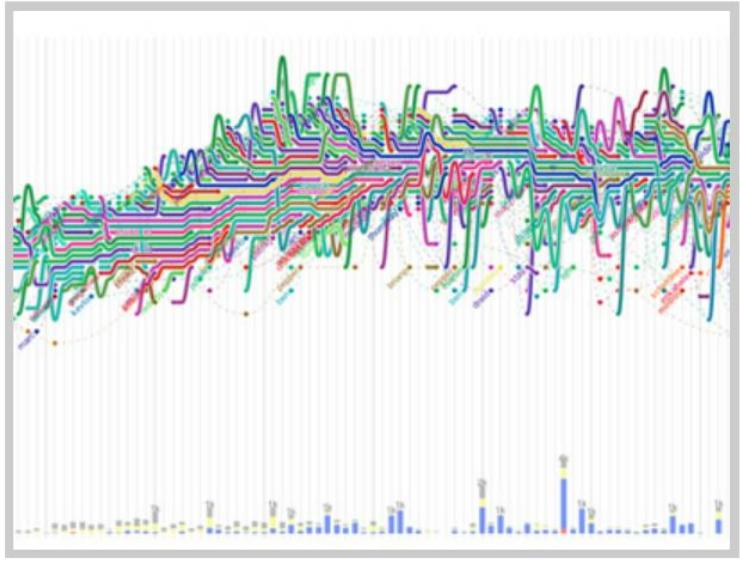
Universidade de Aveiro
Departamento de Electrónica,
Telecomunicações e Informática

Representation- II
Encoding relation

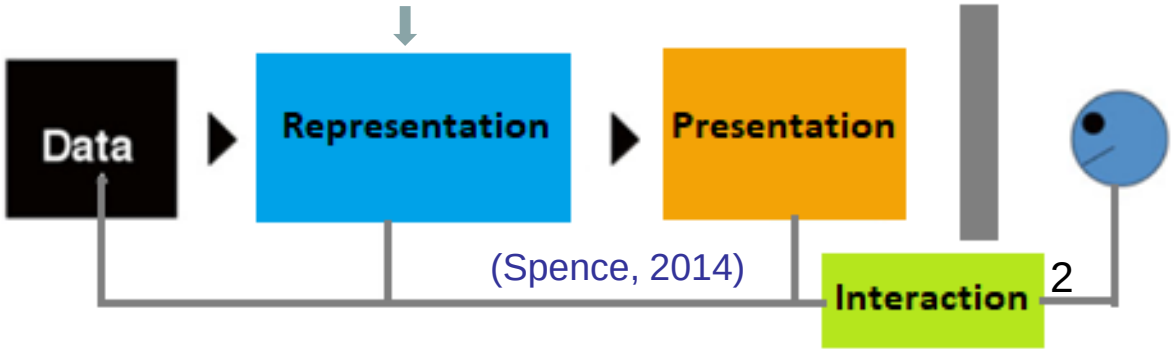


- Two types of data:
  - Value (already addressed)
  - Relation

- What is relation?

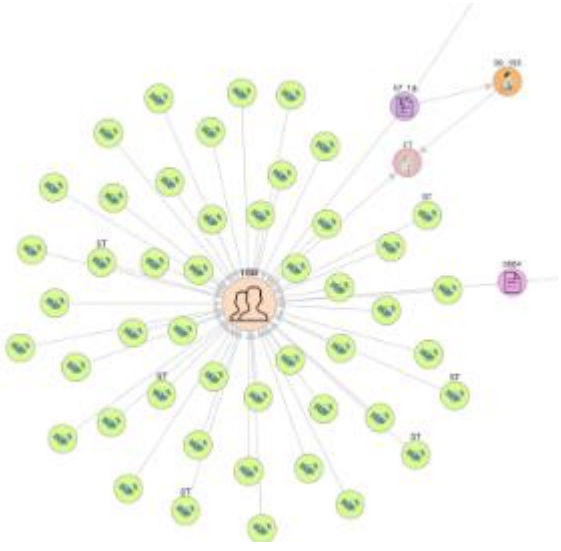
  A logical or natural association between two or more things; relevance of one to another; connection (in dictionary)

- How to represent relation?

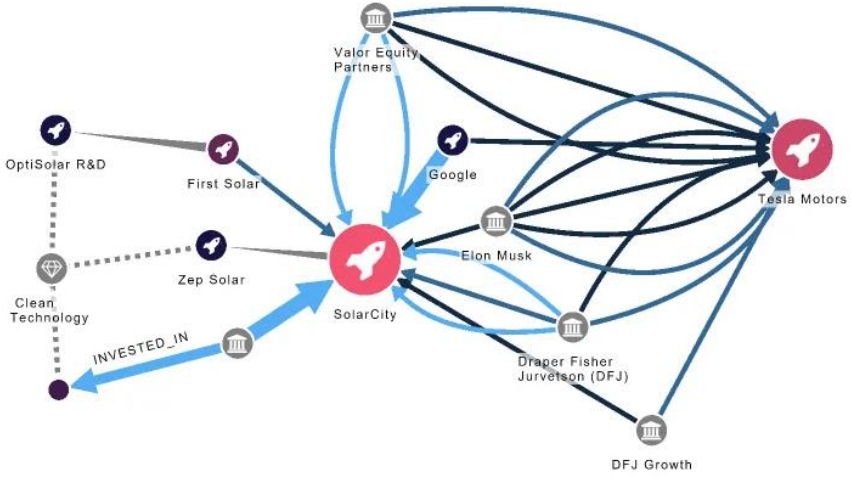


(Spence, 2014)

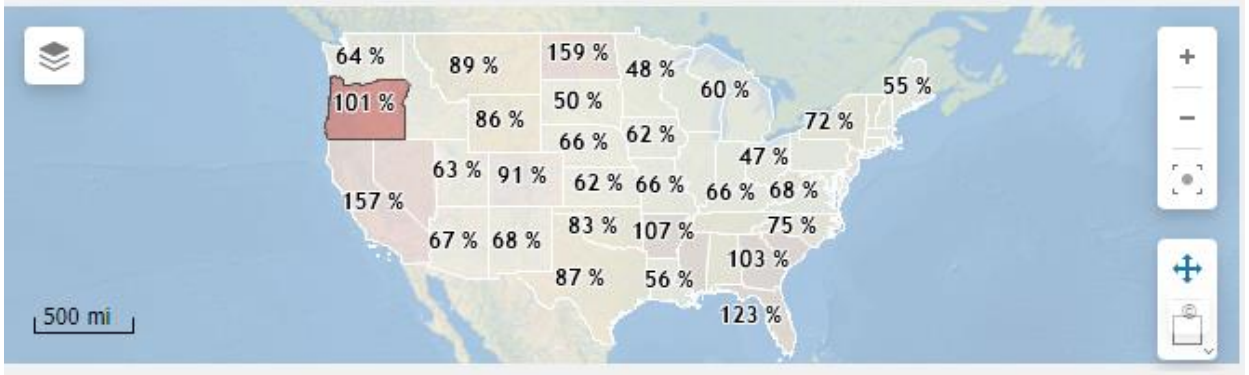
Several ways to represent relation:

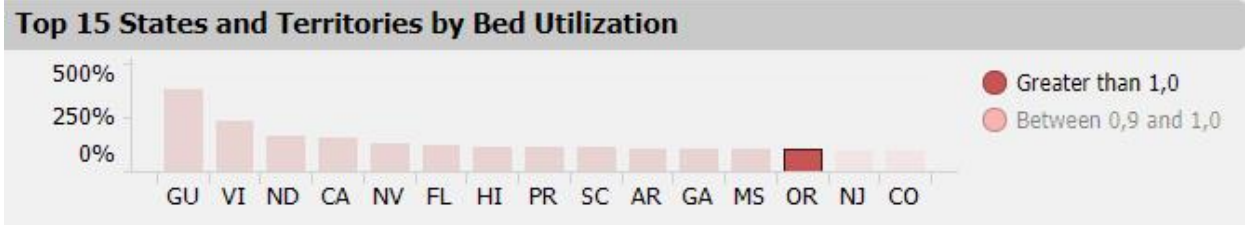


Lines indicate relationship



Arrows indicate unique unilateral functional relations





Color indicates a relation between representations

- The nature of relations is different from values

- However, the prime considerations in the choice of a representation are similar:

  - an understanding of the **task**

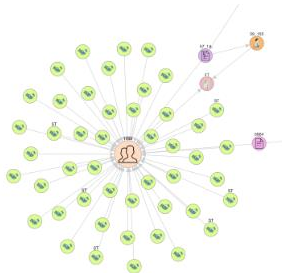
  - the **insight** that is sought

  - what **questions** might be asked of the relation

- Some representations of relation are very **simple, yet powerful**

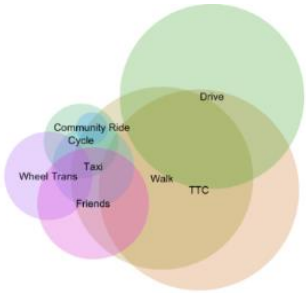
Encoding relation

- Lines



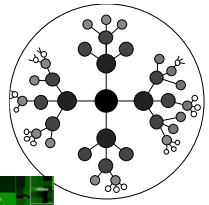
- Diagrams

Venn diagrams



- Trees

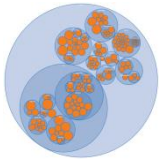
Hyperbolic browser



Treemap

Sunburst

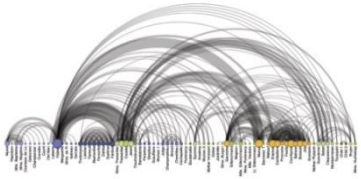
Nested circles



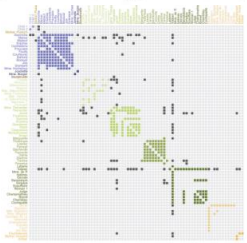
- Networks

node-link

Arc



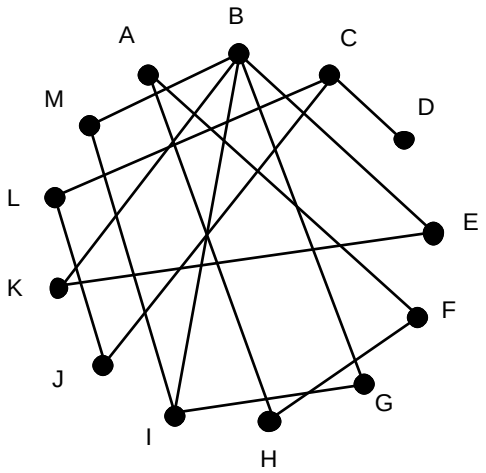
Matrix



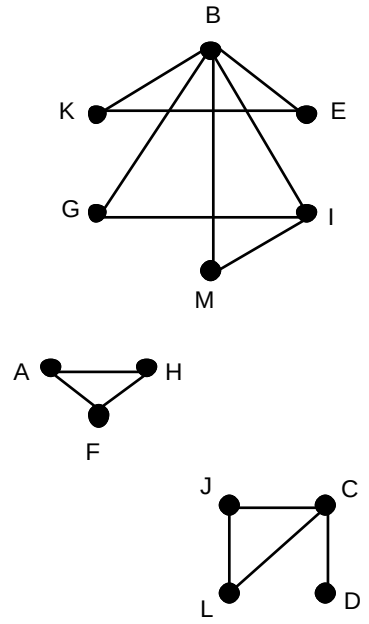
- **Lines** are perhaps the simpler way to represent a relation between two entities

Originator	Receiver
A	H
C	L
I	M
B	E
F	H
G	I
I	B
B	M
K	B
G	B
K	E
C	J
D	C

(a)



(b)



(c)

Insight into even a short list of telephone calls (a) is enhanced by their node-link representation (b), especially if disconnected subsets can be identified (c).

(Spence, 2007)

Topological transportation maps:

- Exploit the shapes into which lines connecting stations are arranged

- Use color to denote different lines

- Use symbols to denote different types of stations

- Have general (but not necessarily) accurate veracity

Perhaps the most familiar use of lines to represent relations is in transportation maps

Classical example:

Original London Underground map

Harry Beck's map (1933)
[Harry Beck's Tube map - Transport for London]

-Much simpler, with general (but not necessarily) accurate veracity

[Harry Beck's Tube map - Transport for London]

• The **arc diagrams** use a one-dimensional layout of nodes, with circular arcs to represent links

• May not convey the overall structure of the graph as effectively as a two-dimensional layout, with a good ordering of nodes it is easy to identify cliques and bridges

•, Multivariate data can easily be displayed alongside nodes

• Seriation is the problem of sorting the nodes in a manner that reveals underlying cluster structure is formally called seriation

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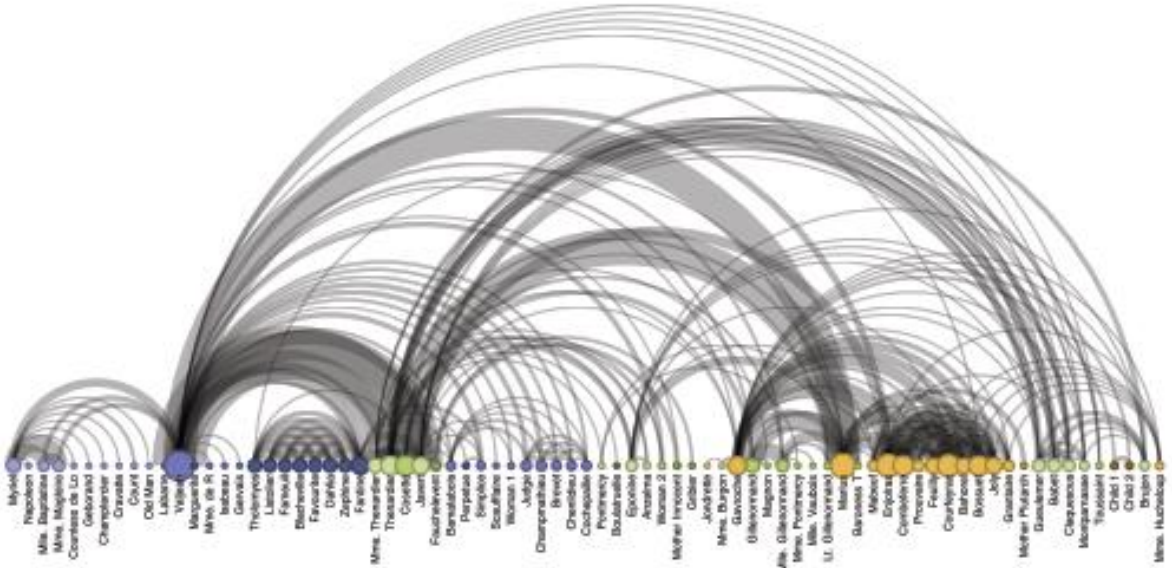

(Heer *et al*., 2010)

• The **node-link (force directed)** layout is a common and intuitive approach to network layout; it models the graph as a physical system

• Nodes are charged particles that repel each other, and links are dampened springs that pull related nodes together

Force-directed graph drawing - Wikipedia

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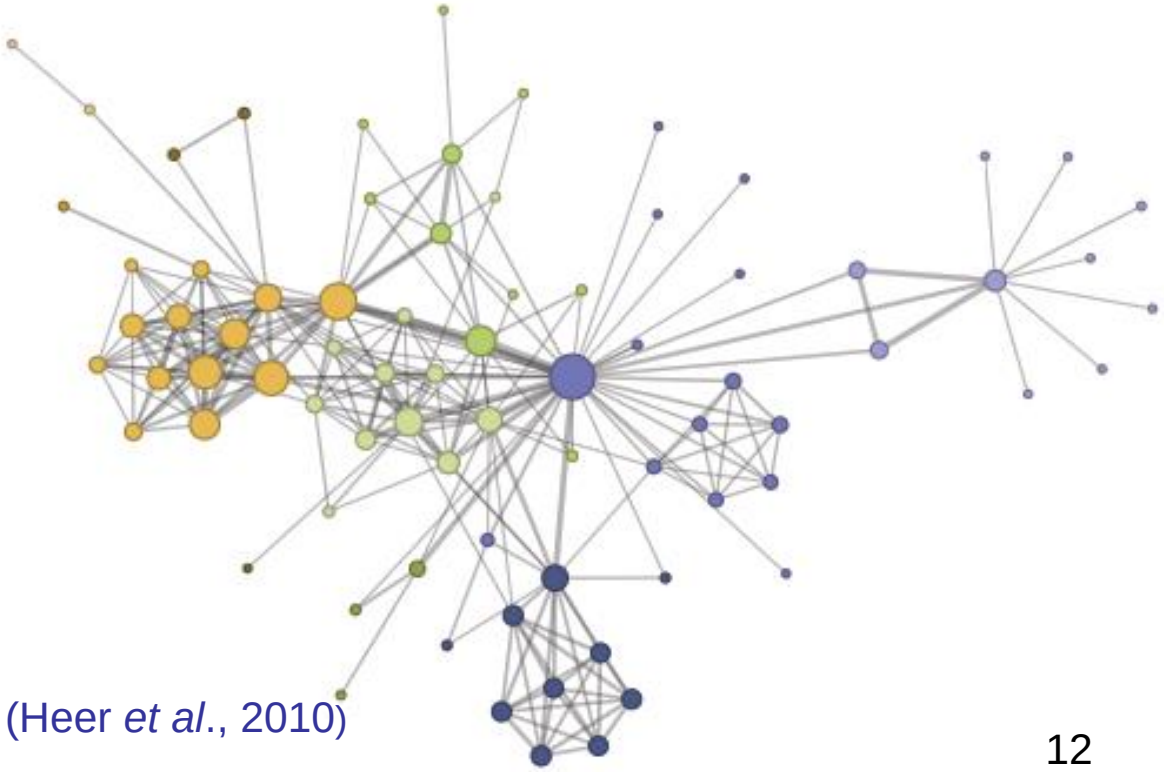

(Heer *et al*., 2010)

• The **matrix views** represent the adjacency matrix of a graph

• Using color or saturation instead of text allows values associated with the links to be perceived more rapidly

