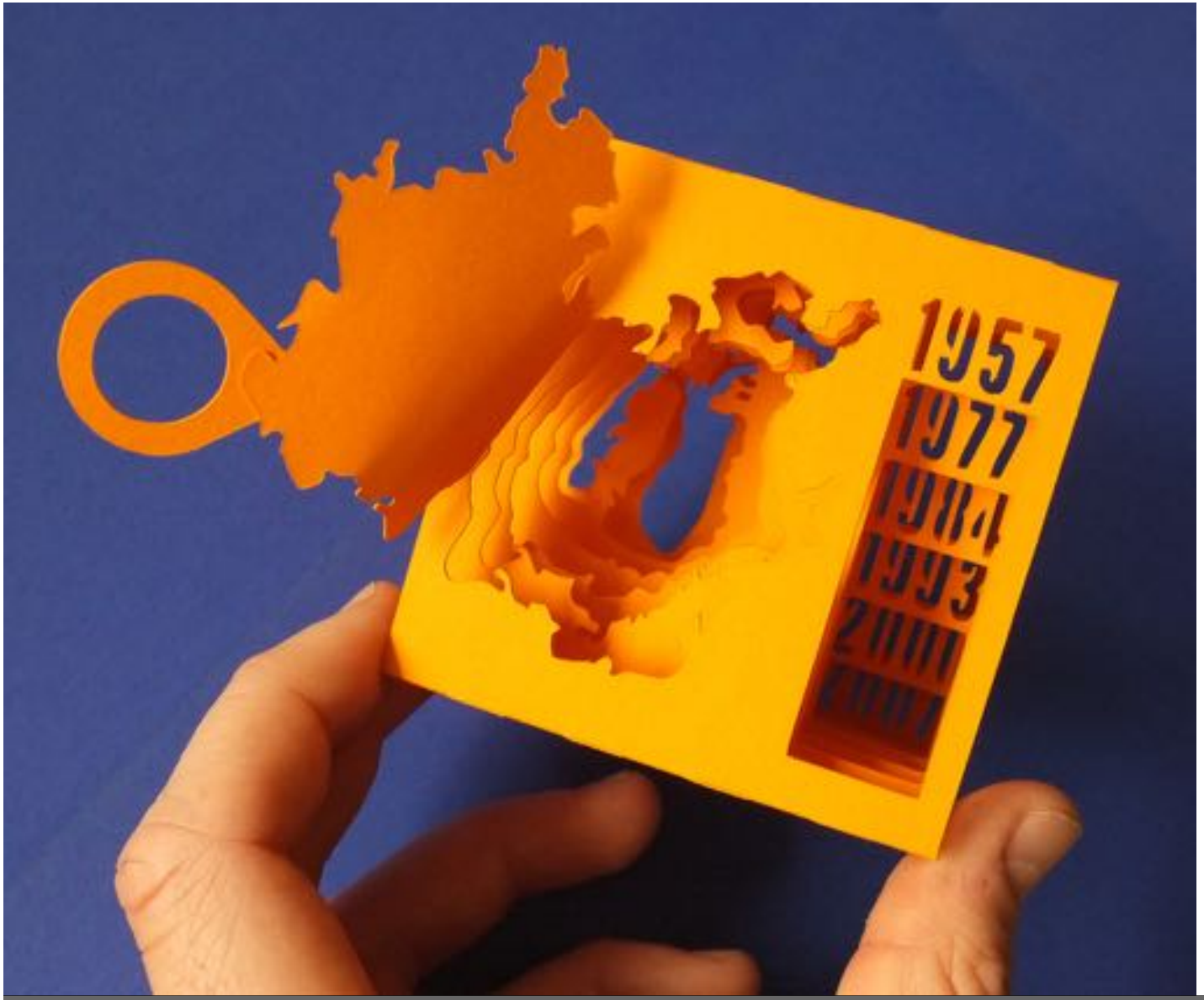
[Hilbert 2011]

# physical visualization the future?

[http://dataphys.org/list/]

poppies at the Tower of London

[http://dataphys.org/list/]




# 3D Paper Model of Shrinking Aral Sea

[http://dataphys.org/list/]

end