

25 YEARS ANNIVERSARY
SOICT

HA NOI UNIVERSITY OF SCIENCE AND TECHNOLOGY
SCHOOL OF INFORMATION AND COMMUNICATION TECHNOLOGY



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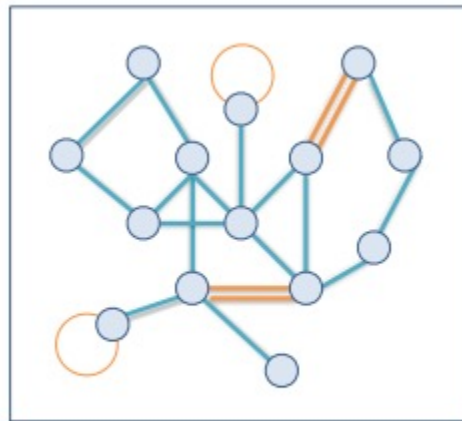
Graph data visualization

Graph data visualization



Graph

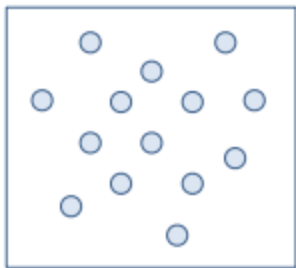
- The graph $G(V,E)$ includes the set of vertices V and the set of edges E
- A simple graph is unweighted, undirected graph containing no graph loops or multiple edges
- Directed graph distinguishes edge AB and edge BA



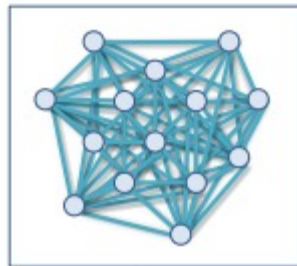
Not a simple graph!
→ A *general graph*

Basic concepts

- **An independent set, stable set, coclique or anticlique** is a set of vertices in a graph, no two of which are adjacent.
- **Clique** is a subset of vertices of an undirected graph such that every two distinct vertices in the clique are adjacent.
- **A graph** is said to be **connected** if every pair of vertices in the graph is connected.
- **A tree** is an undirected graph in which any two vertices are connected by exactly one path, or equivalently a connected acyclic undirected graph.



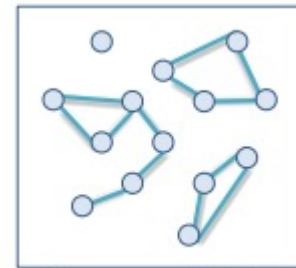
Independent Set



Clique



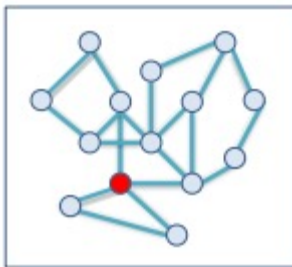
Tree



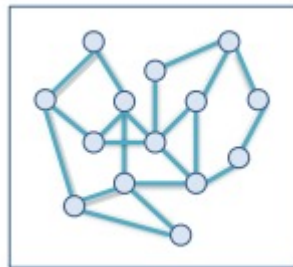
Unconnected Graph

Basic concepts

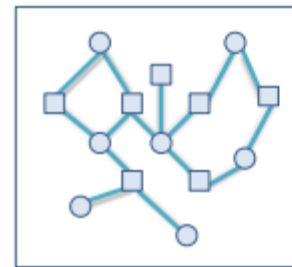
- **An articulation point (or cut vertex) (Điểm khớp)** is defined as a vertex which, when removed along with associated edges, makes the graph disconnected
- **A biconnected graph (đồ thị nối đôi)** is a connected and "nonseparable" graph, meaning that if any one vertex were to be removed, the graph will remain connected.
 - A biconnected graph has no articulation vertices.
- **A bipartite graph (or bigraph) (đồ thị hai phần)** is a graph whose vertices can be divided into two disjoint and independent sets U and V such that every edge connects a vertex in U to one in V



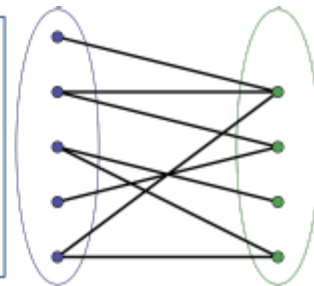
Articulation Point (red)



Biconnected Graph



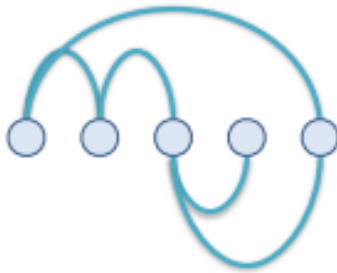
Bipartite Graph



Basic concepts

- Degree (bậc) of a vertex
 - $\deg(n)$ is the number of edges that are incident to the vertex
- Graph diameter (đường kính)
 - $\text{diam}(G)$ is the greatest distance (shortest path) between any pair of vertices

Graph visualization



Explicit
(Node-Link)