•, The seriation problem also applies

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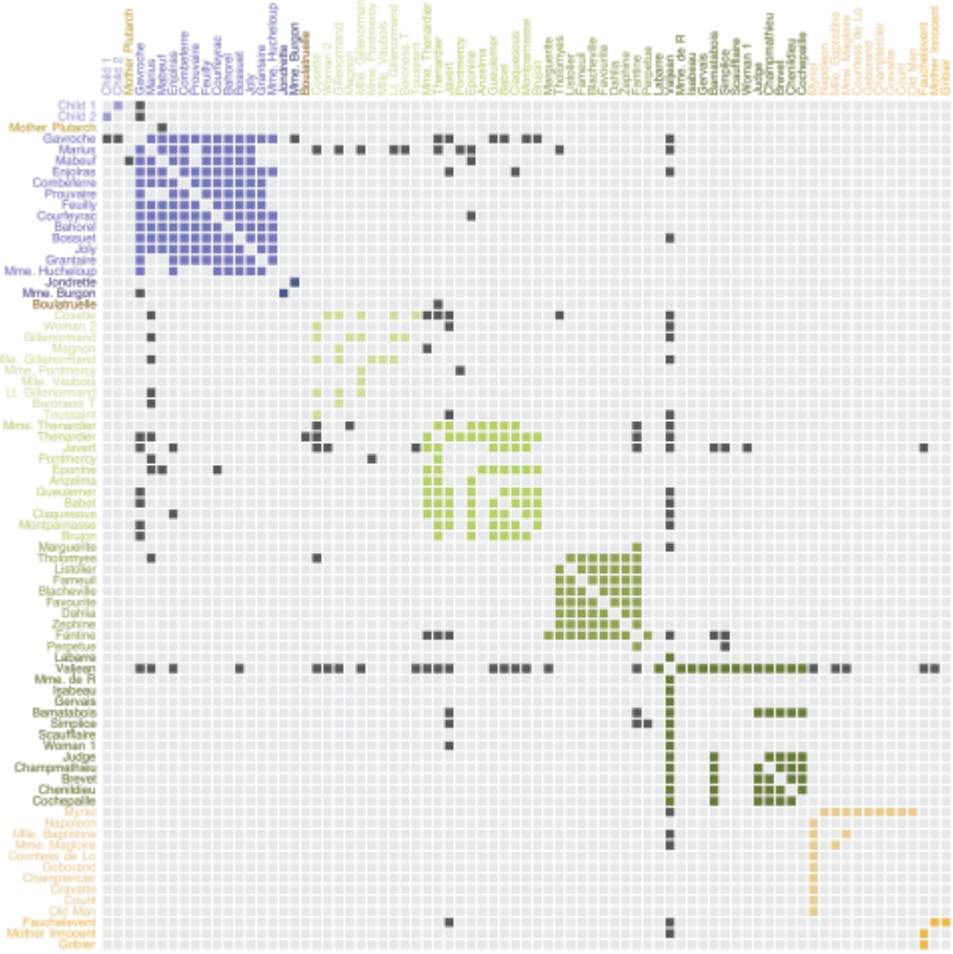
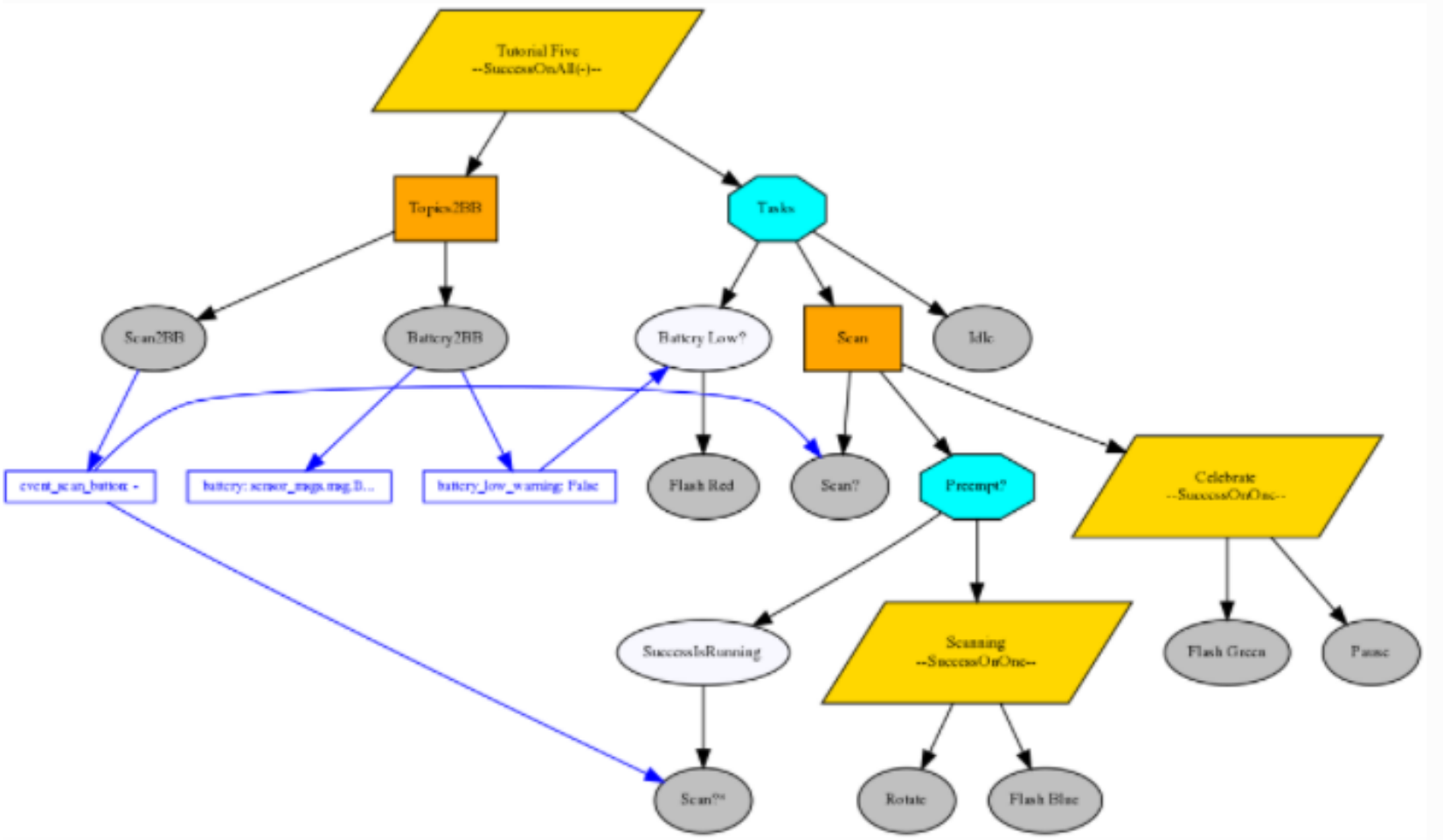


(Heer *et al*., 2010)

Example of graph visualization: The ROS Computation Graph



five_action_clients.py#tutorial_create_root

[Tutorials — py_trees_ros_tutorials 2.1.0 documentation]

- The previous representations show relations with no restriction upon what is connected (networks)

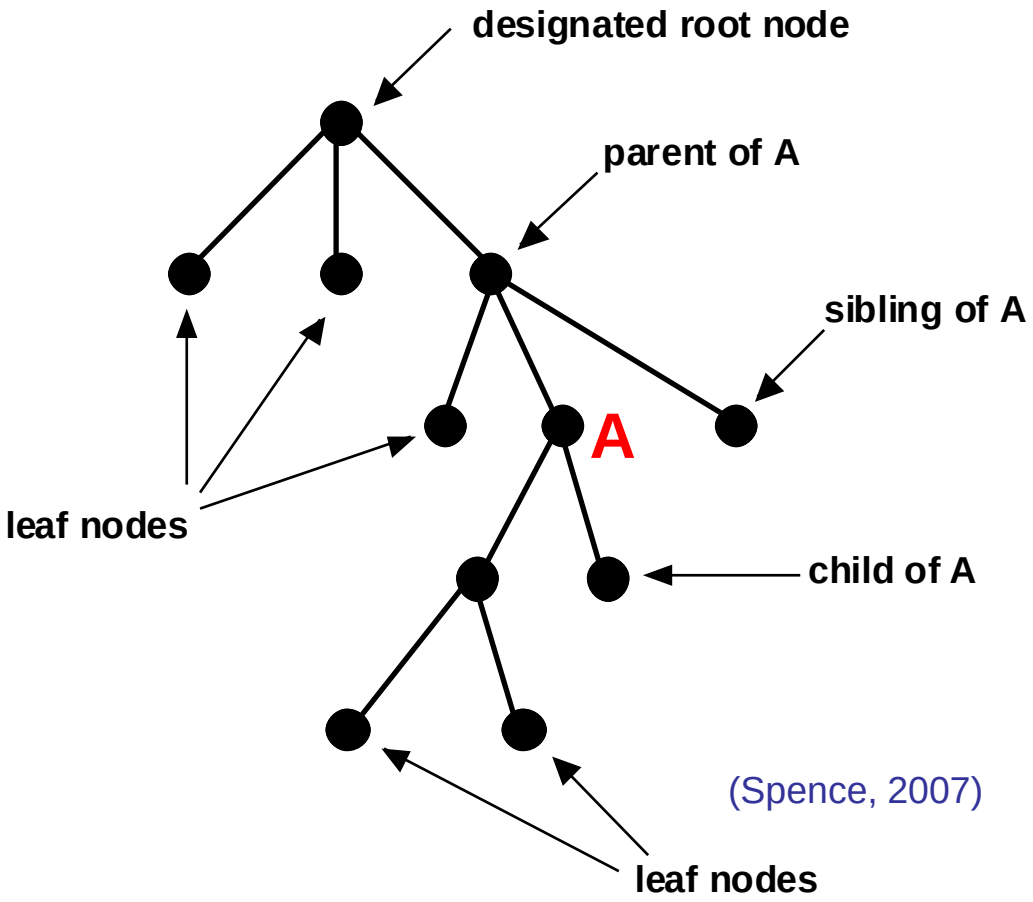
- Trees are a class of networks which have no loops

- There are several common representations:

  - tree maps

  - hyperbolic browser

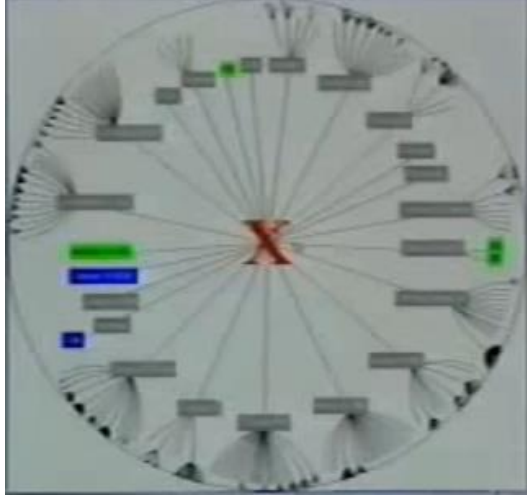
  - sunburst …



(Spence, 2007)

- Can you think of application domains where representing tree is important?

