

Paul Rosen

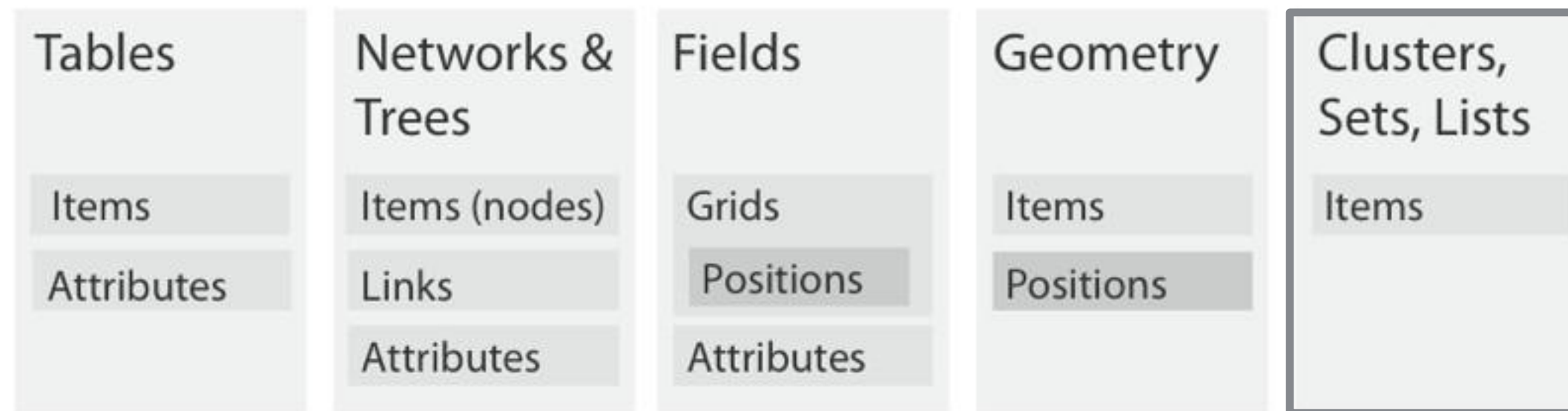
paul.rosen@utah.edu
@paulrosenphd
<https://cspaul.com>



Visualization for Data Science

DS-4630 / CS-5630 / CS-6630

VISUALIZING SETS



(hint: these are categorical data)

thought experiment...

- item: lego
- attributes: ???



thought experiment...

- item: lego
- attributes:
 - color
 - height
 - width
 - length
 - shape



dataset

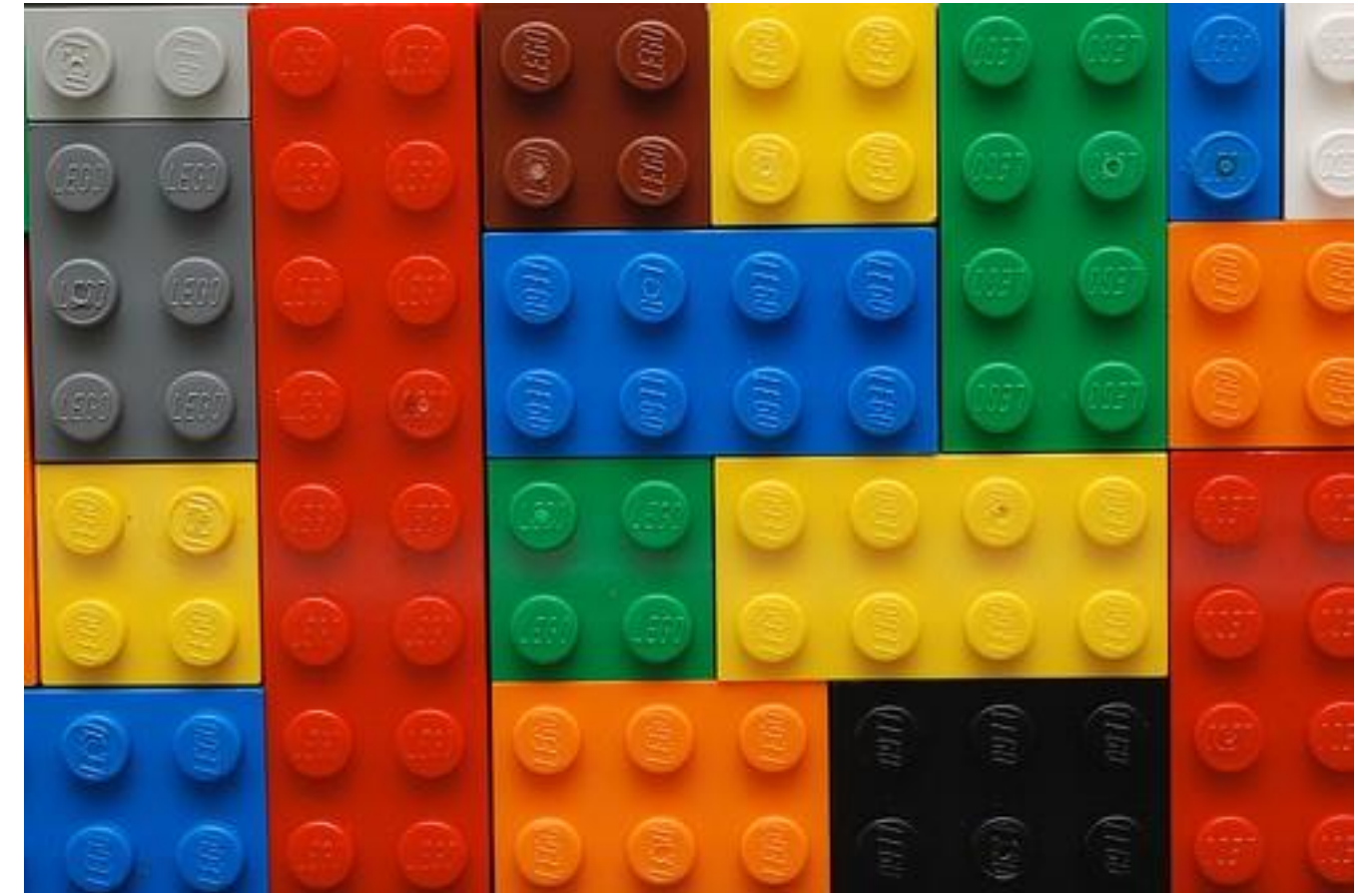


dataset: more realistic



dataset

- where do we start?
- we need to organize!
- but, how?



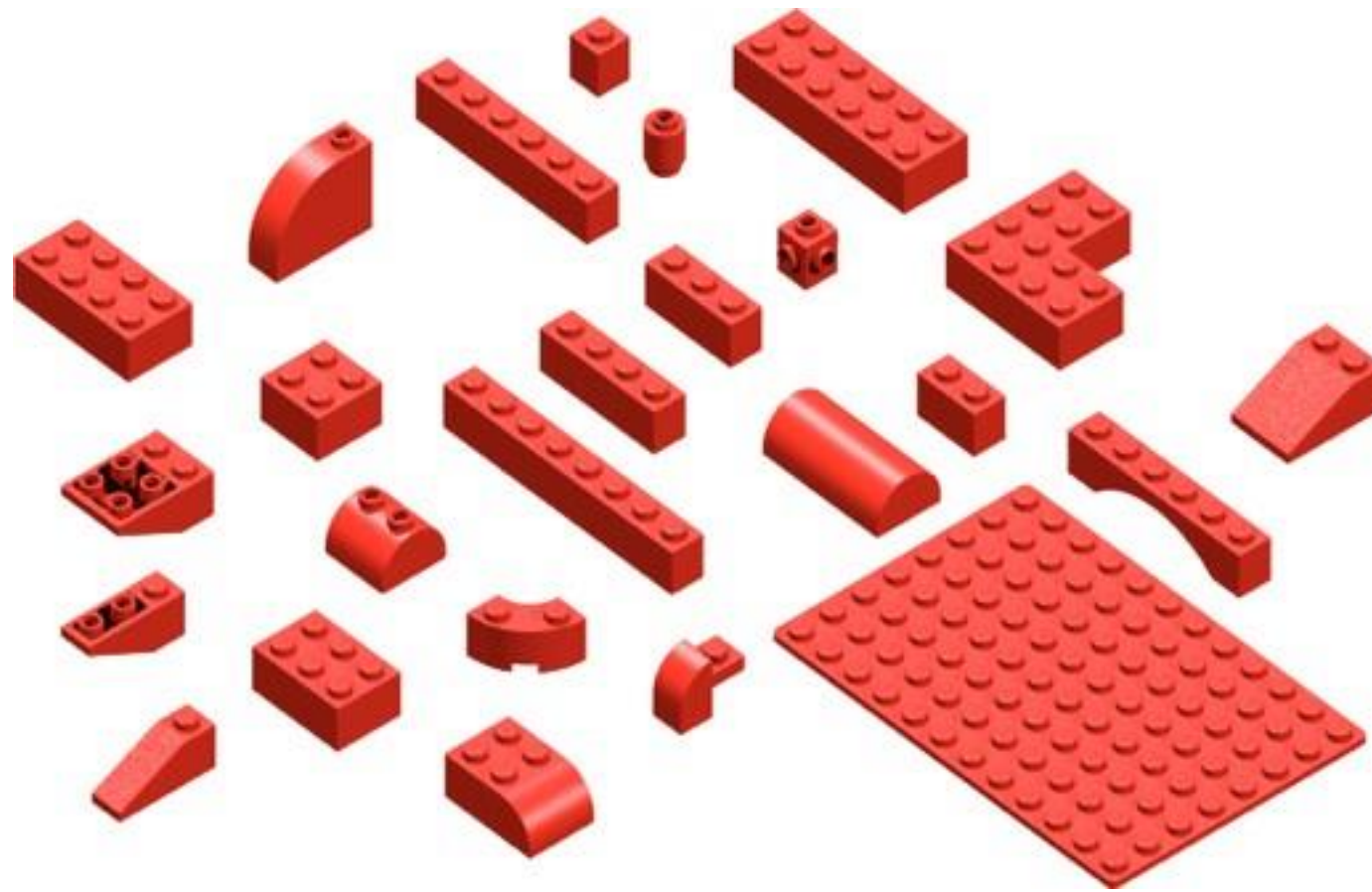
dataset

- sort by color



dataset

- sort by size, shape



dataset

- task: organization
- drawbacks?



Set Challenge

DATA



SORTED



ARRANGED



PRESENTED
VISUALLY

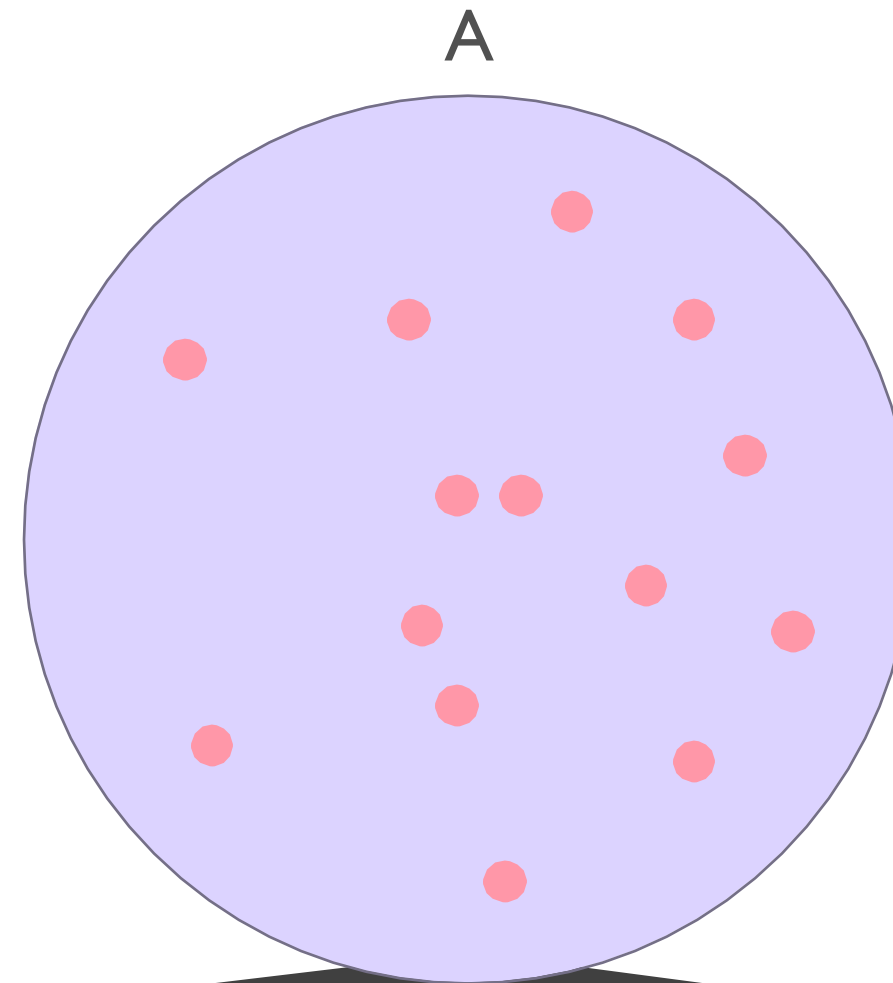


Dataset

- organization leads us to a set problem
- so what are sets?

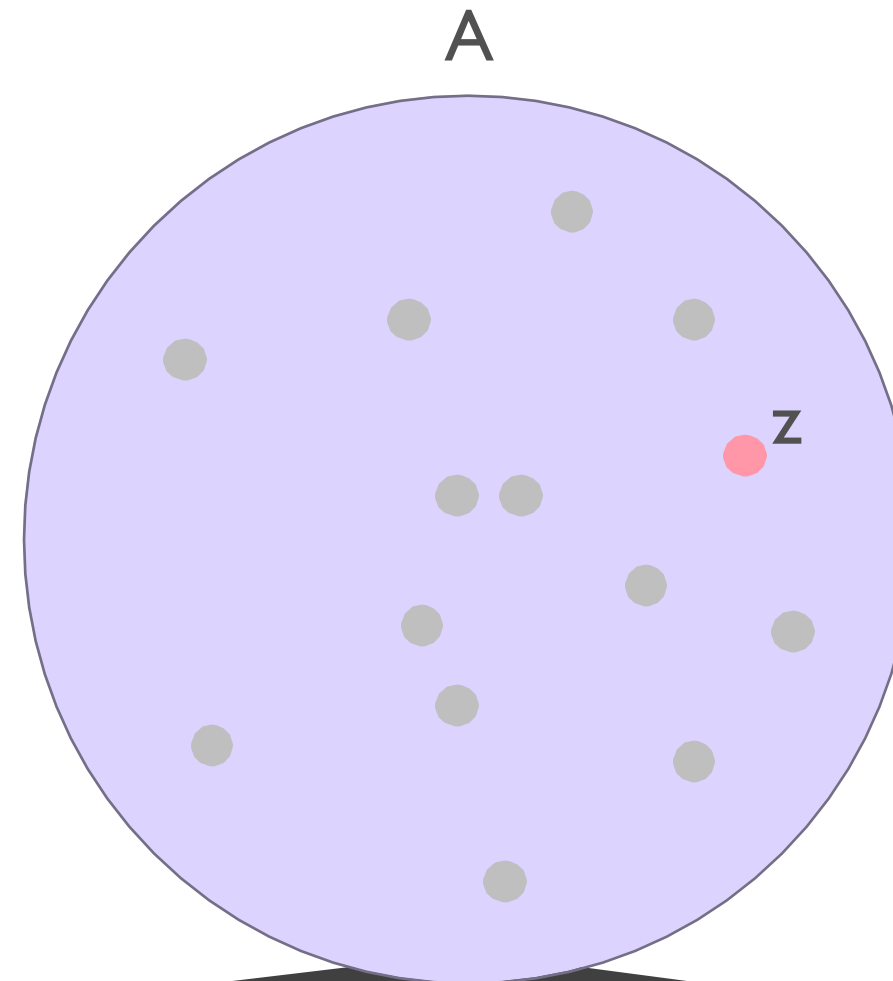
set theory

- set
 - a collection of objects
 - some set: A



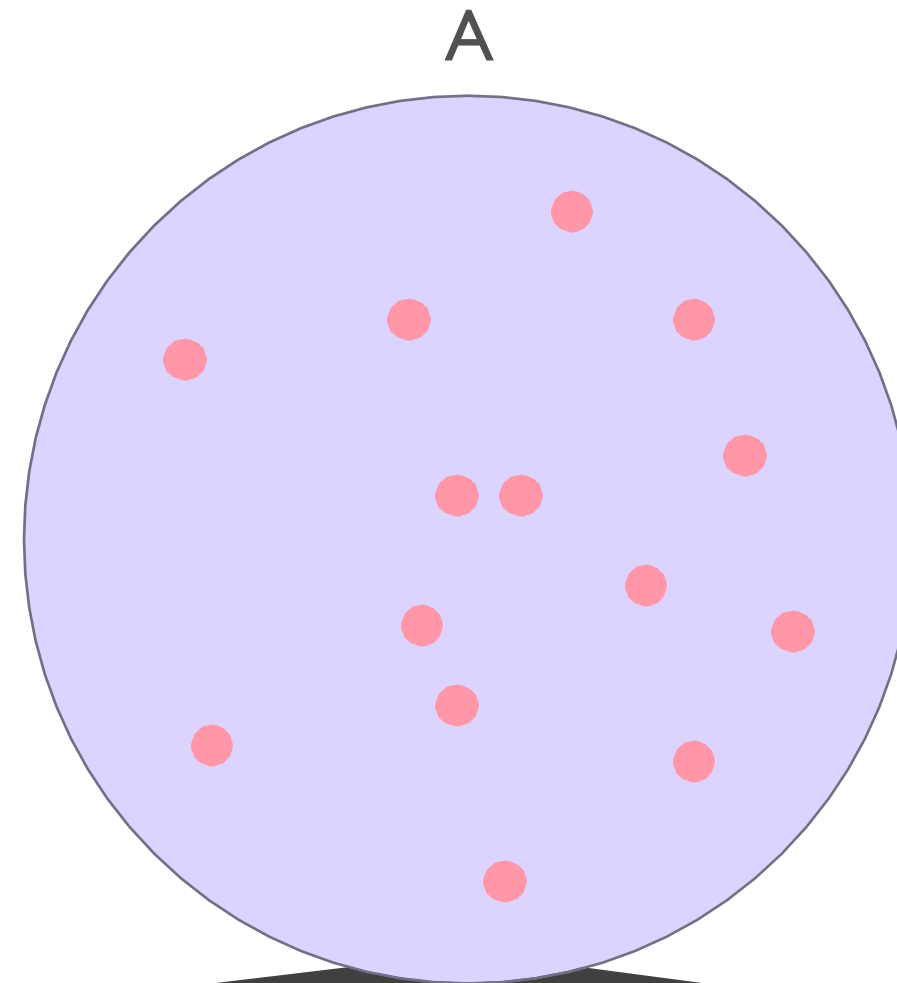
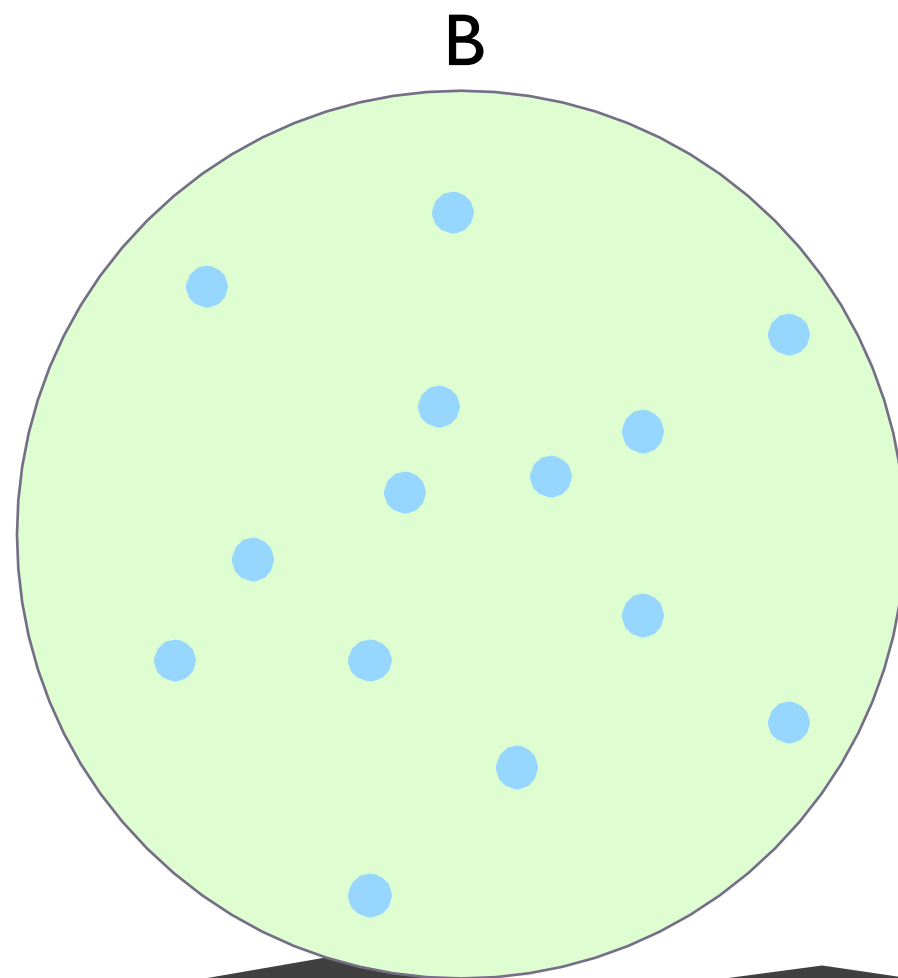
set theory