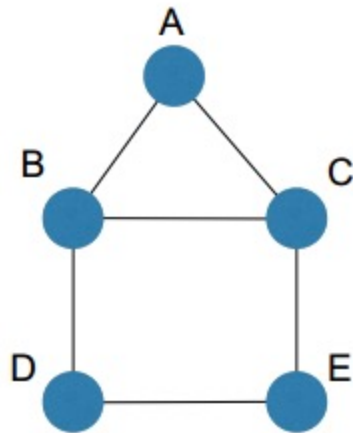


Matrix

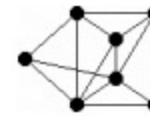


Implicit

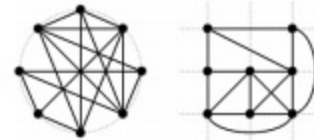
Explicit graph visualization (node-link)



Free



Styled



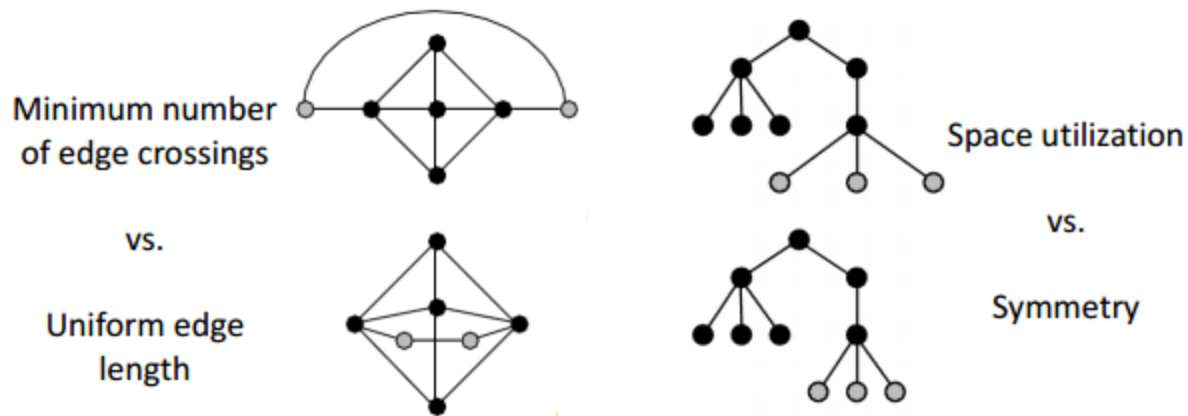
Fixed



HJ Schulz 2006

Criteria for node-link representation

- Minimizing the intersection edges
- Minimize the distance between the vertices
- Minimize drawing area
- Edges of similar length
- Maximum angle between different edges
- Symmetry (graphs with the same structure must look the same)



Force-directed graph

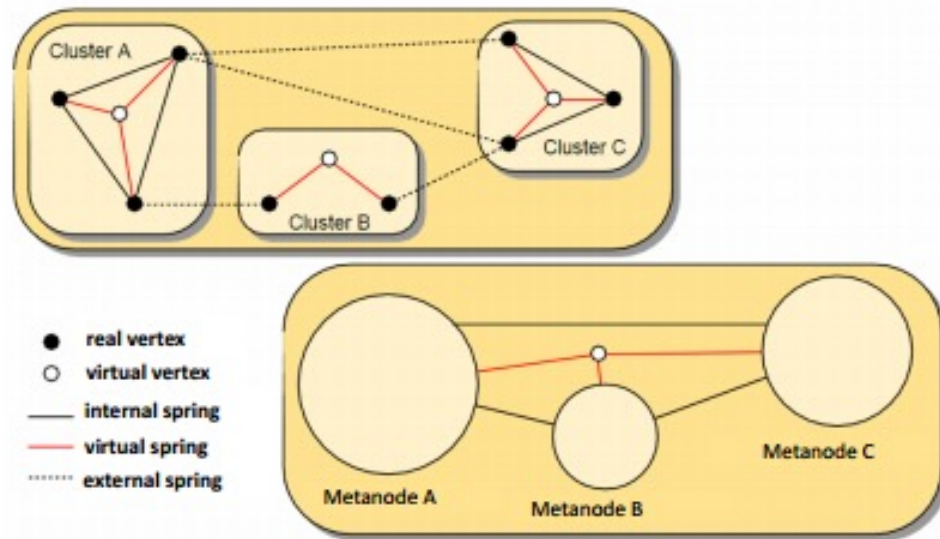
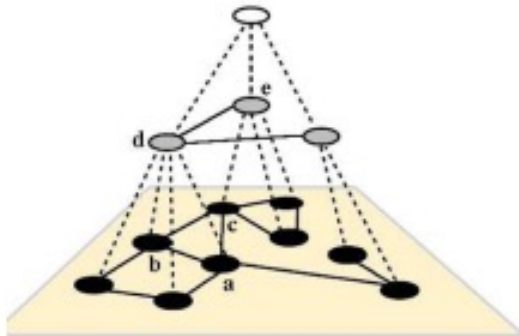
- The forces are applied to the nodes, pulling them closer together or pushing them further apart.
- This is repeated iteratively until the system comes to a mechanical equilibrium state