- The **Hyperbolic Browser** (Lamping et al., 1995) represents a tree within a circle



Hyperbolic Tree Browser -- 1995

- It is based on a hyperbolic geometric transformation:
  - the designated root node is at the center
  - its children are distributed around it at a particular distance
  - as the number of levels increase:
    - the distance between each node and its parent decreases
    - the size of the node also decreases
  - drawing stops at one pixel resolution

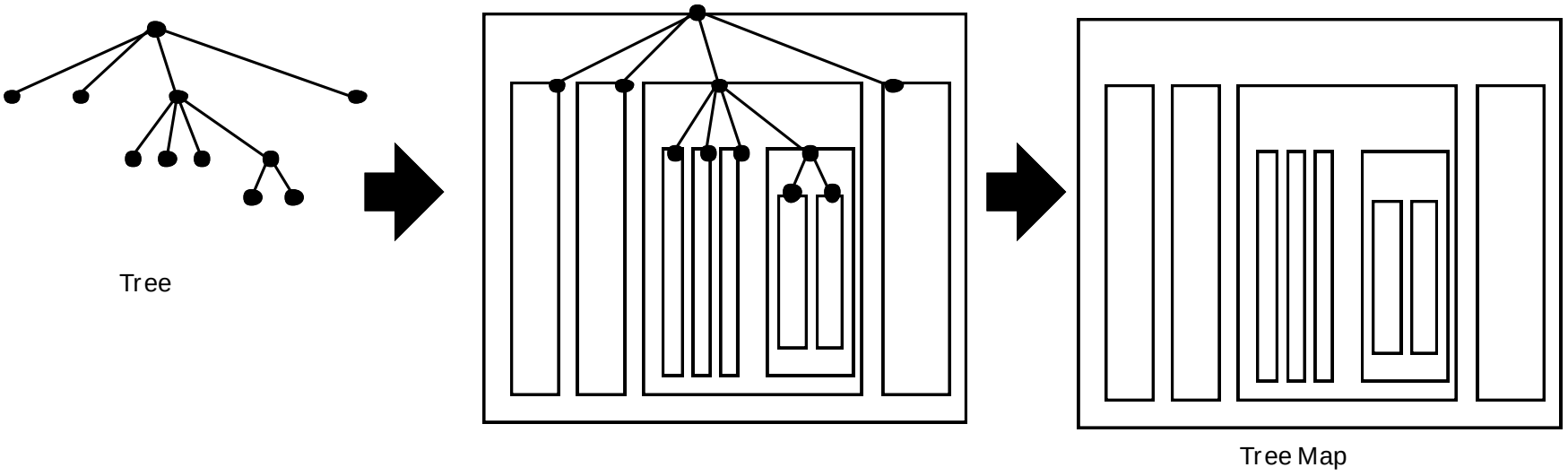
- The principal advantage is its interactive nature: any node of interest can be moved to the center

• The **Treemap** (Jonhson and Shneiderman, 1991) is another representation of a tree:

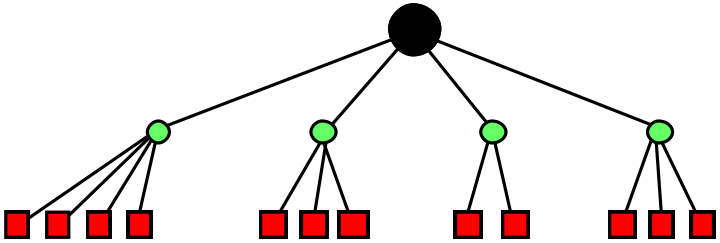
- the root node is represented by a rectangle (usually as large as possible)

- within this rectangle there are smaller rectangles (one for each child node)

- this is repeated until all the nodes are represented

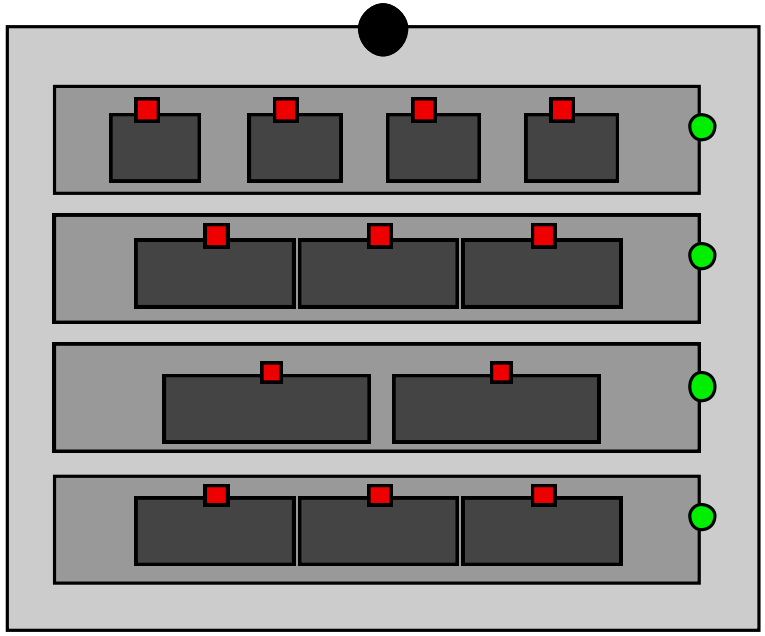


The construction of a Tree Map (Spence, 2007)



Tree

Tree Map

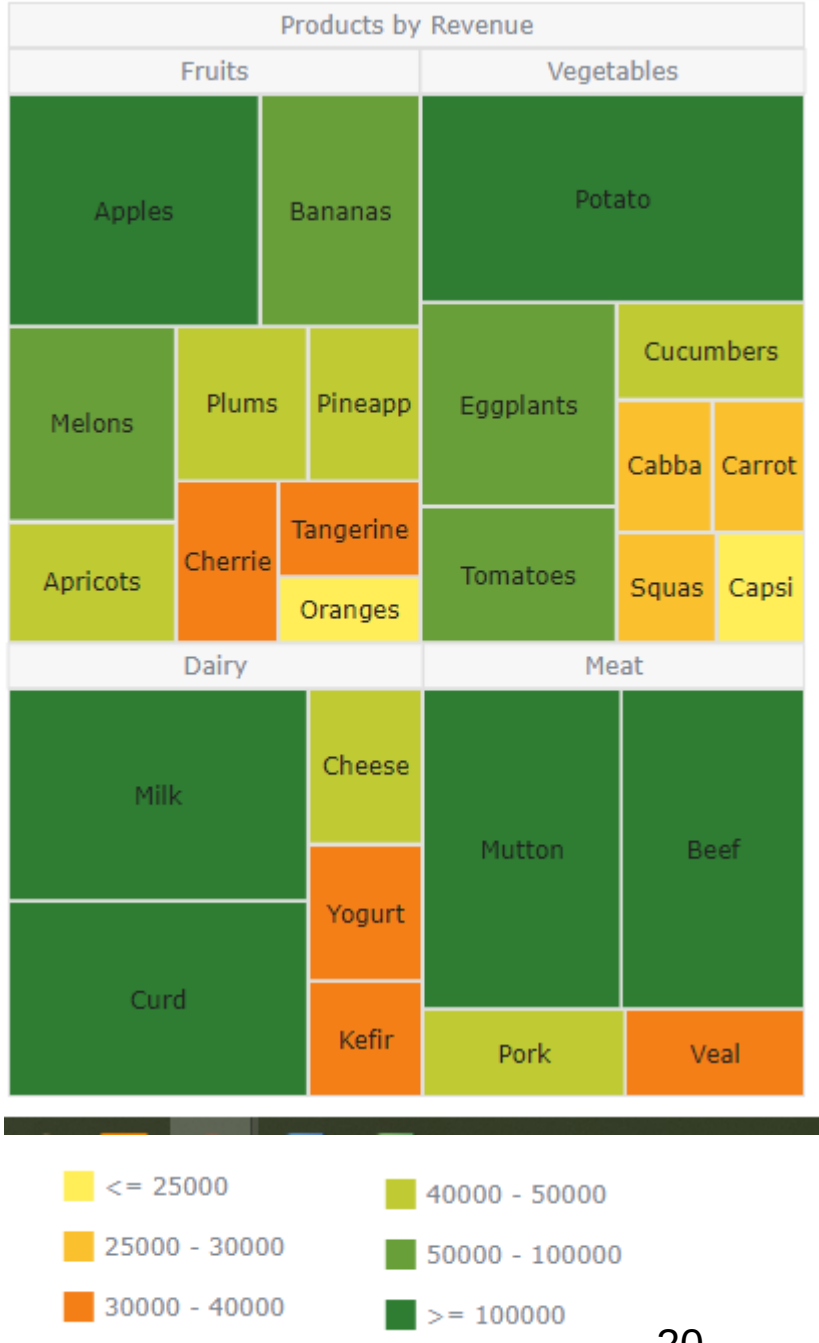


The ‘slice-and-dice’ construction of a Tree Map to obtain leaf nodes represented by rectangles more suited to the inclusion of text and images (Spence, 2007)

