

CS49000-VIZ - Fall 2020

## Introduction to Data Visualization

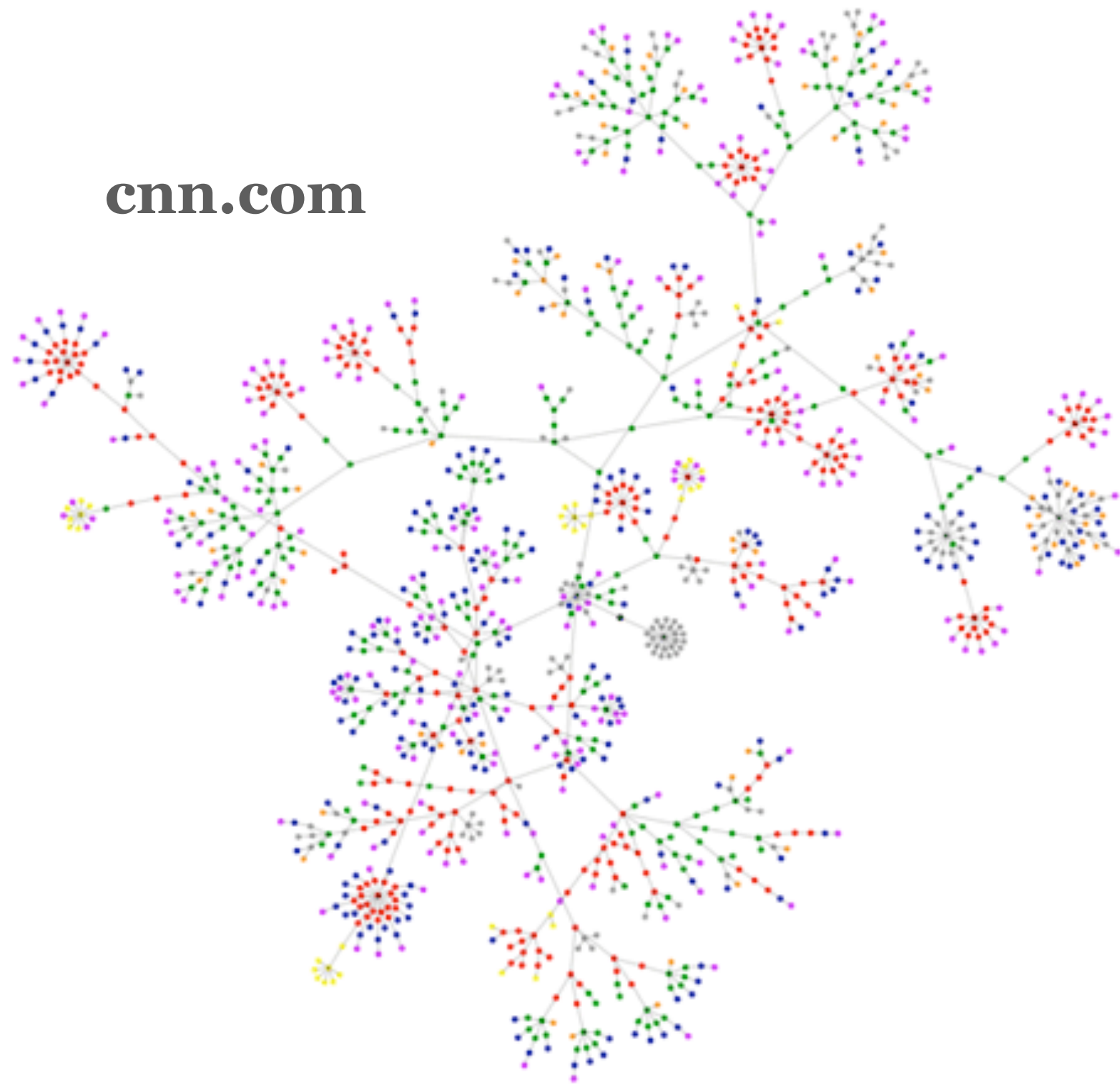
# Trees

## Lecture 9

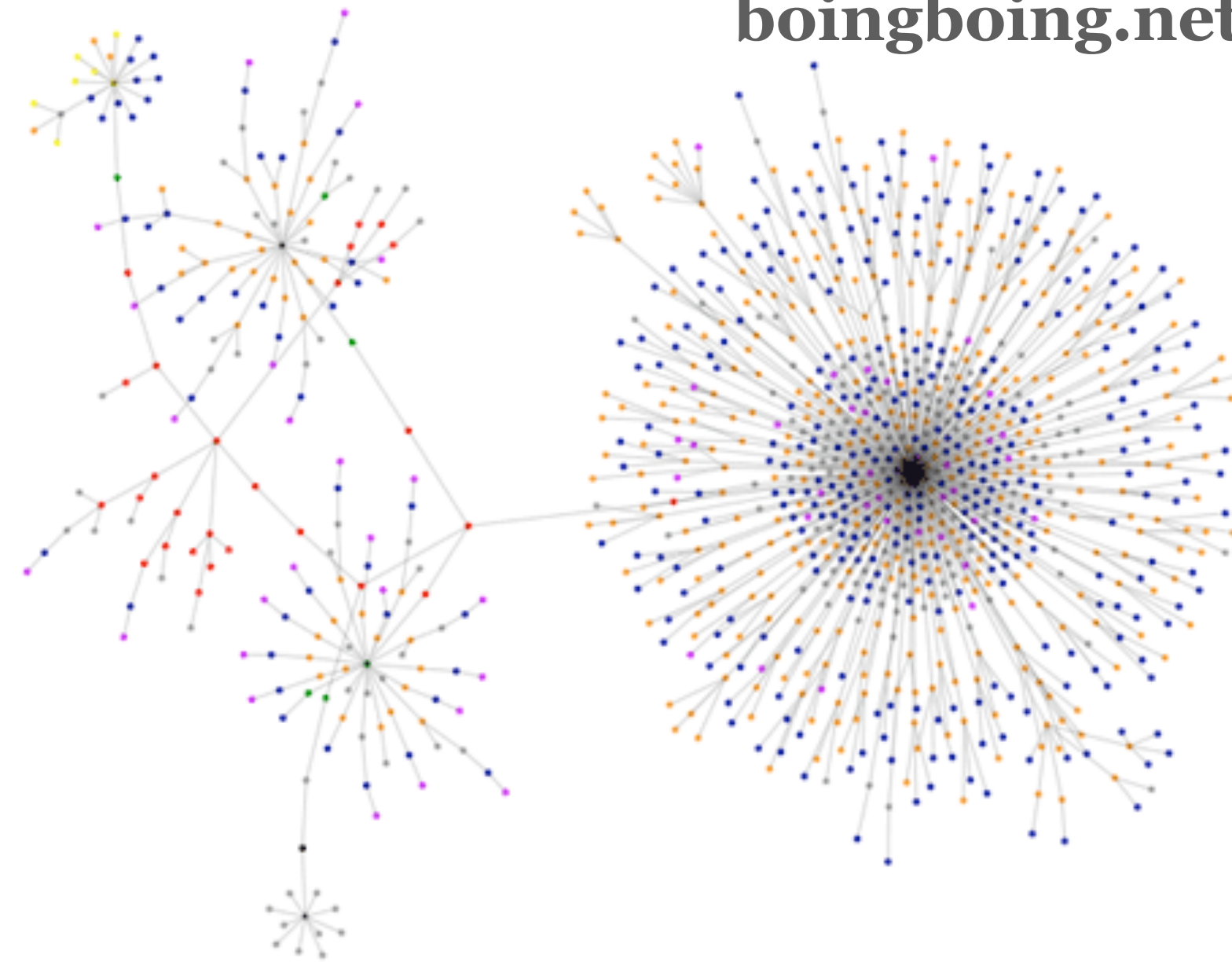
*Slides credits: T. Munzner (UBC)*