- set
 - a collection of objects
 - some set: A
- object
 - some object: z
 - $z \in A$



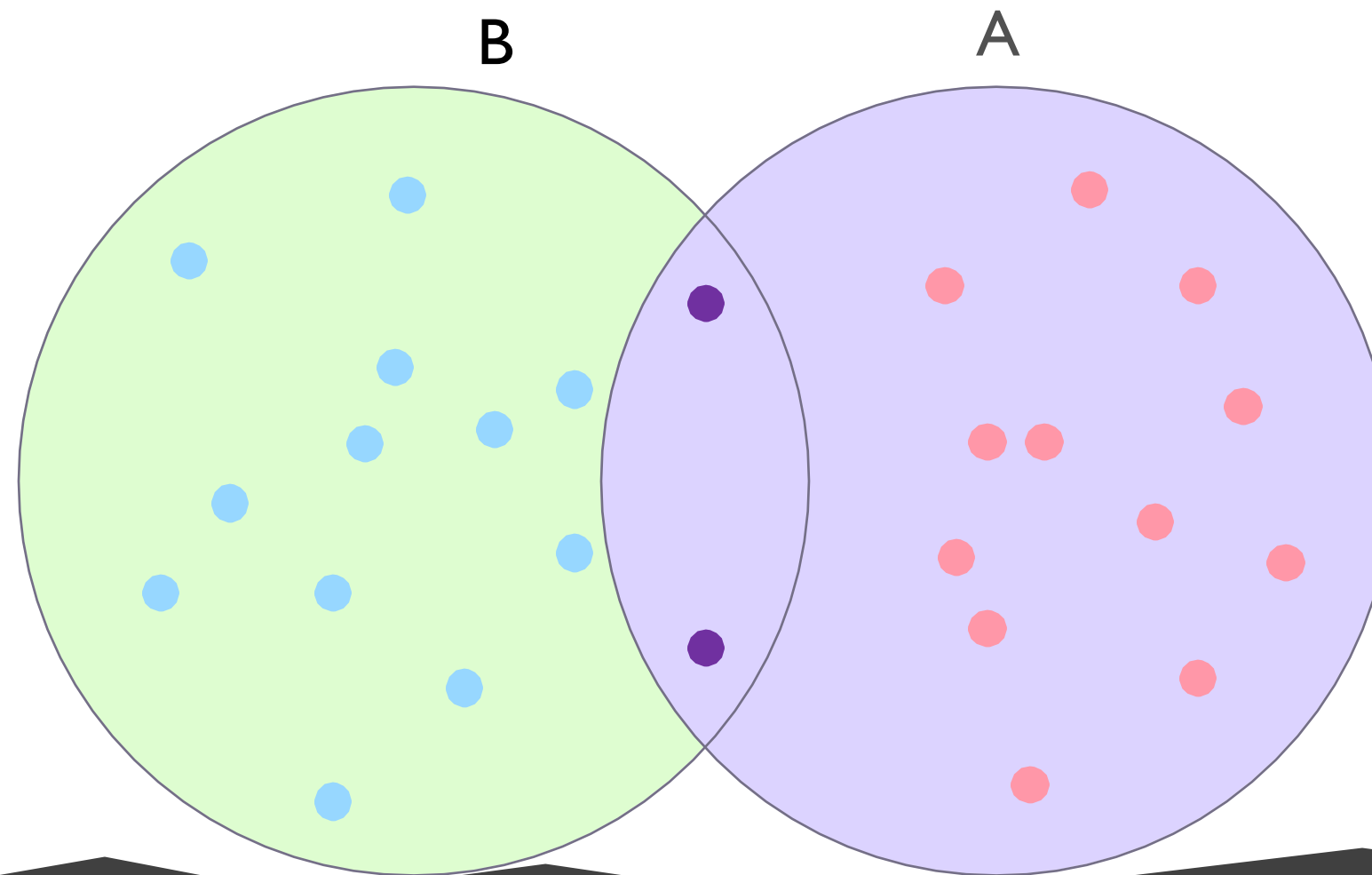
set theory

- multiple sets: A & B



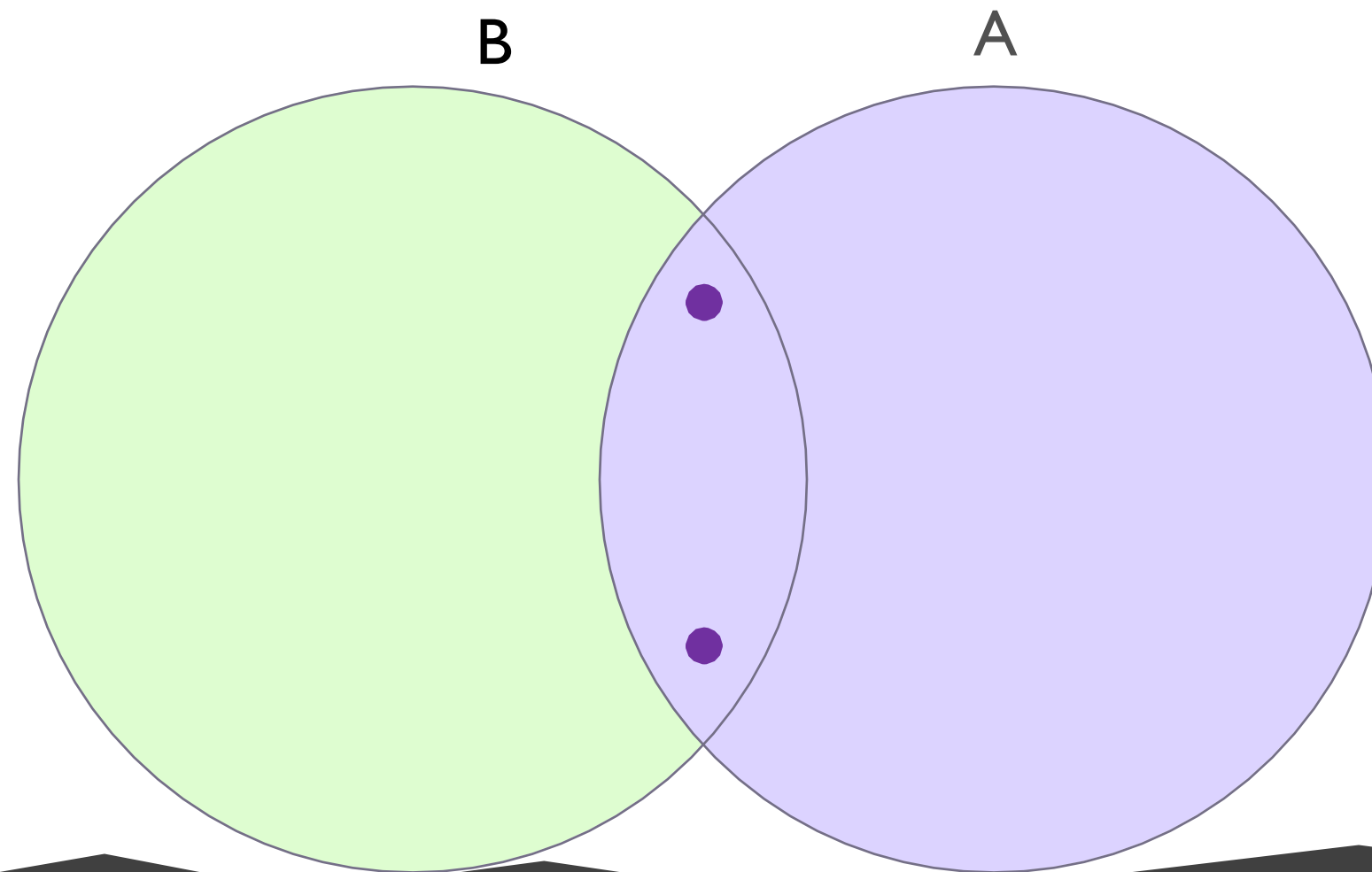
set theory

- union: $A \cup B$



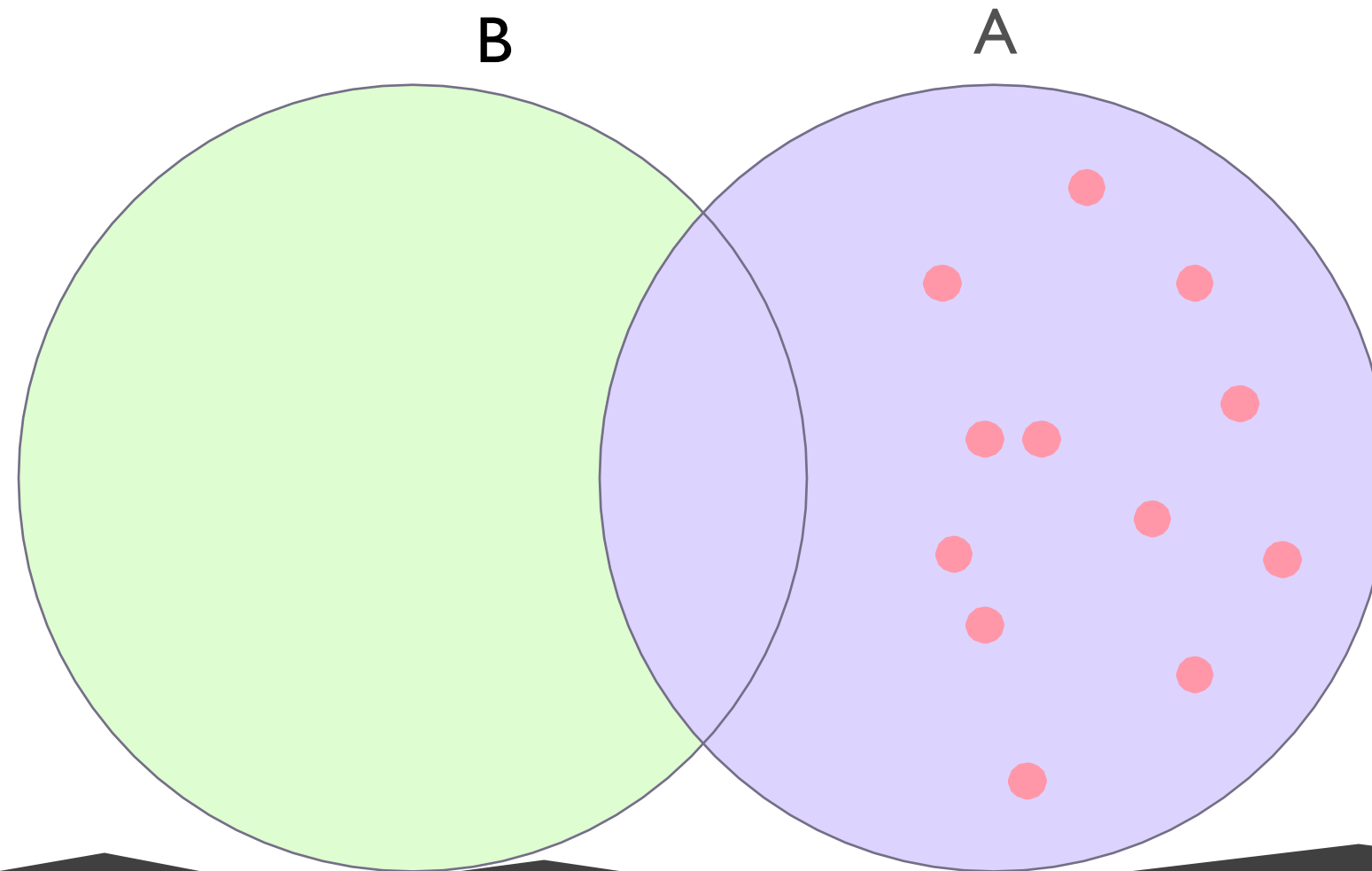
set theory

- intersection: $A \cap B$



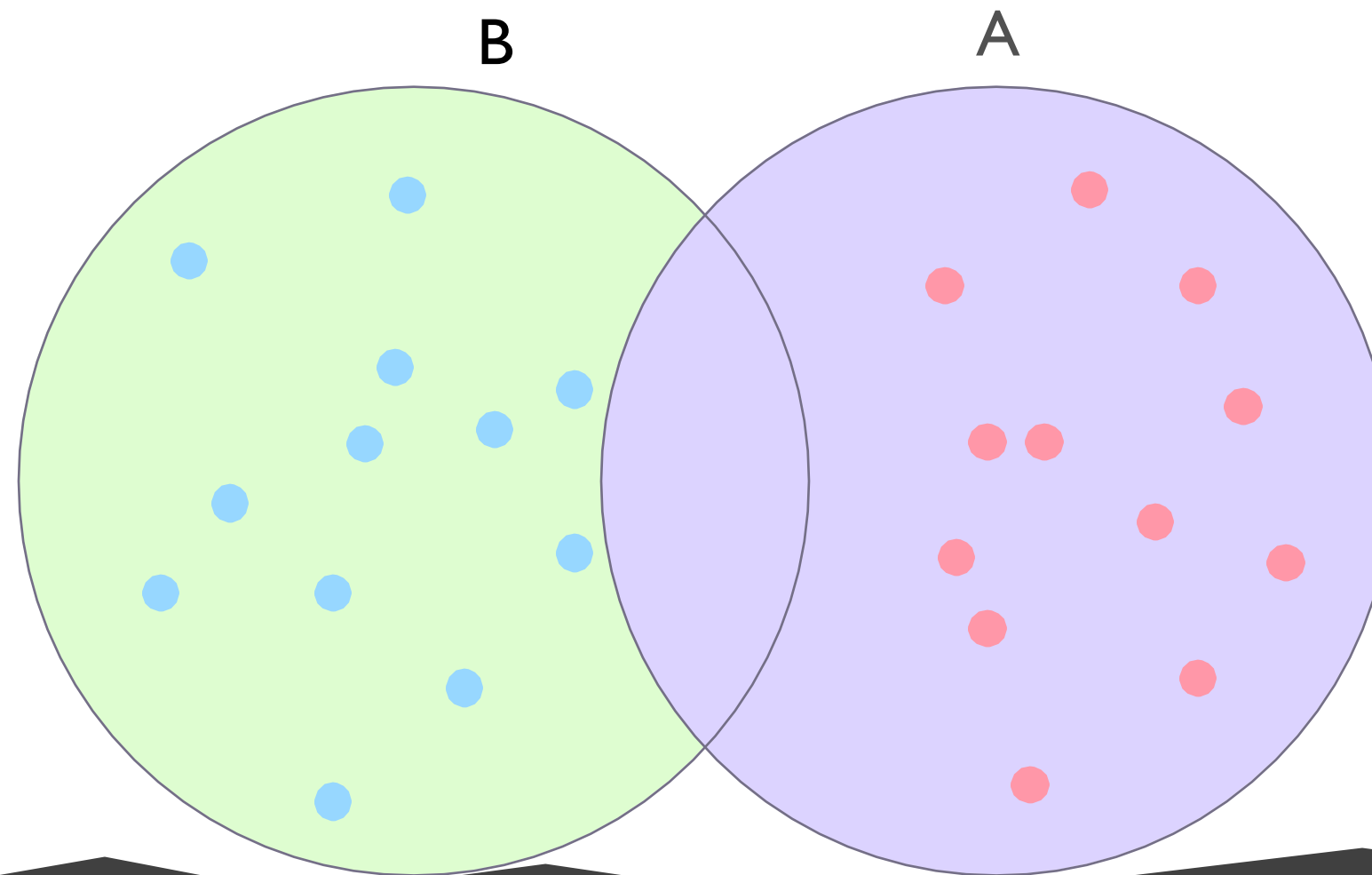
set theory

- set difference: $A \setminus B$



set theory

- symmetric difference: $A \ominus B$

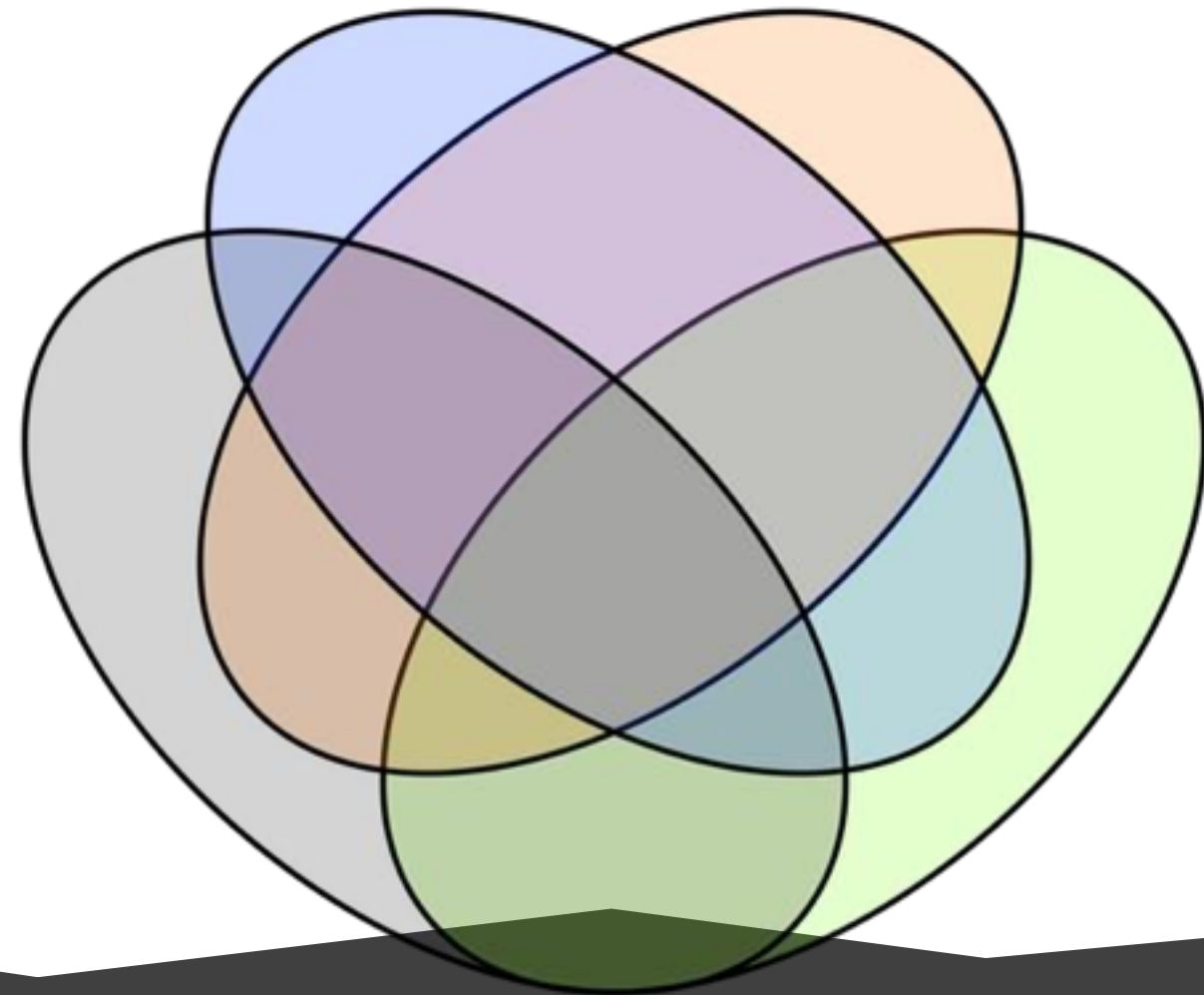
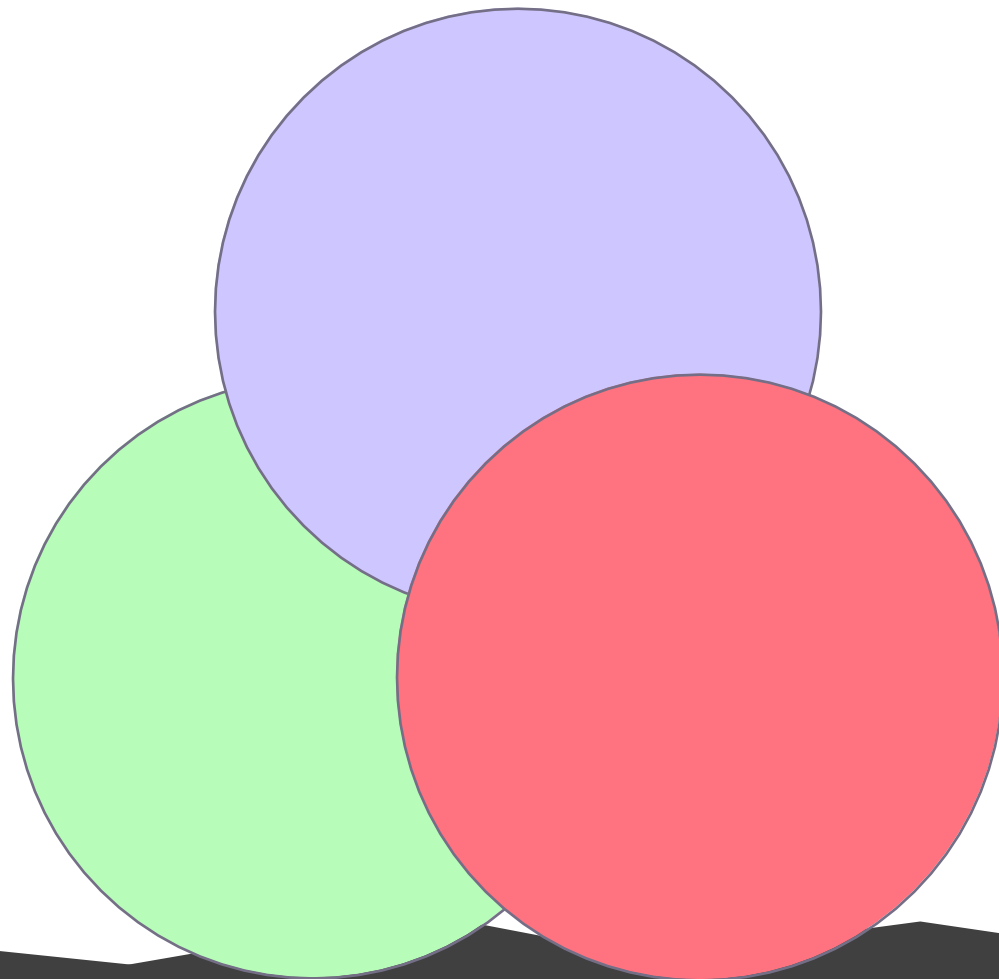
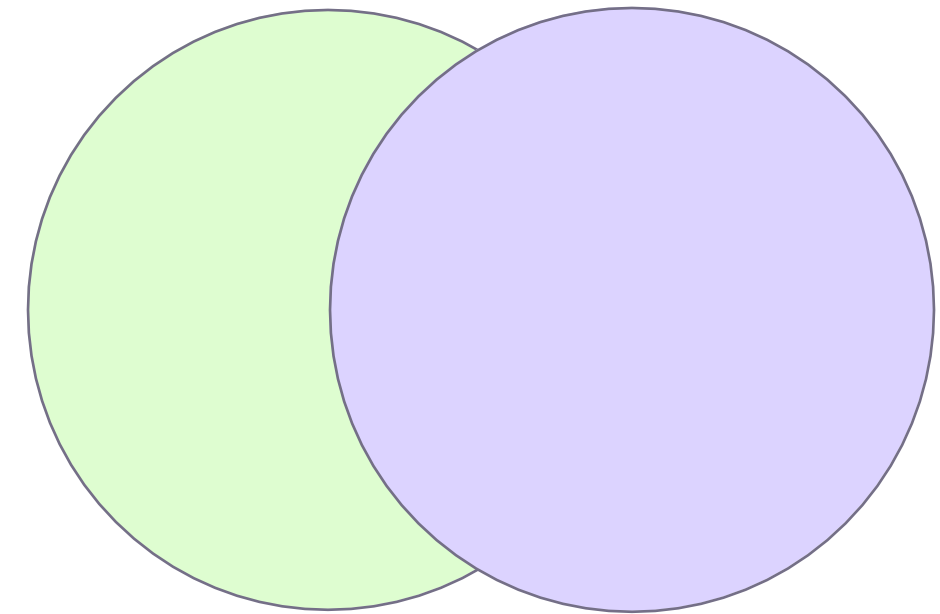