Visualization Lecture - Treemap Construction

Main advantages of Treemaps:

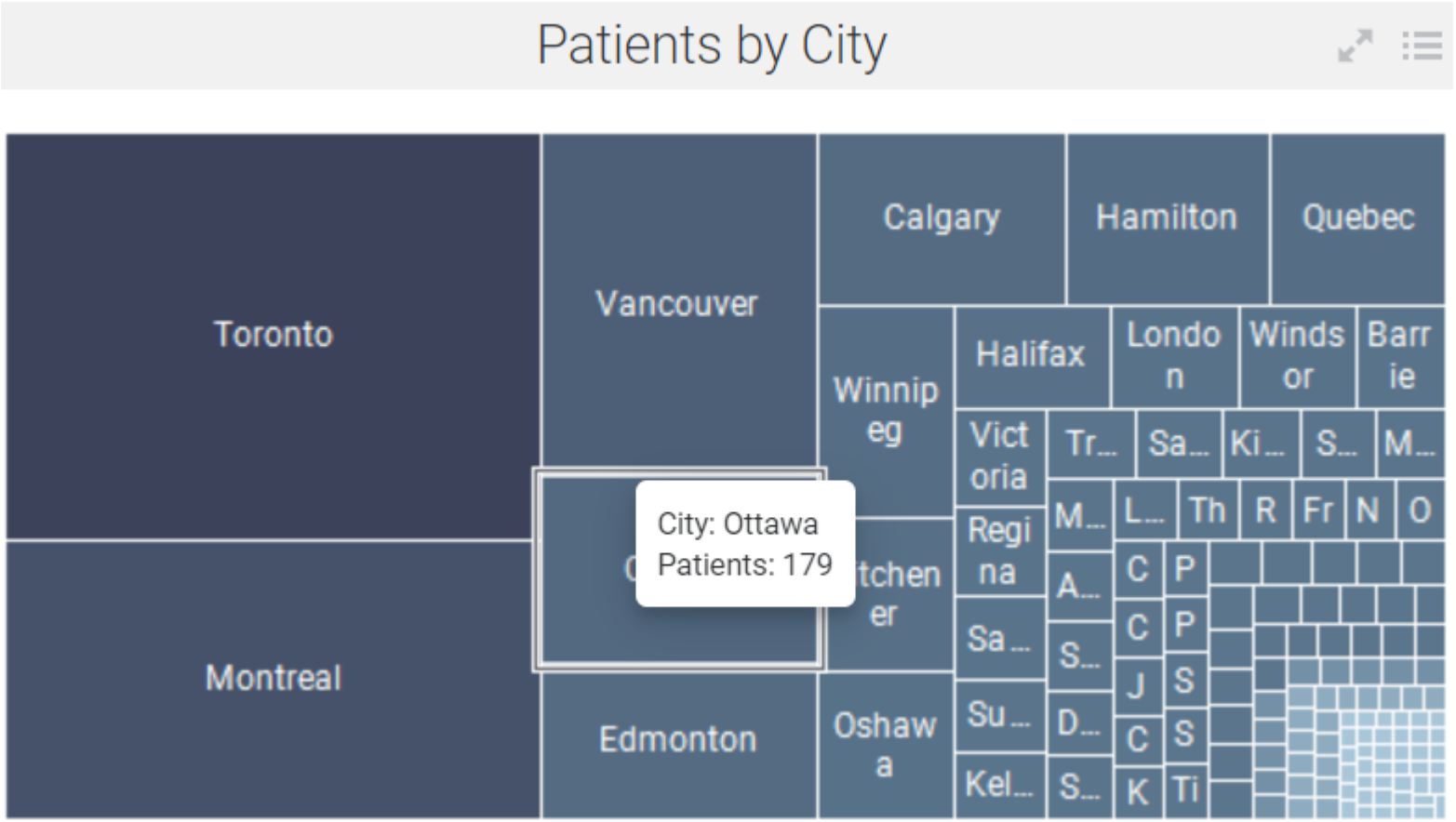
- Allow identifying the relationship between two elements in a hierarchy
- optimize the use of space
- accurately display multiple elements together
- show ratios of each part to the whole



- The treemap offers a lot of opportunities for

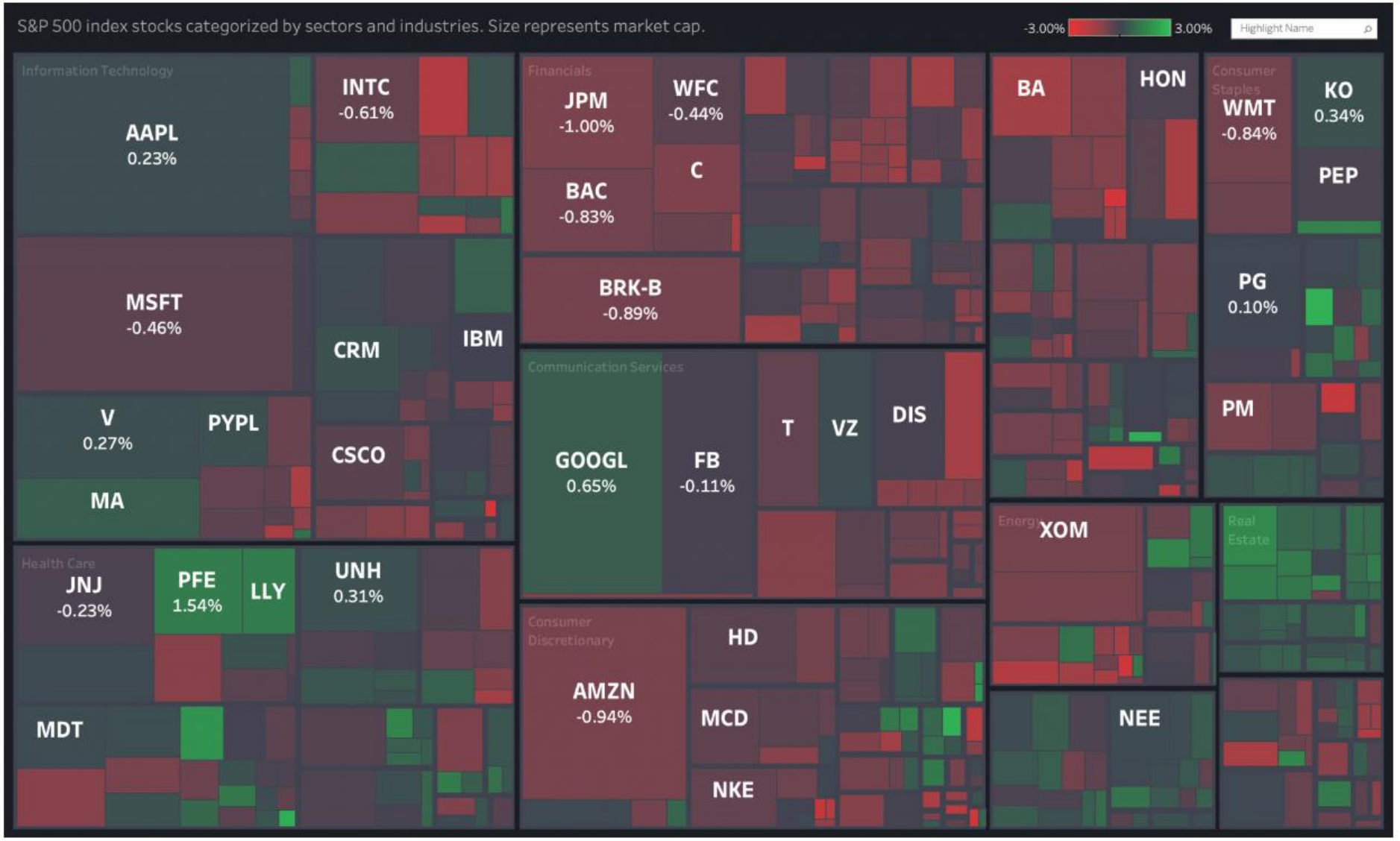
  - encoding by color and area

  - interaction by mouse-over and selection of further detail by mouse click



[Heart Disease Prevalence | TIBCO Software]