<https://observablehq.com/@d3/force-directed-graph>

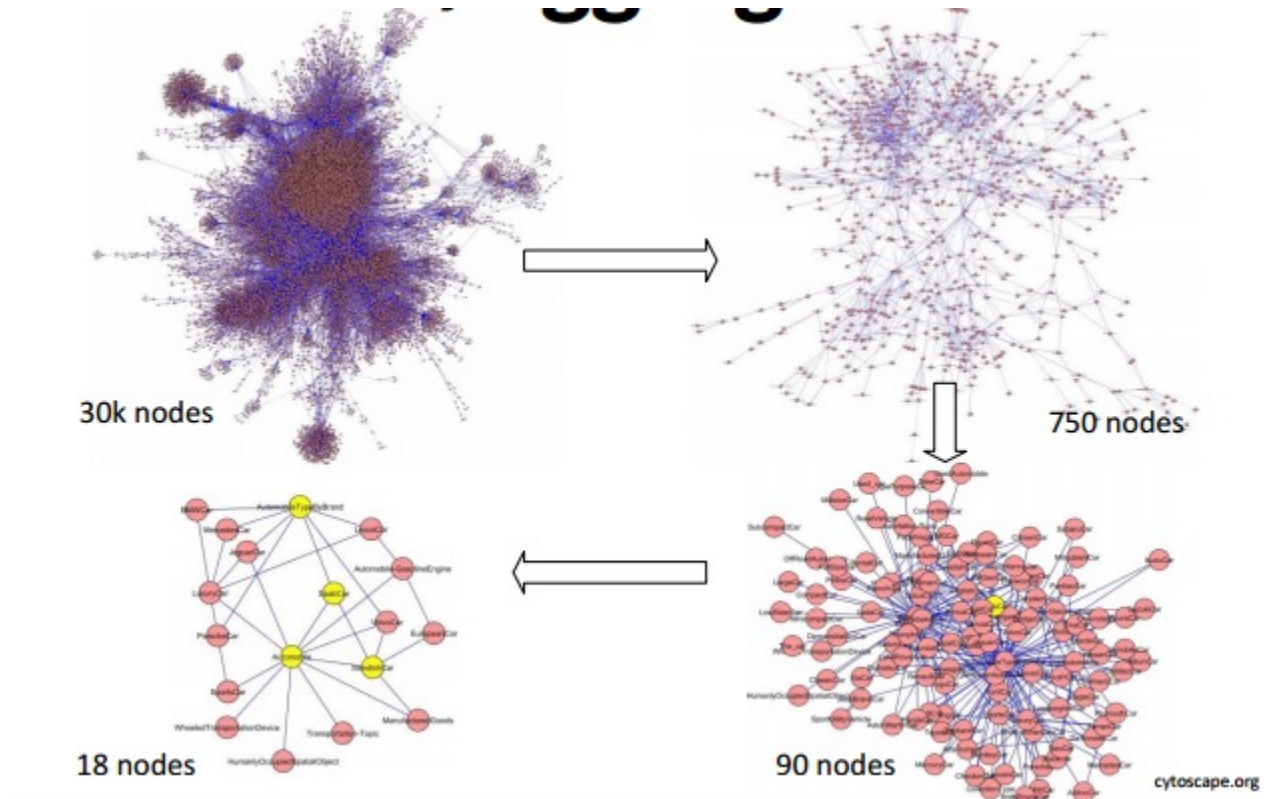
Multi-level technique

- Reduce the magnitude of a graph by merging vertices together, compute a partition on this reduced graph, and finally project this partition on the original graph.

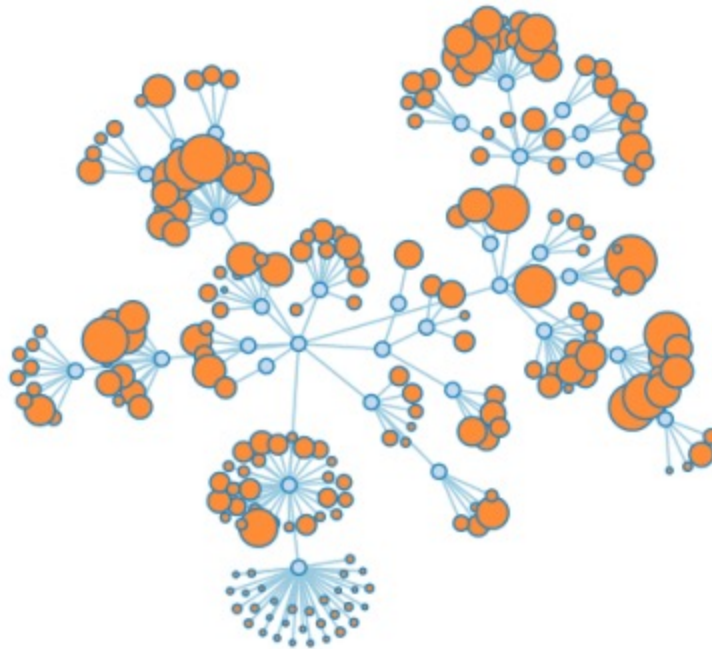


[Schulz 2004]