September 28, 2020

**cnn.com**



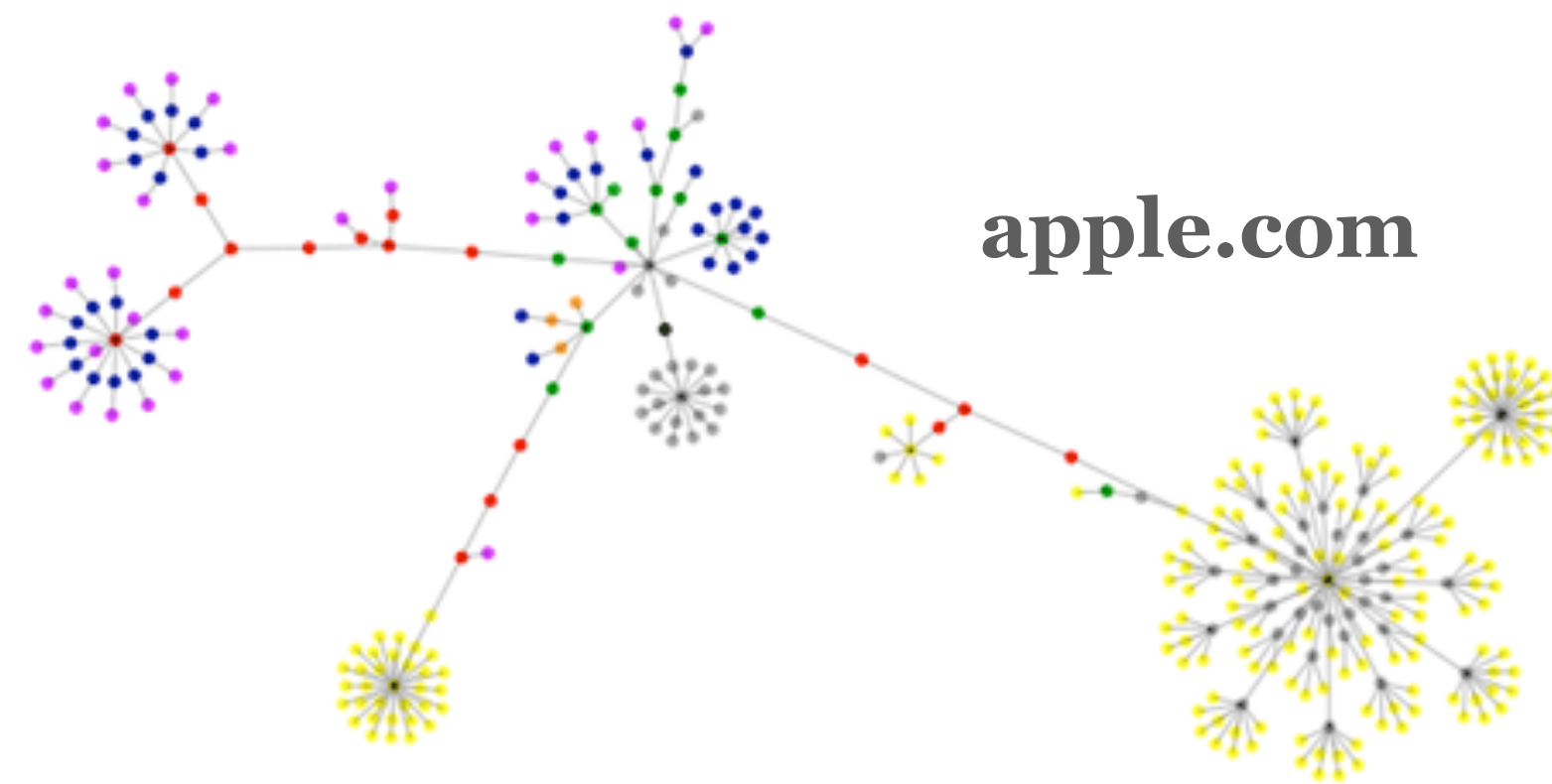
**boingboing.net**



**wired.com**

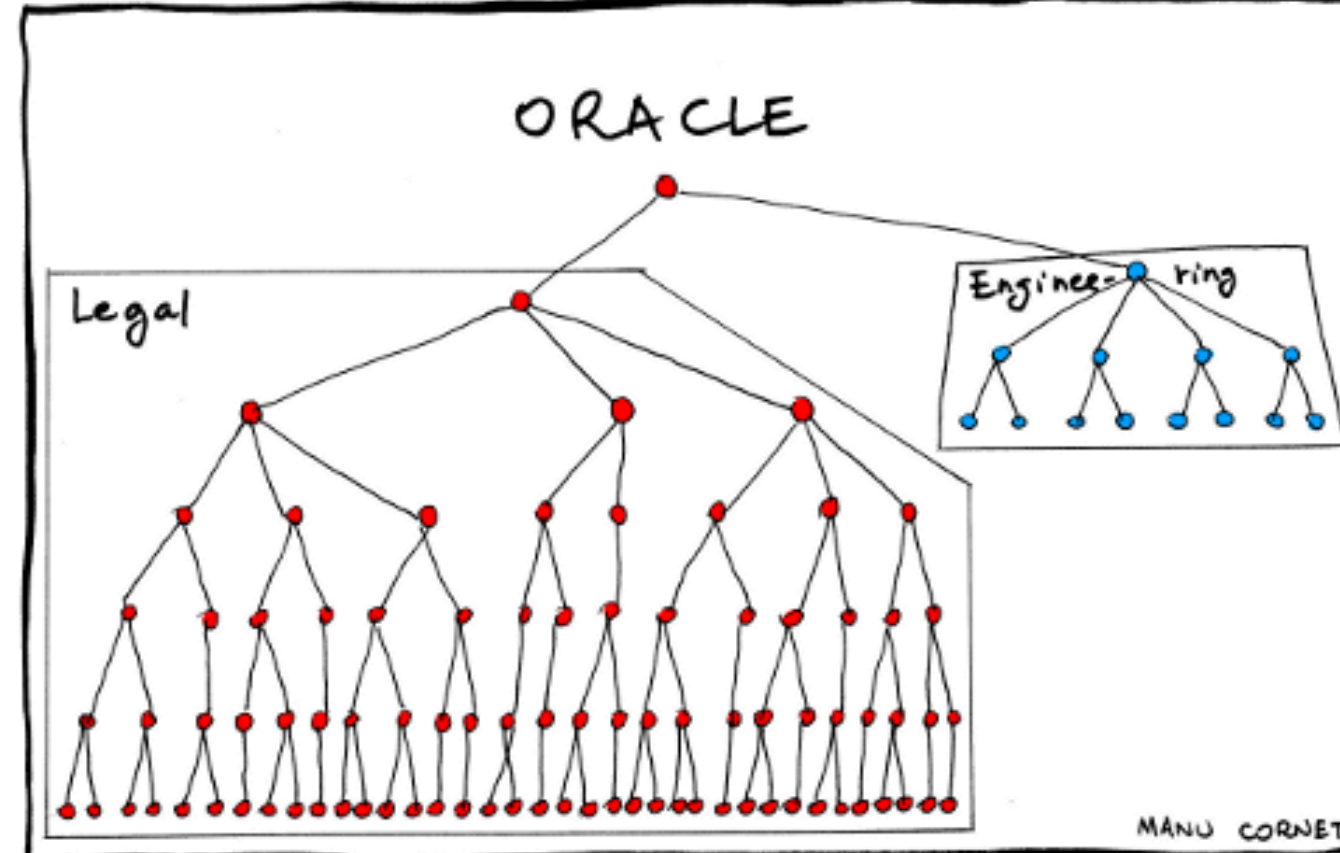