<http://students.brown.edu/seeing-theory/index.html>

visualizing sets

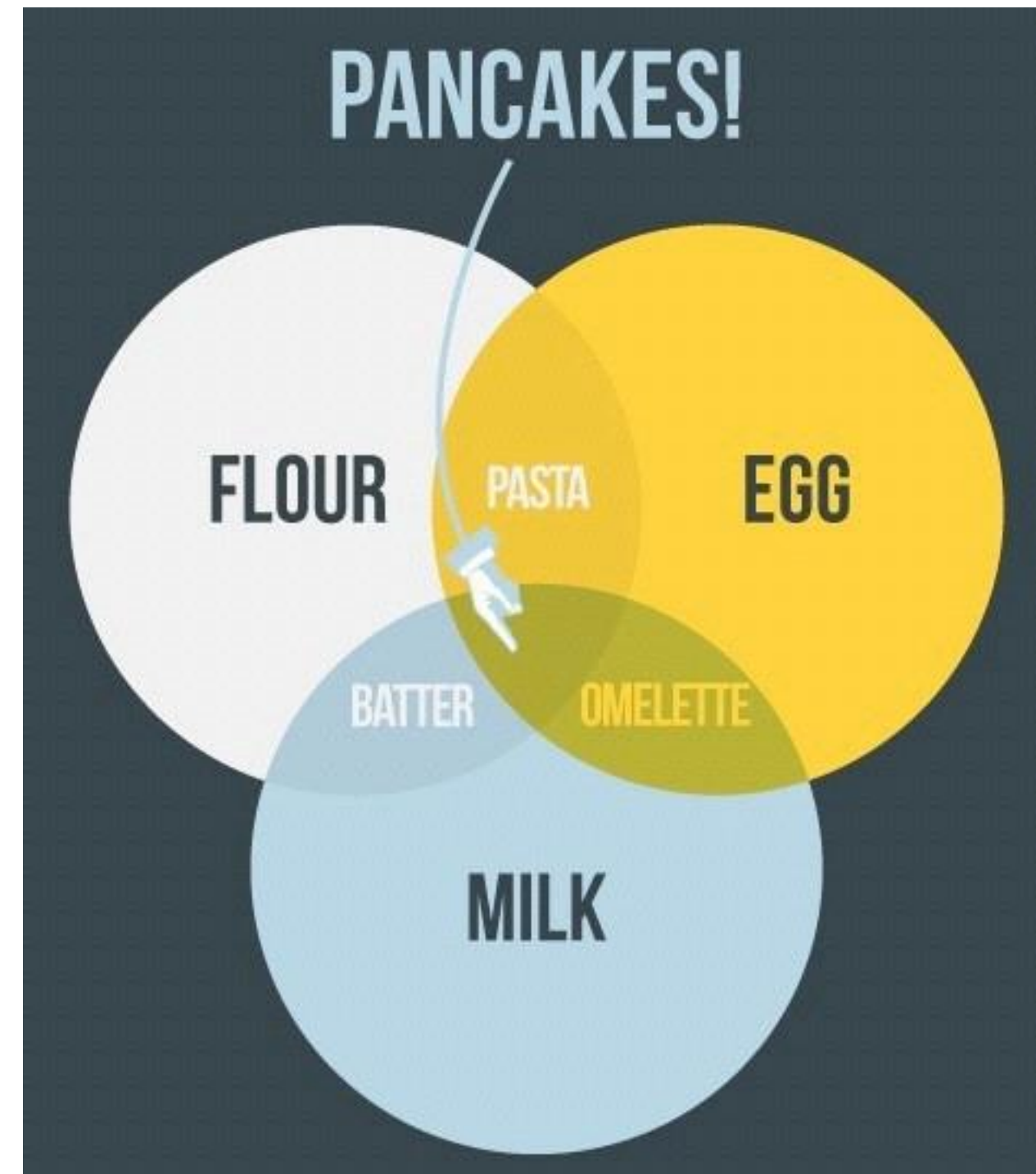
venn diagrams

- show all possible relationships



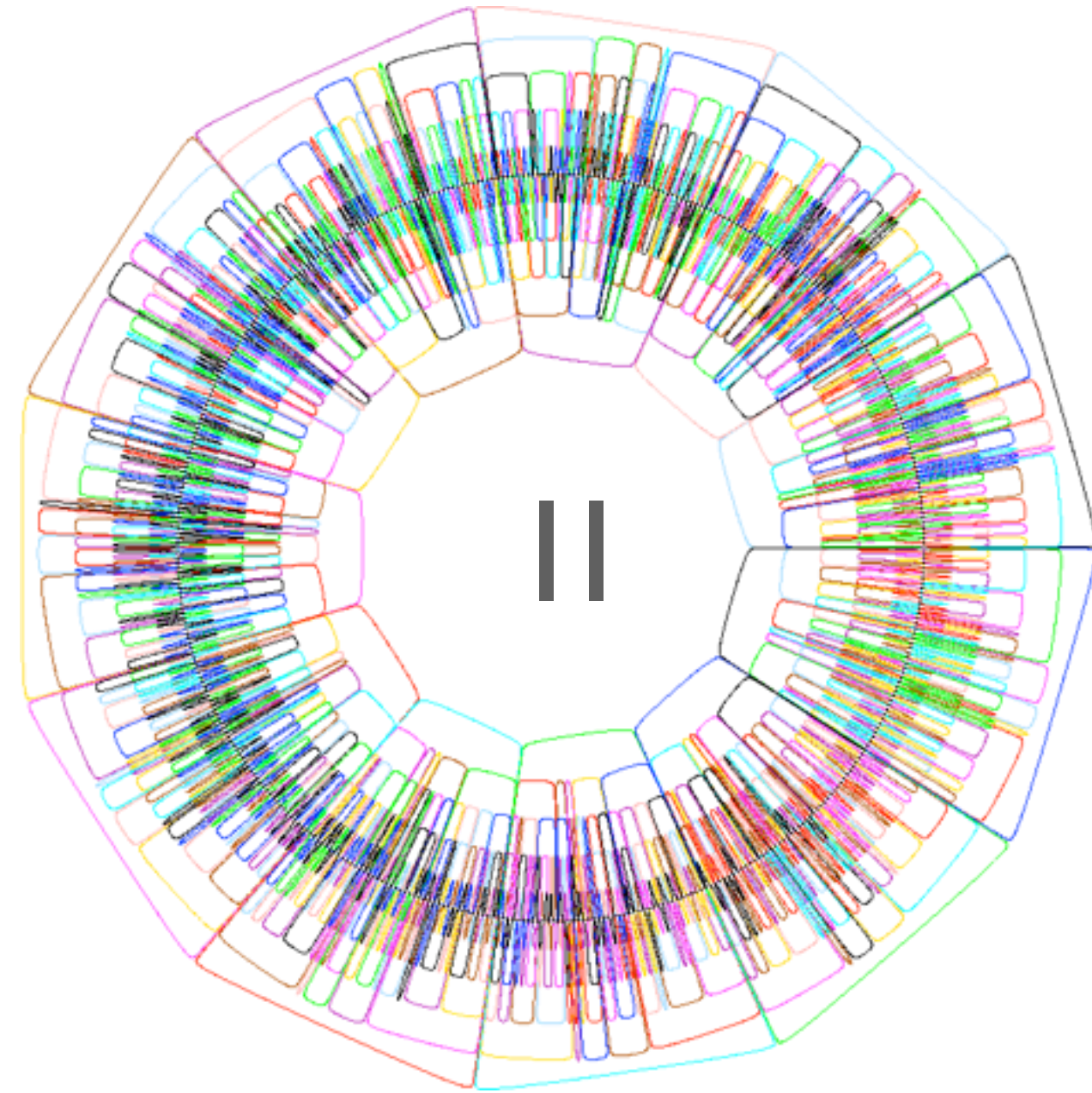
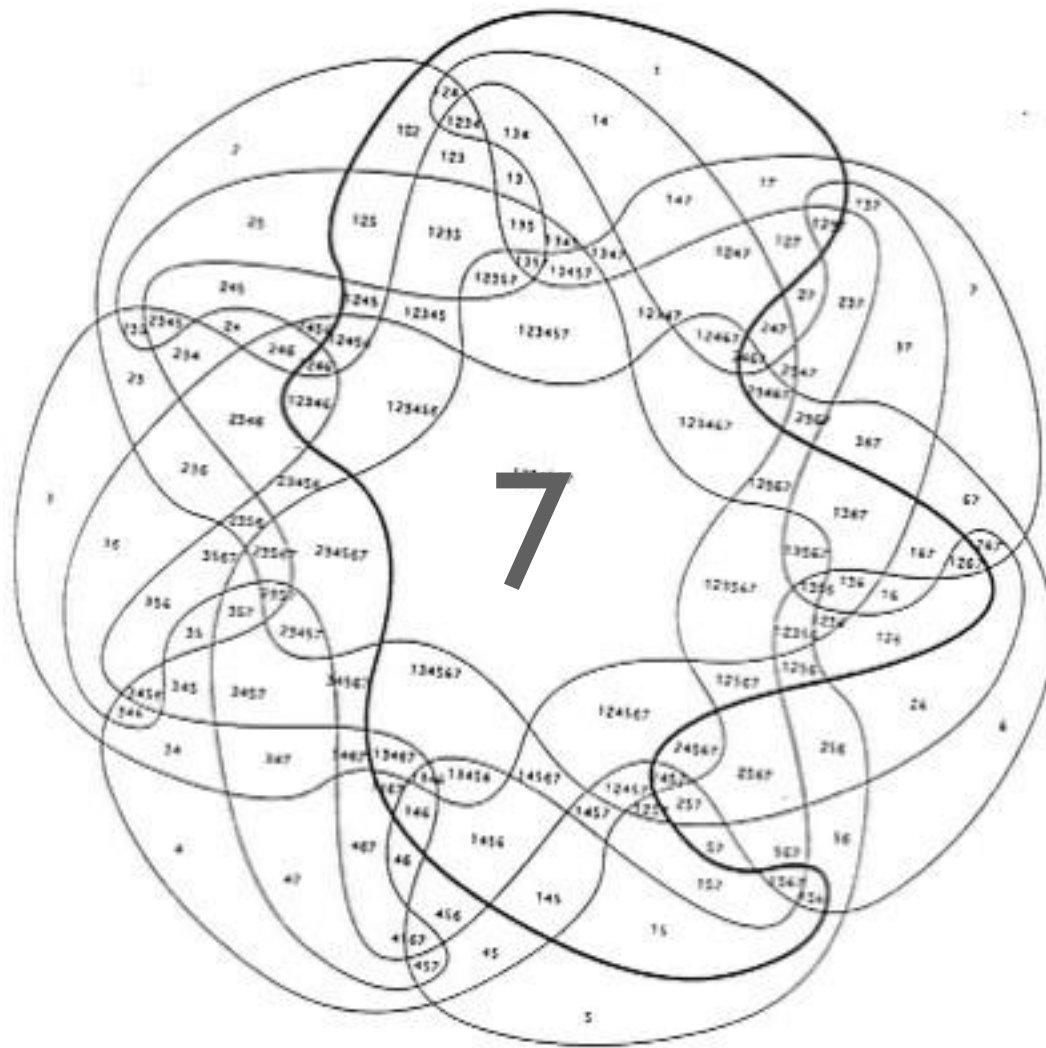
venn diagrams

- “casual infovis”



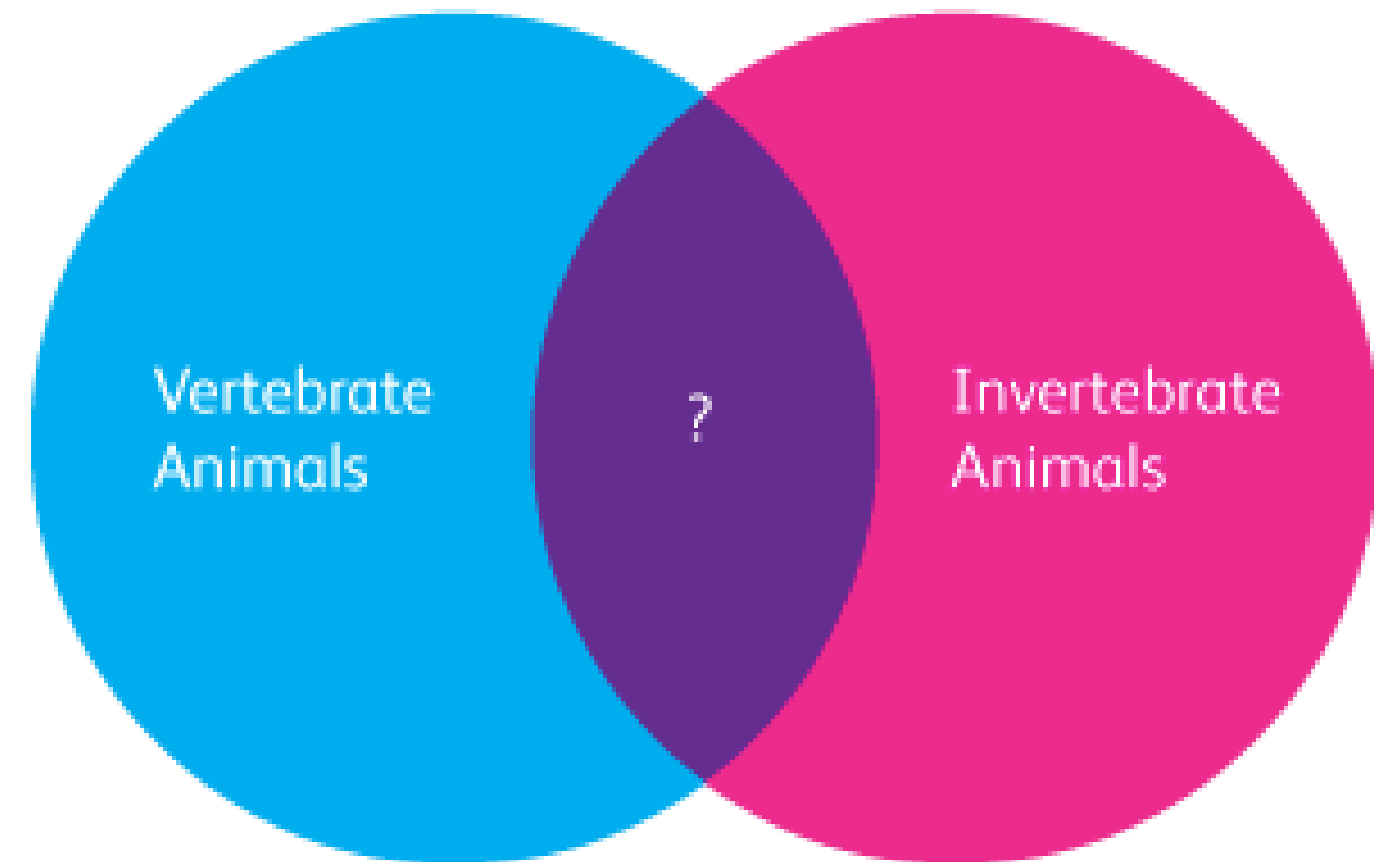
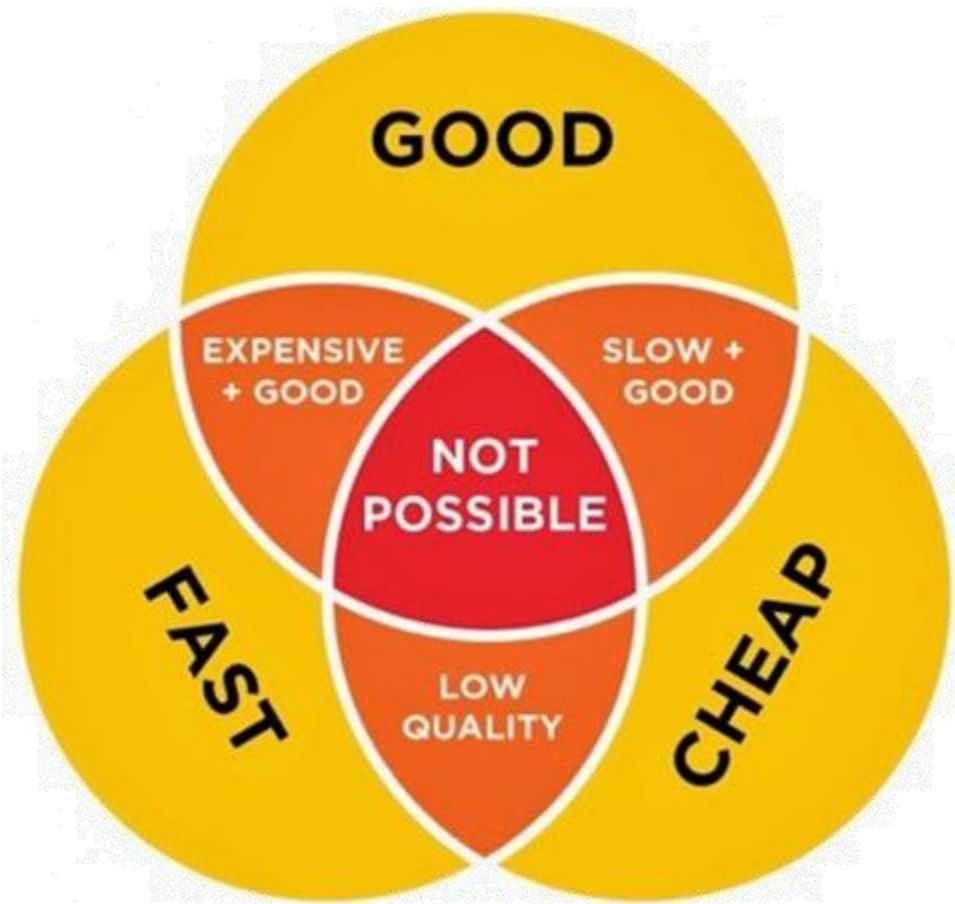
venn diagrams