Sampling



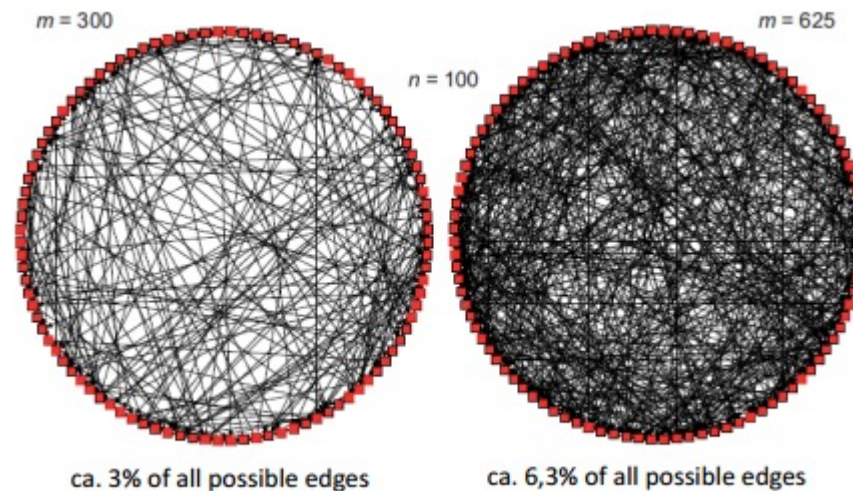
Collapse/Expand



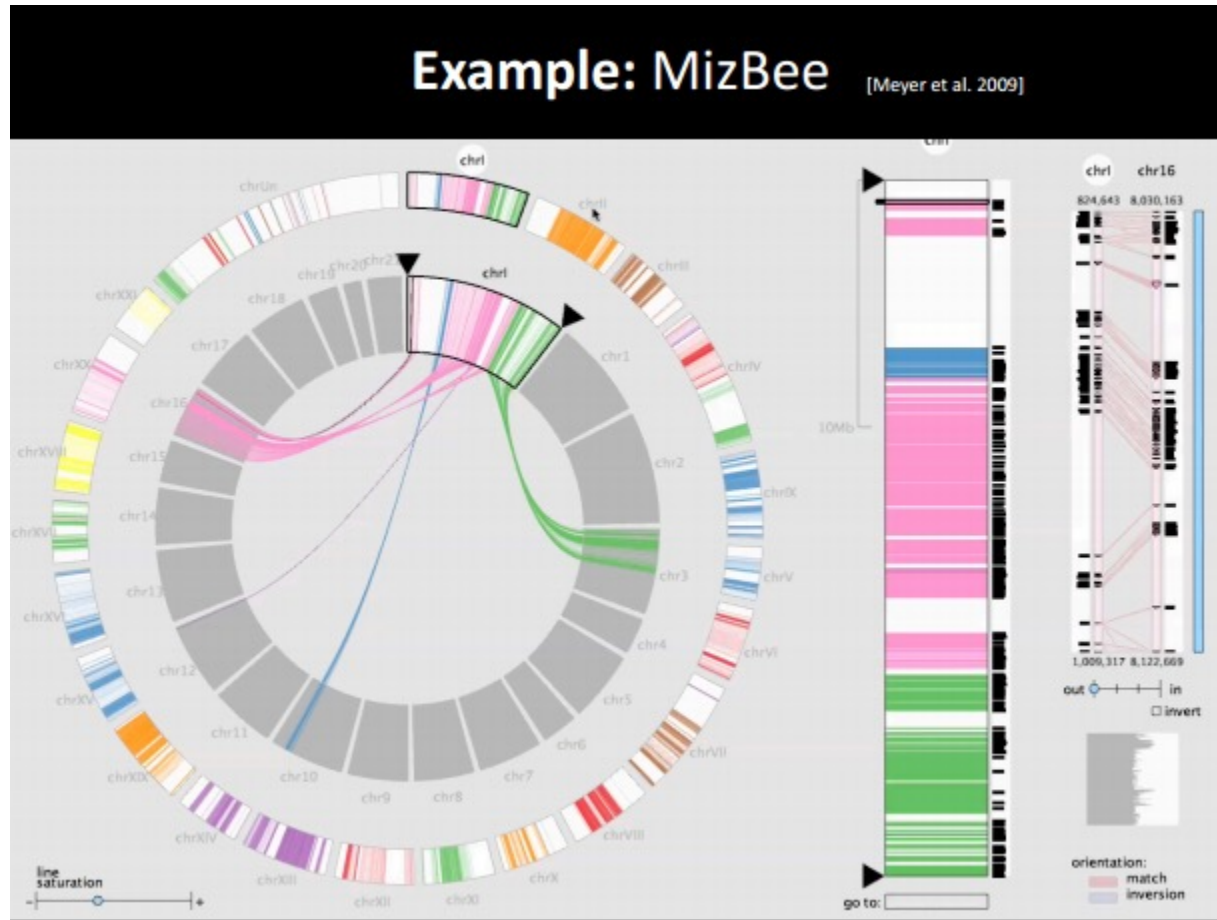
<http://bl.ocks.org/mbostock/1062288>