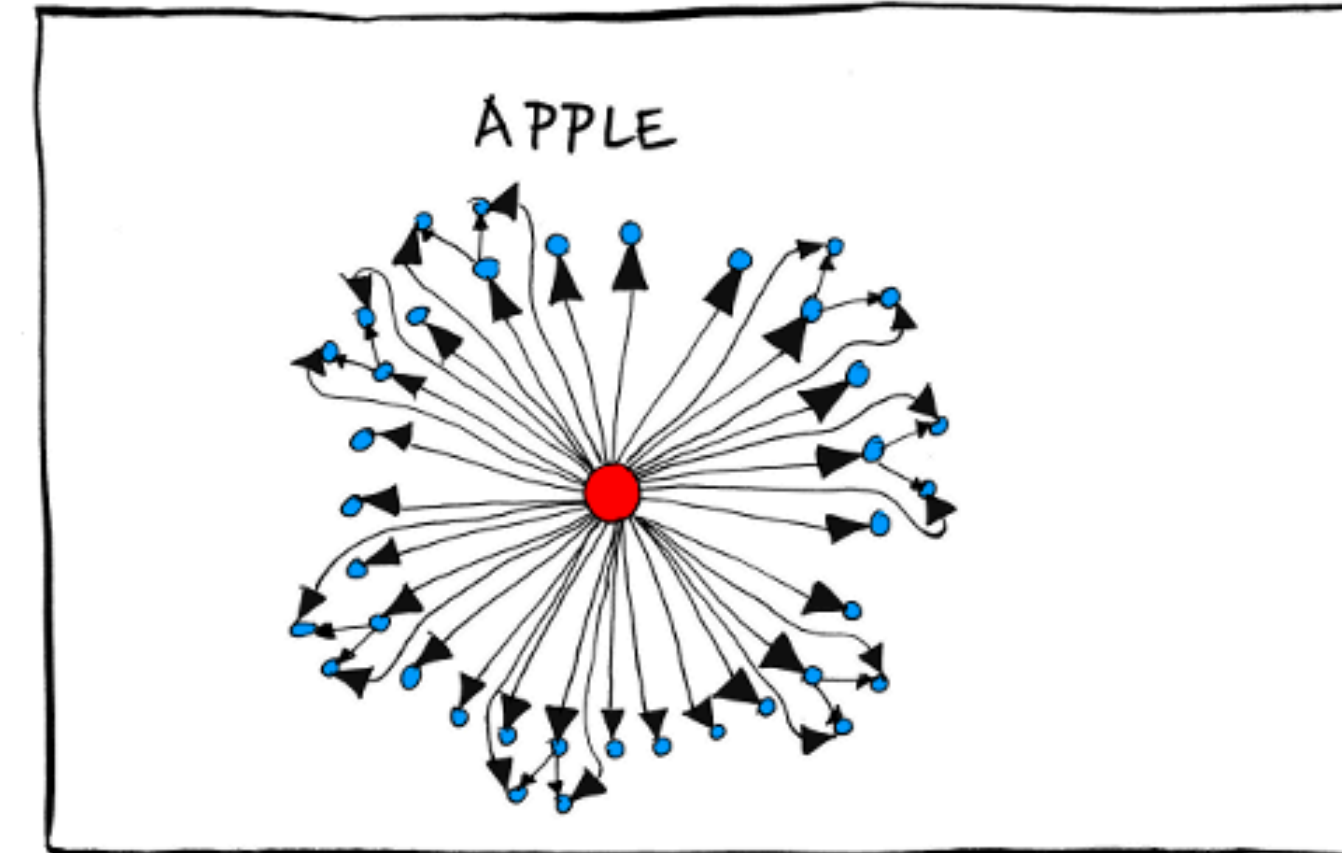
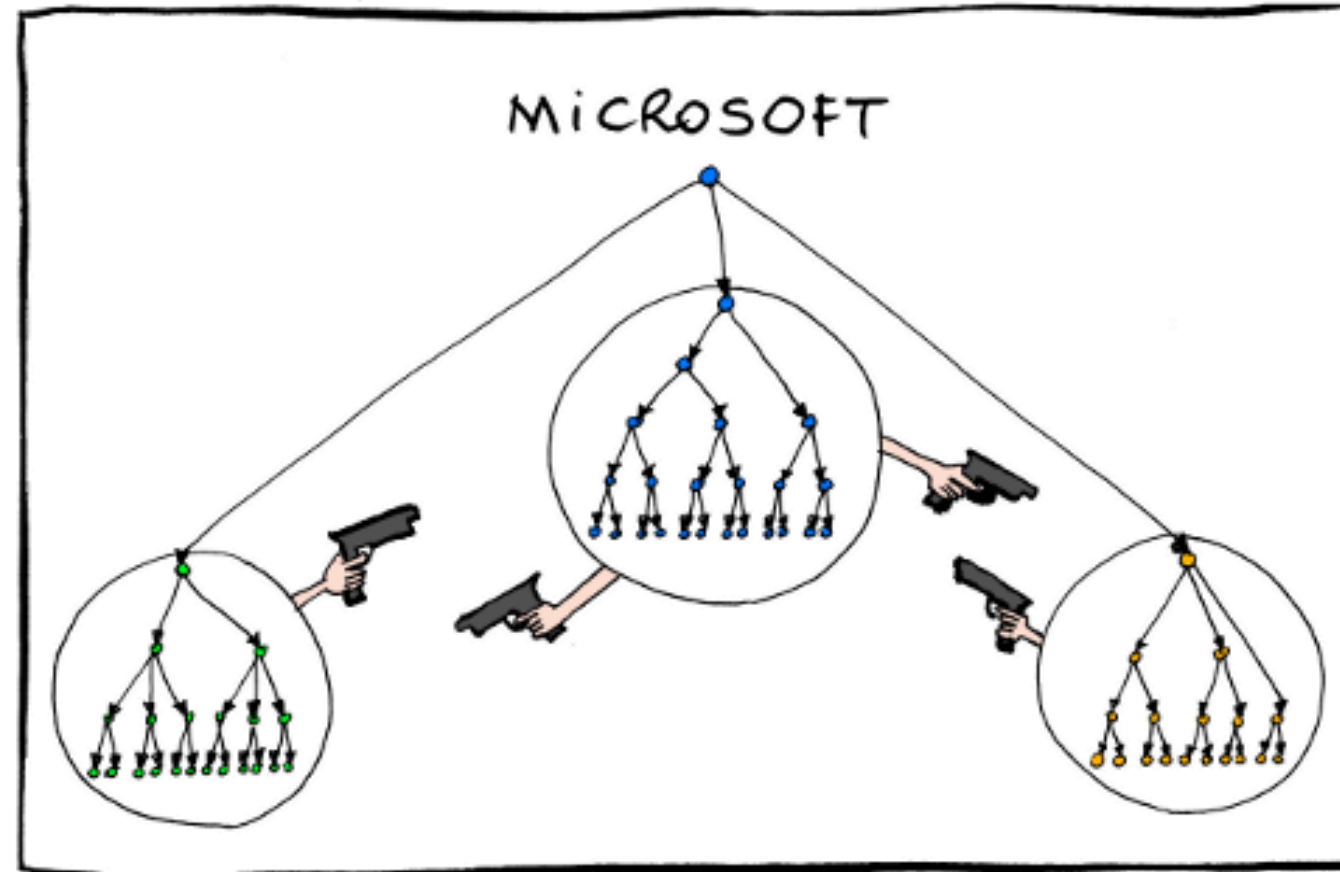
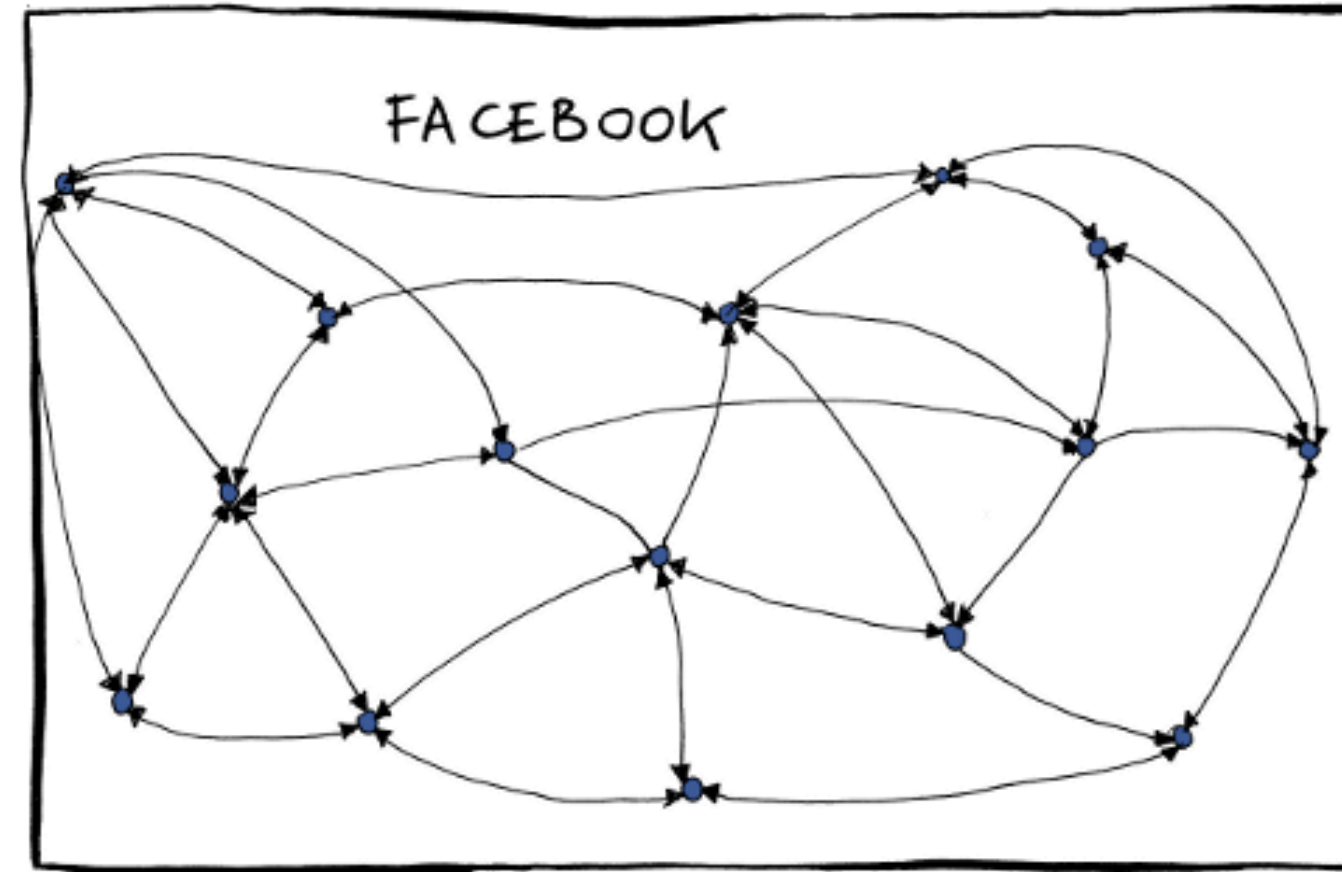
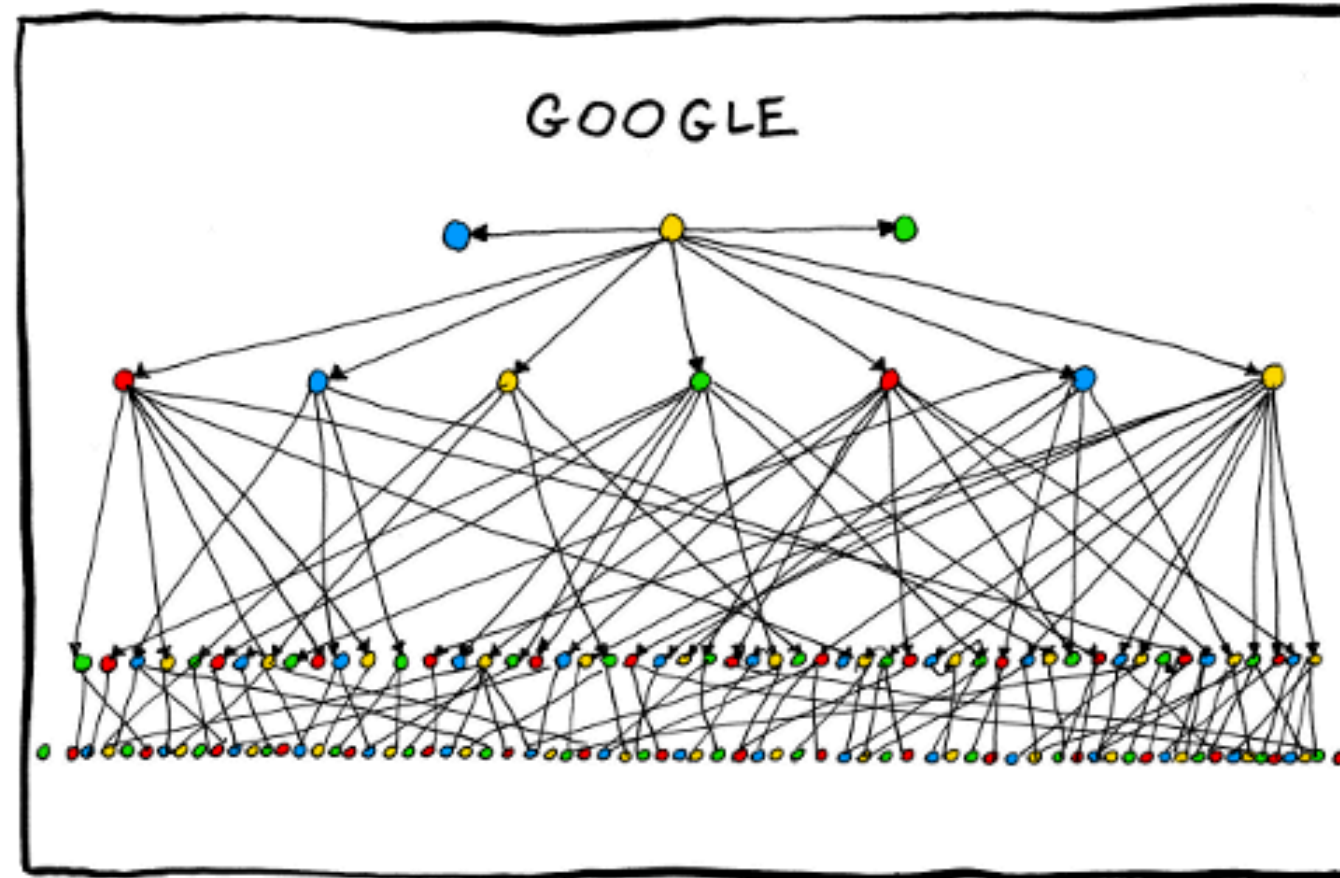
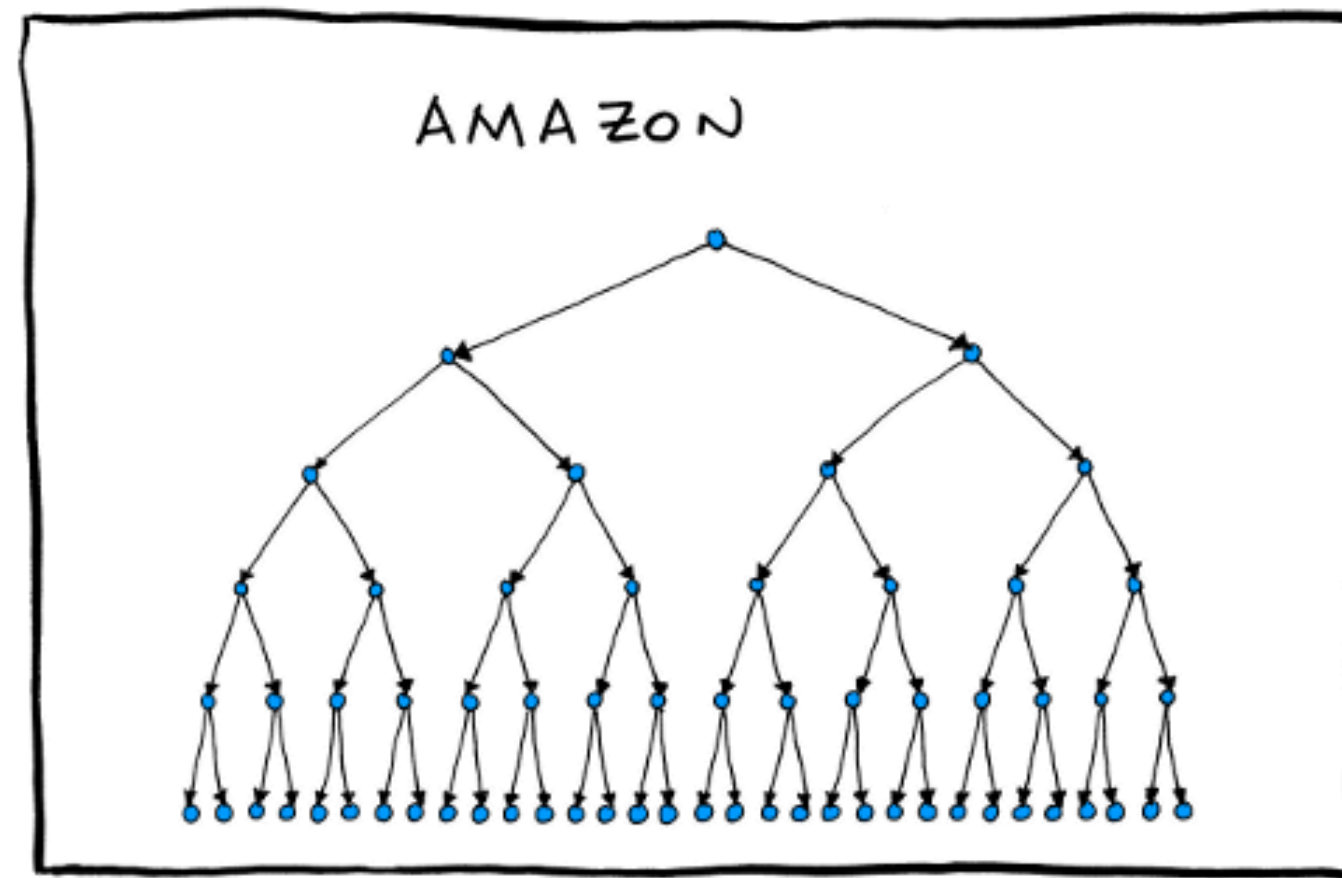