Example: Using a treemap to visualize stock markets

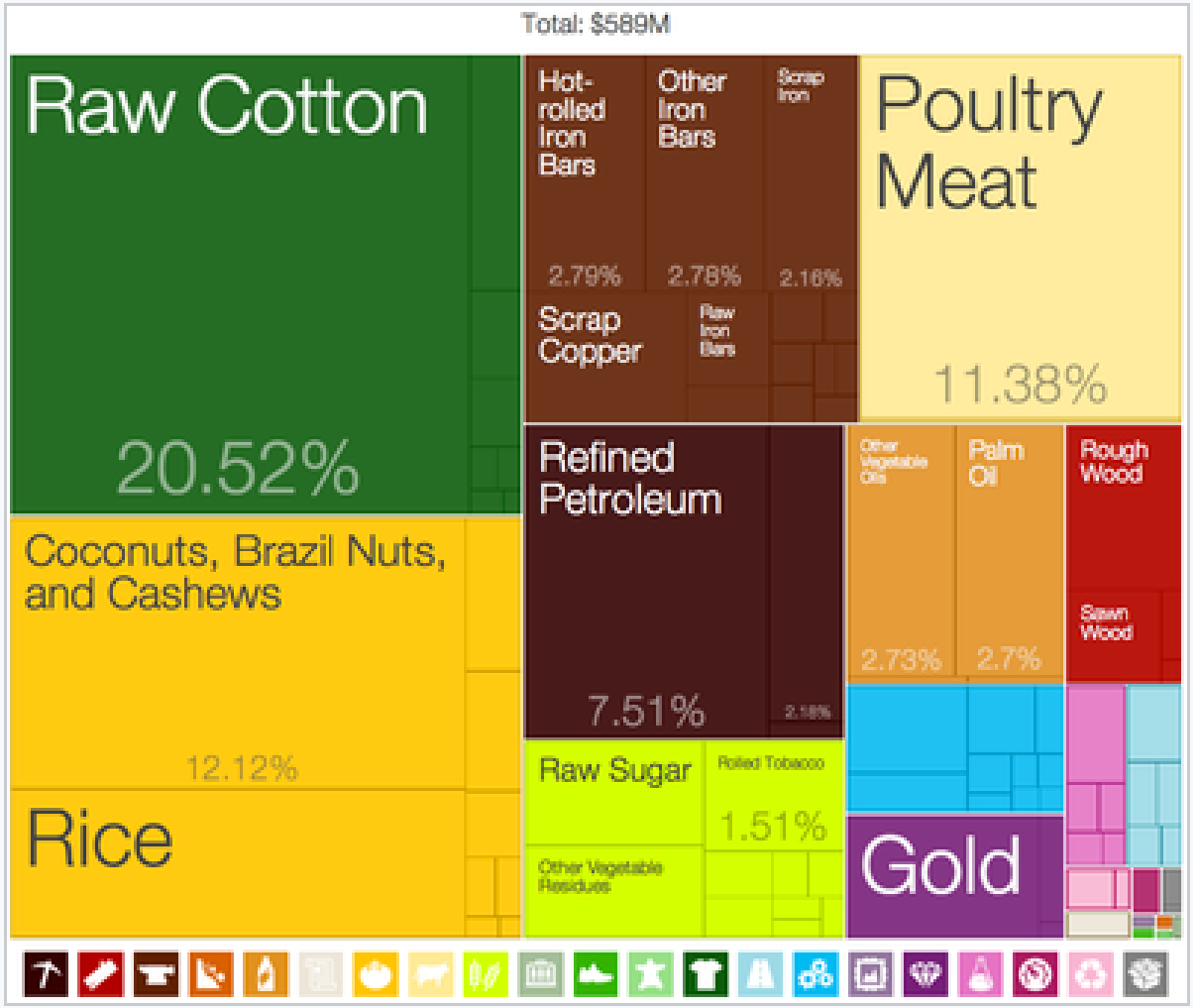


Status of companies within a number of sectors

[Financial Analytics in Tableau: Viz Finance]

- A typical example in stock market analysis

S&P 500 Map



Treemap of Benin's exports by product category, 2009. The Product Exports Treemaps are one of the most recent applications of these kind of visualizations, developed by the Harvard-MIT Observatory of Economic Complexity

Treemapping - Wikipedia

• The **Sunburst** is another enclosure diagram used to represent a tree

• Also known as Ring Chart, Multi-level Pie Chart, and Radial Treemap

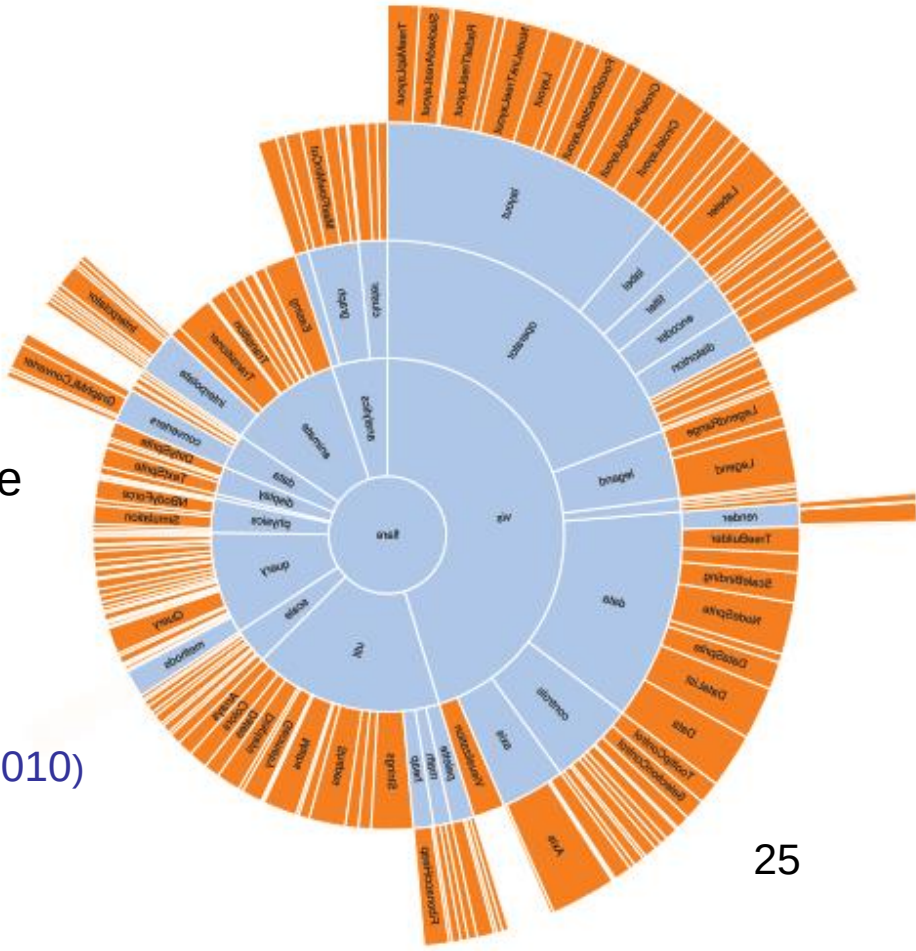
• An inner circle surrounded is by rings of deeper hierarchy levels

• The angle of each segment is:

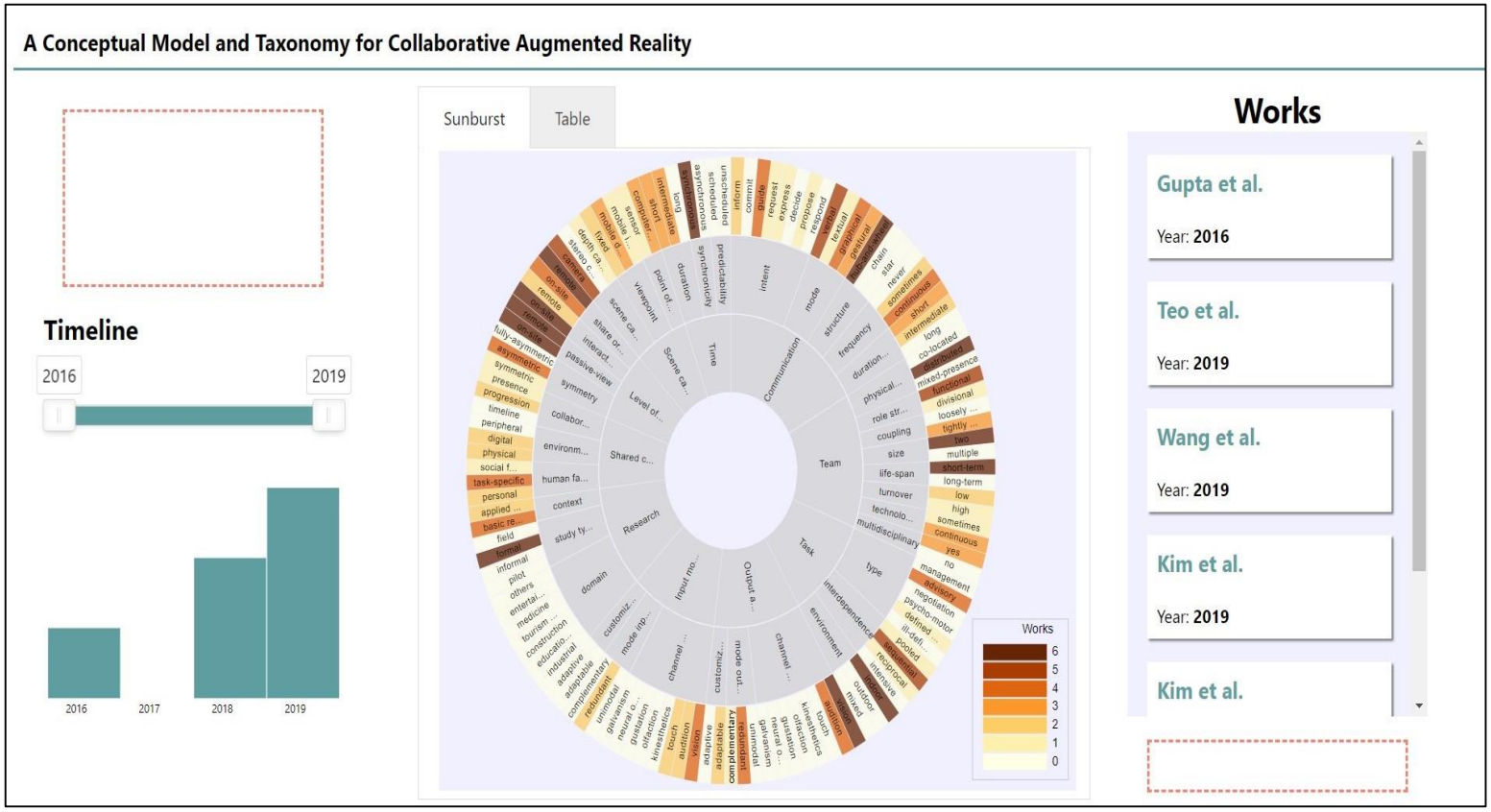
  - divided equally under its parent node
  or
  - proportional to a value