Fixed arrangement for graphs

- Circos Layout

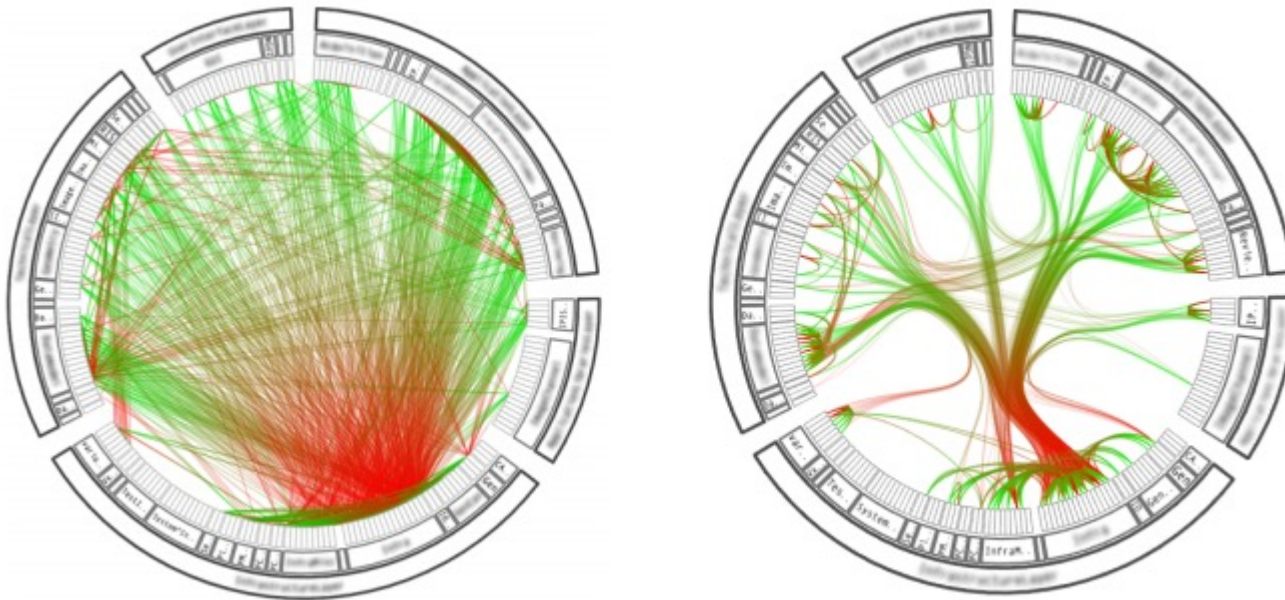


Fixed arrangement for graphs



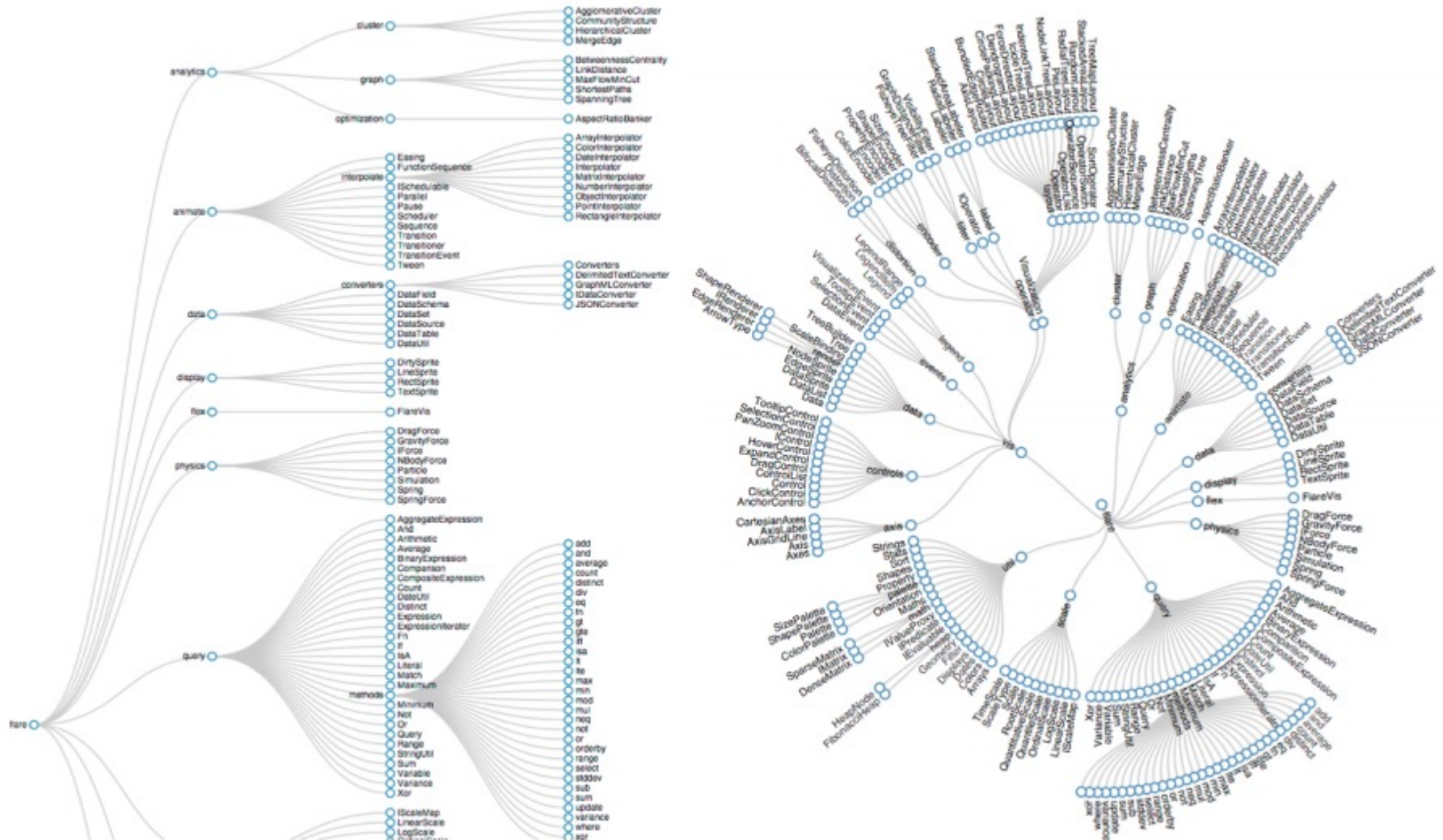
