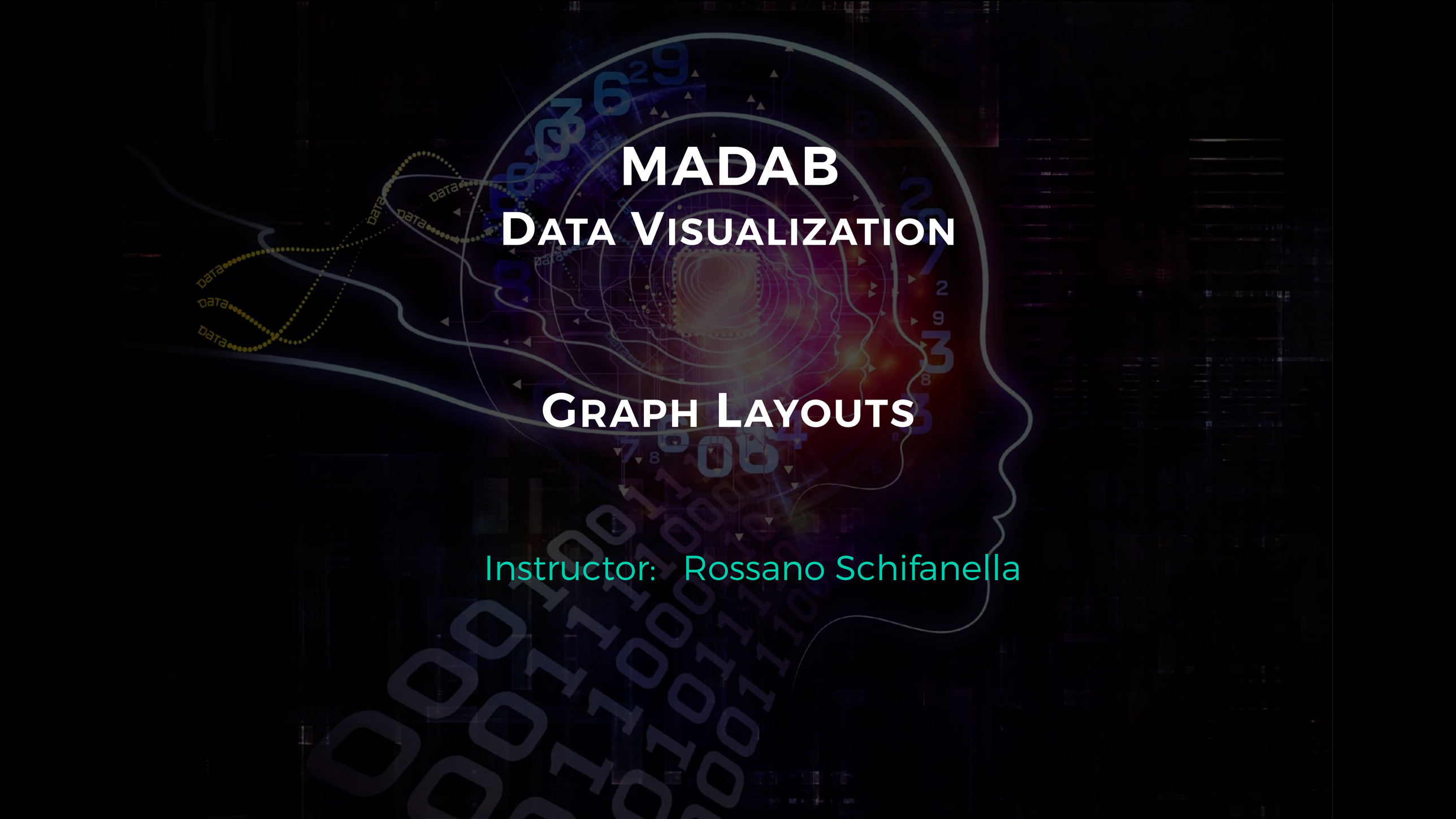
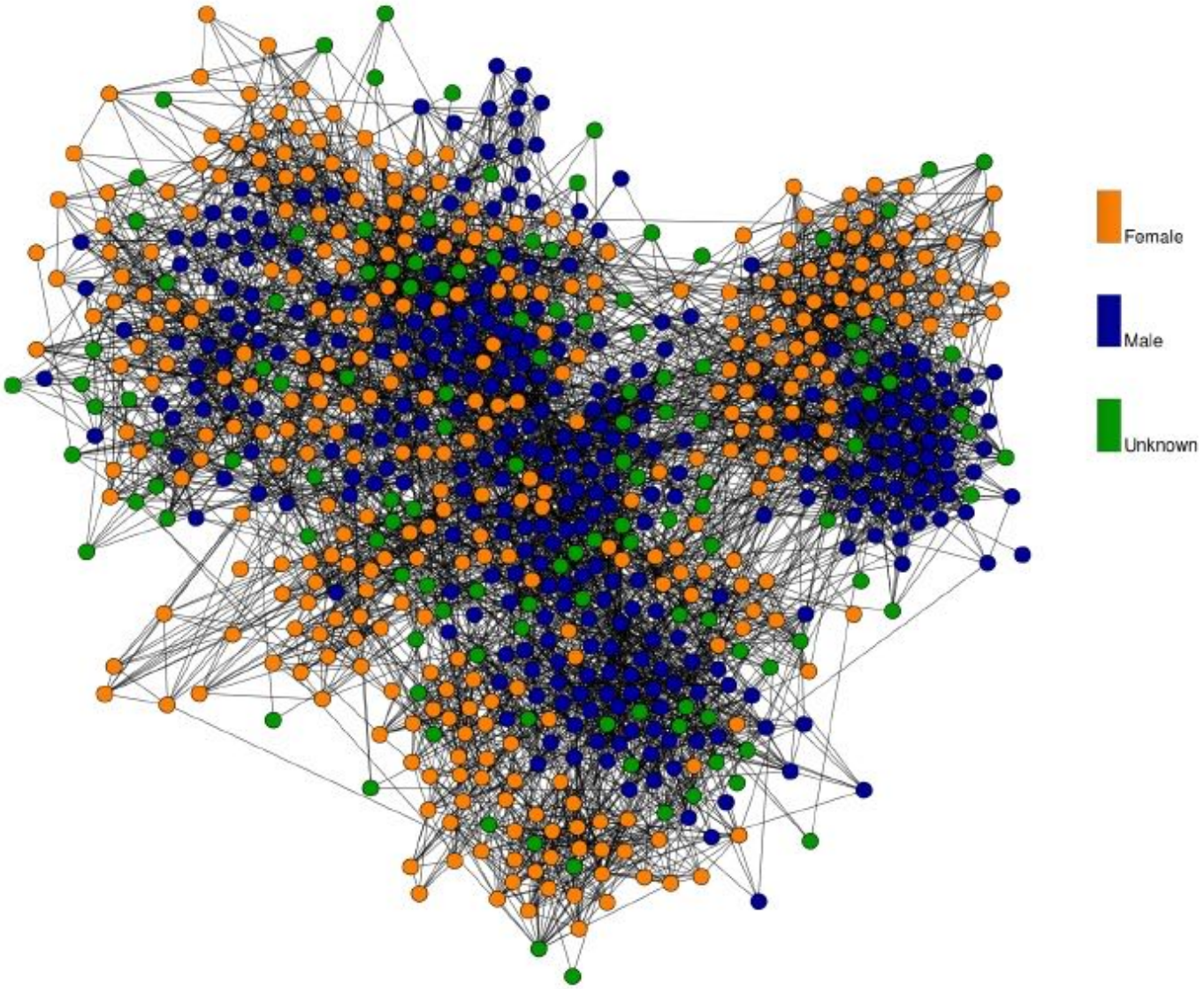