**apple.com**



**Webpages as Graphs**





# Tree terminology

## Root:

Node without parent (e.g., A)

## Internal node:

Node with at least one child (e.g., A, B, C, F)

## External node:

Node without children (e.g., E, I, J, K, G, H, D)

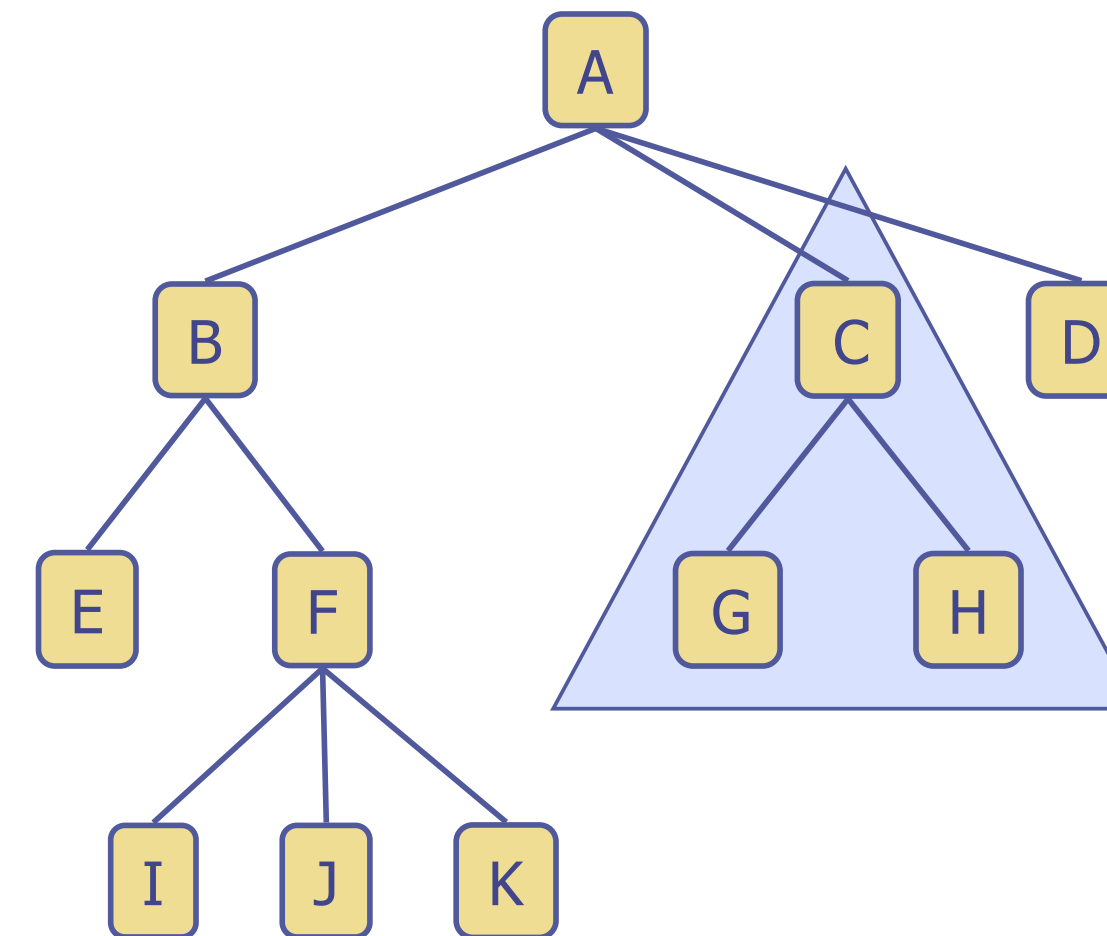
Also known as **leaf node**

Depth of a node:

- Number of ancestors

Height of a tree:

- Maximum depth of any node (e.g., 3)



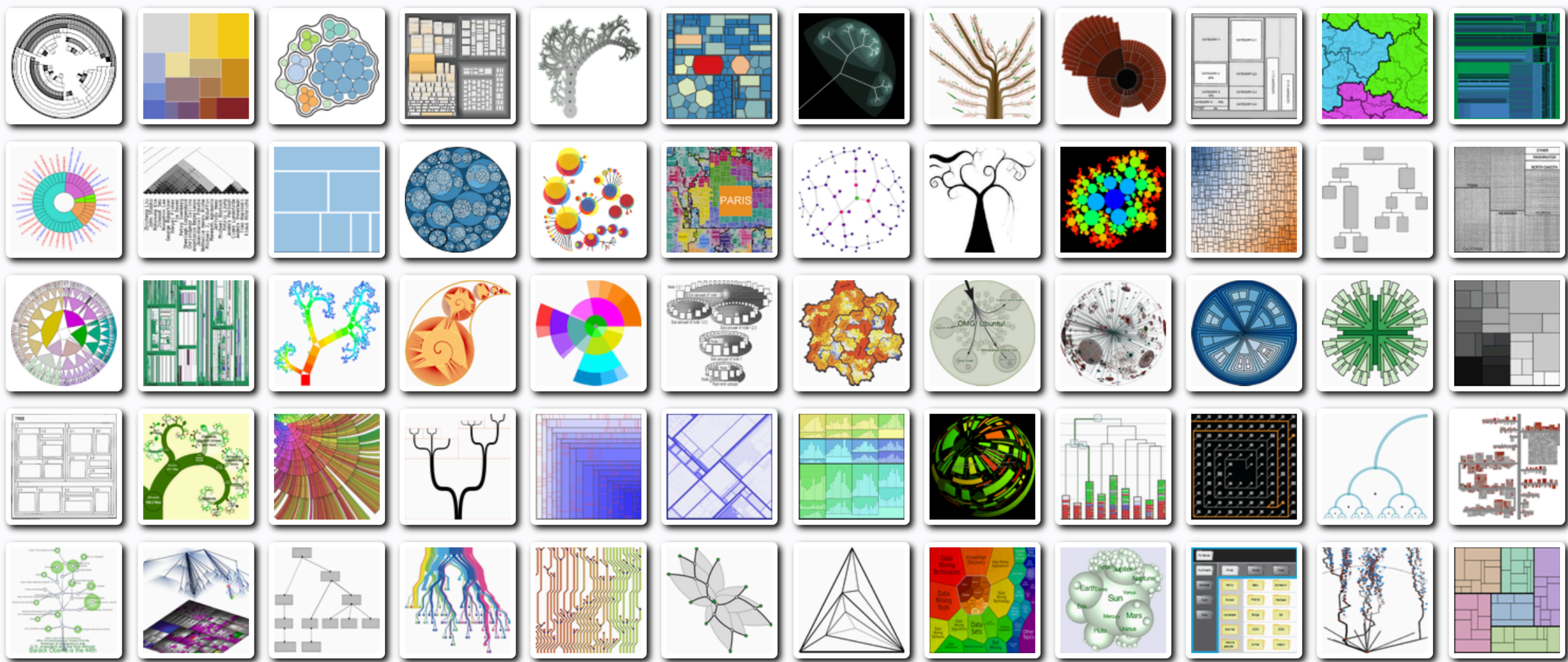
Subtree:

- Tree consisting of a node and its descendants



Dimensionality      Representation      Alignment      Fulltext Search      Techniques Shown

All     
 All     
 All     
  ×     
 **303**





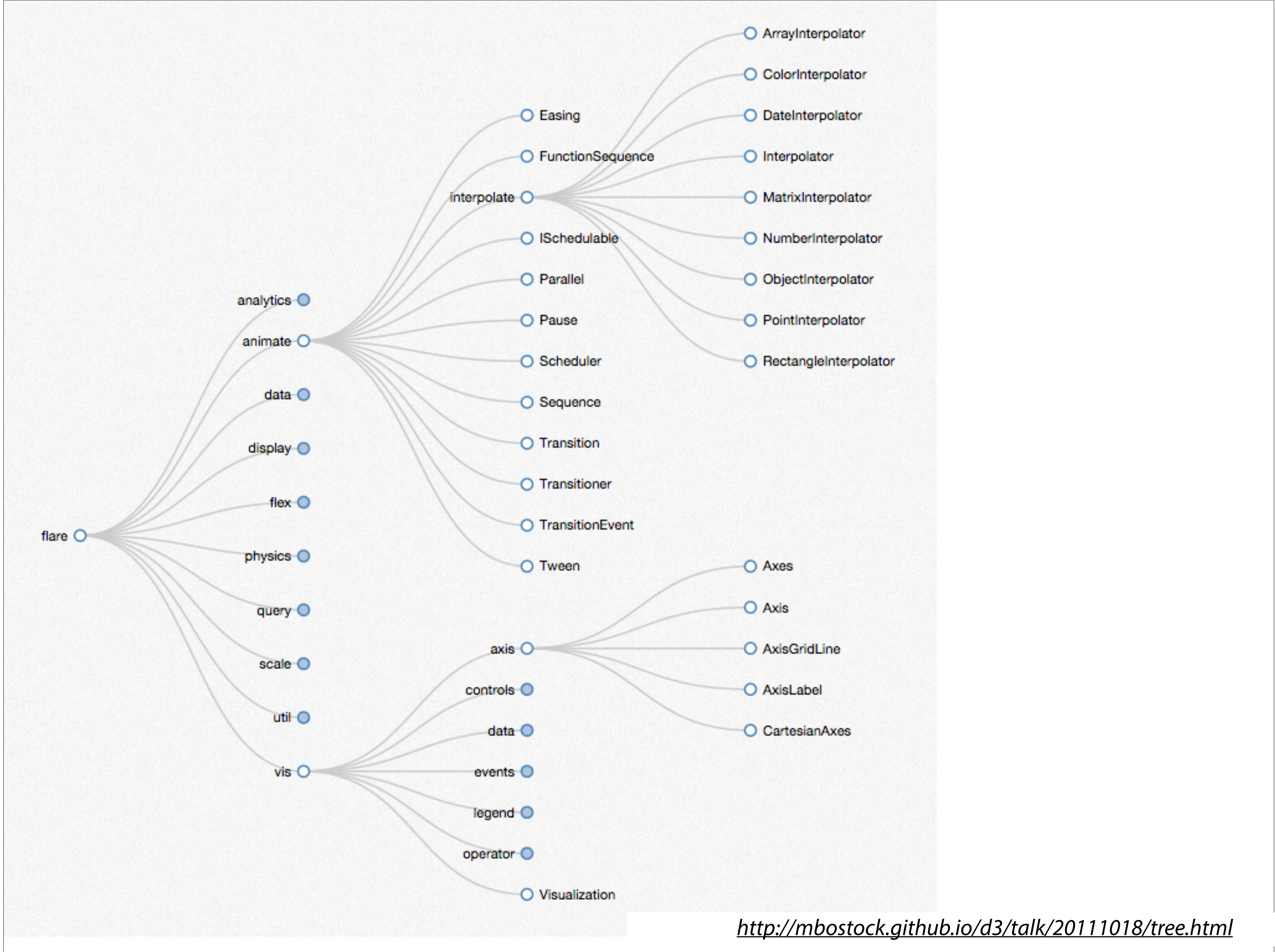
# Rooted Tree

- **recursion** makes it elegant and fast to draw trees
- approaches:
  - node link
  - layered
  - indentation - enclosure

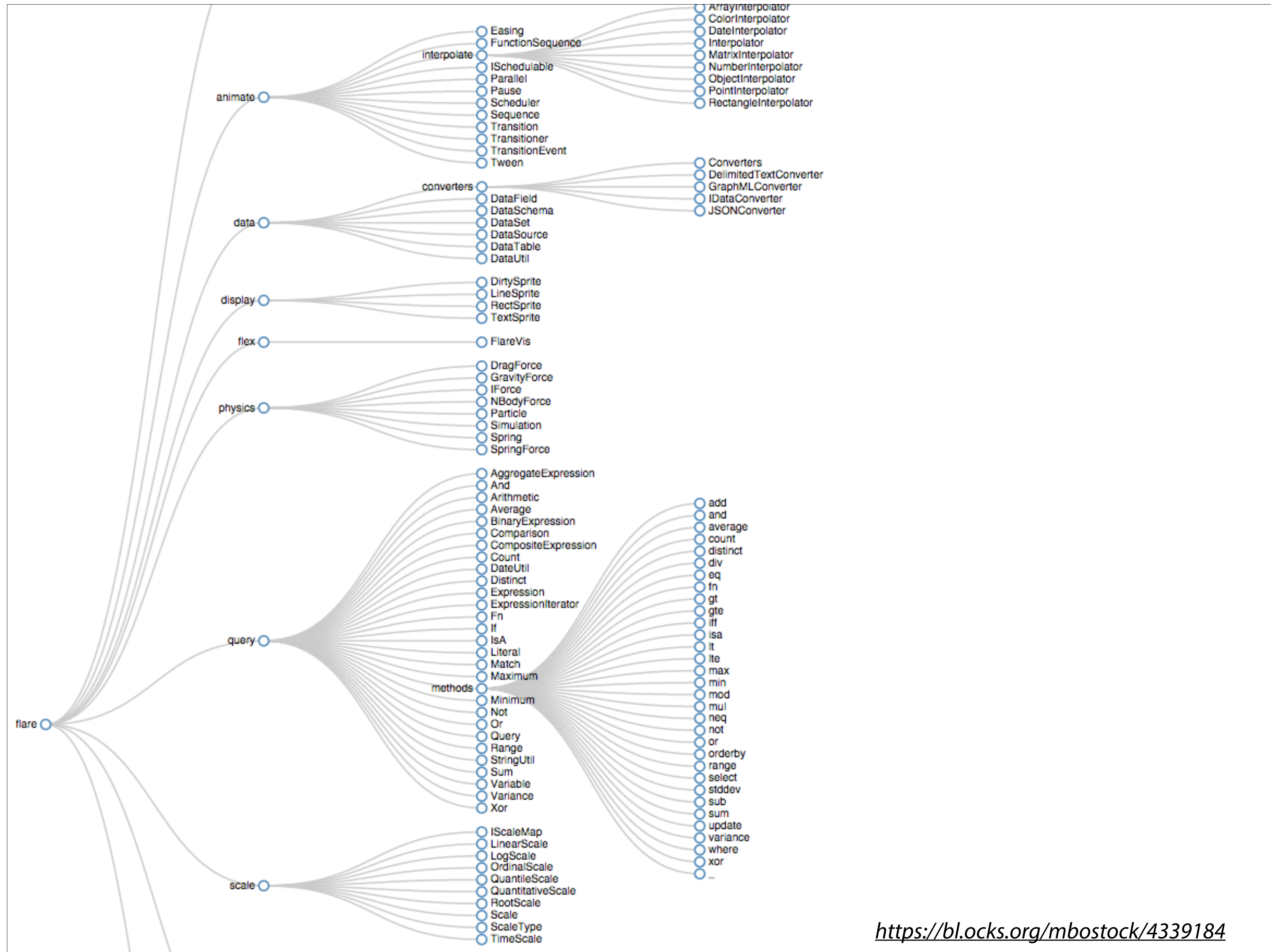
# Node-Link Diagrams

- nodes are distributed in space, connected by straight or curved lines
- typical approach is to use 2D space to break apart breadth and depth
- often space is used to communicate hierarchical orientation