Fixed arrangement for graphs

- Edge bundling

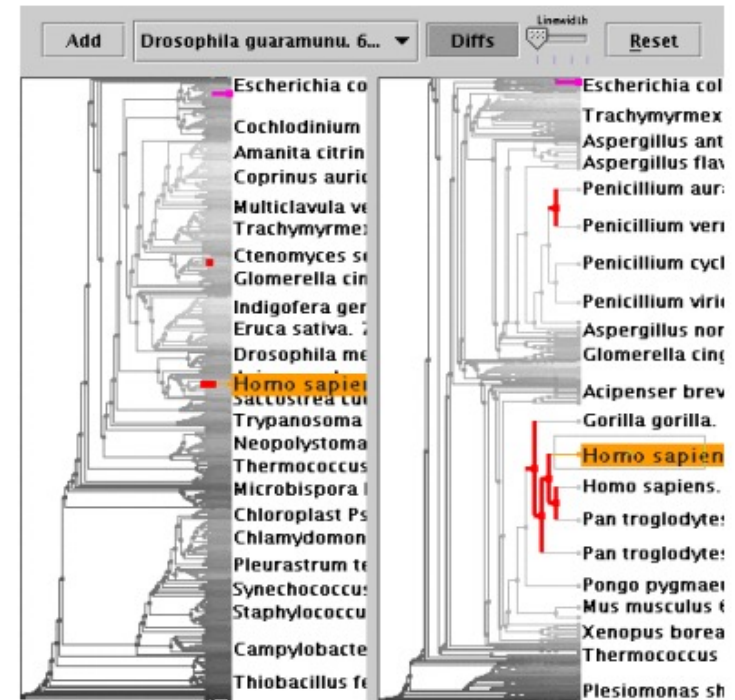
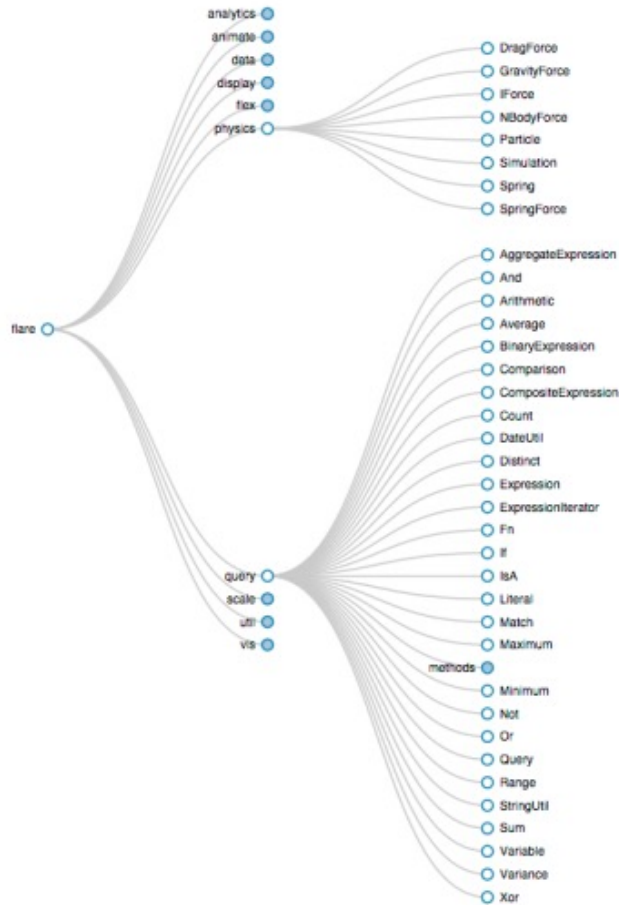