- get messy fast



venn diagrams

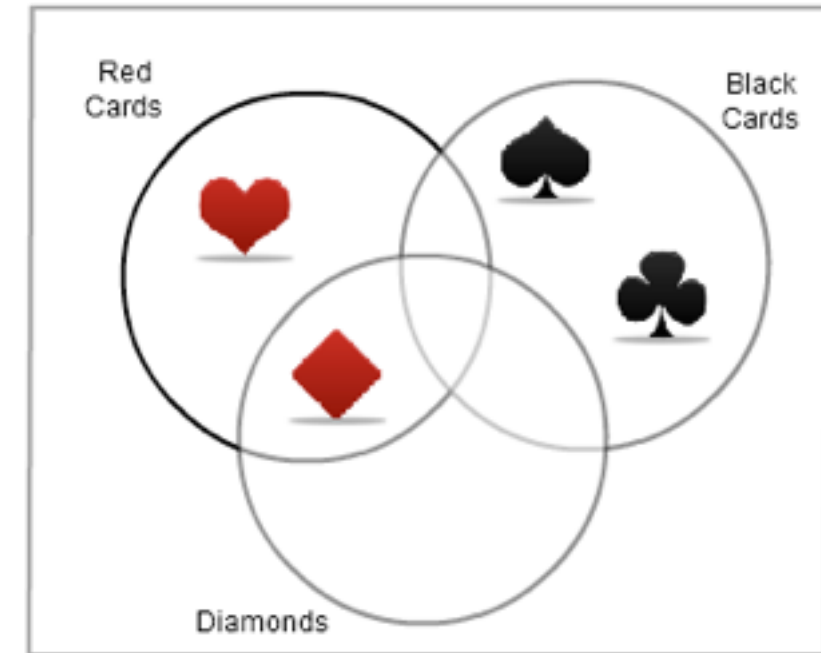
- non-sensical



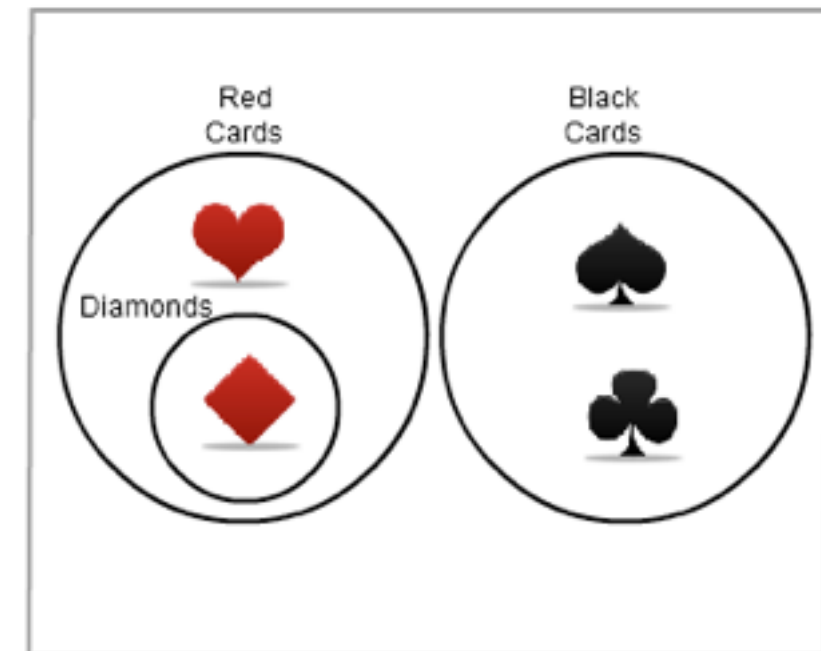
euler diagrams

- show only existing relationships

V
E
N
N

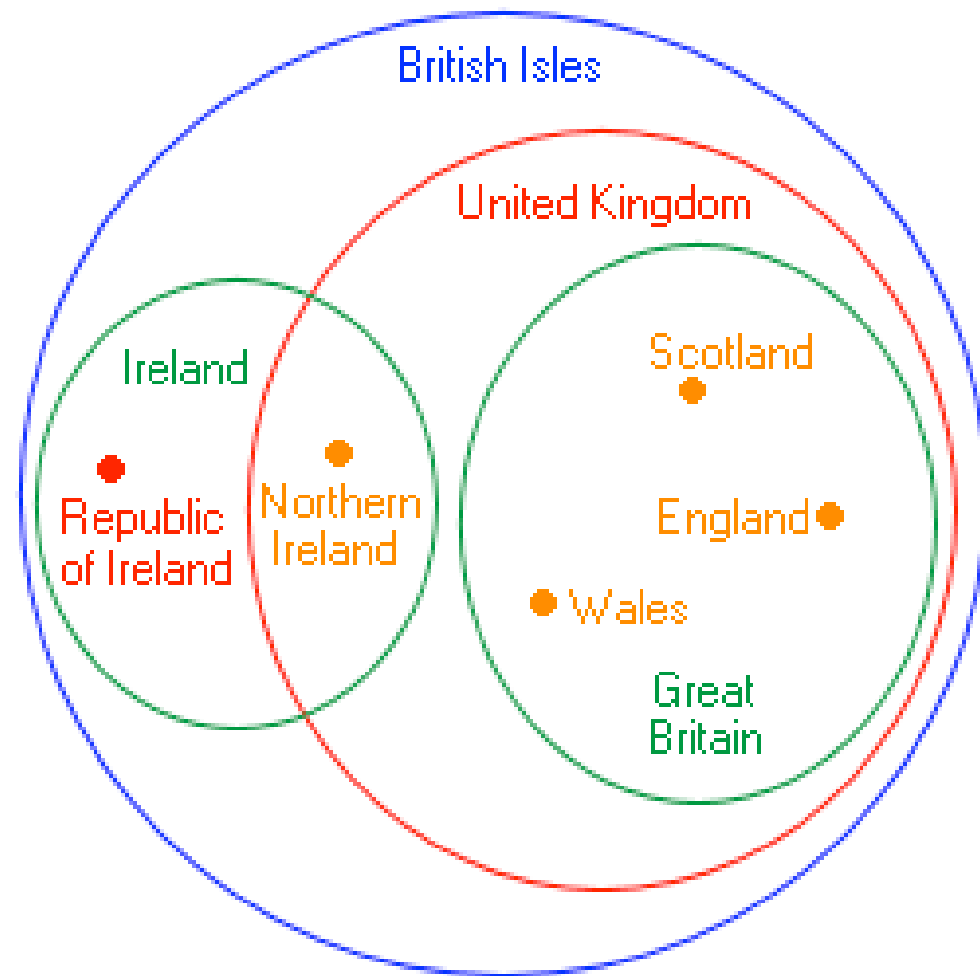


E
U
L
E
R

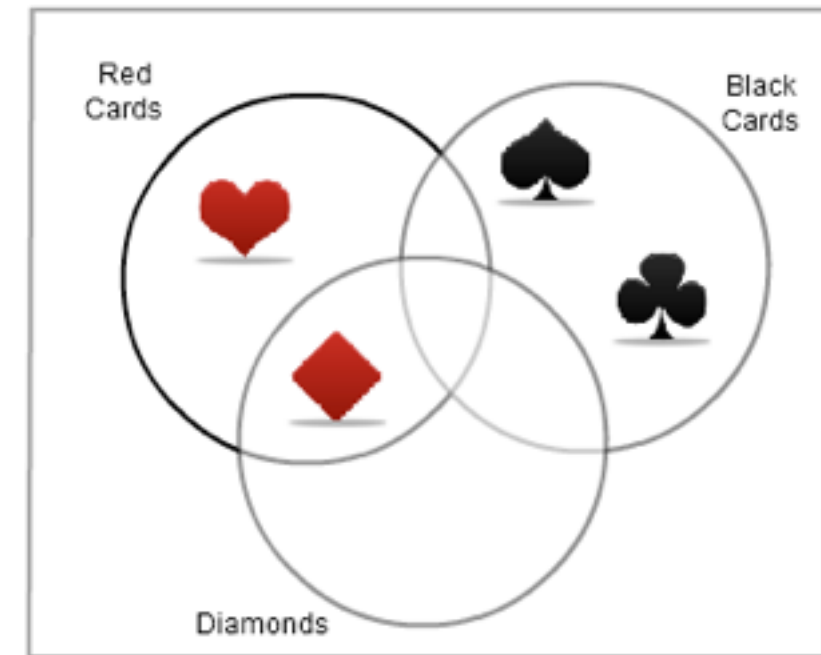


euler diagrams

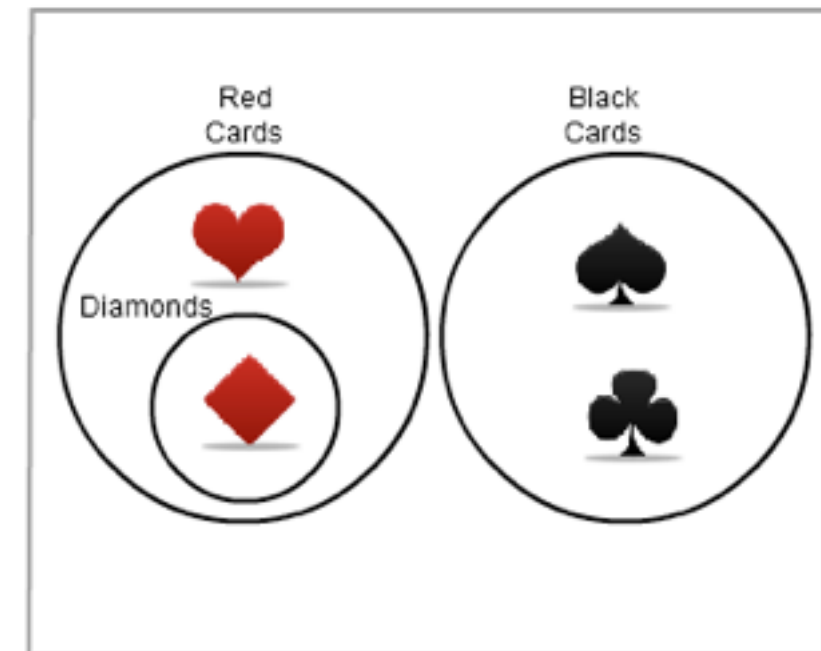
- show only existing relationships



V
E
N
N



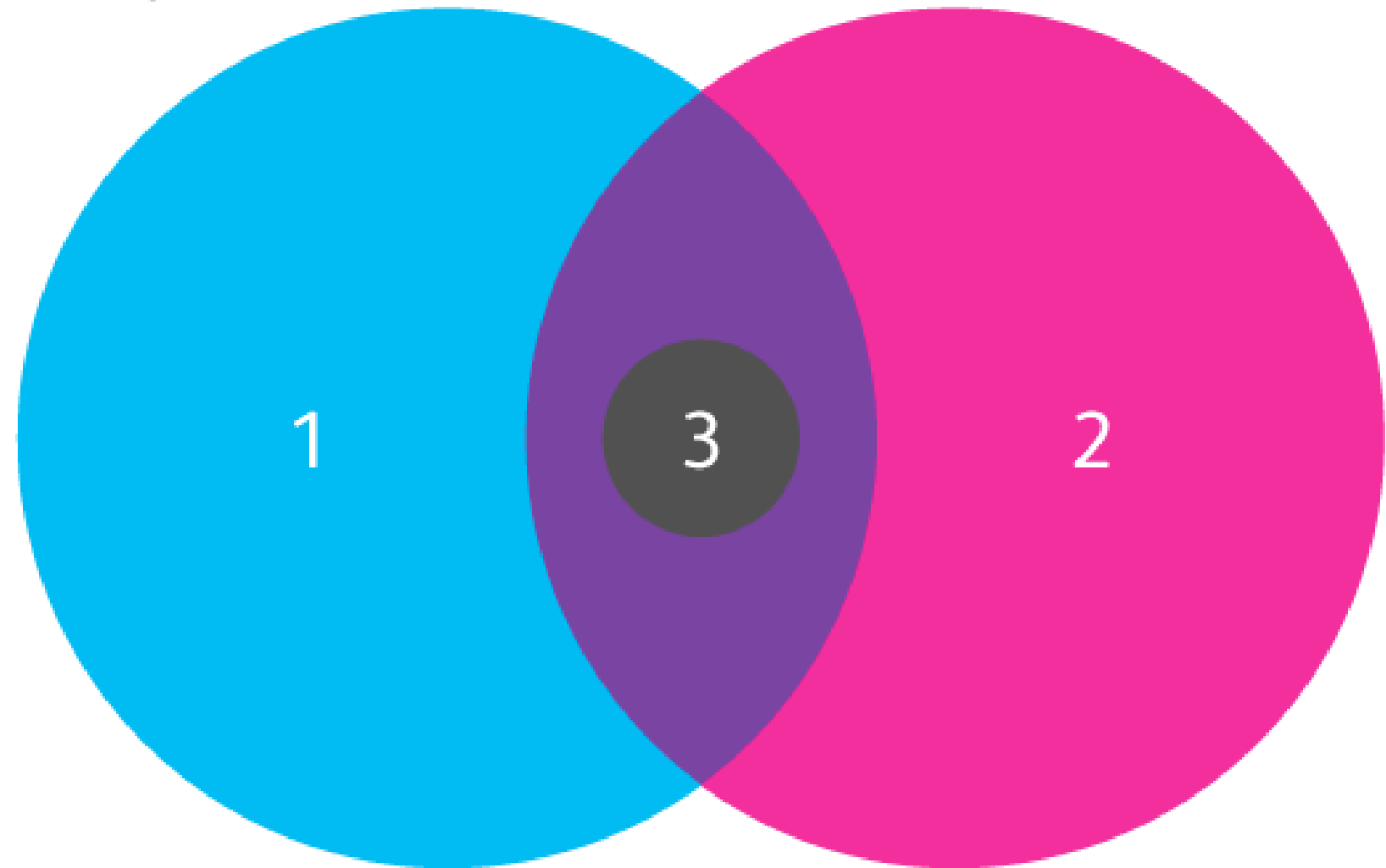
E
U
L
E
R



euler diagrams

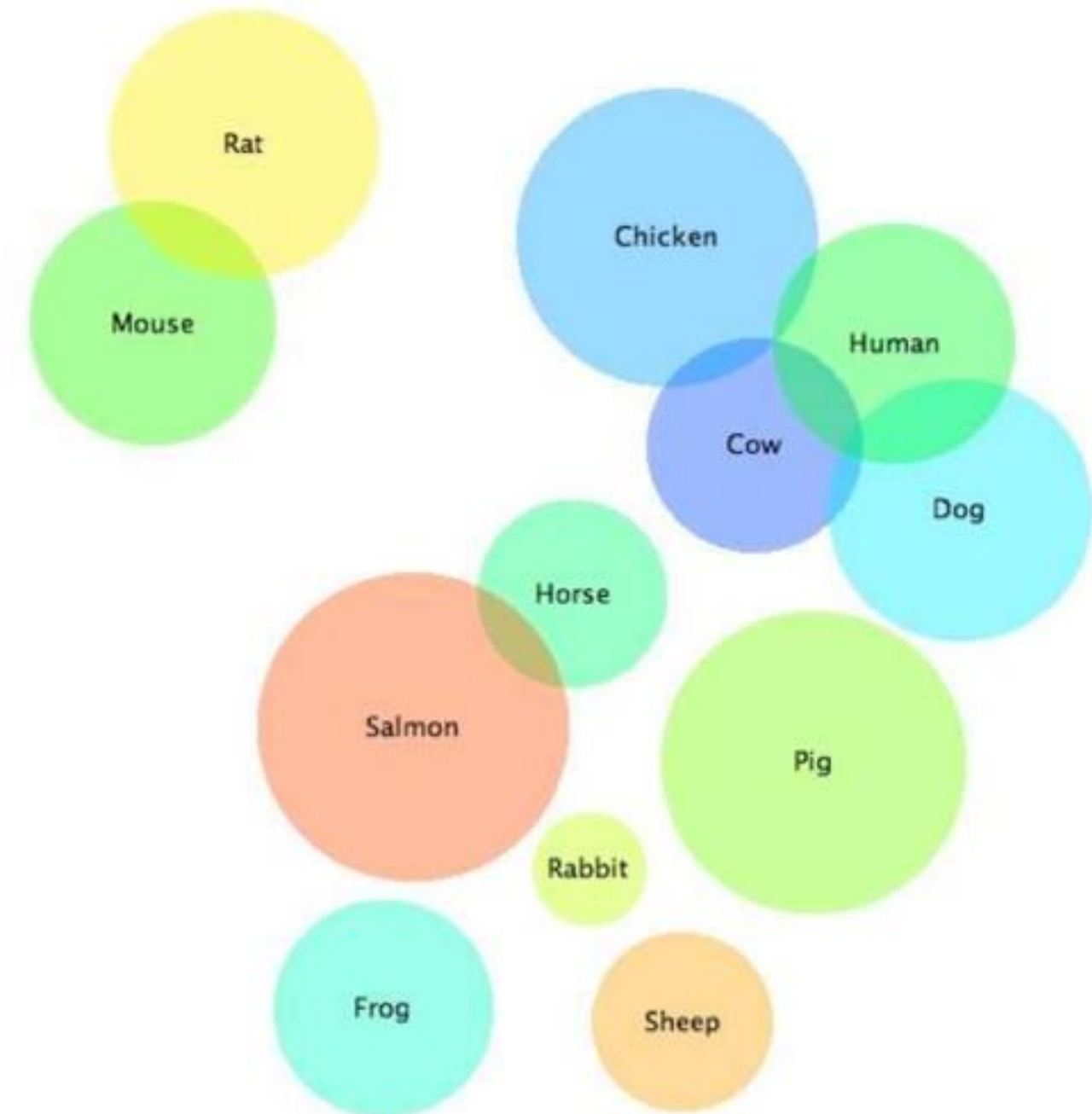
- Misunderstood

1: People who know what a Venn Diagram is.
2: People who know what an Euler Diagram is.
3: People who know the difference.



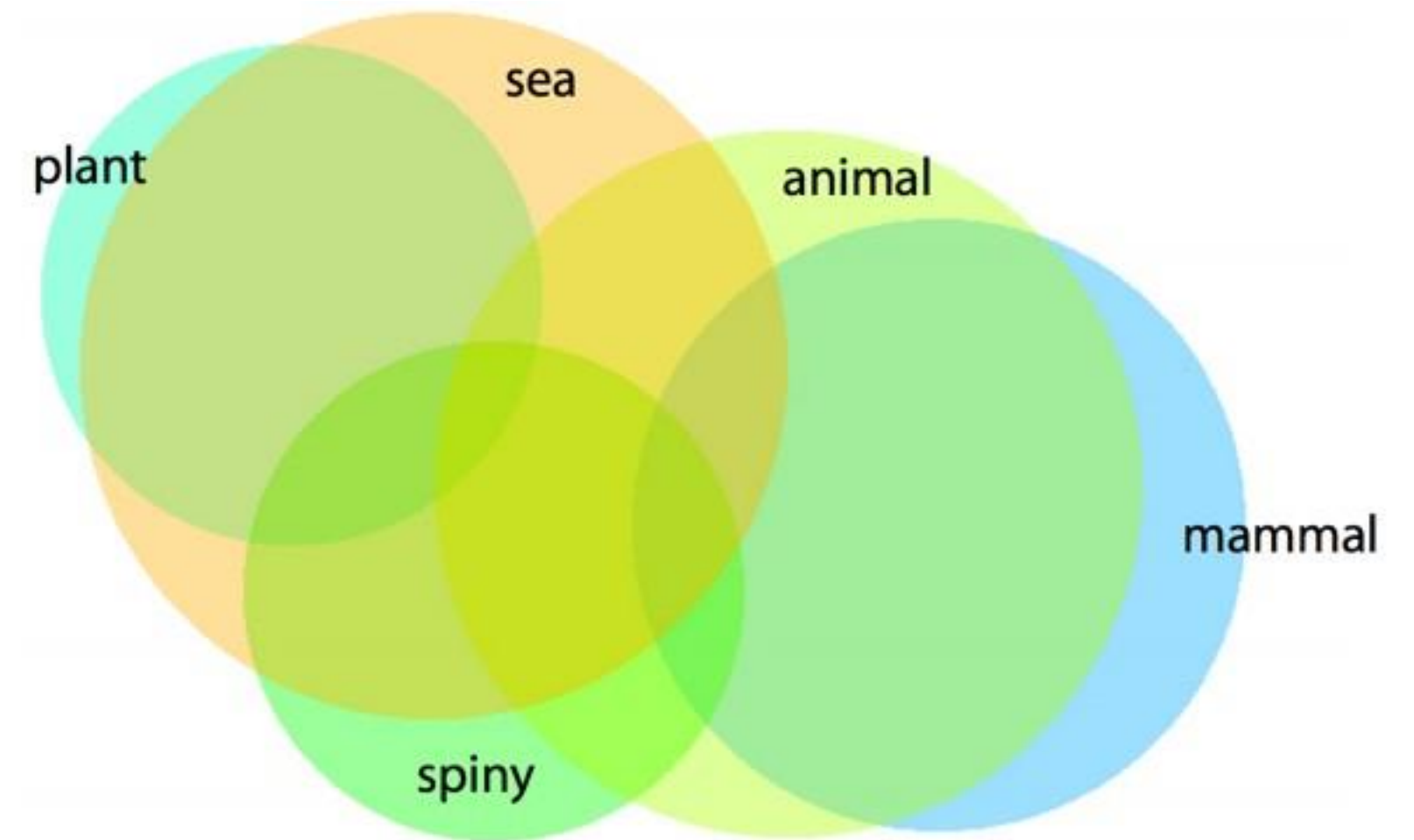
venn & euler diagrams

- adjust for area
- starts getting tricky!