<https://bl.ocks.org/mbostock/4339184>



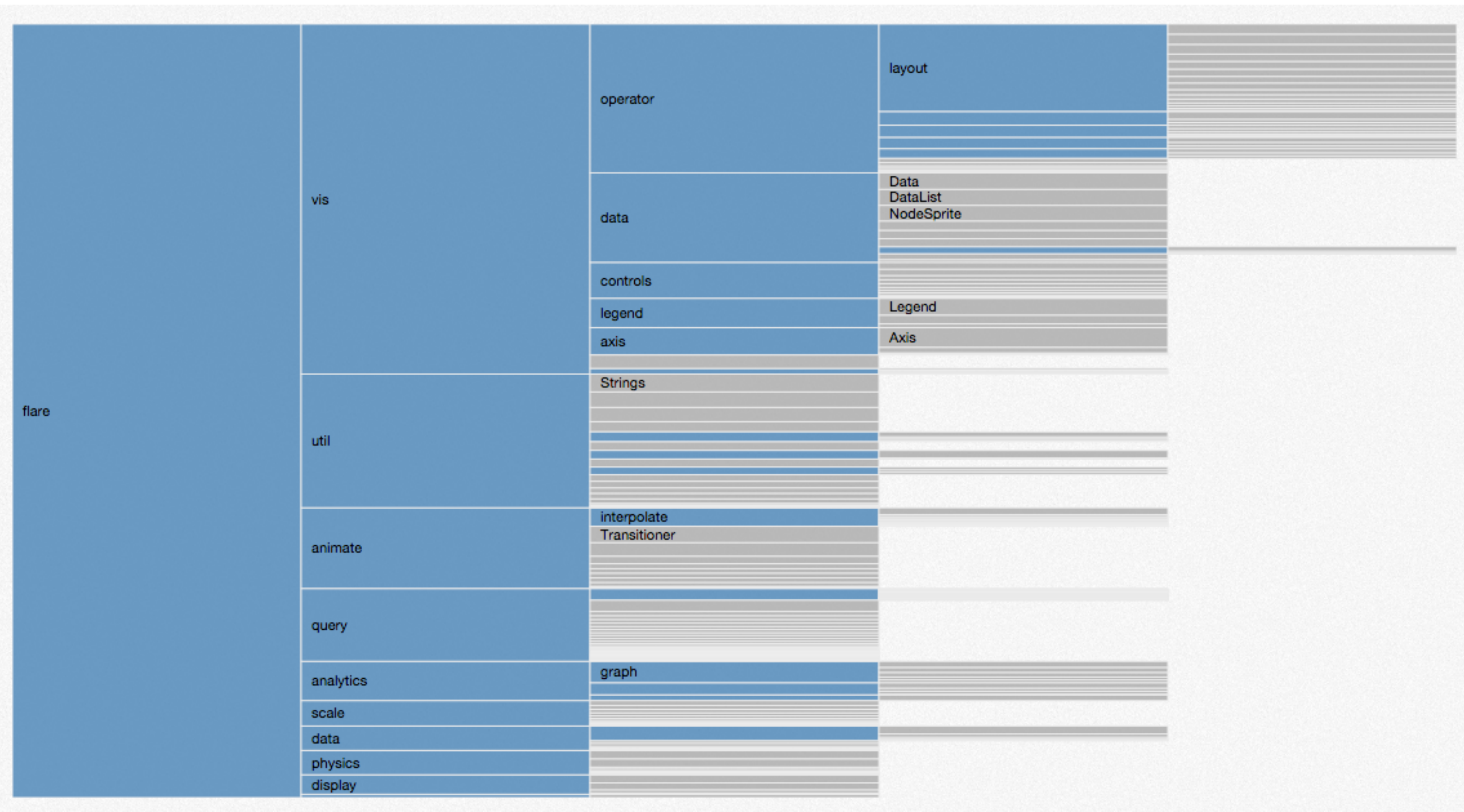




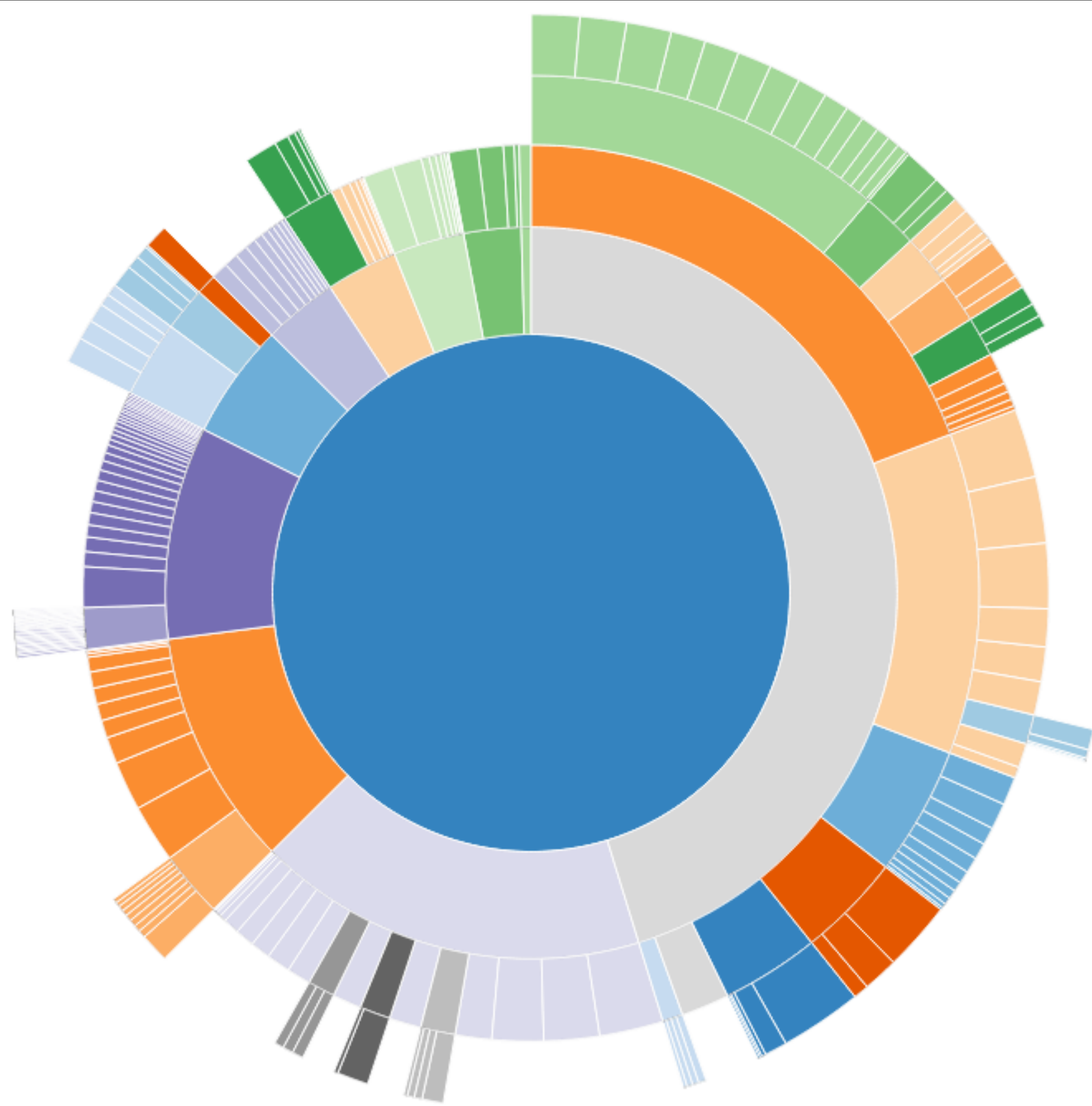
# Layered Diagrams

- recursive subdivision of space
- structure encoded using:
  - layering
  - adjacency - alignment





<https://mbostock.github.io/d3/talk/20111018/partition.html>



<https://bl.ocks.org/mbostock/raw/4348373/>



# Scale Problem

- tree breadth often grows exponentially
- quickly run out of space!
- solutions
  - scrolling or panning
  - filtering or zooming
  - hyperbolic layout

# Indentation

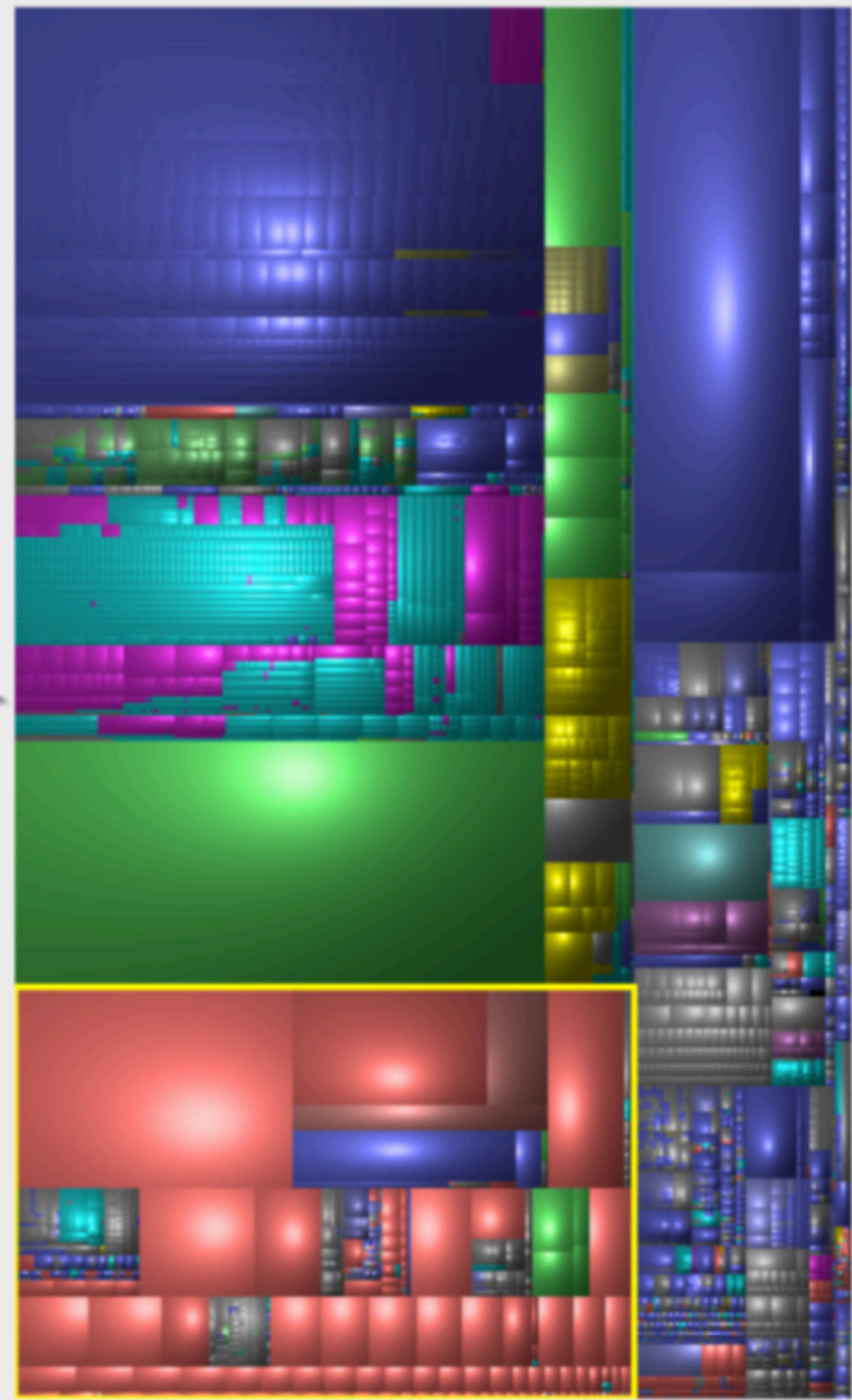
- place all items along vertically spaced rows
- indentation used to show parent/child relationships
- commonly used as a component in an interface
- breadth and depth contend for space
- often requires a great deal of scrolling