MADAB
Data Visualization

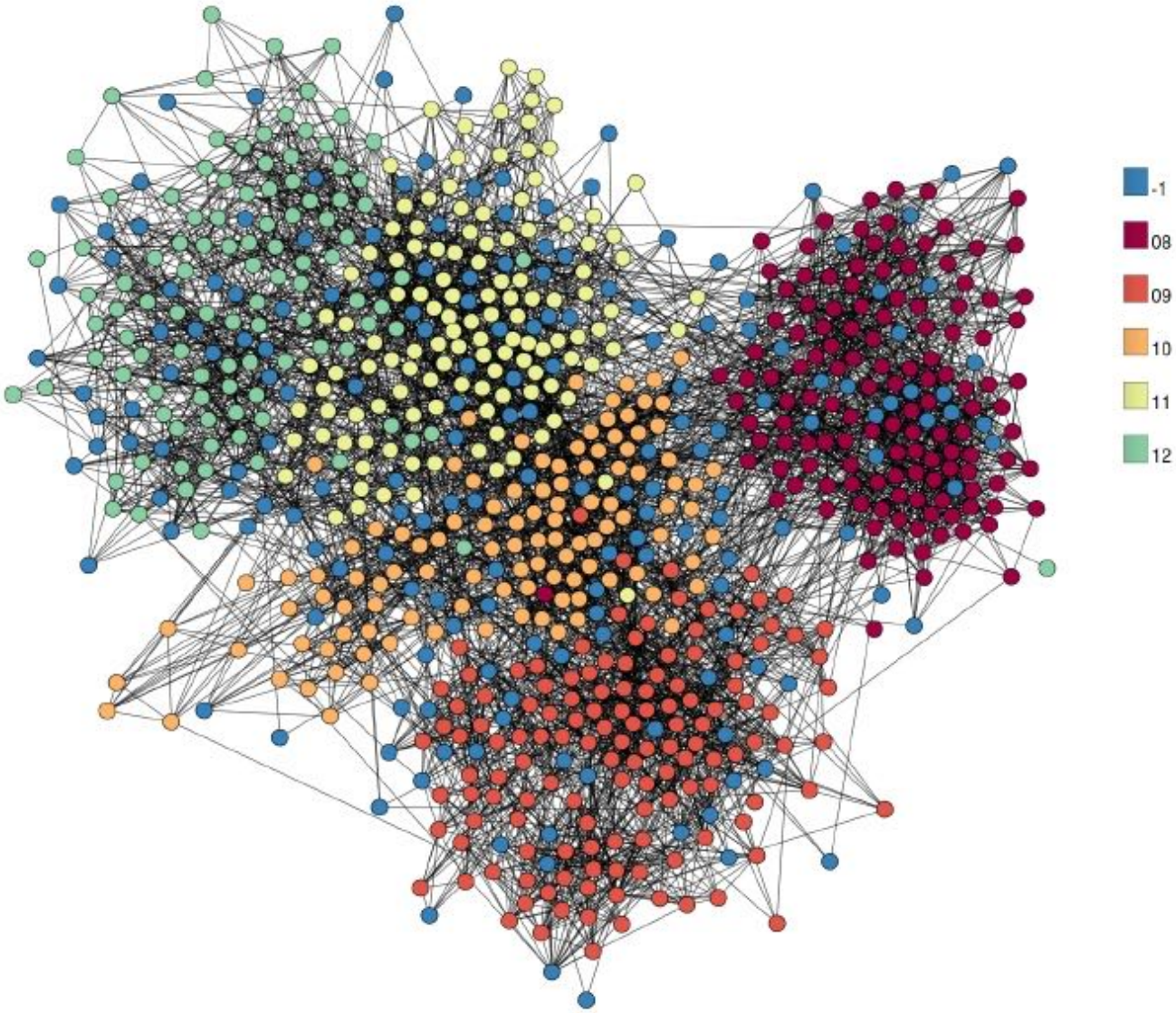
Graph Layouts

Instructor: Rossano Schifanella

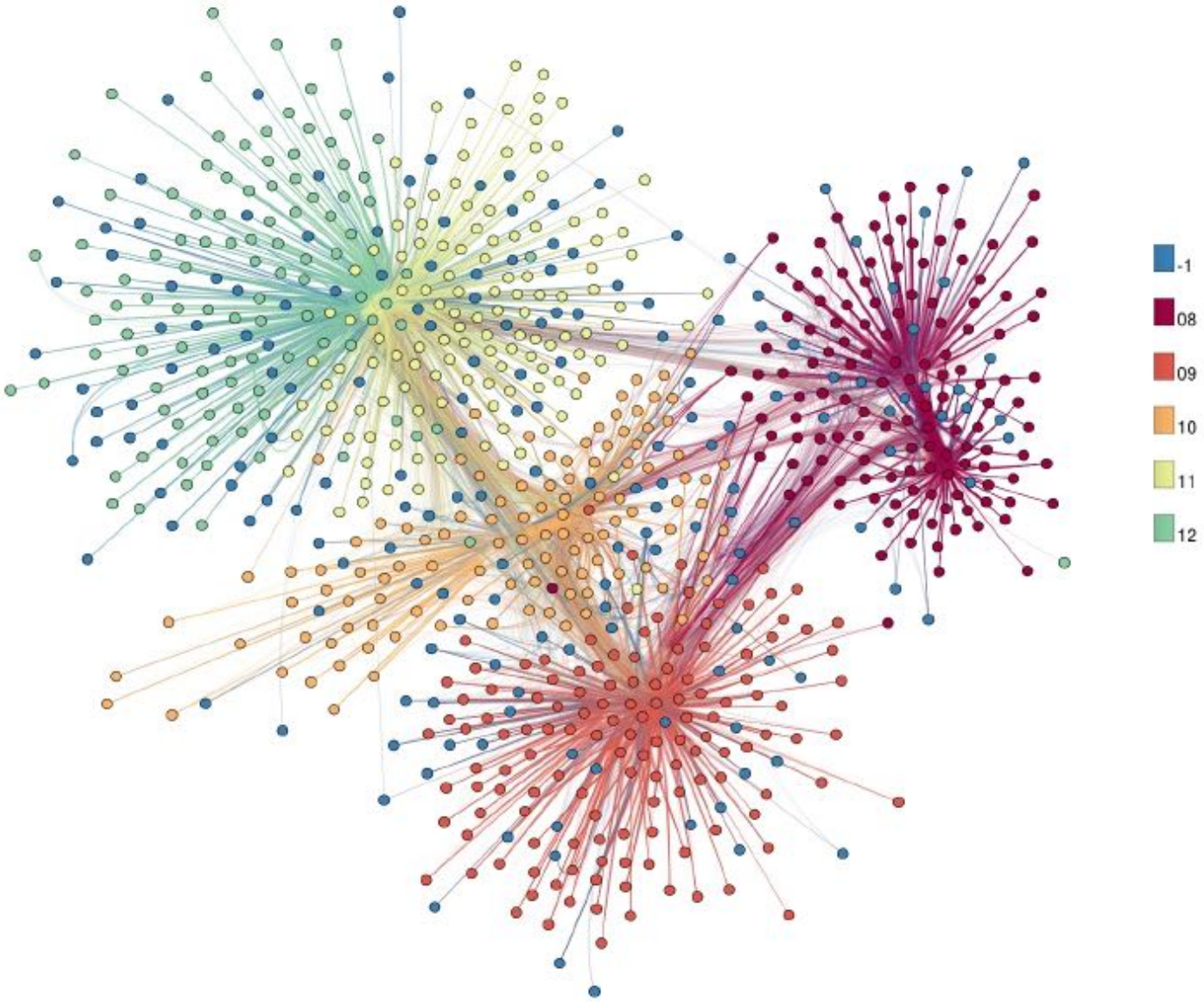
MOTIVATION



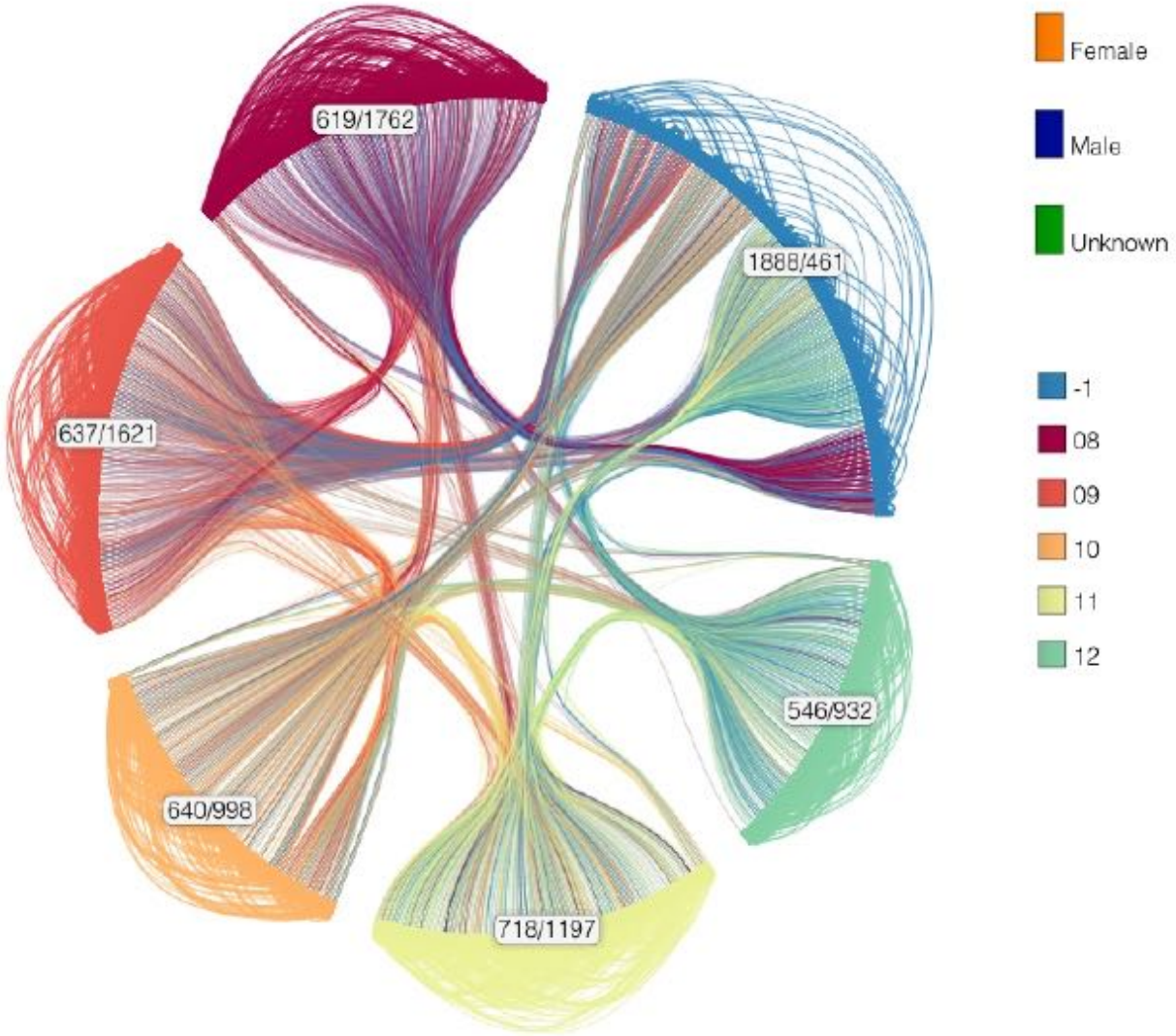
http://vidi.cs.ucdavis.edu/projects/AggressionNetworks/