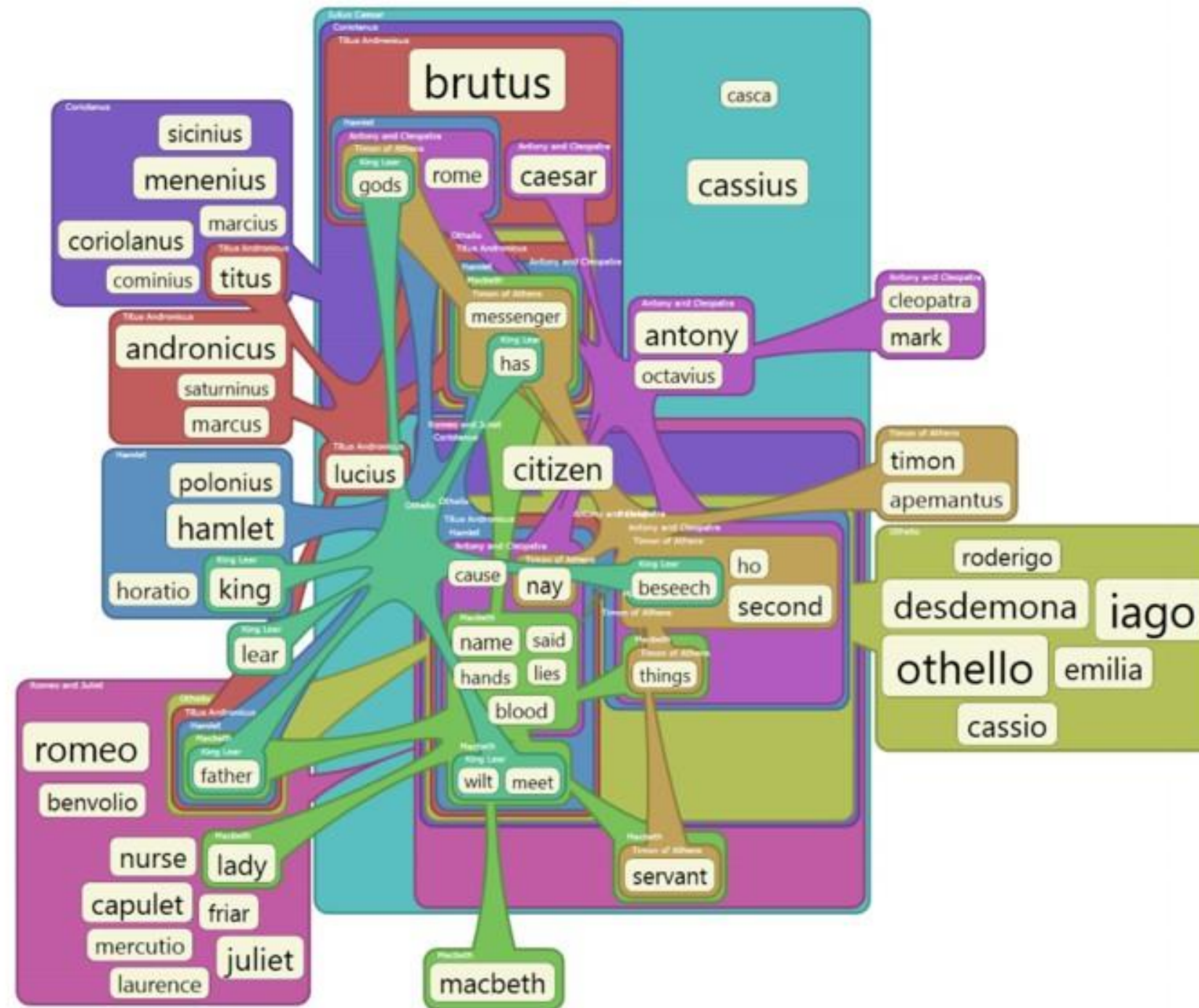


venn & euler diagrams

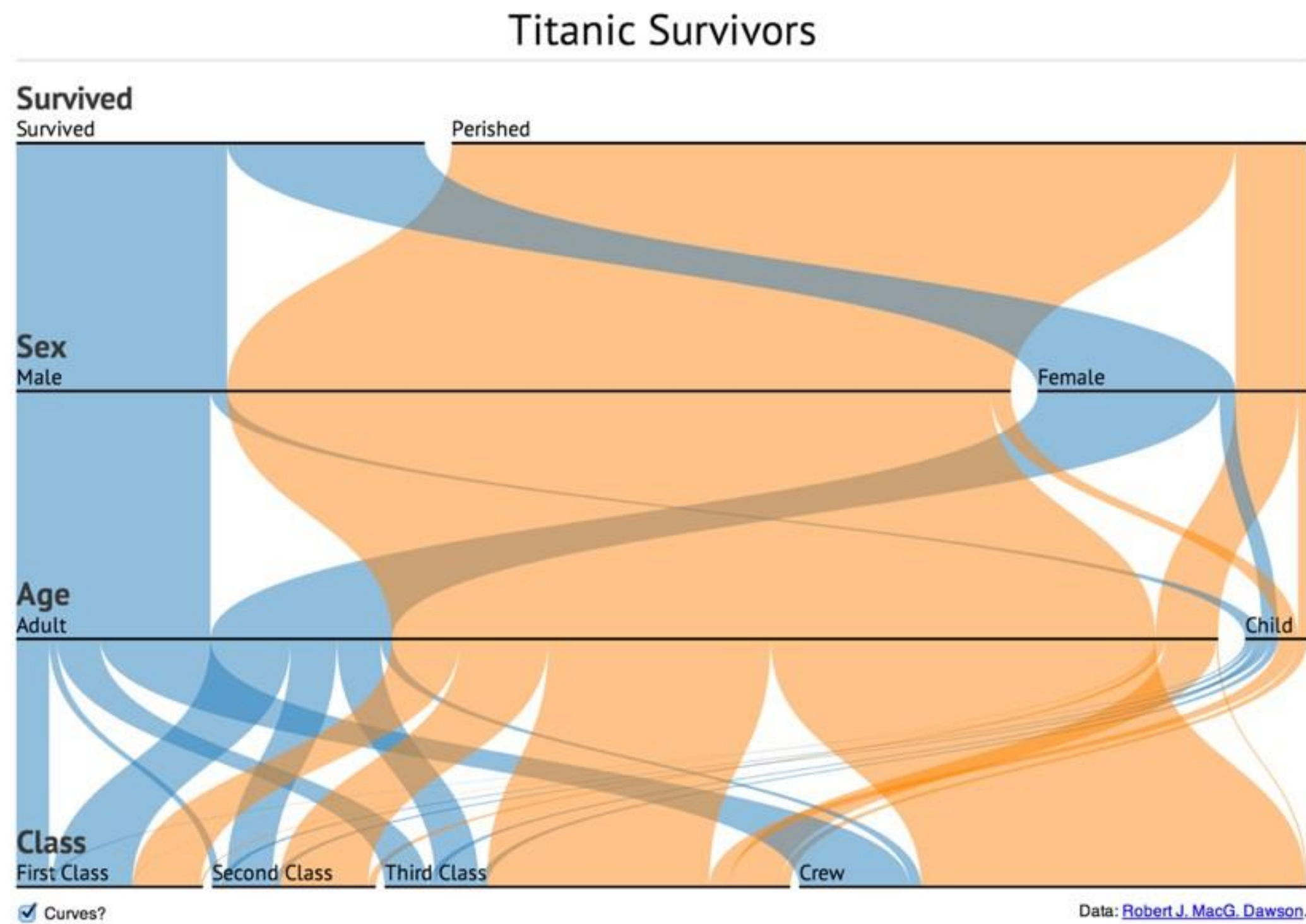
- adjust for area
- starts getting tricky!



compact euler diagrams



parallel sets

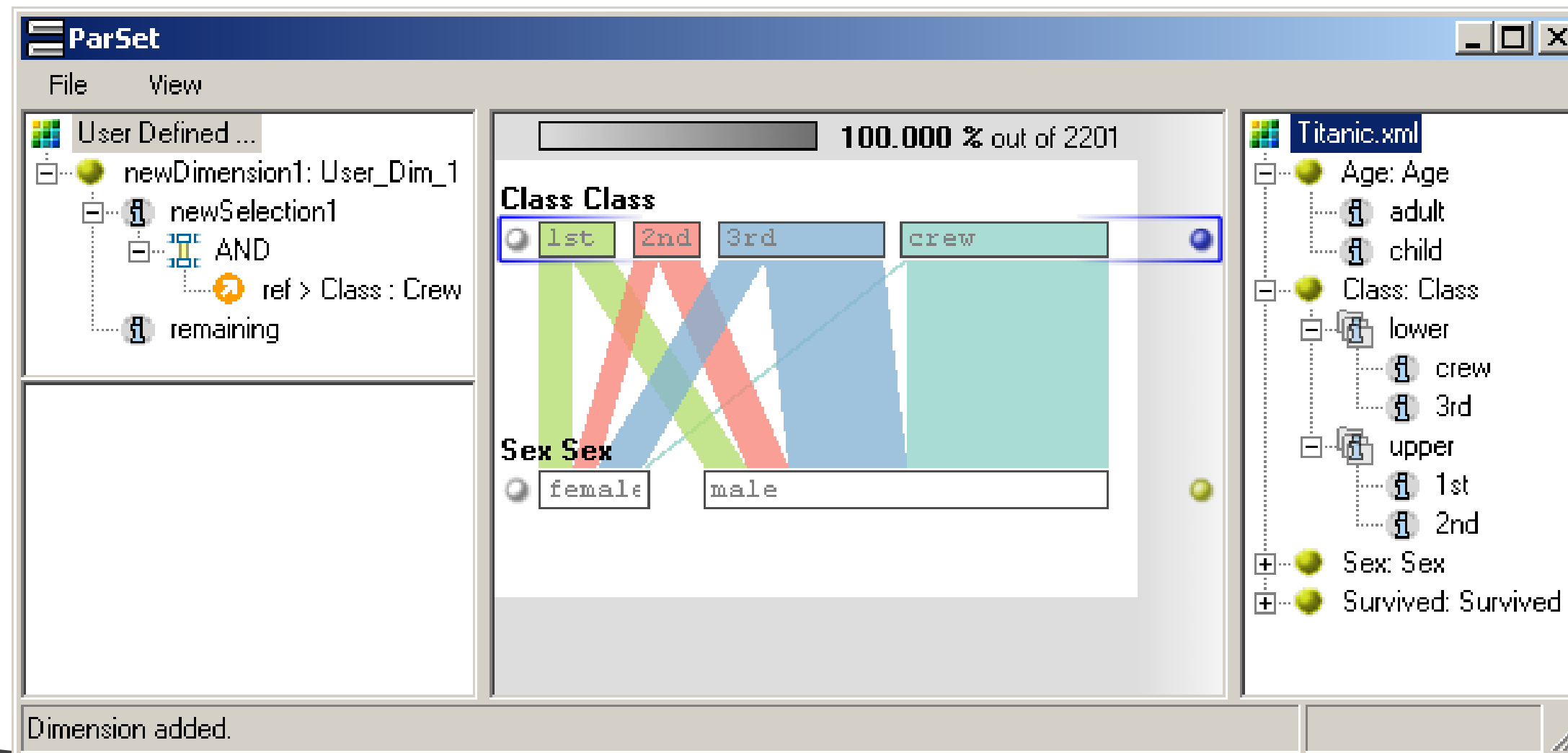


parallel sets

- builds on PC to better handle categorical data
 - discrete
 - small number of values
 - no implied ordering between attributes
- task: find relationship between attributes, not outliers
- interaction driven technique

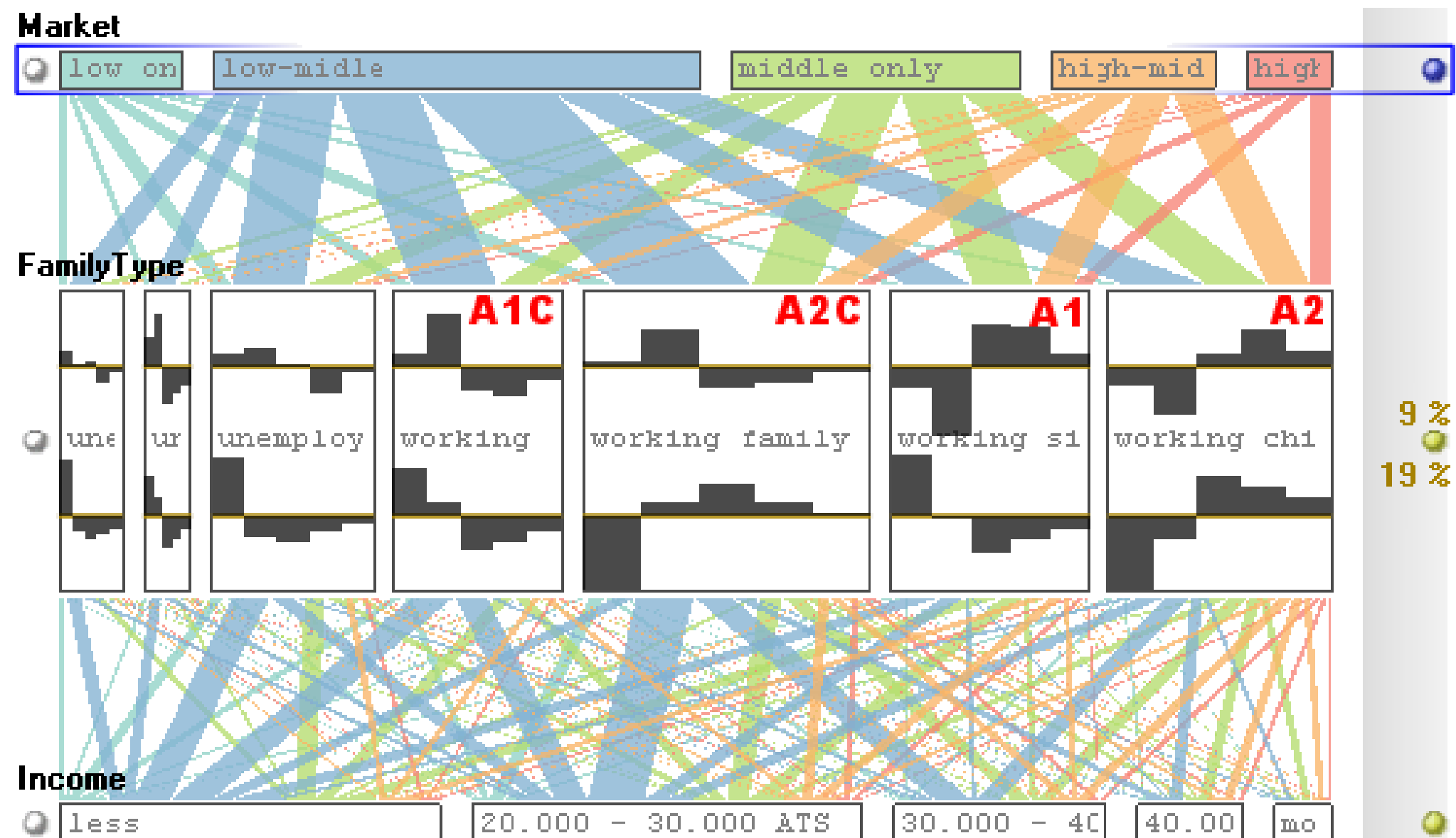
visual encoding

- boxes scaled by frequency
- color coded by values for current active dimension

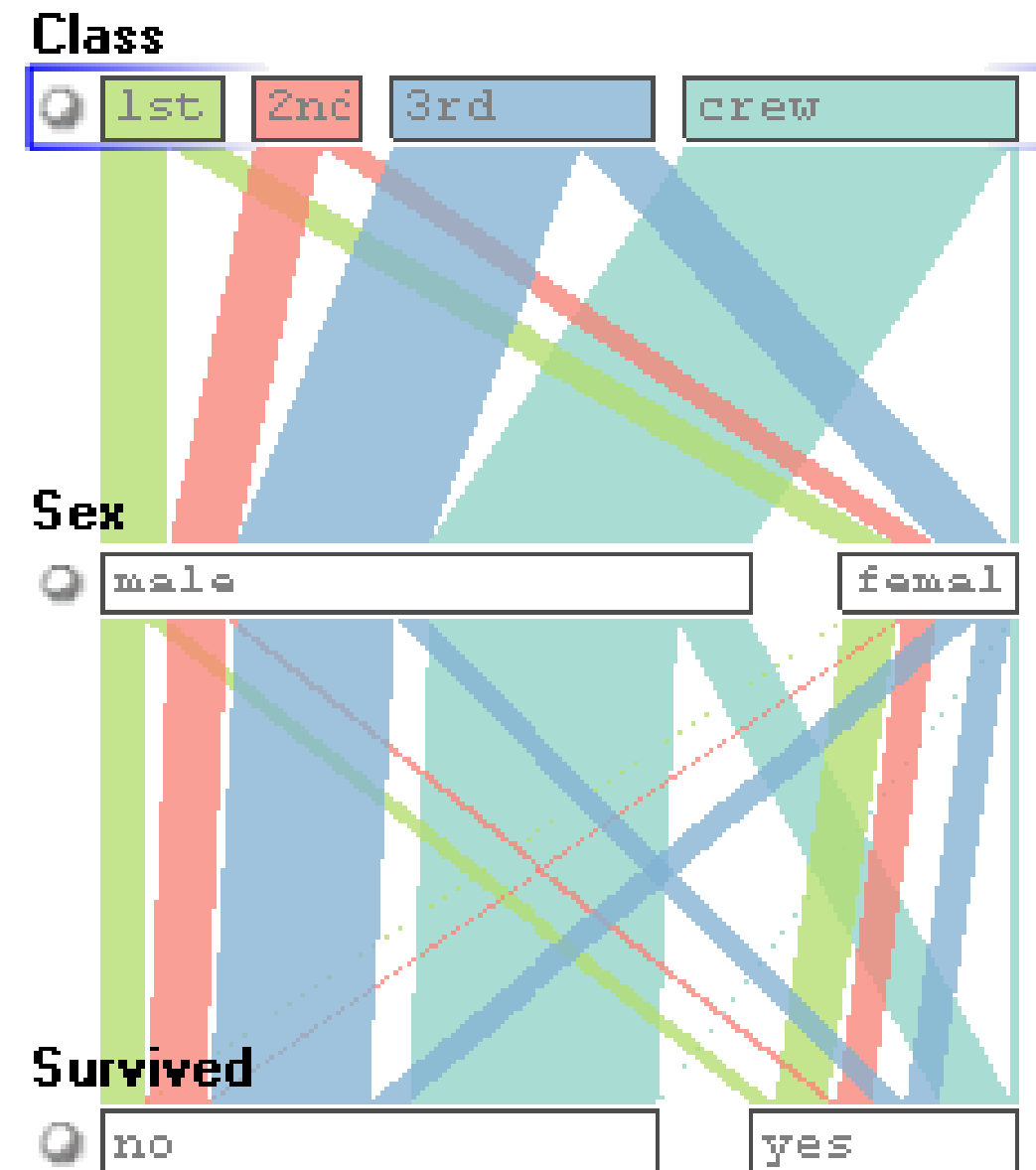
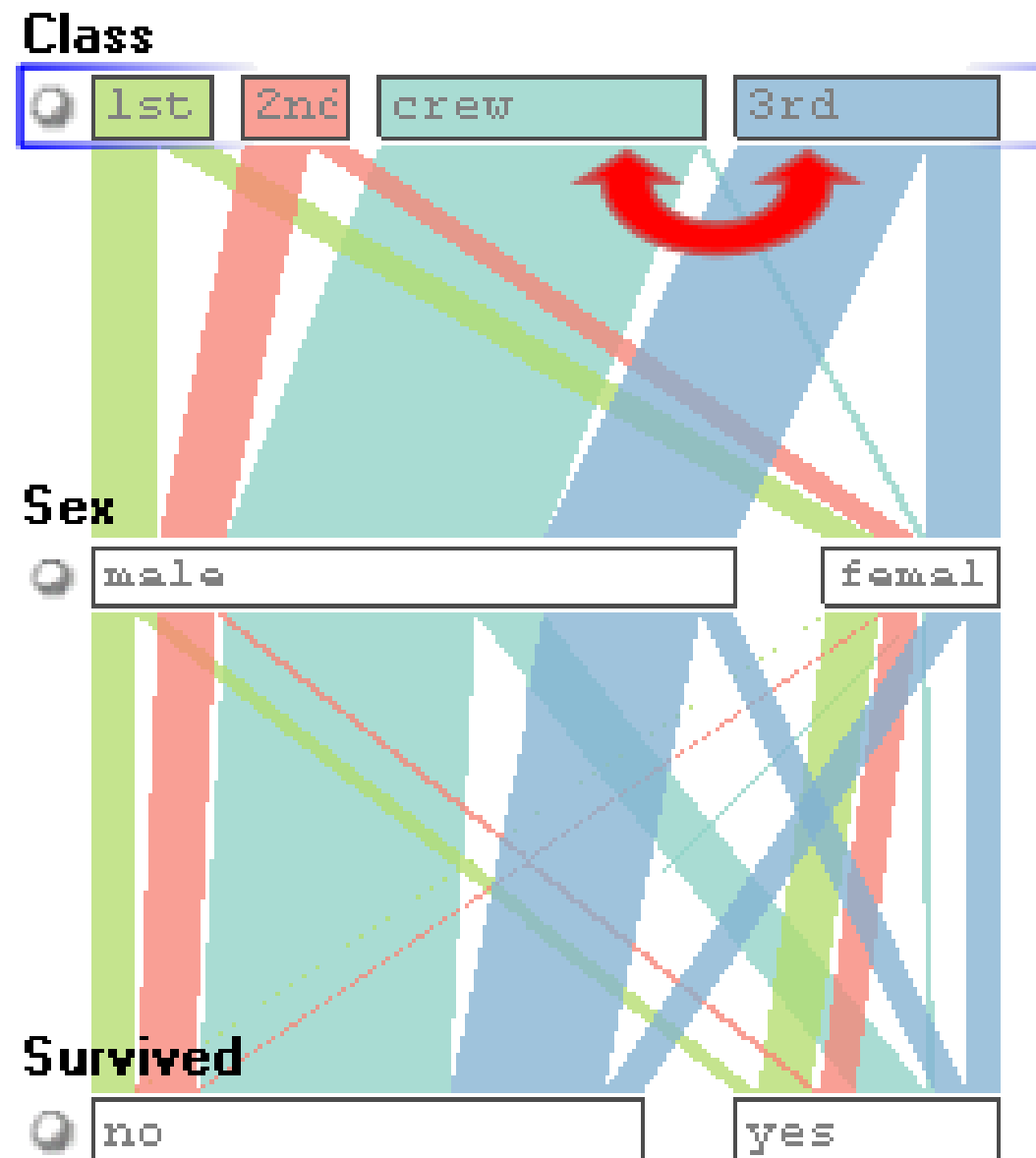