<https://observablehq.com/@d3/hierarchical-edge-bundling>

Tree layout

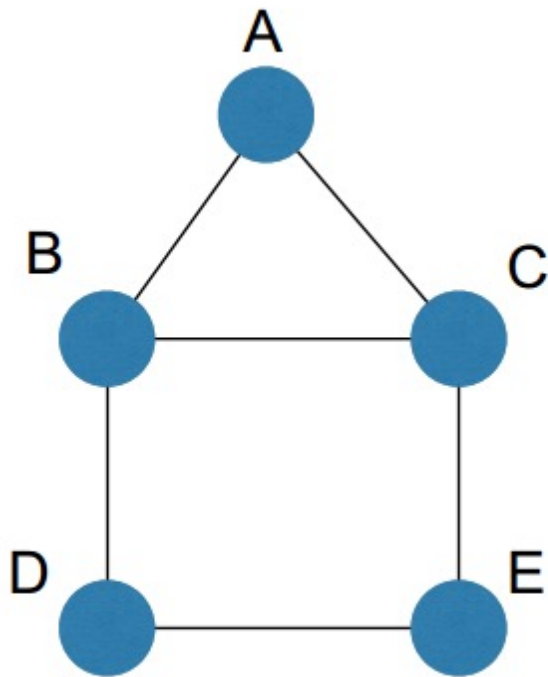


Tree layout



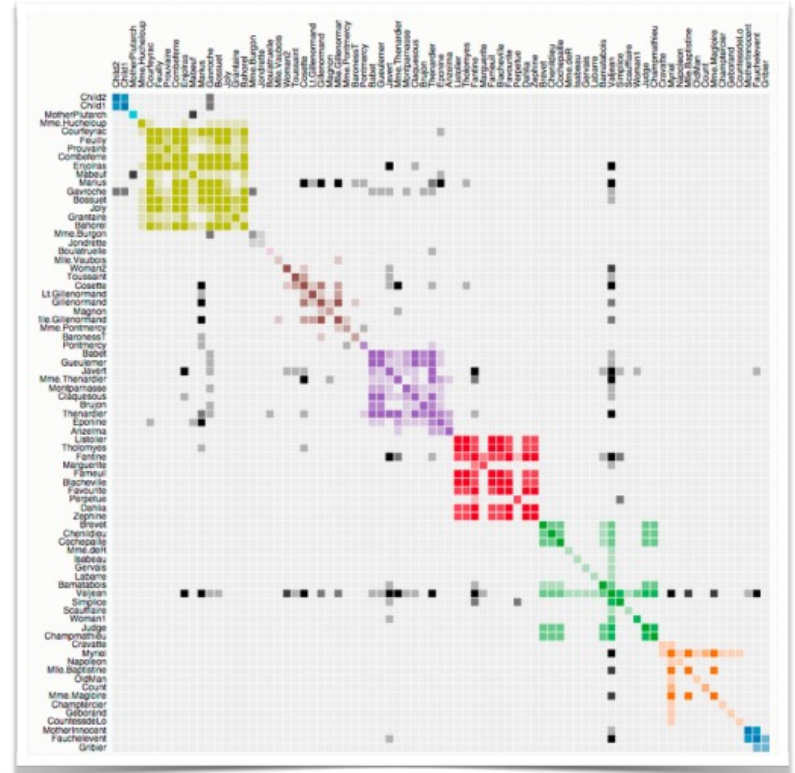
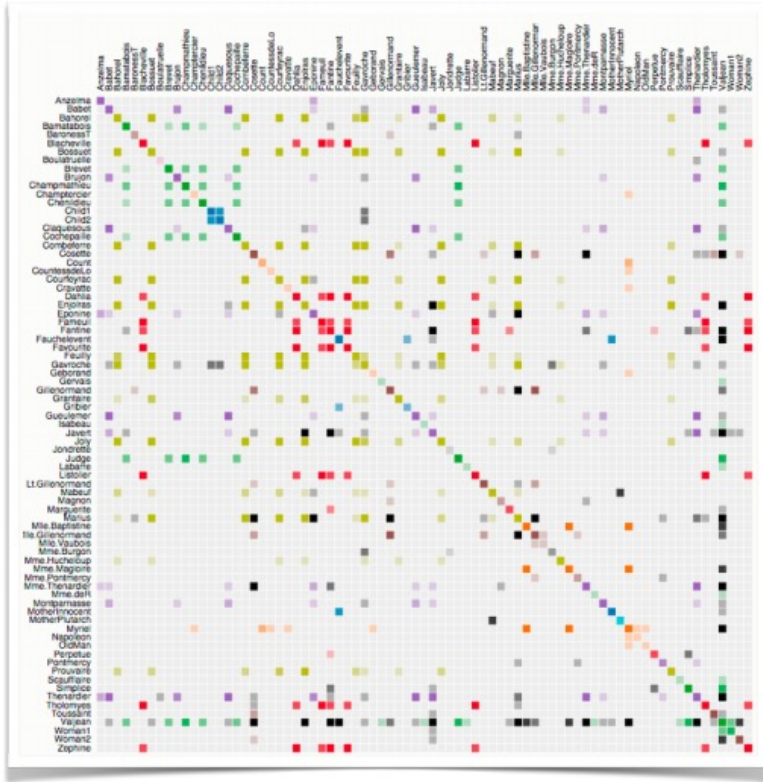
<http://bl.ocks.org/mbostock/4339083>