http://vidi.cs.ucdavis.edu/projects/AggressionNetworks/



http://vidi.cs.ucdavis.edu/projects/AggressionNetworks/

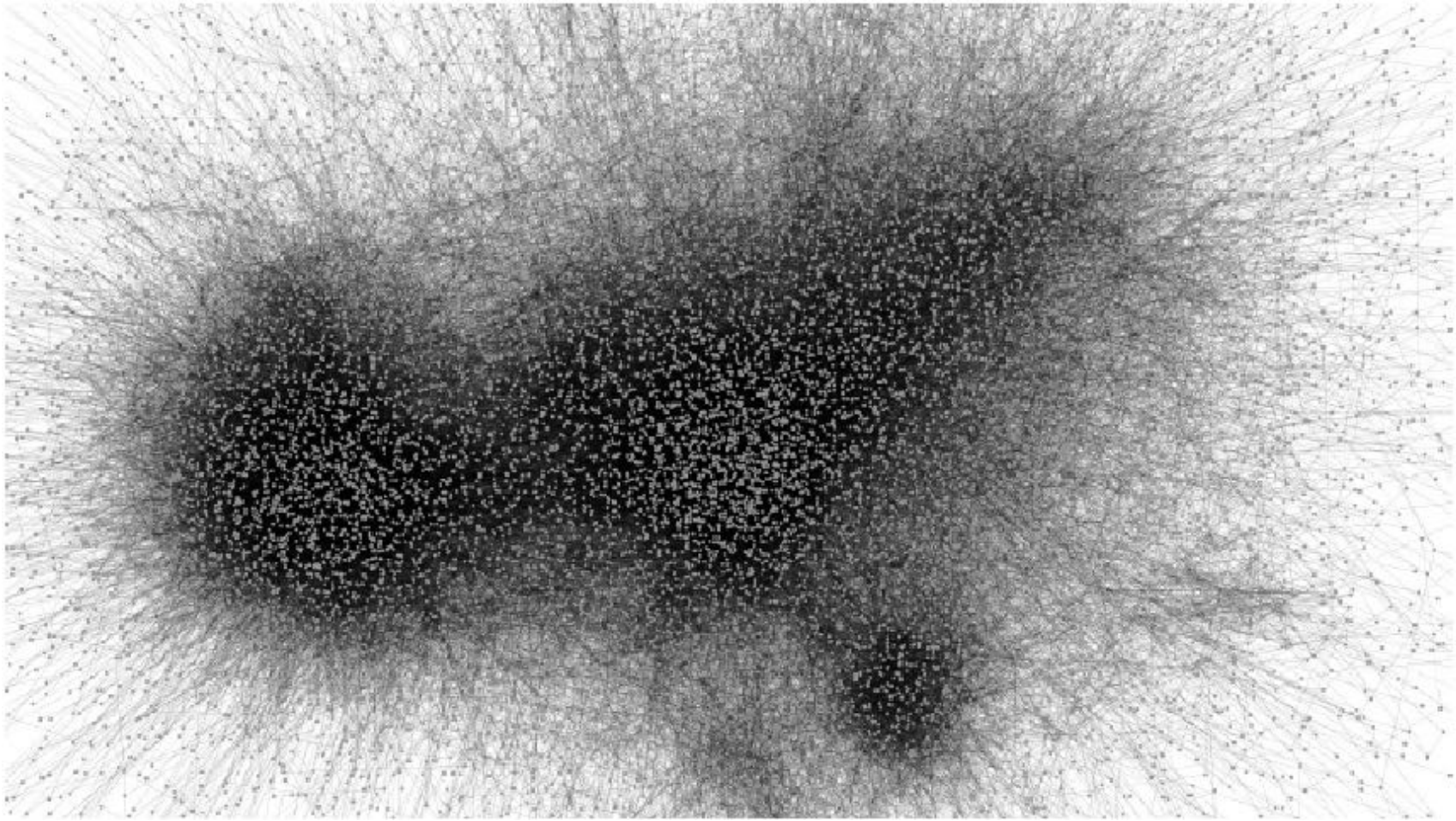


http://vidi.cs.ucdavis.edu/projects/AggressionNetworks/

CONSIDERATIONS

What considerations should we make when visualizing graphs?