visual encoding

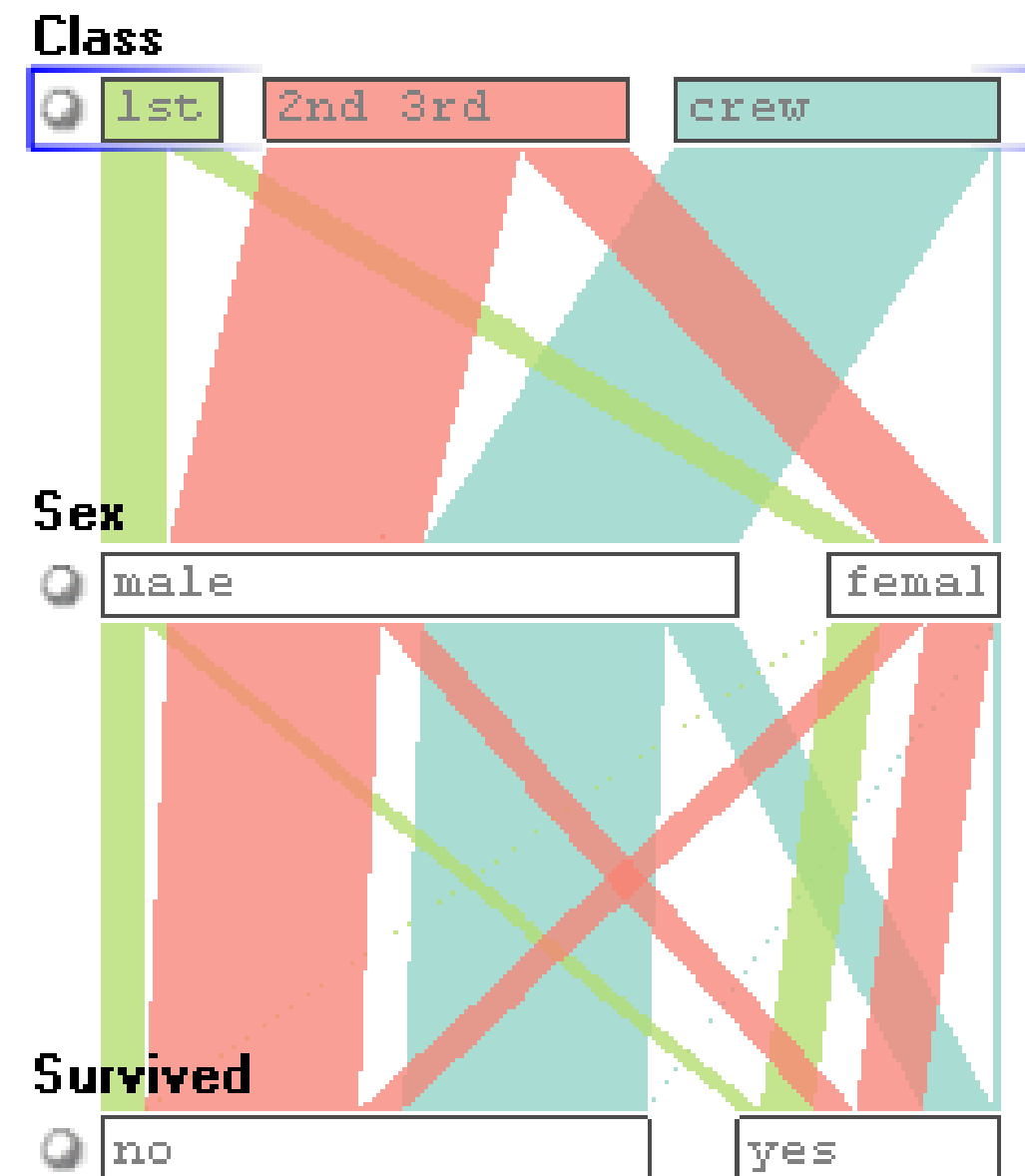
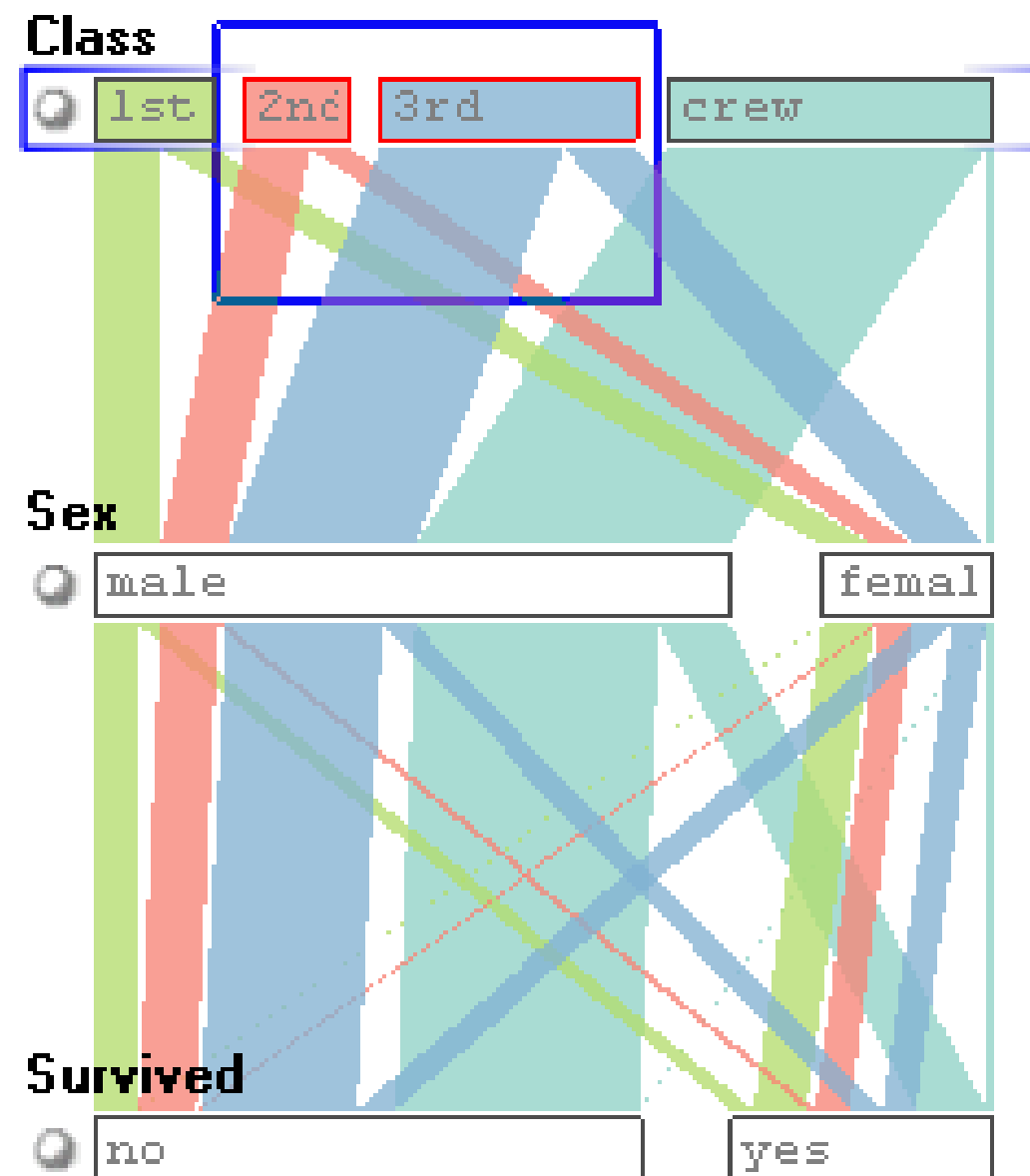
- boxes expand to show histogram



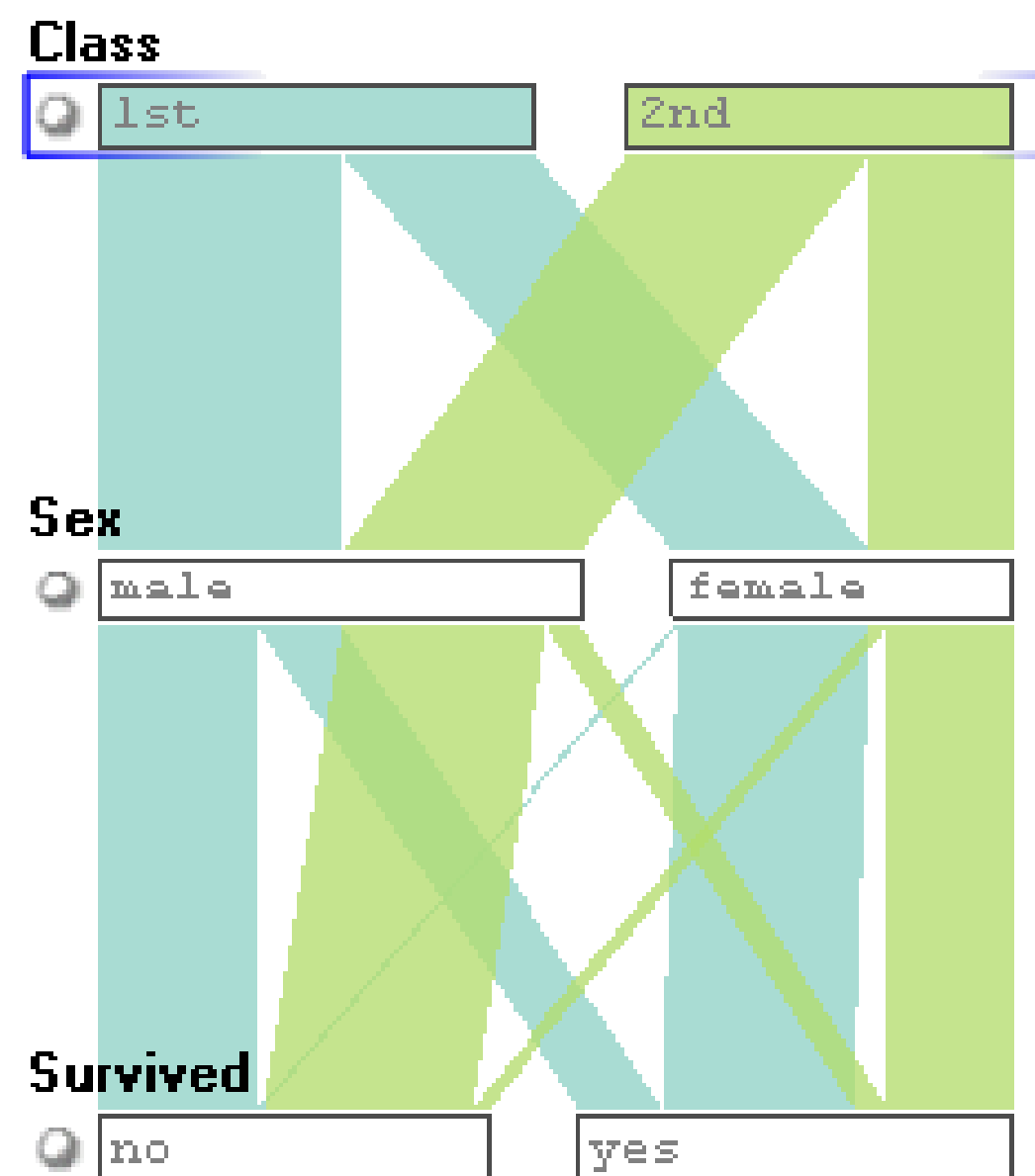
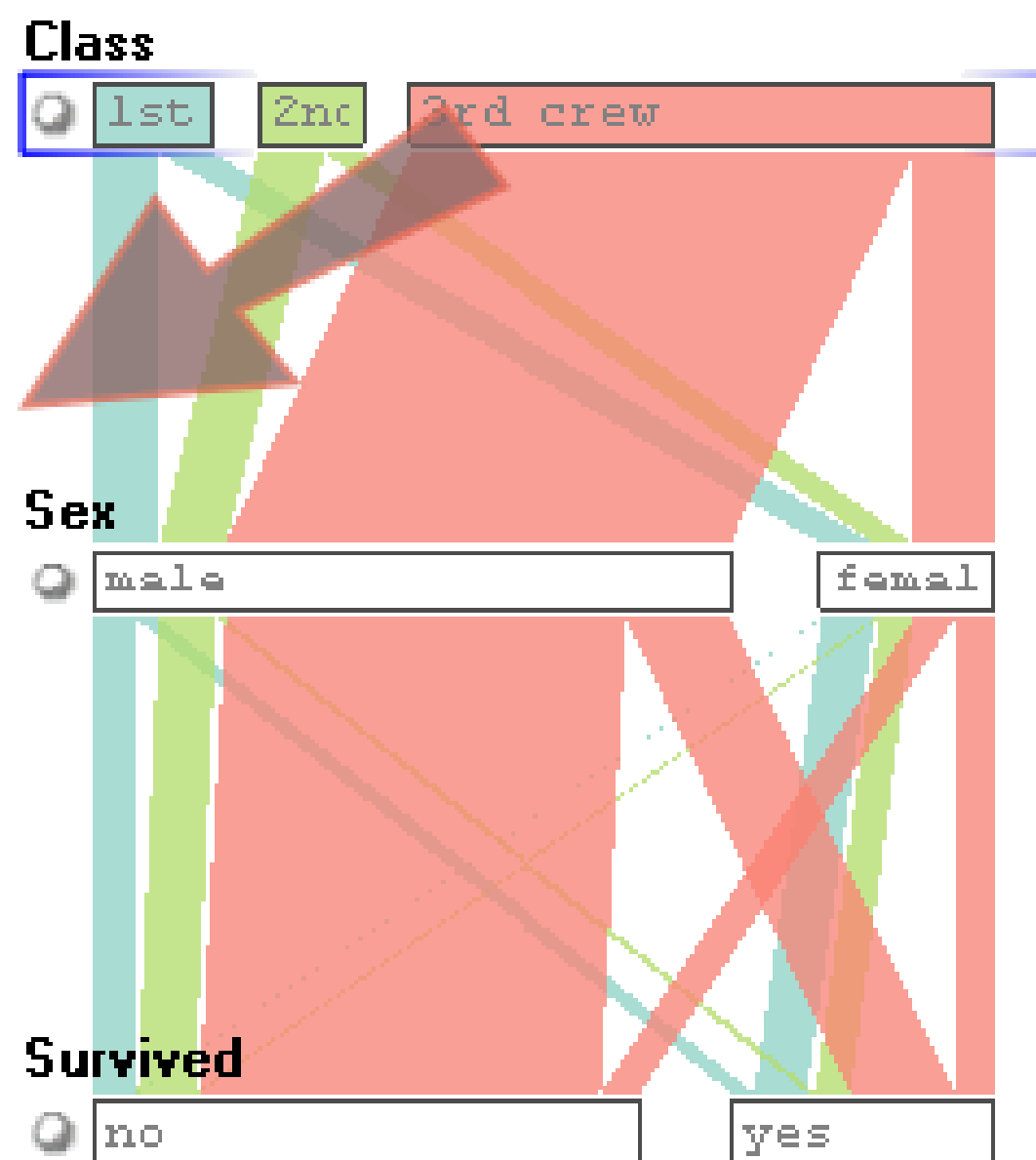
interaction: reorder