• All segments may be colored according to category or hierarchy level (Heer *et al*., 2010)

SunBurst Page



Example: Using a Sunburst to visualize a taxonomy of papers

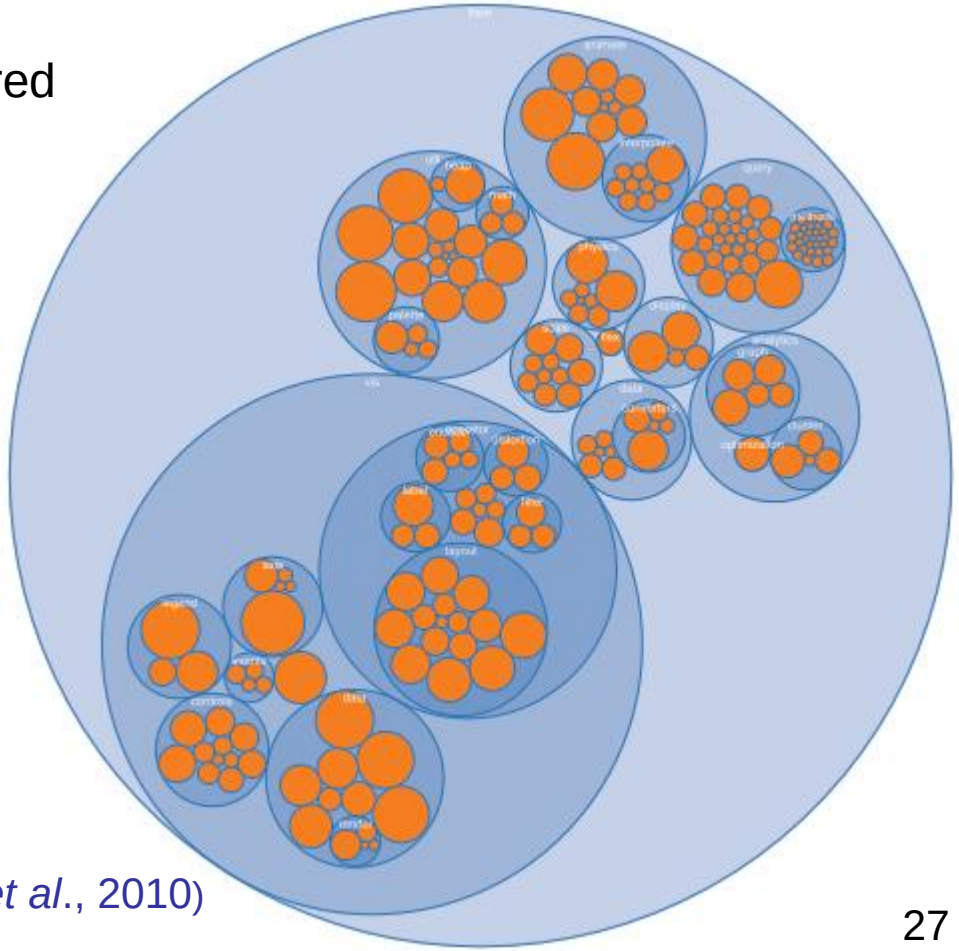


[Survey Viewer]

- The **nested circles** layout is a different sort of enclosure

- It does not use space as efficiently as a treemap, but it effectively reveals the hierarchy

- Node sizes can be rapidly compared using area judgments.



(Heer *et al*., 2010)

• The **dendrogram** is a branching diagram that represents the relationships of similarity among a group of entities

• It is used to visualize the result of clustering (group samples by similarity)

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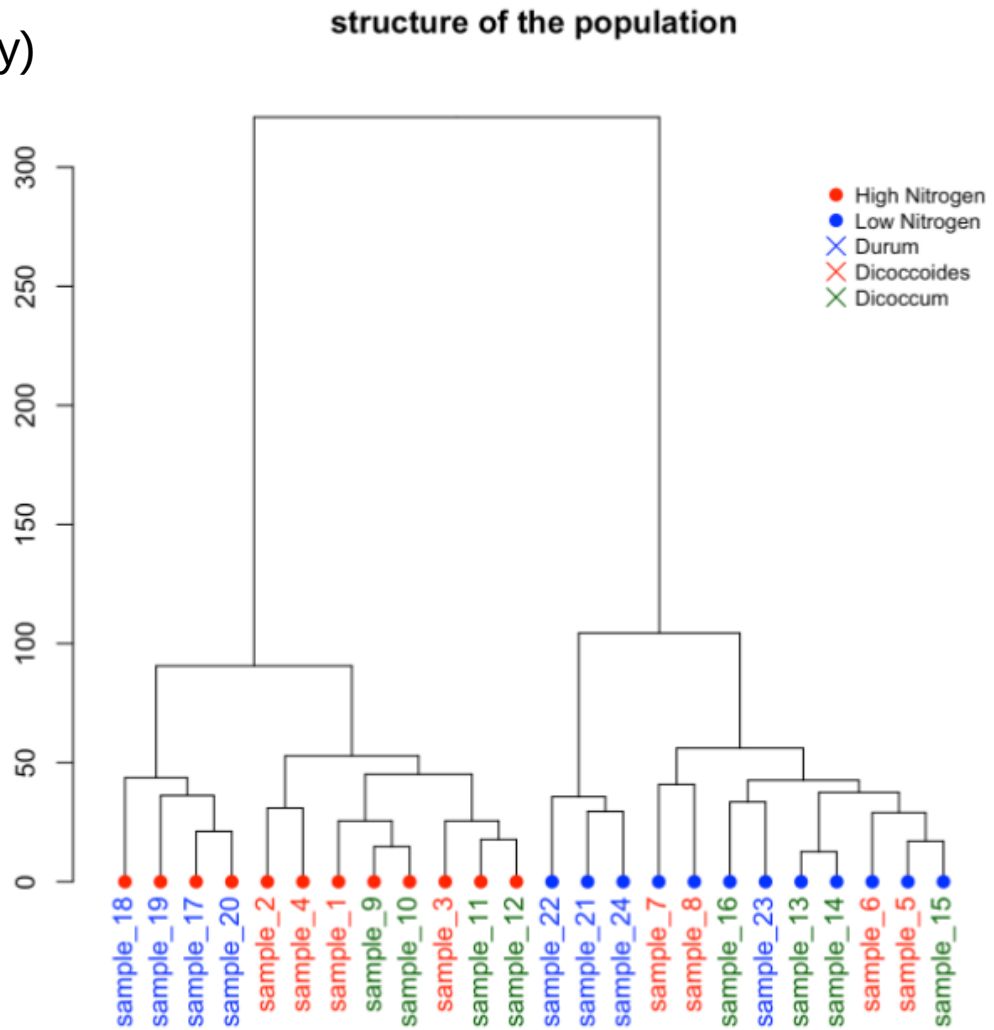
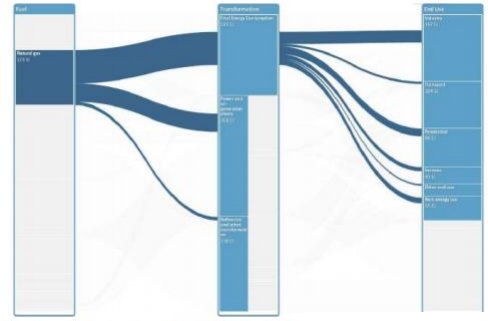
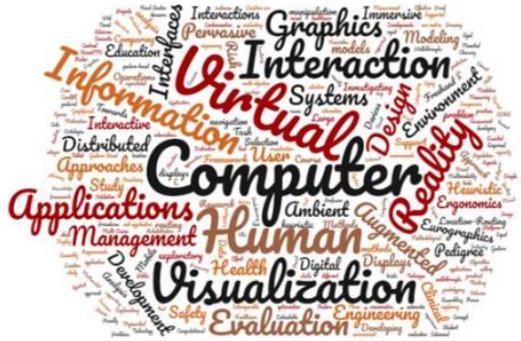
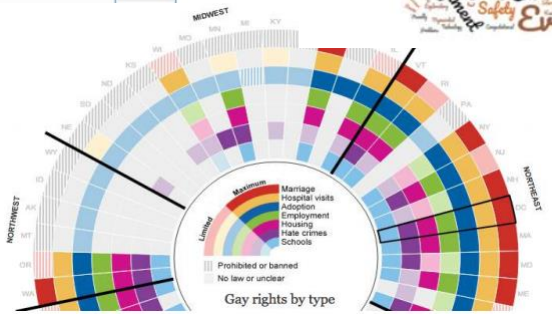