Hairballs



http://www.michelecoscia.com/?p=171

Hairballs

http://www.nytimes.com/imagepages/2008/11/20/science/20mammoth.ready.html

Considerations

- Node Layout
  - Place randomly?
  - Place on grid?
  - Place by metric?
  - Place using physics?
- Node Attributes
  - Color?
  - Size?
  - Shape?
- Edge Layout
  - Straight edges?
  - Curved edges?
  - Edge crossings?
  - Edge bundling?
- Edge Attributes
  - Color?
  - Width?
  - Arrows?

Considerations

- Non overlapping nodes?
- Visible labels?
- Minimize edge crossings?
- Minimize distance between nodes?
- View overall structure?
- View connections and connectivity?
- View detailed subgraphs?

MATRIX DIAGRAMS

Matrix Diagrams

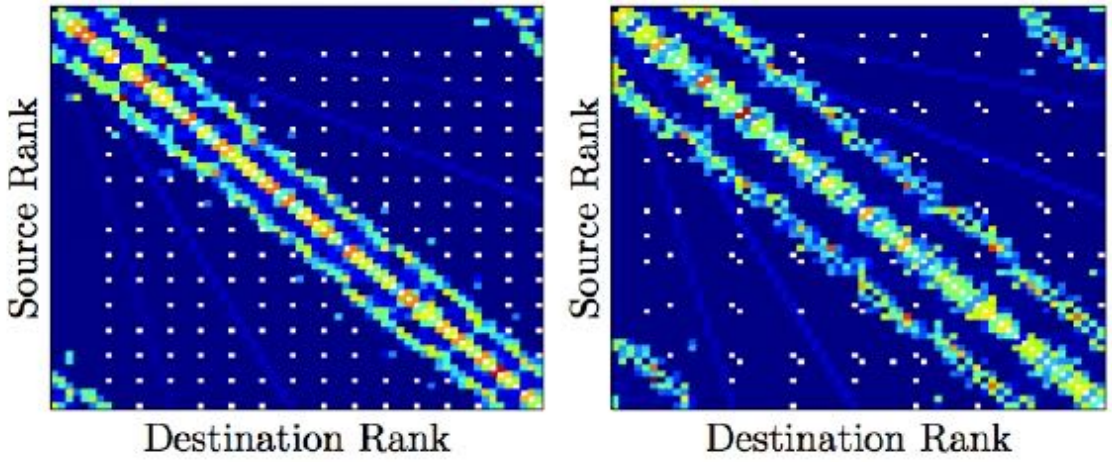
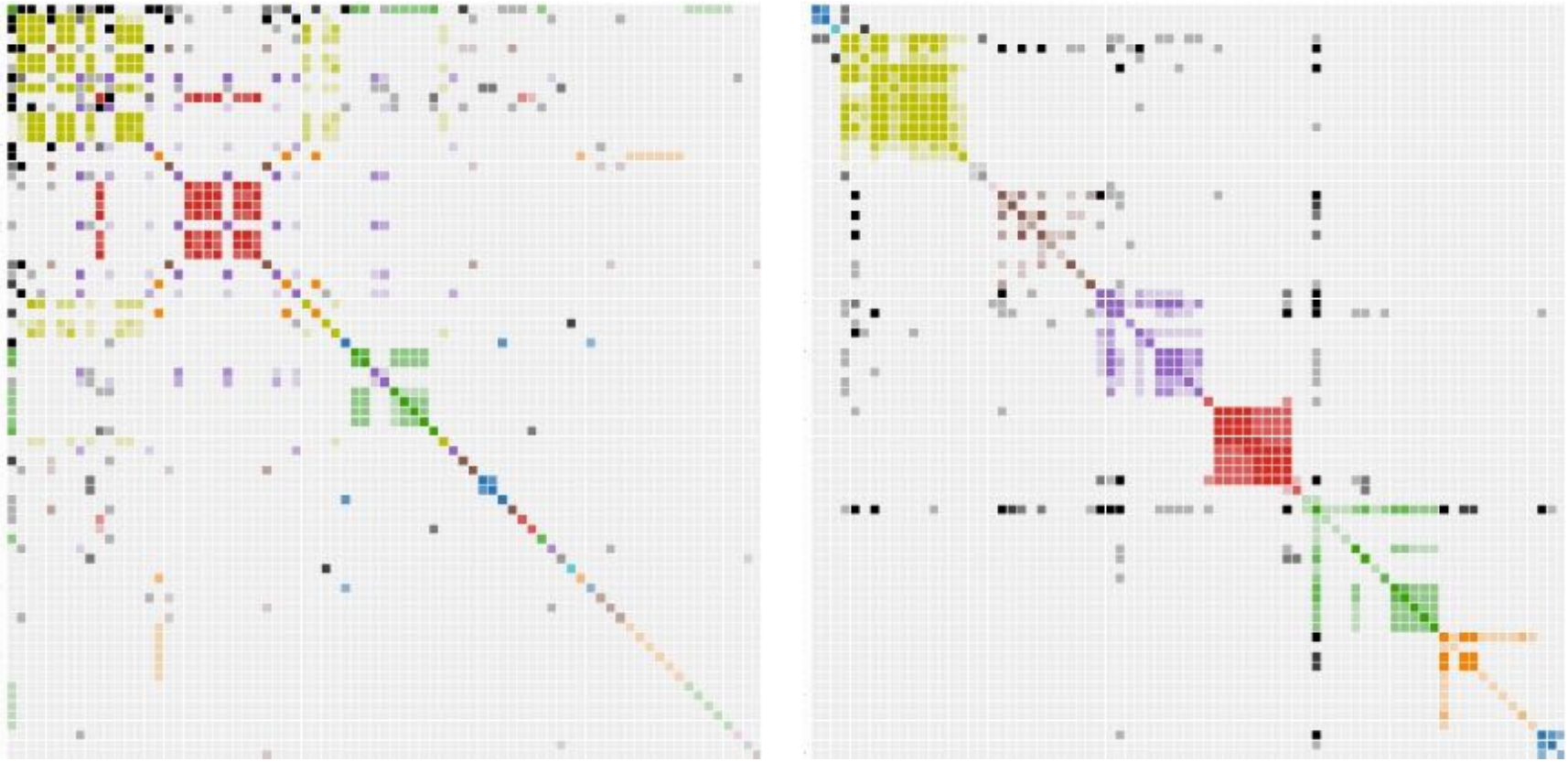


Figure 3: Data dependent topology demonstrated by molecular dynamics simulator NAMD under different molecular arrangements. The number of bytes sent between ranks is linearly mapped from dark blue (lowest) to red (highest), with white indicating an absence of communication.