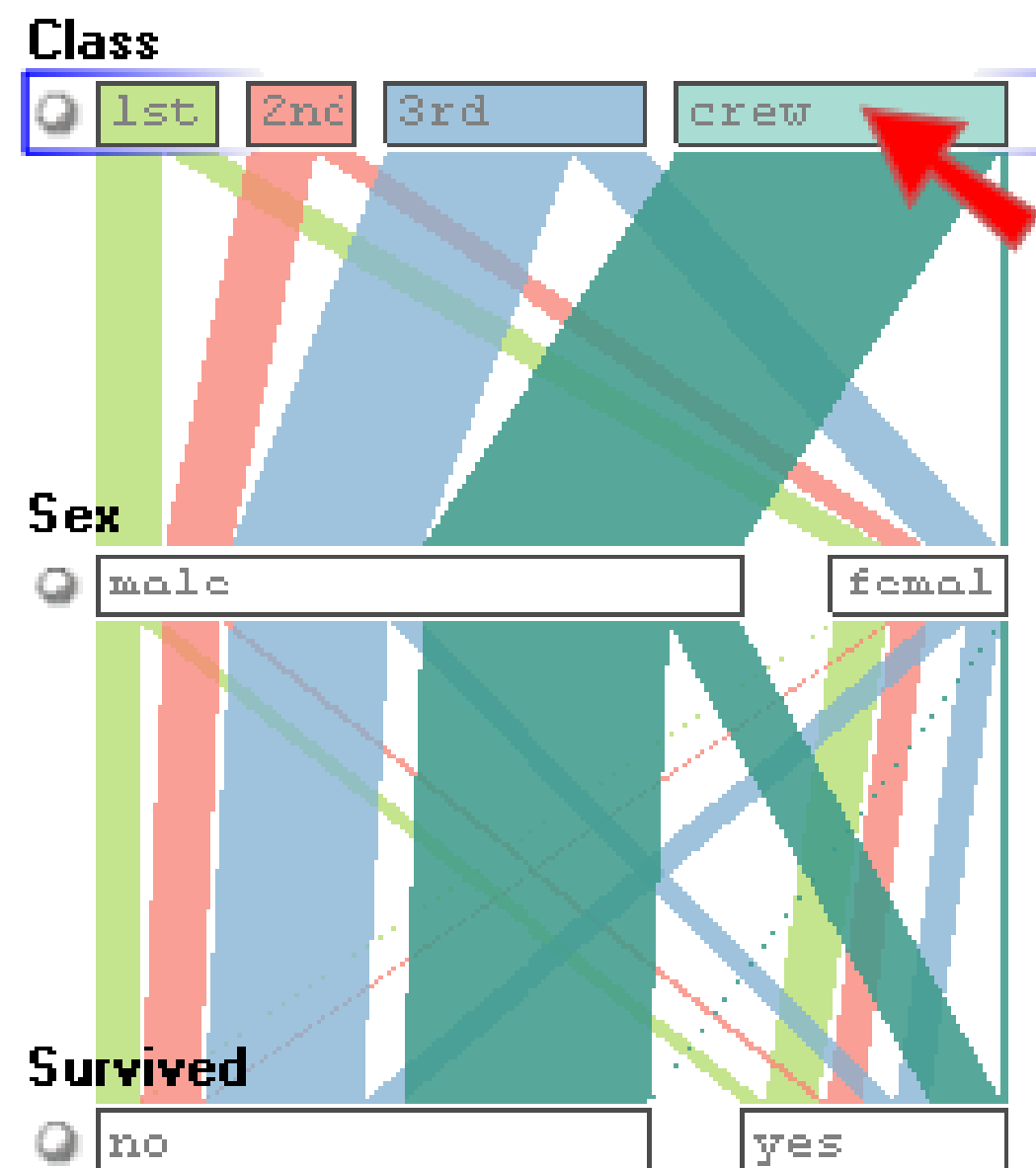
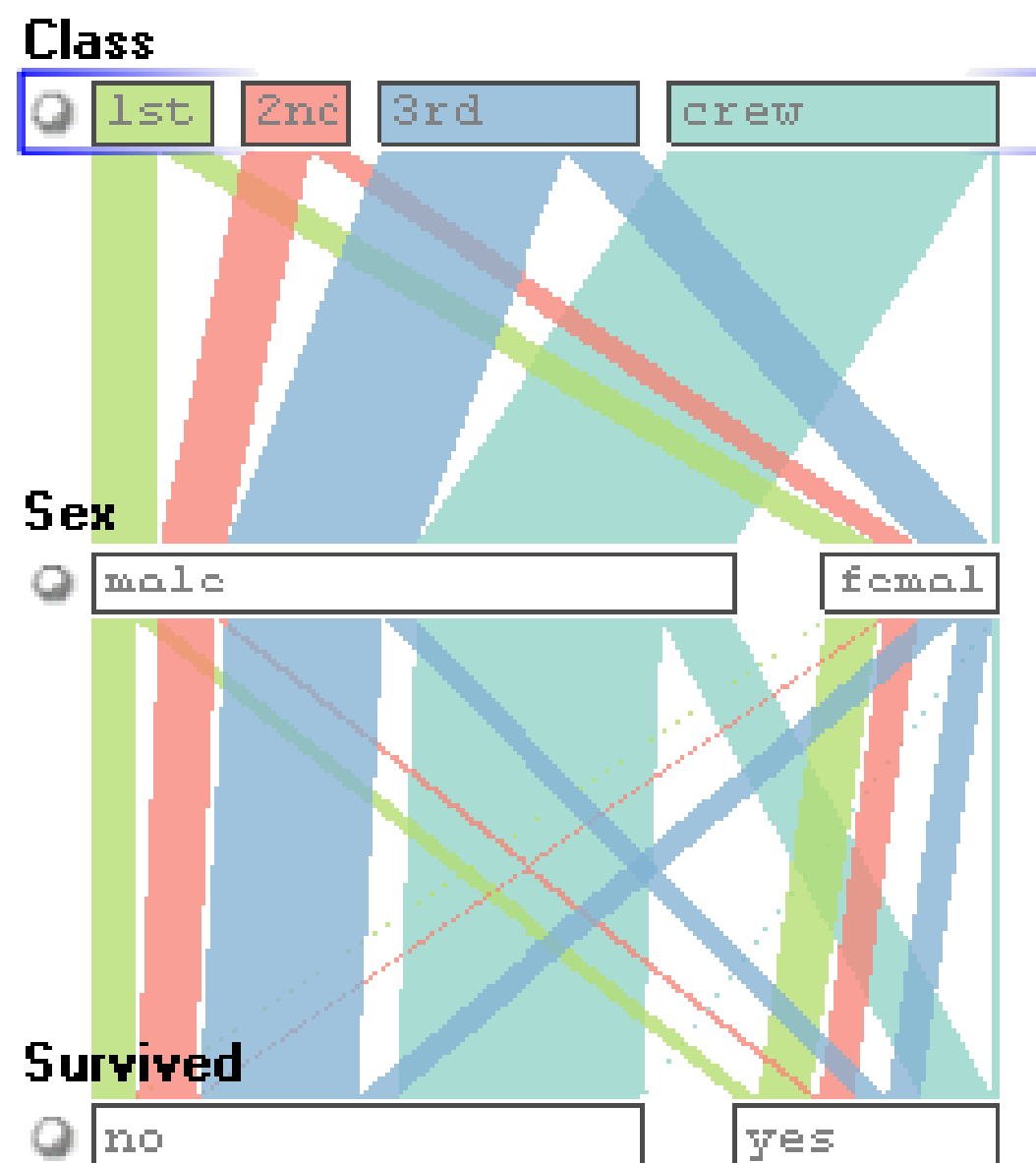
interaction: aggregate