Most basic dendrogram for clustering with R – the R Graph Gallery

Representation III - other …



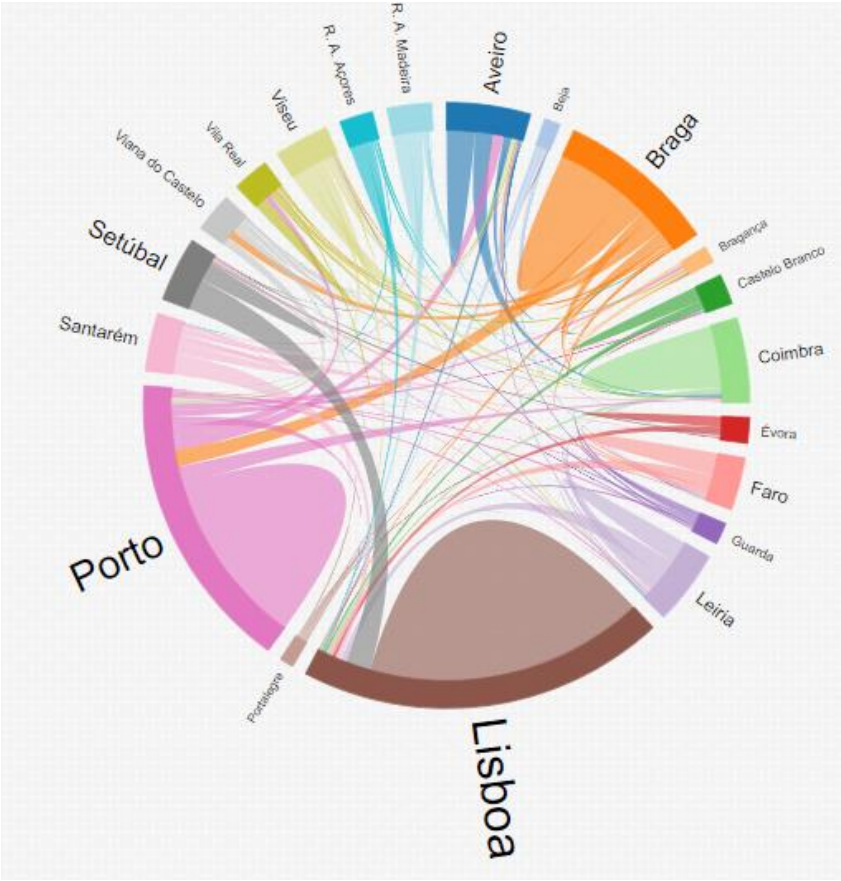


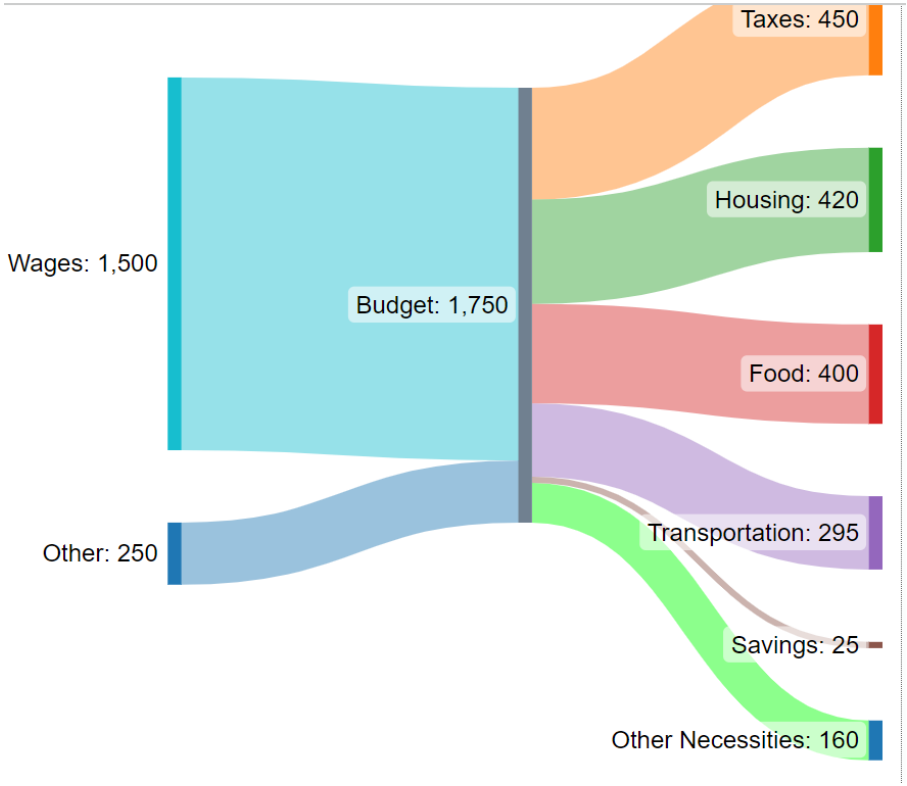


“ **many more … visualization exist** … Emerging domains such as bioinformatics and text visualization are driving researchers and designers to continually formulate new and creative representations … the DNA underlying all visualizations remains the same: the principled mapping of data variables to visual features such as position, size, shape and color…” (Heer *et al*., 2010)

Sankey diagrams

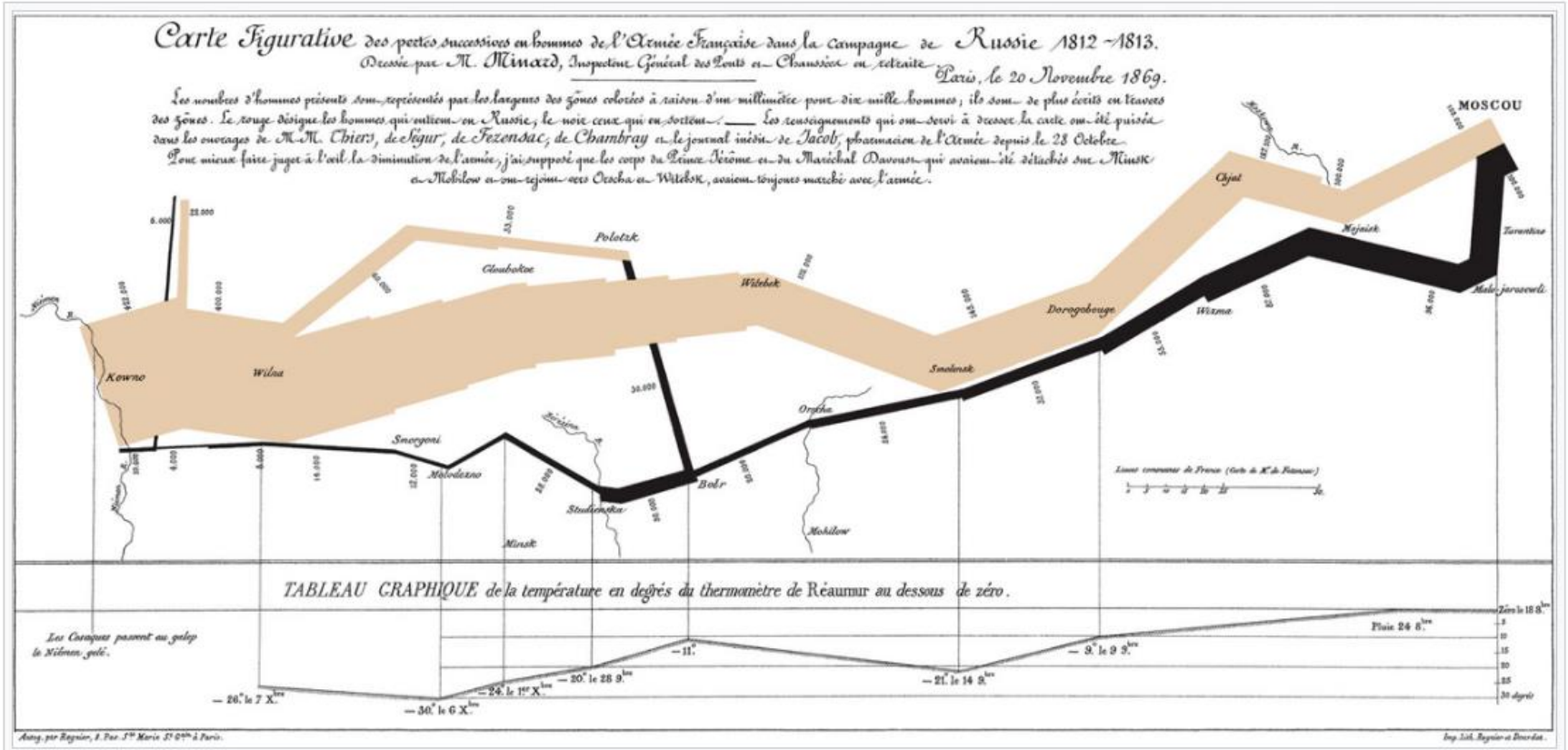
- Useful to convey the idea of flow





SankeyMATIC: Build a Sankey Diagram

A classical example:



Charles Minard's map of Napoleon's disastrous Russian campaign of 1812. The graphic is notable for its representation in two dimensions of six types of data: the number of Napoleon's troops; distance; temperature; the latitude and longitude; direction of travel; and location relative to specific dates

[Charles Joseph Minard - Wikipedia]

Word Cloud: simple representation of text

- Used to visualize free form text or tags

- After preprocessing the text the number of occurrences of each word is shown with font size or color

Wordl from R. Mazza, *Introduction to Information Visualization*, 2009 (chap.1):

“Data” was the most often used word

[Creating Emordle: Animating Word Cloud for Emotion Expression | IEEE TVCG2024]

Main Bibliography

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