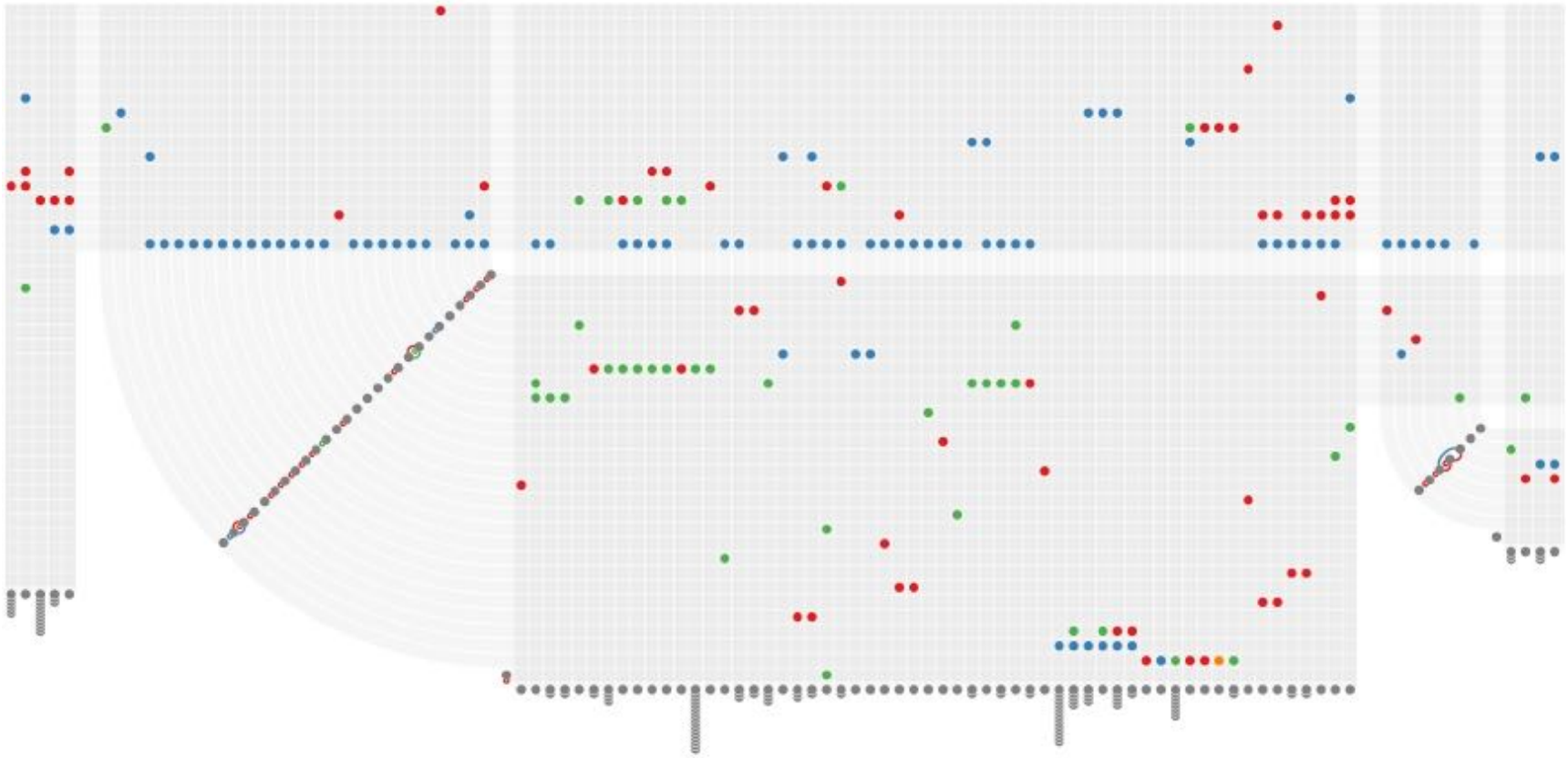
http://node99.org/papers/ntc-journal.pdf

Les Misérables Co-Occurrence



http://bost.ocks.org/mike/miserables/

Compressed Adjacency Matrix



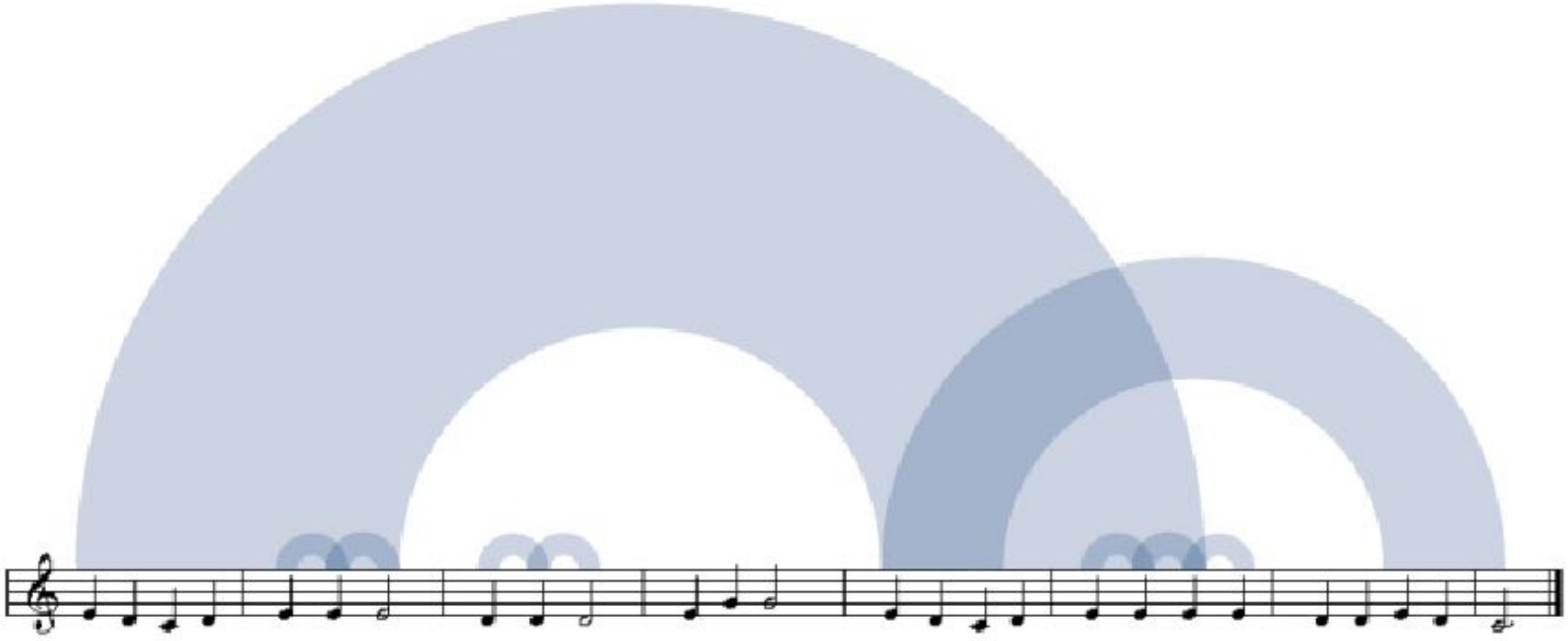
http://www.computer.org/csdl/trans/tg/2012/12/ttg2012122457-abs.html