interaction: filter

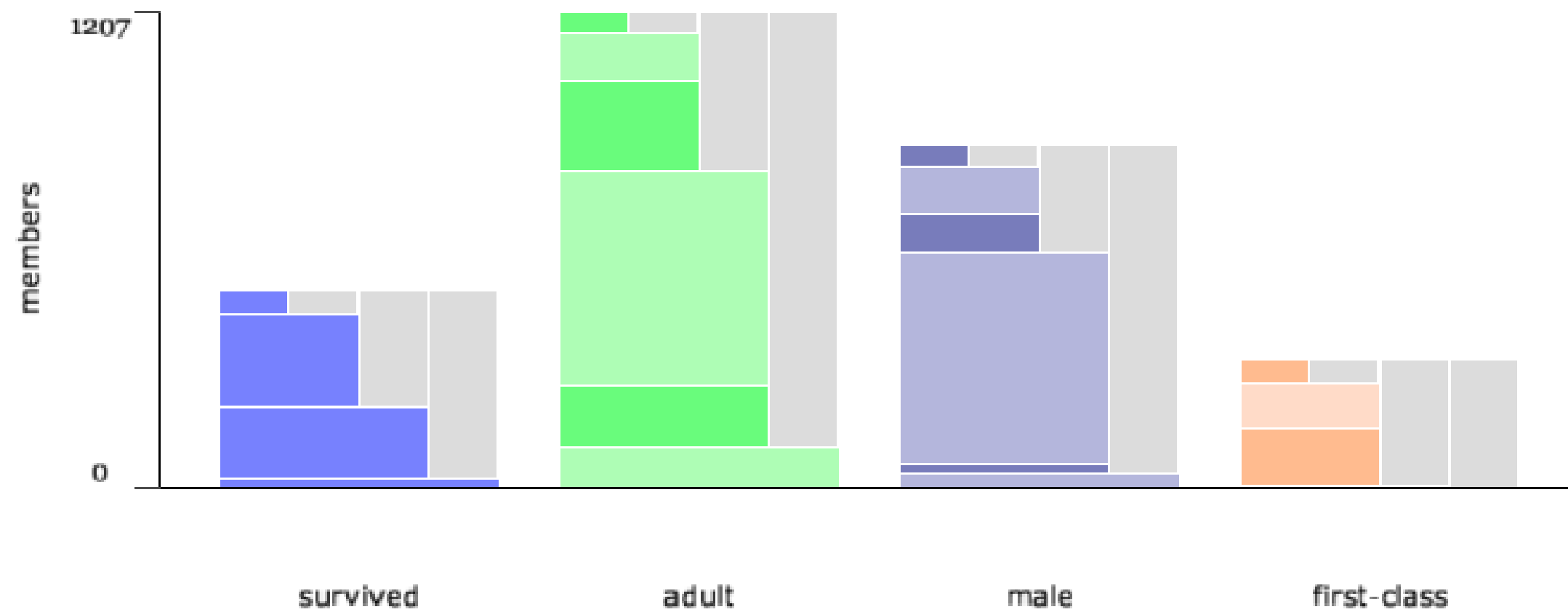


interaction: highlight



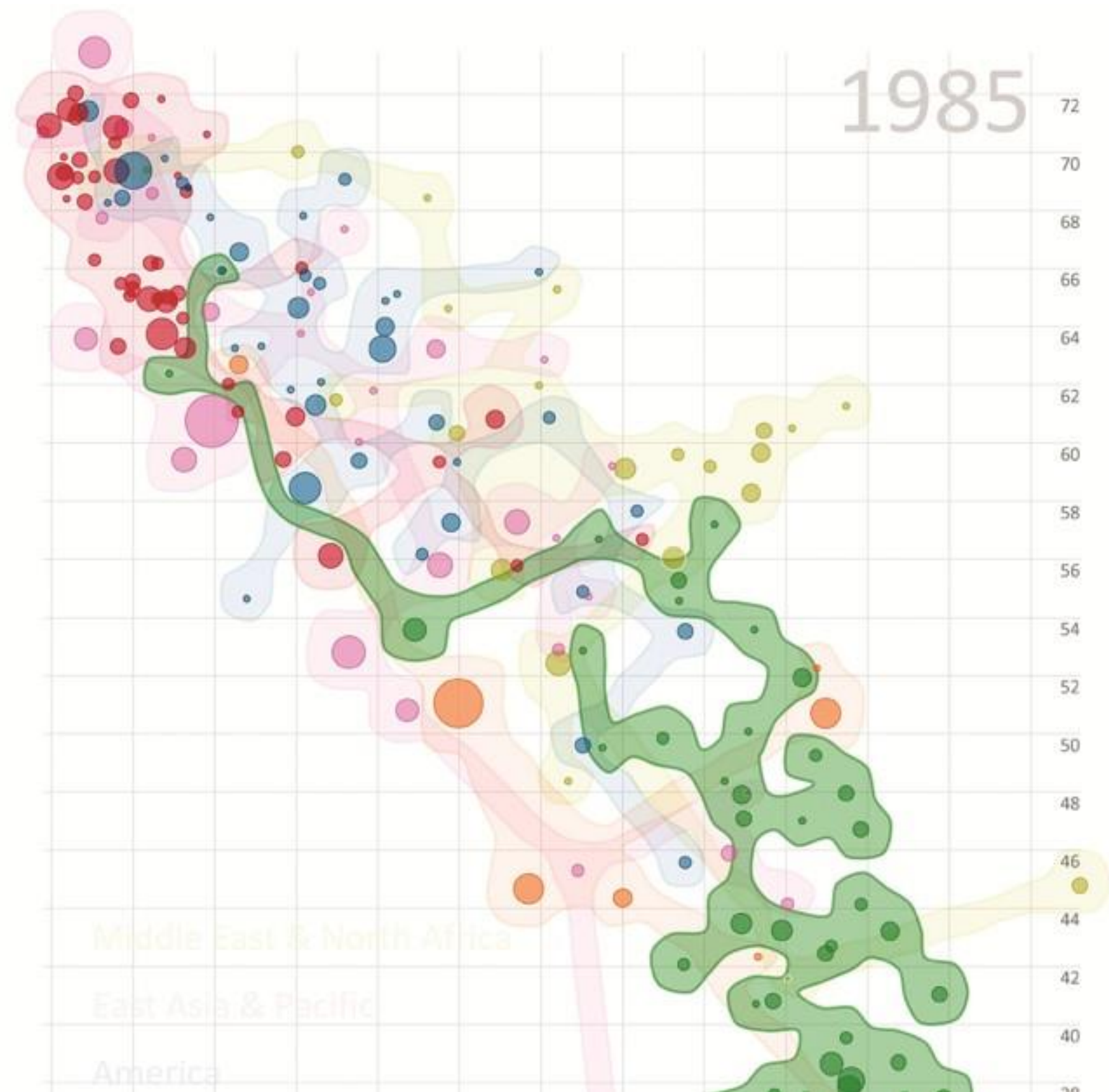
set o'gram

Titanic



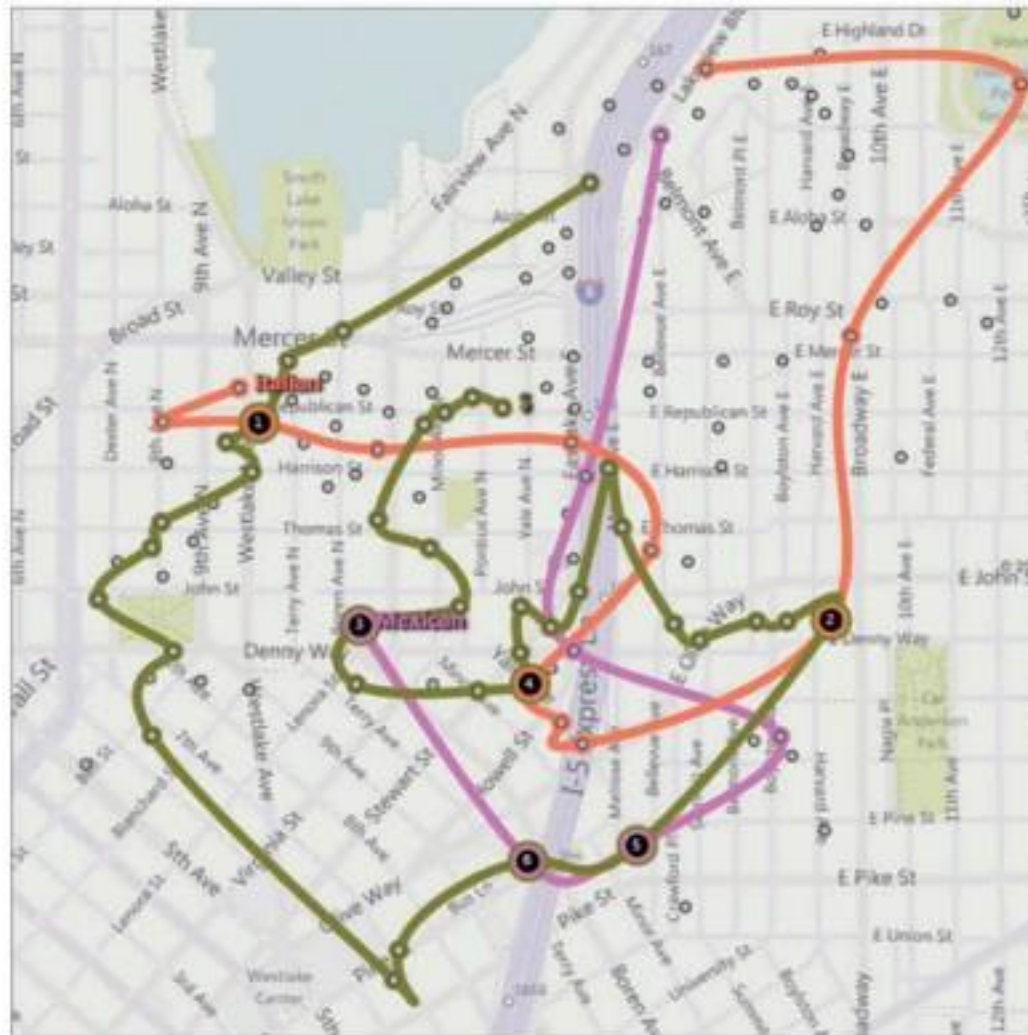
visualizing sets with constraints

bubble sets

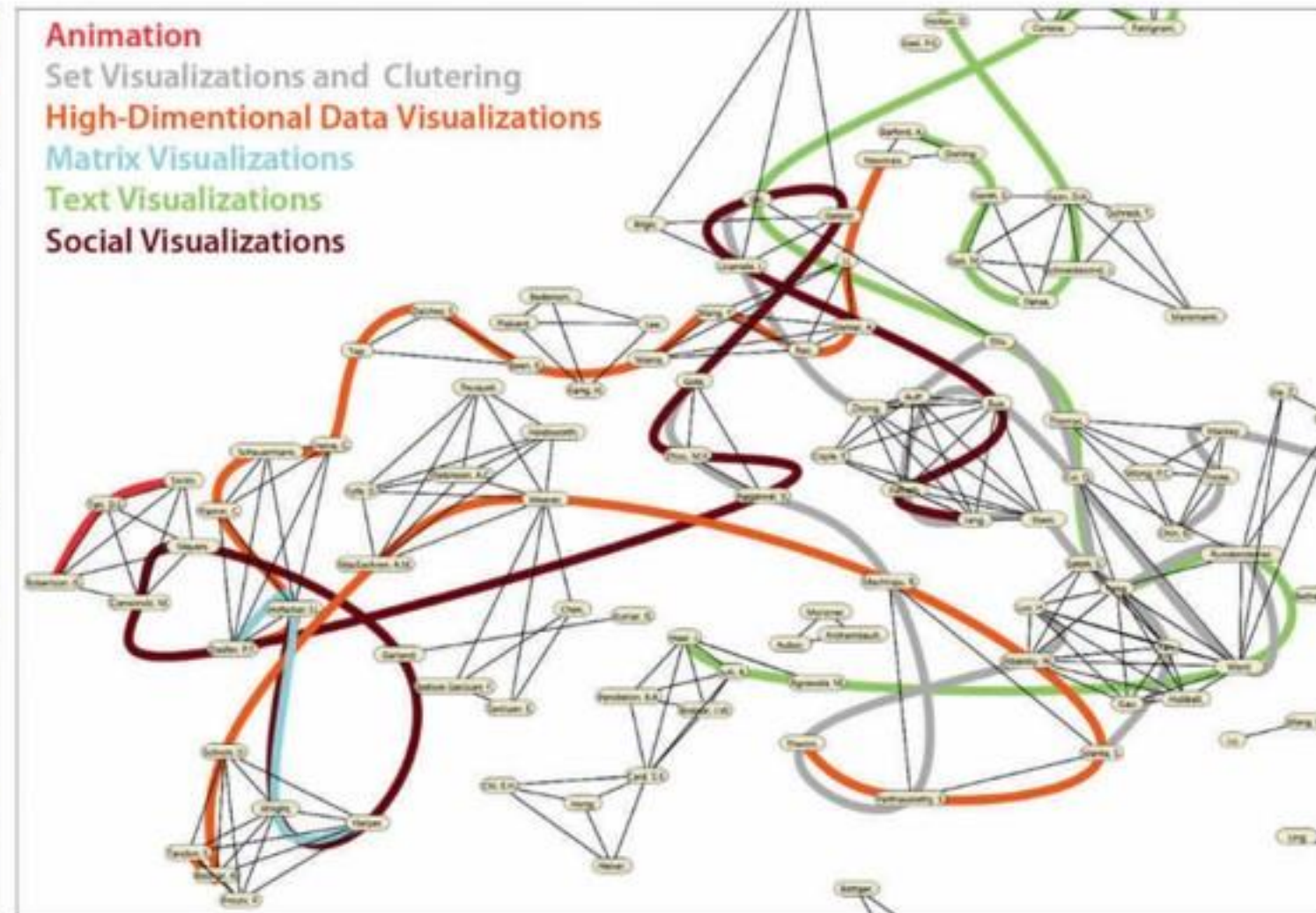


line sets

restaurants



social communities

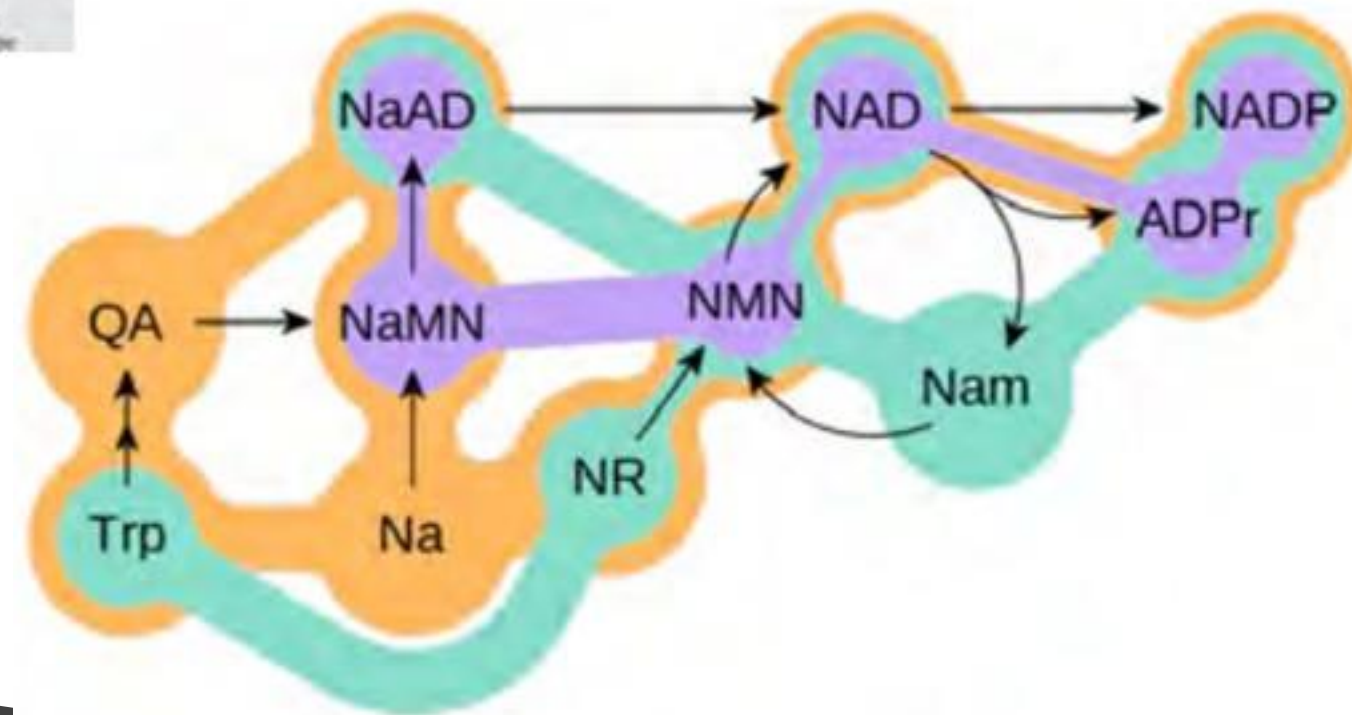


kelp diagrams



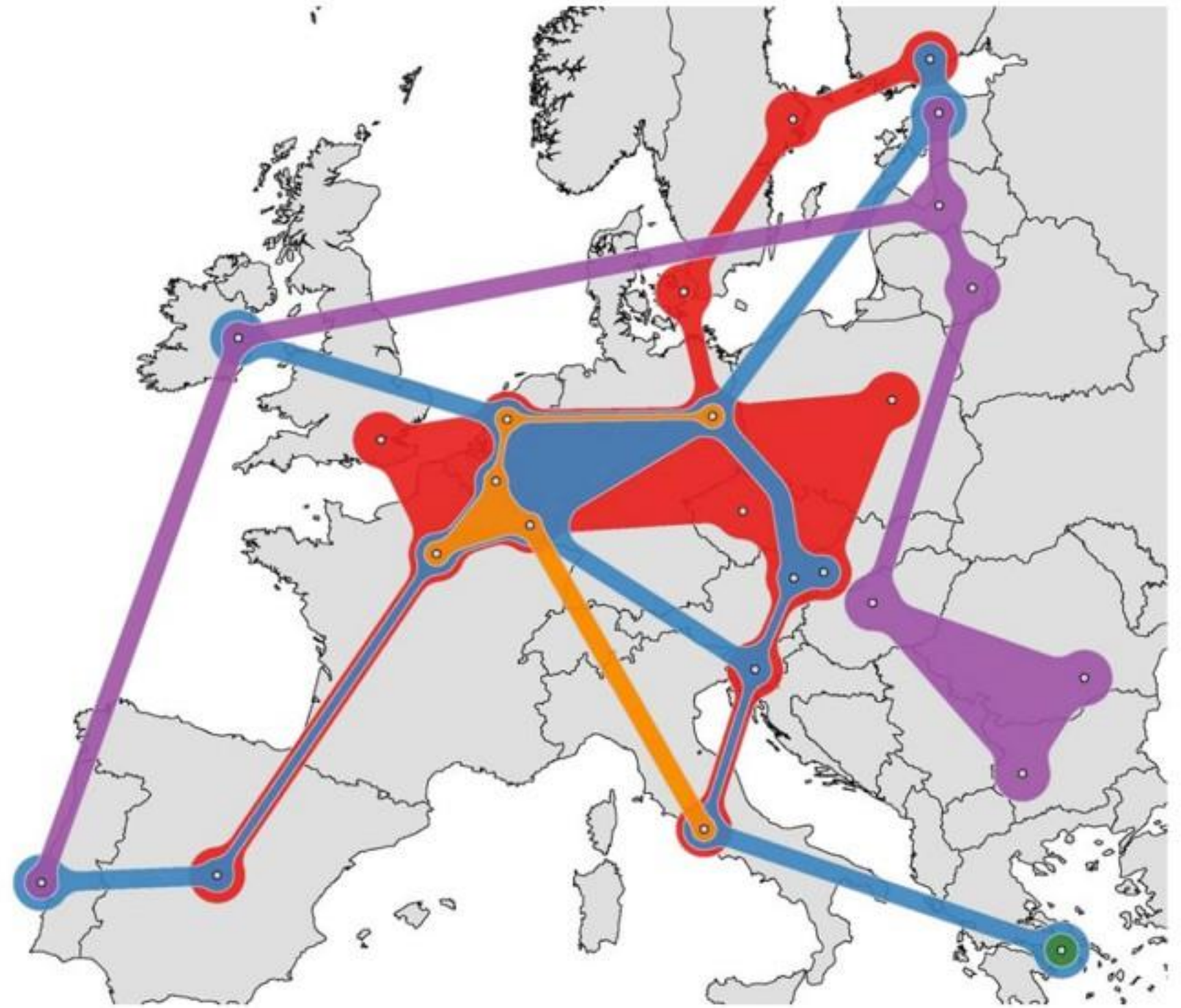
cities on a map

metabolic network



kelp fusion

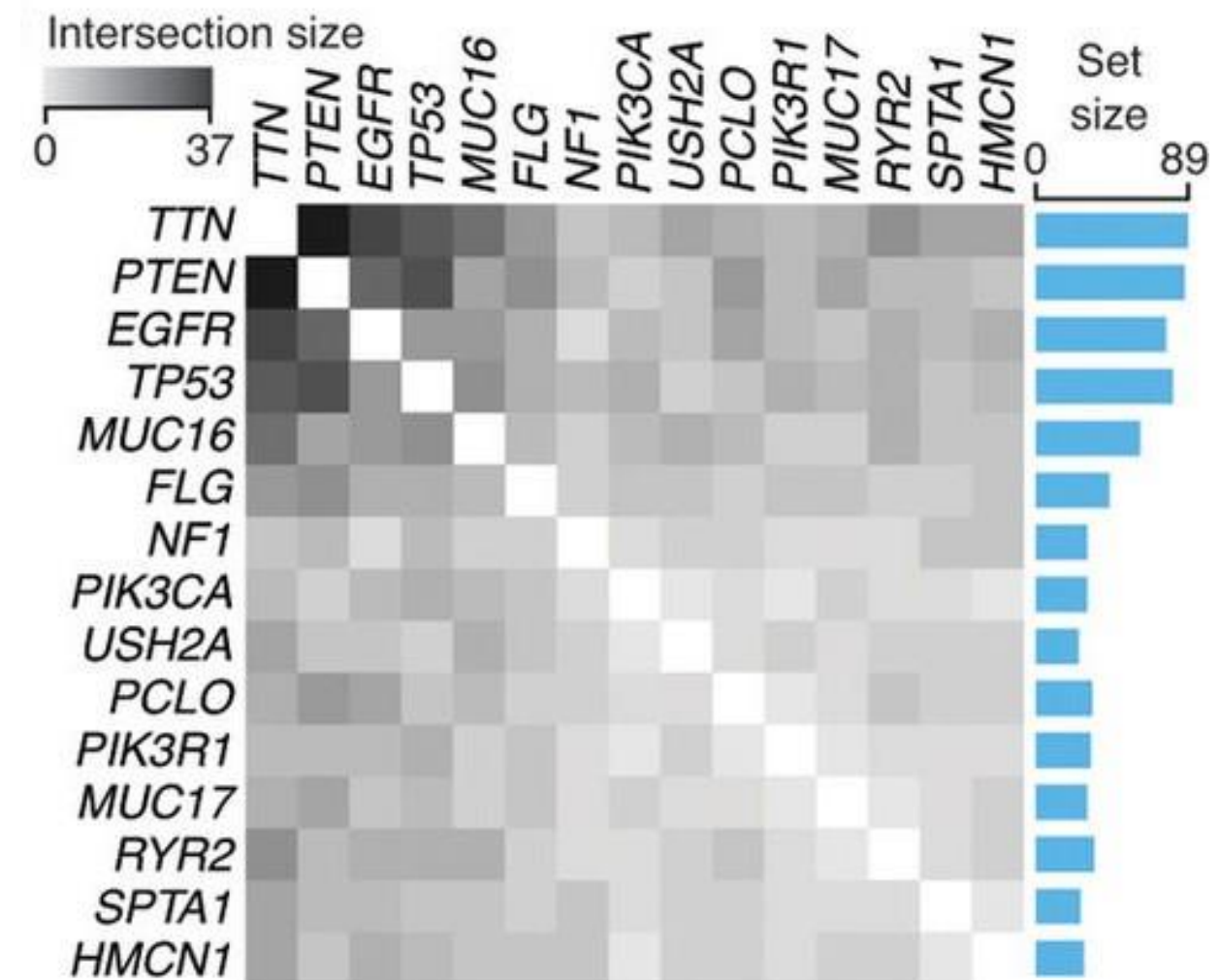
- cities on map
- lines & areas



Showing Pairwise Overlap

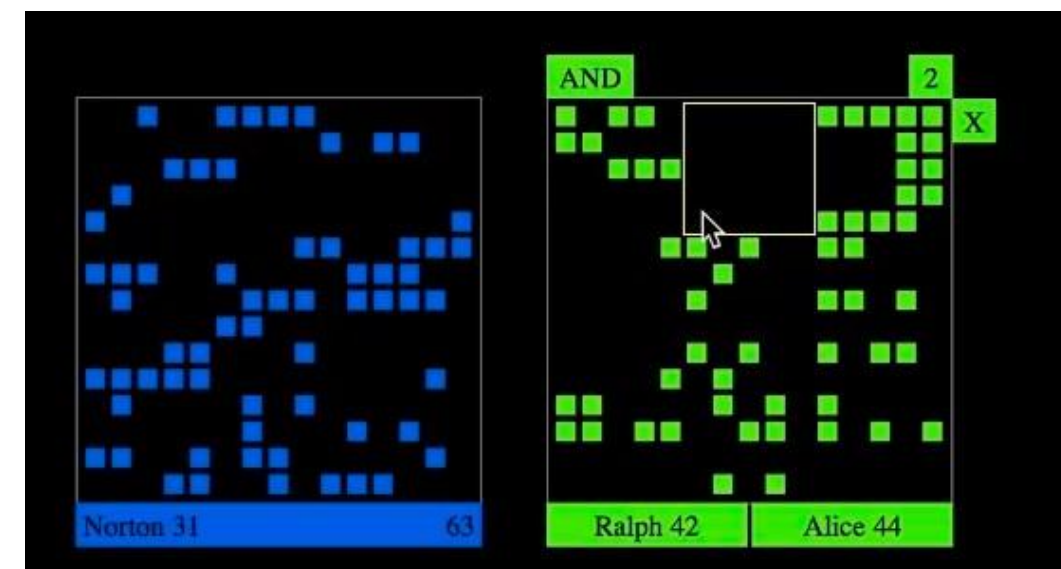
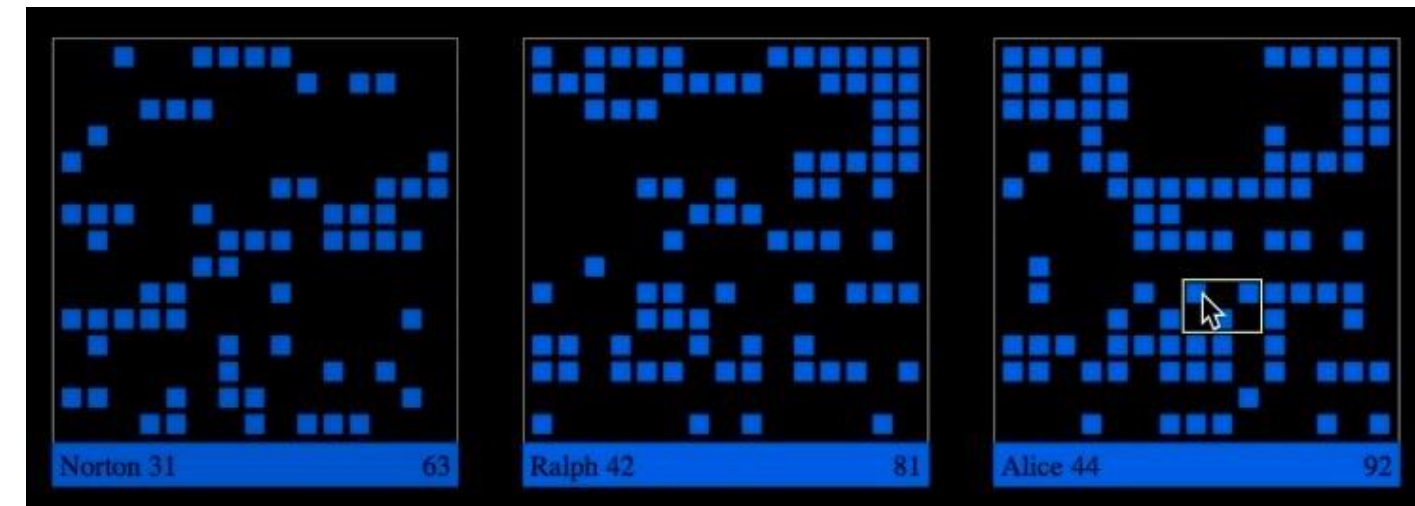
- Doesn't show higher-order overlaps
- Very scalable
- Can't show attributes

Co-Mutations of genes



Set Matrices: OnSet

- Set membership for each item shown in matrix
- Comparisons can be made using AND or OR operations
- Good for many sets and few items



Linear Diagrams



Fig. 1. Visualizing sets: linear diagrams.

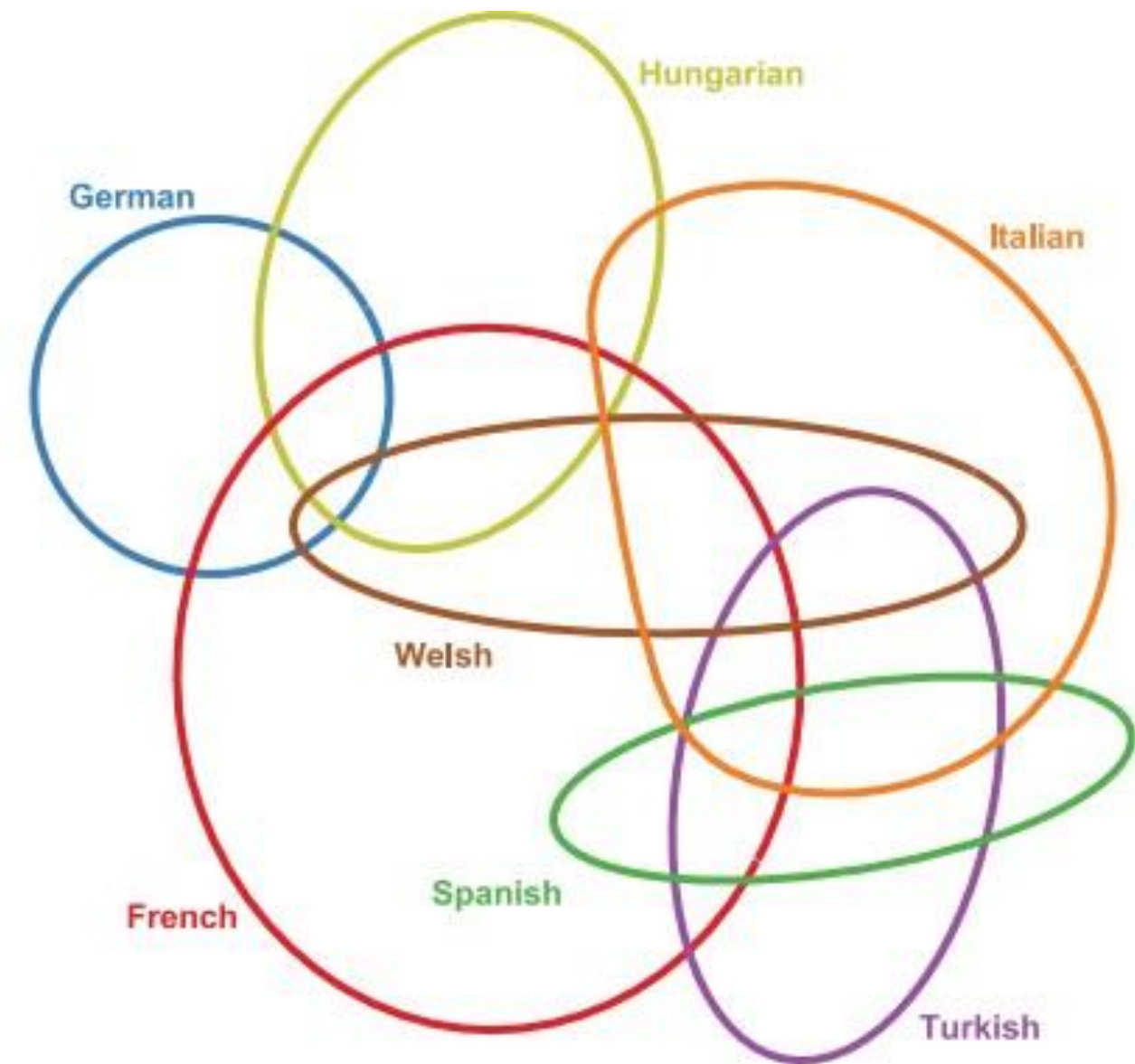
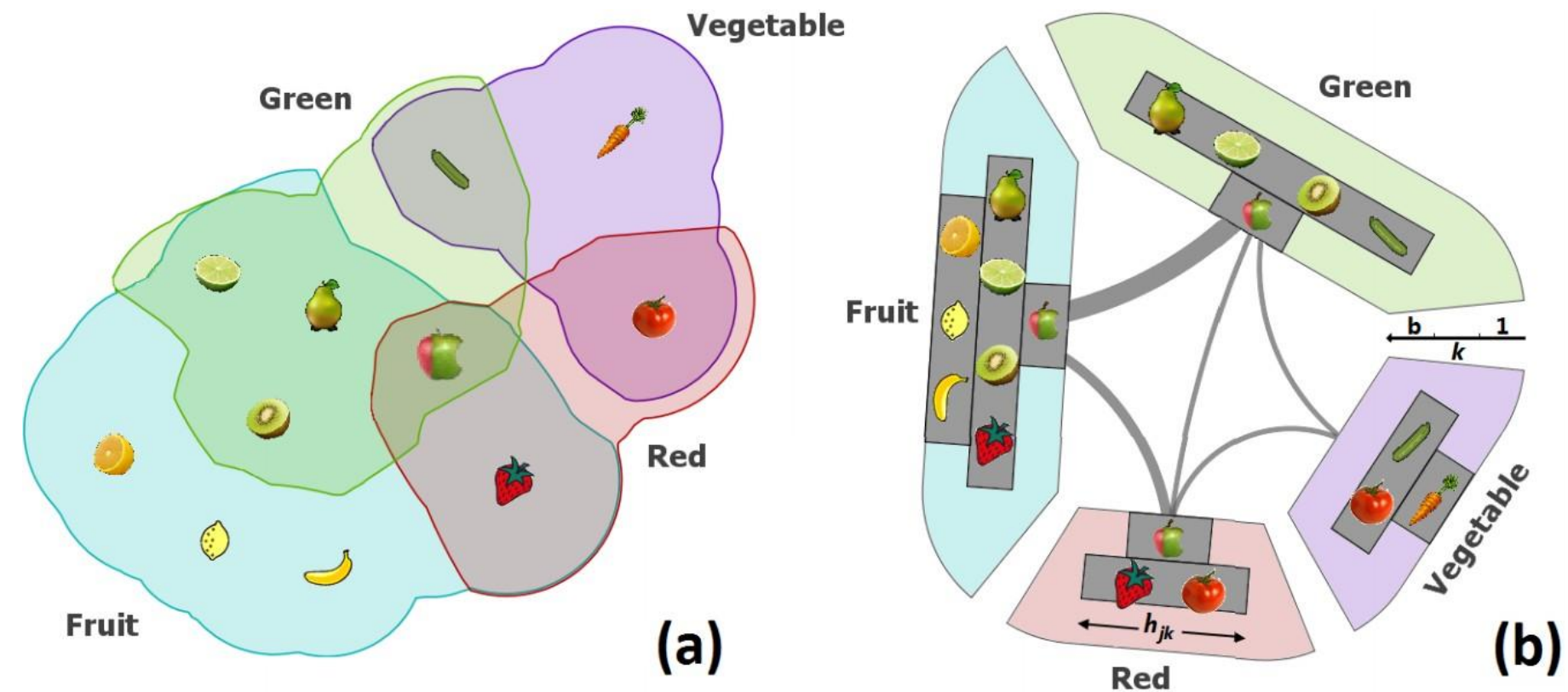


Fig. 2. Visualizing sets: Euler diagrams.

Radial Sets

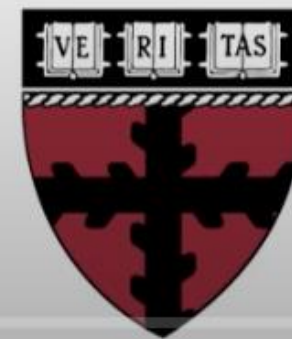
- Sets are segments on a “circle”
- Relationships are encoded as ribbons
- Size of segments encodes size of sets
- Histograms in segments show degrees



UpSet: Visualization of Intersecting Sets

Alexander Lex, Nils Gehlenborg, Hendrik Strobelt,
Romain Vuillemot, and Hanspeter Pfister

<http://vcglab.org/upset>



HARVARD
School of Engineering
and Applied Sciences



0:00 / 4:55



HD



Sets

- applies to many datasets
 - Many categorical data can be viewed as sets
- many combinations may be interesting
- limited numbers of sets more tractable