Adjacency matrix



	A	B	C	D	E
A					
B					
C					
D					
E					

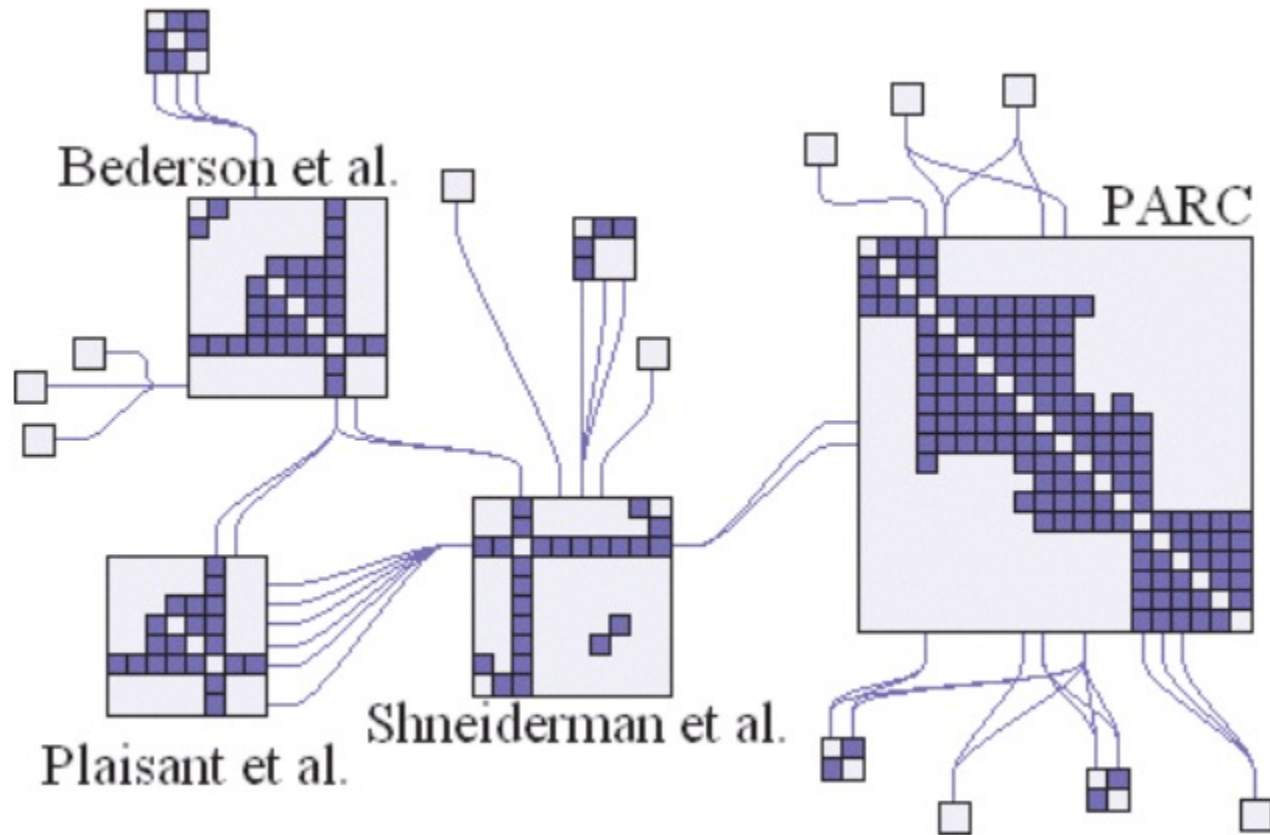
Adjacency matrix



Adjacency matrix

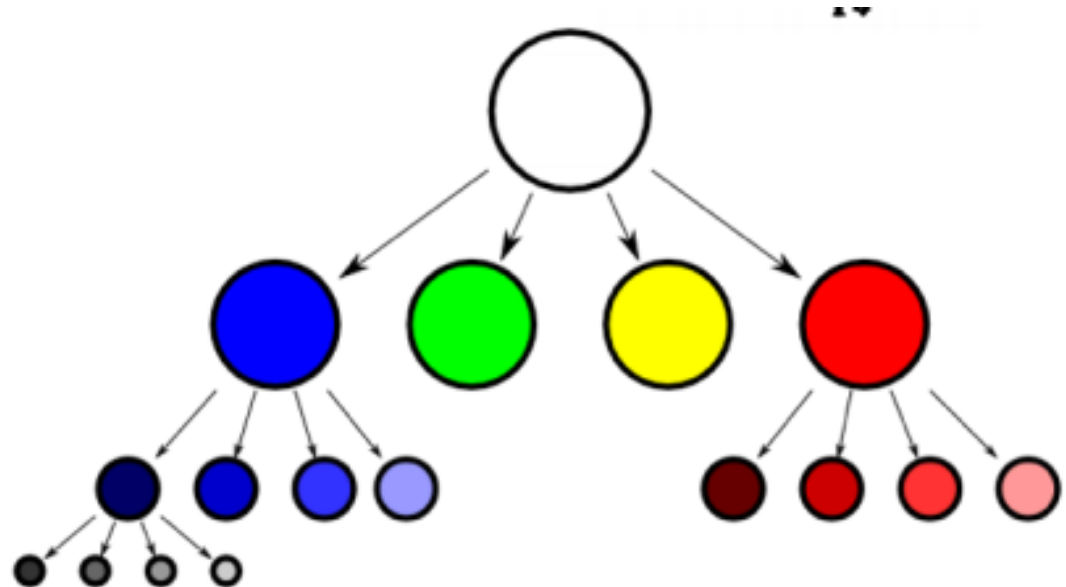
- Advantage
 - Can represent most graphs (except hypergraphs)
 - Focus on edges instead of vertices
 - No need to care about layout
- Disadvantage
 - Difficult to detect relationships such as paths, cycles, etc.

Hybrid layoub



Implicit presentation

- TreeMap



<http://www.nytimes.com/packages/html/newsgraphics/2011/0119-budget/>

Implicit presentation

- Sunburst



<https://observablehq.com/@d3/sunburst>

<https://observablehq.com/@d3/zoomable-sunburst>

- <https://observablehq.com/@3cd7d5ec89dc7f68/graph-visualization-introduction>



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Thank you
for your
attention!!!



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