NODE LAYOUT

Common Graph Layouts

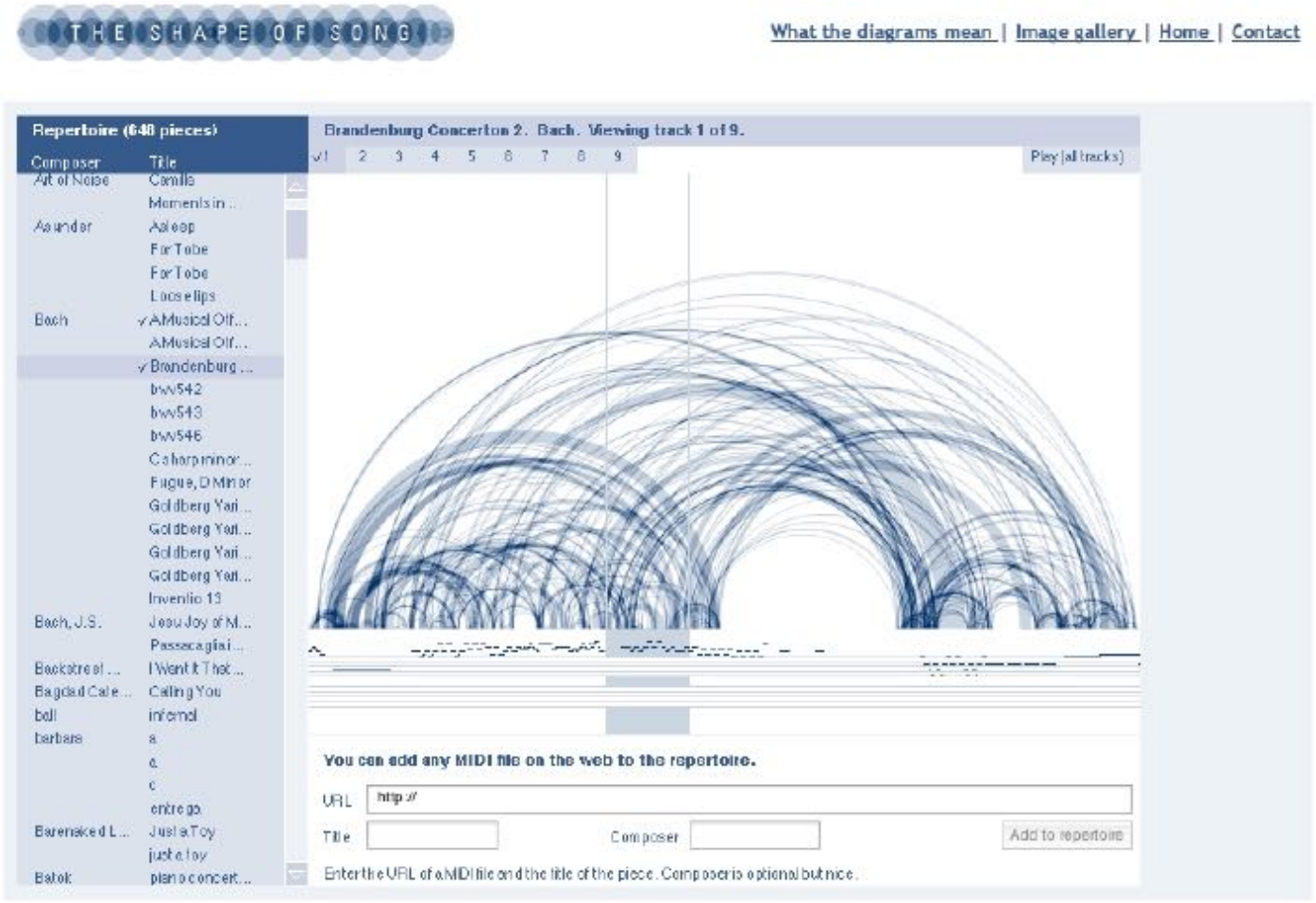
- Arc Diagrams
- Circle Layout
- Spring and Force-Directed Layouts
- Self-Organizing Map Layout
- Fruchterman Reingold Layout
- Kamada Kawai Layout
- Hive Plots
- Multi-Level Layouts

Arc Diagram



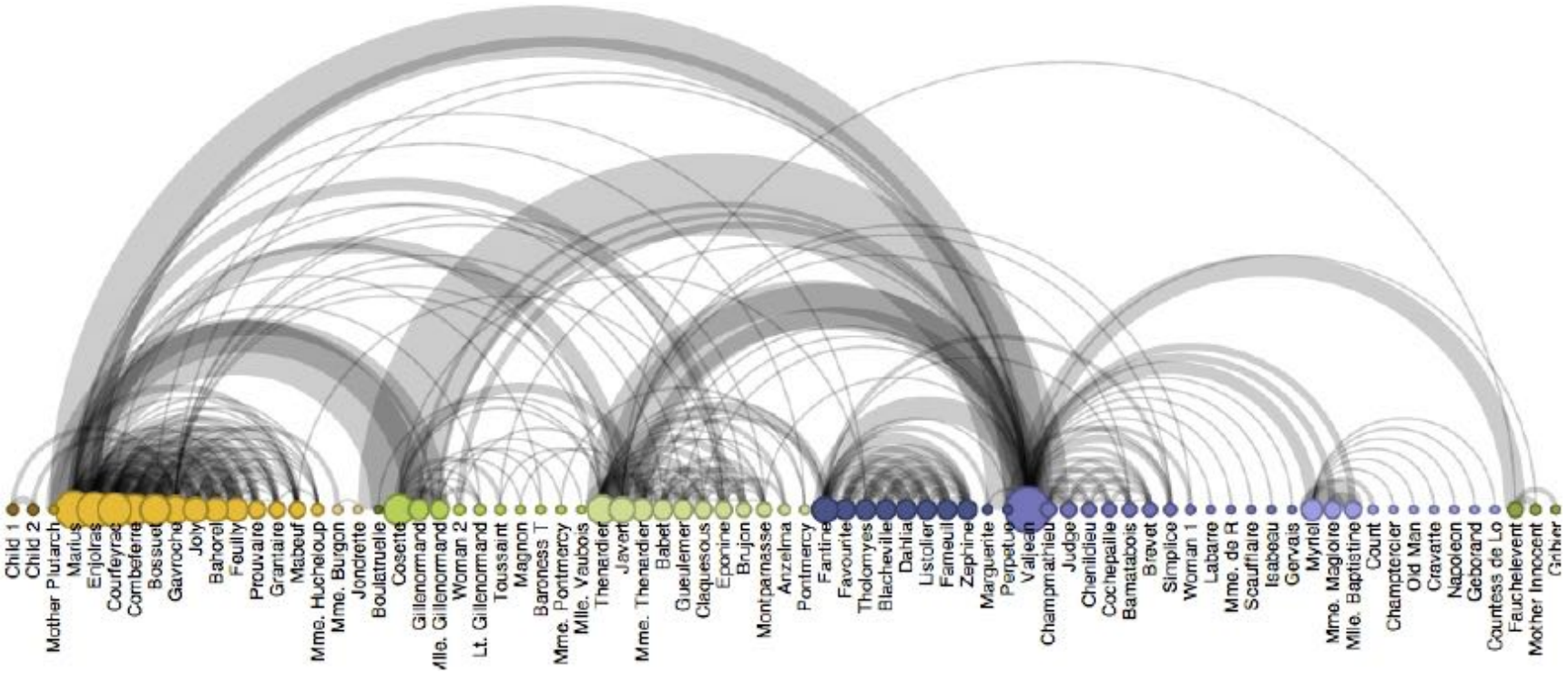
http://www.turbulence.org/Works/song/method/method.html