# Enclosure Diagram

- encode structure using spatial enclosure
- often referred to as treemaps
- benefits
  - provides single view of entire tree
  - easier to spot small / large nodes
- problems
  - difficult to accurately read depth

| Name                   | Size     |
|------------------------|----------|
| ▶ Trash                | 0 Bytes  |
| ▶ .gnome2              | 0 Bytes  |
| ▶ Guest                | 3 Bytes  |
| ▶ Shared               | 1 Bytes  |
| ▶ .localized           | 0 Bytes  |
| ▼ Applications         | 22.2 GB  |
| ▶ Xcode                | 4.8 GB   |
| ▶ Emulators            | 4.5 GB   |
| ▶ Adobe                | 1.5 GB   |
| ▶ Microsoft Office     | 1.2 GB   |
| ▶ GarageBand           | 1.1 GB   |
| ▶ Adobe Illustrator... | 8,59.7 M |
| ▶ Utilities            | 6,33.4 M |
| ▶ LibreOffice          | 6,00.3 M |
| ▶ Adobe Illustrator... | 5,77.9 M |
| ▶ Adobe                | 5,40.6 M |
| ▶ Tableau              | 4,74.1 M |
| ▶ Steam                | 4,65.6 M |
| ▶ Spyder               | 4,56.7 M |
| ▶ Adobe Bridge CS6     | 3,46.8 M |
| ▶ eclipse              | 3,31.0 M |

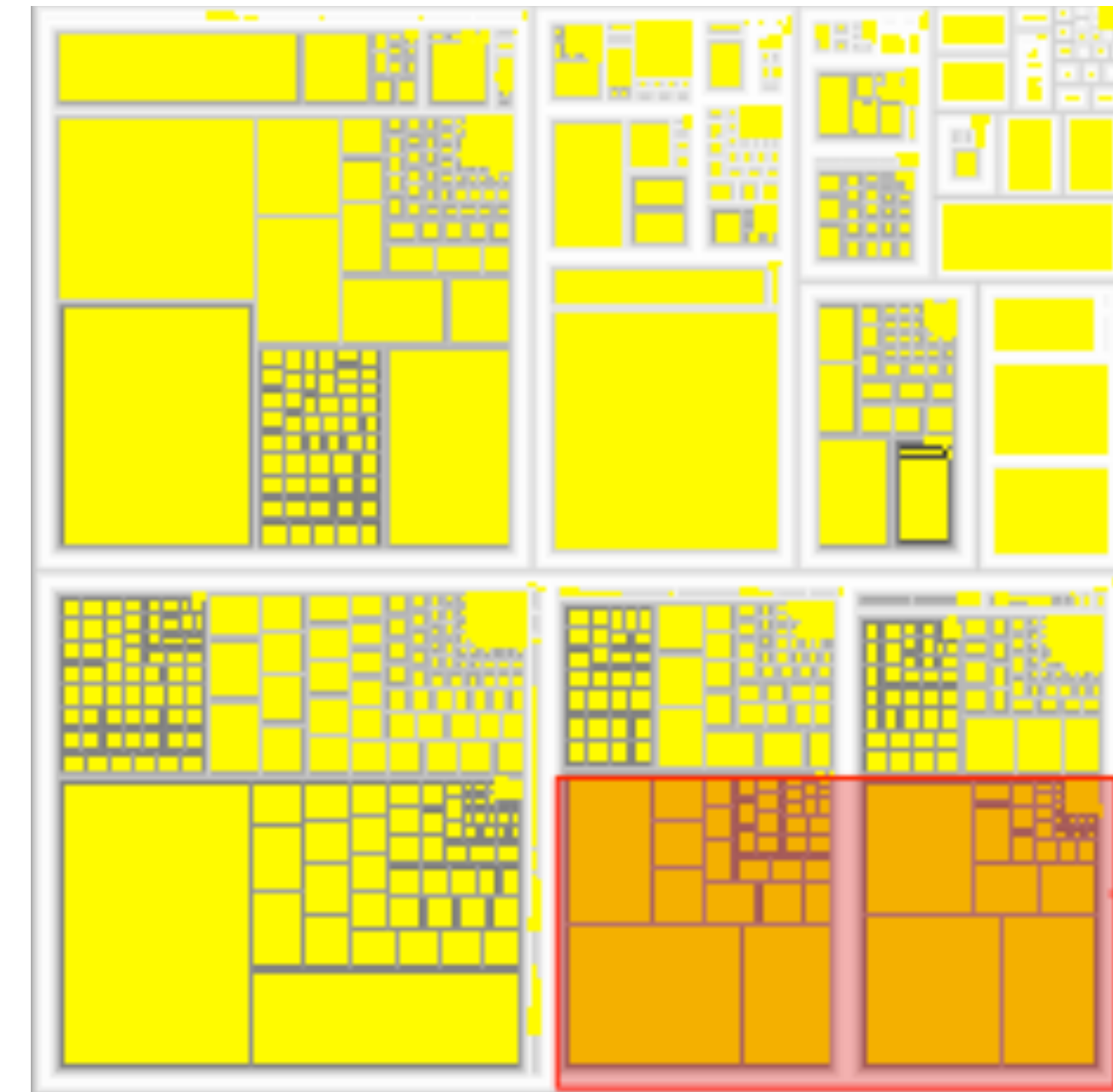




# Tree Maps

# Idiom: treemap

- **data**
  - tree
  - 1 quant attrib at leaf nodes
- **encoding**
  - area containment marks for hierarchical structure
  - rectilinear orientation
  - size encodes quant attrib
- **tasks**
  - query attribute at leaf nodes
- **scalability**
  - 1M leaf nodes



[http://tulip.labri.fr/Documentation/3\\_7/userHandbook/html/ch06.html](http://tulip.labri.fr/Documentation/3_7/userHandbook/html/ch06.html)



# Link marks: Connection and Containment

⌚ Containment ⌚ Connection

- marks as links (vs. nodes)

- common case in network drawing

- 1D case: connection

- ex: all node-link diagrams

- emphasizes topology, path tracing

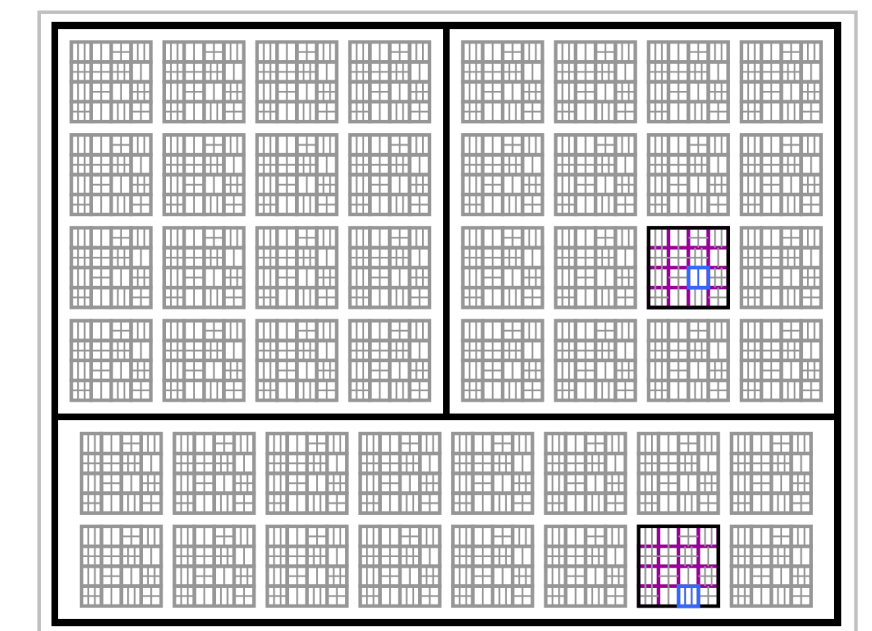
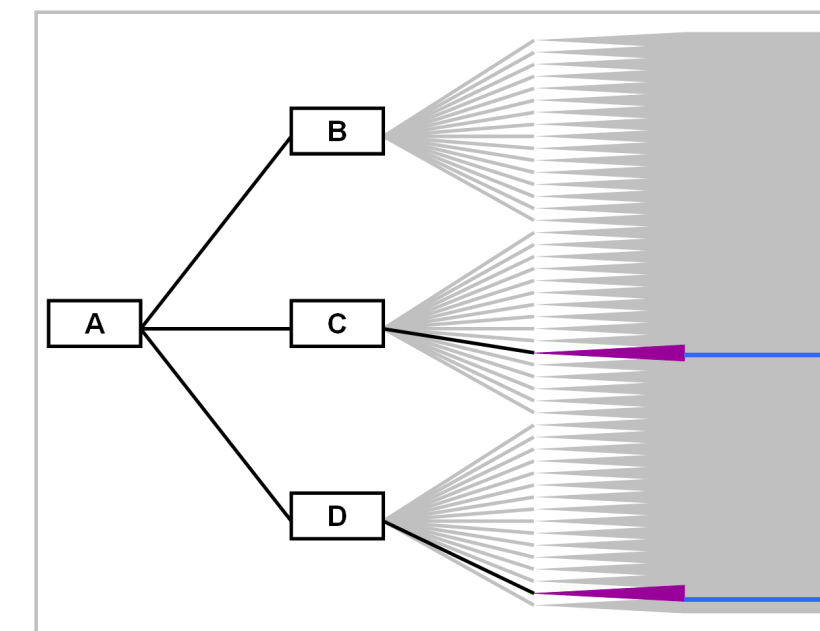
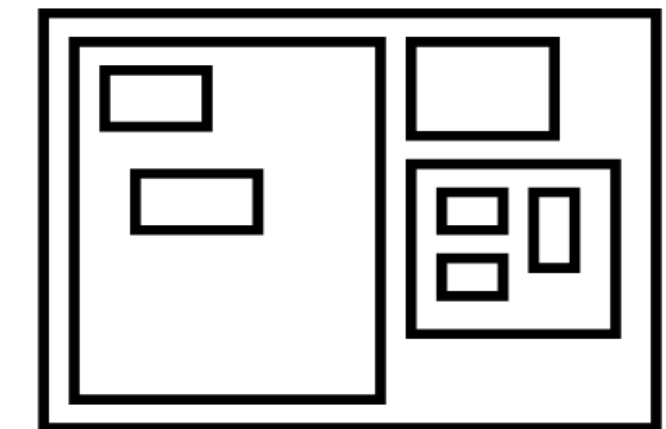
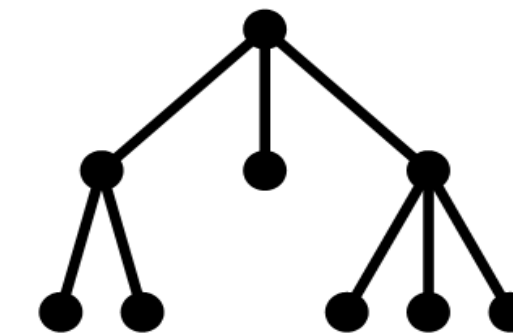
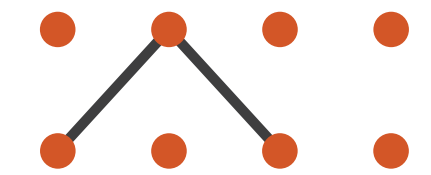
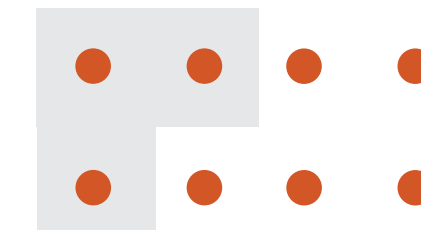
- networks and trees