Arc Diagram



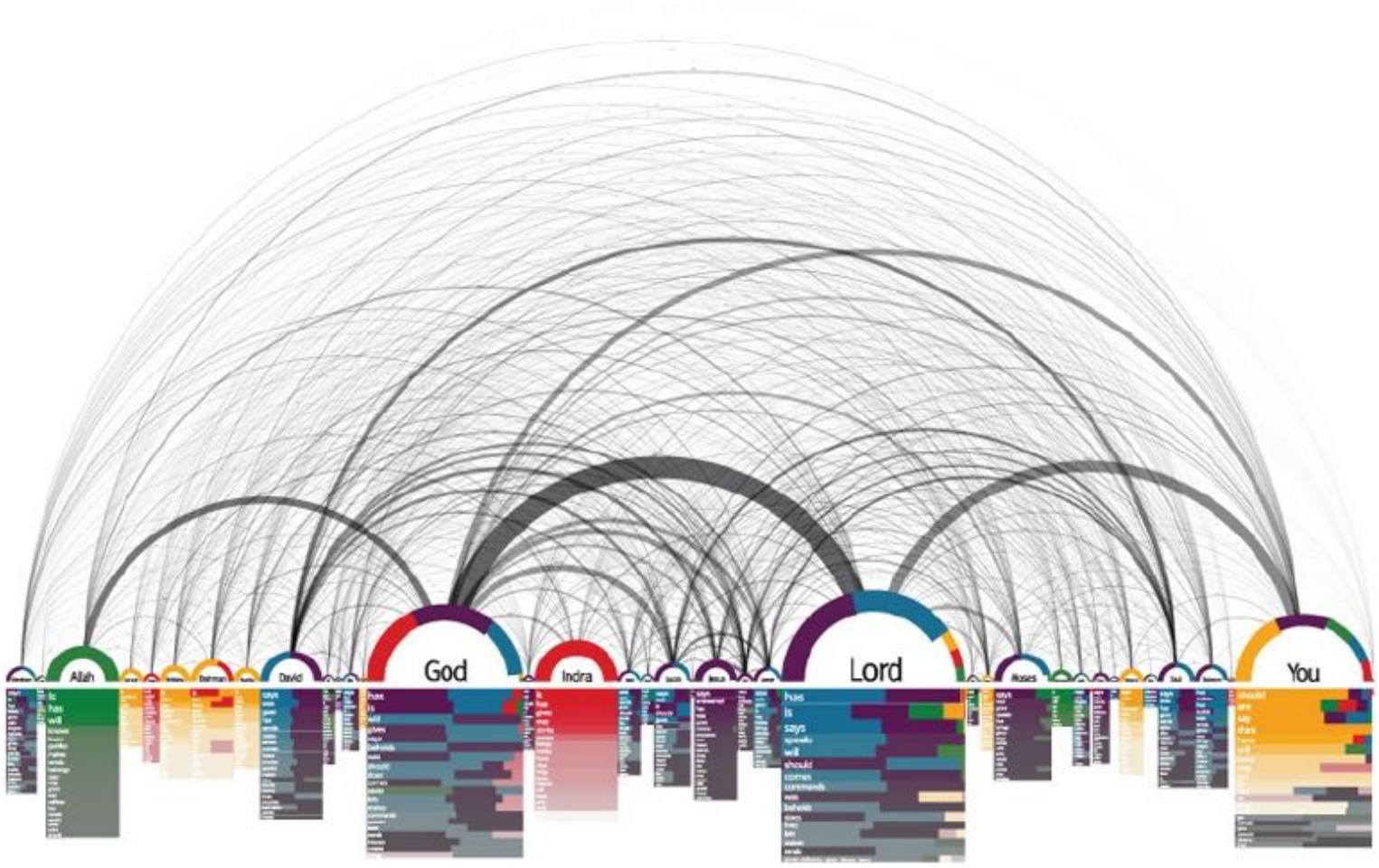
http://www.turbulence.org/Works/song/mono.html

Arc Diagram in Protovis



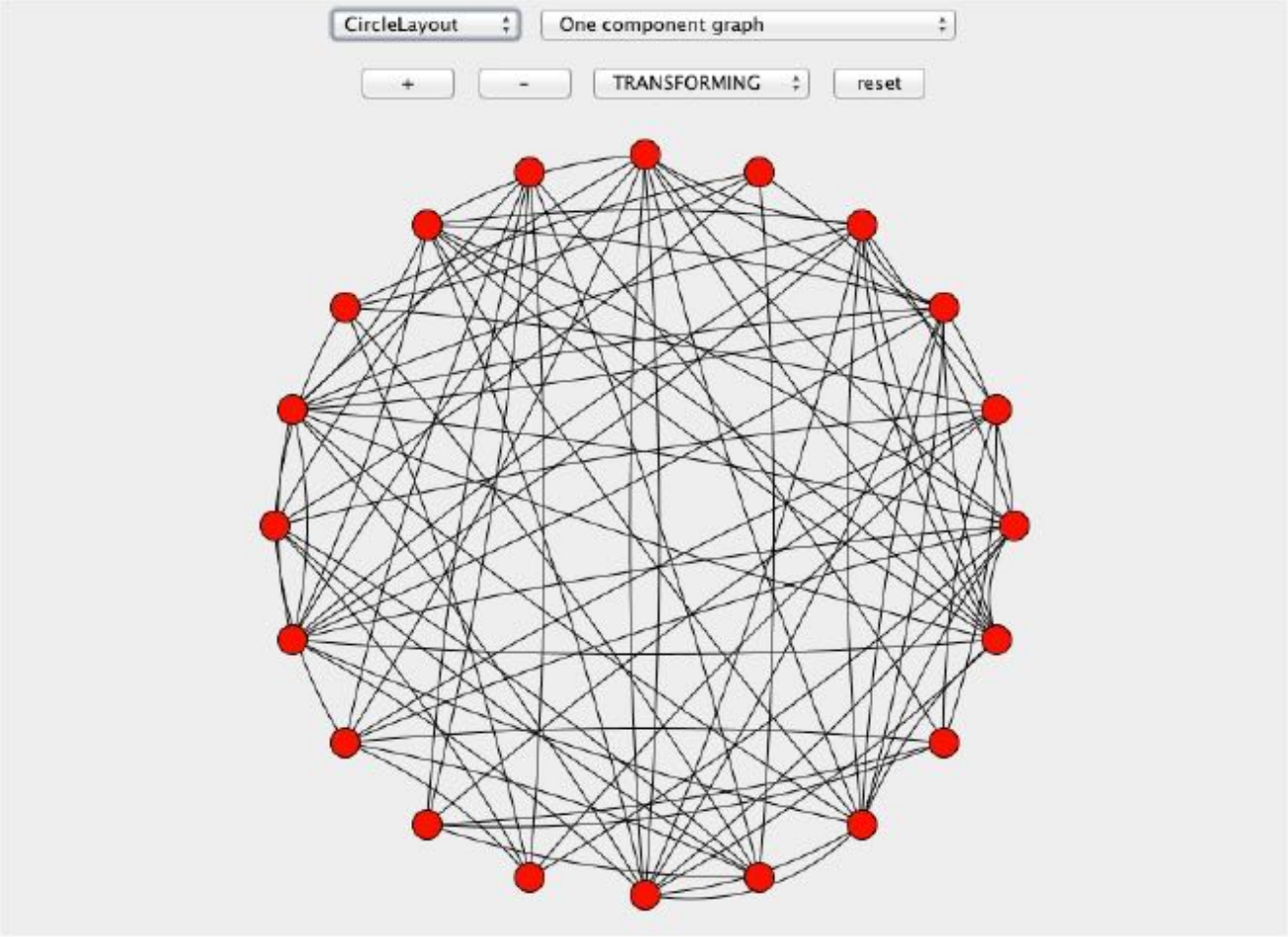
http://mbostock.github.io/protovis/ex/arc.html