- 2D case: containment

- ex: all treemap variants

- emphasizes attribute values at leaves (size coding)

- only trees



**Node-Link Diagram**

**Treemap**

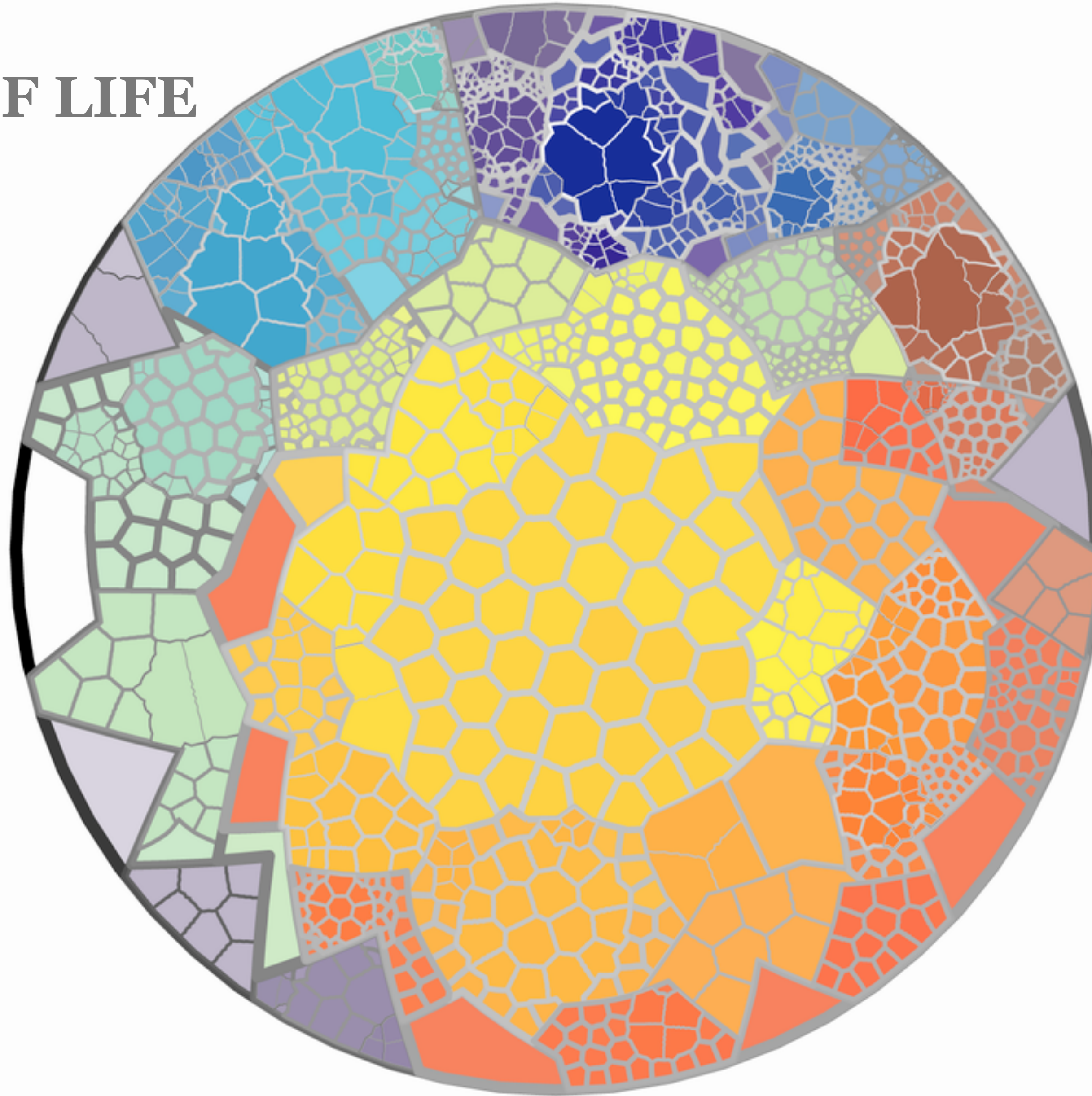
[Elastic Hierarchies: Combining Treemaps and Node-Link Diagrams. Dong, McGuffin, and Chignell. Proc. InfoVis 2005, p. 57-64.]





# TREE OF LIFE

mammals

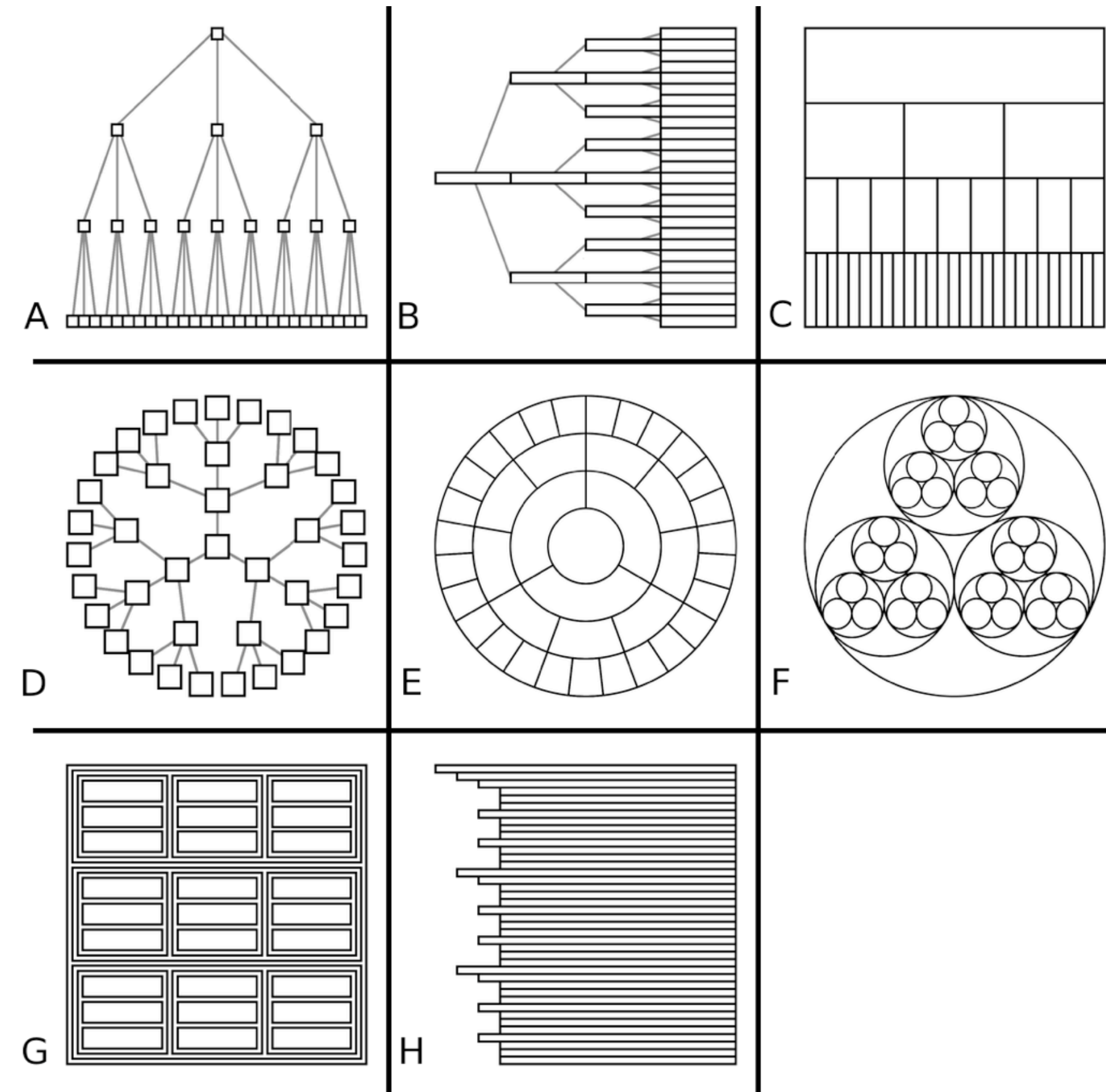


<https://www.flickr.com/photos/arenamontanus/2037614308/in/album-72157594387083580/>



# Tree drawing idioms comparison

- data shown
  - link relationships
  - tree depth
  - sibling order
- design choices
  - connection vs containment link marks
  - rectilinear vs radial layout
  - spatial position channels
- considerations
  - redundant? arbitrary?
  - information density?
    - avoid wasting space



[Quantifying the Space-Efficiency of 2D Graphical Representations of Trees. McGuffin and Robert. Information Visualization 9:2 (2010), 115–140.]