Similar Diversity



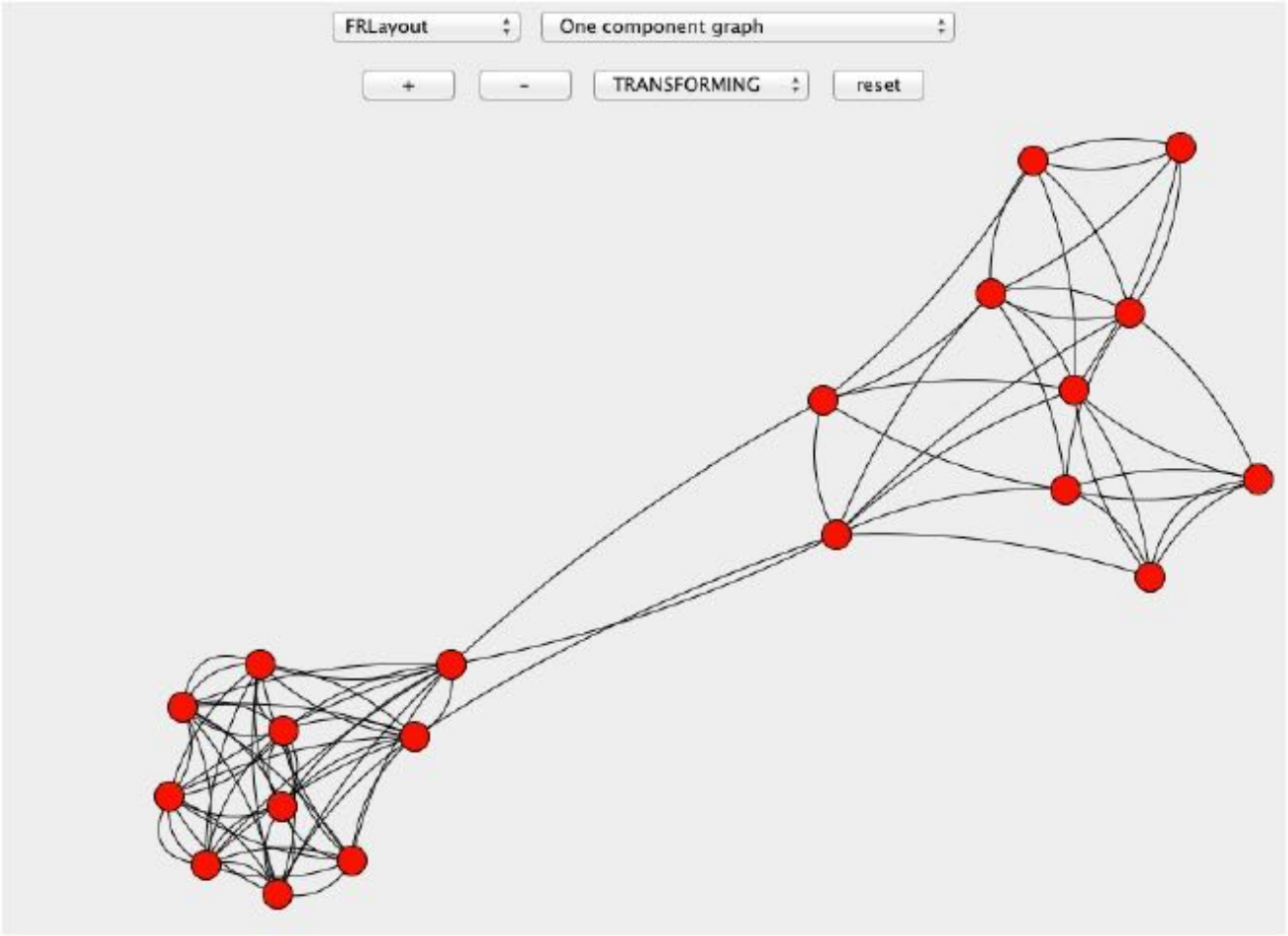
http://similardiversity.net/about/

JUNG Layouts



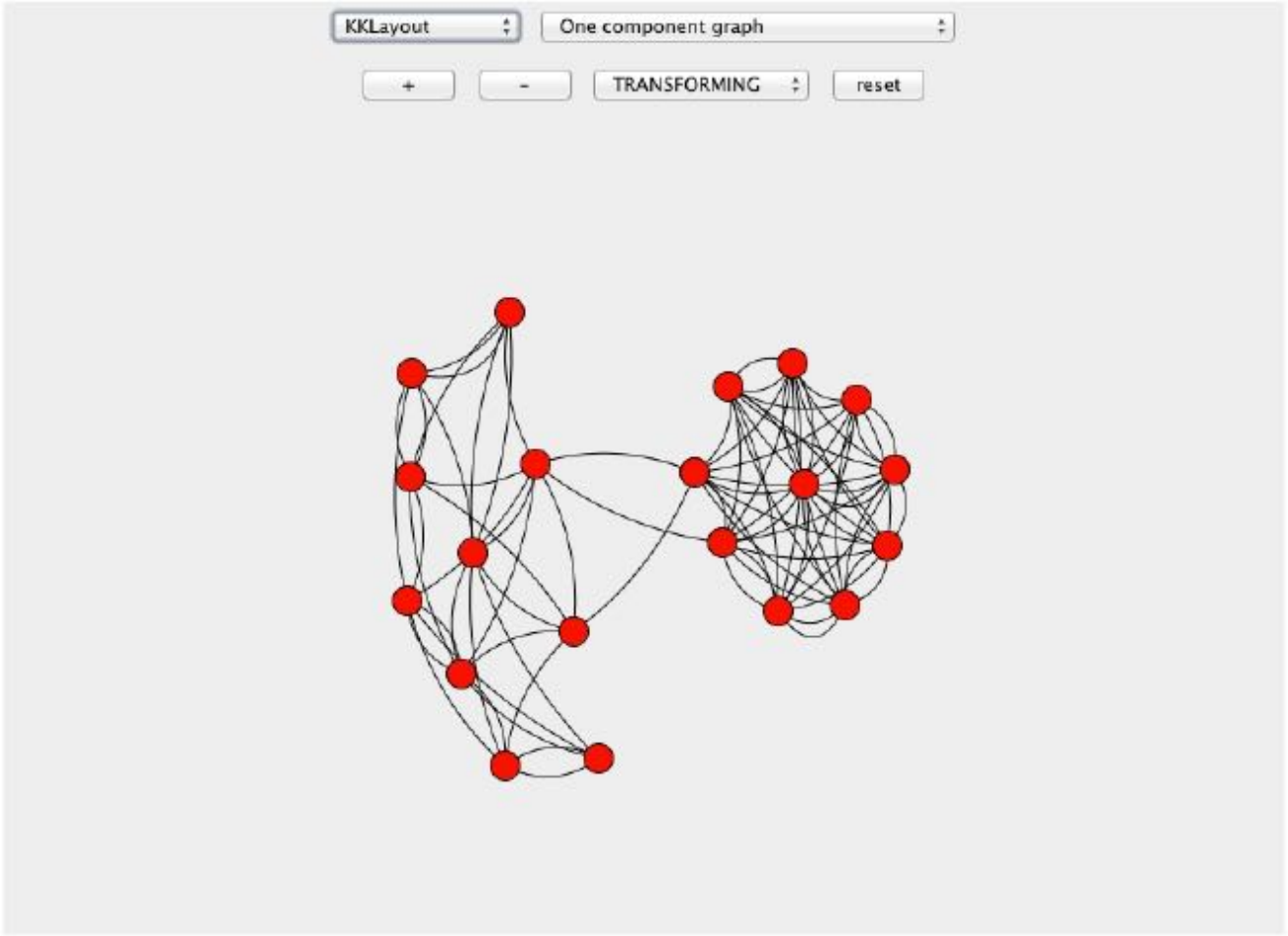
http://jung.sourceforge.net/applet/showlayouts2.html

JUNG Layouts



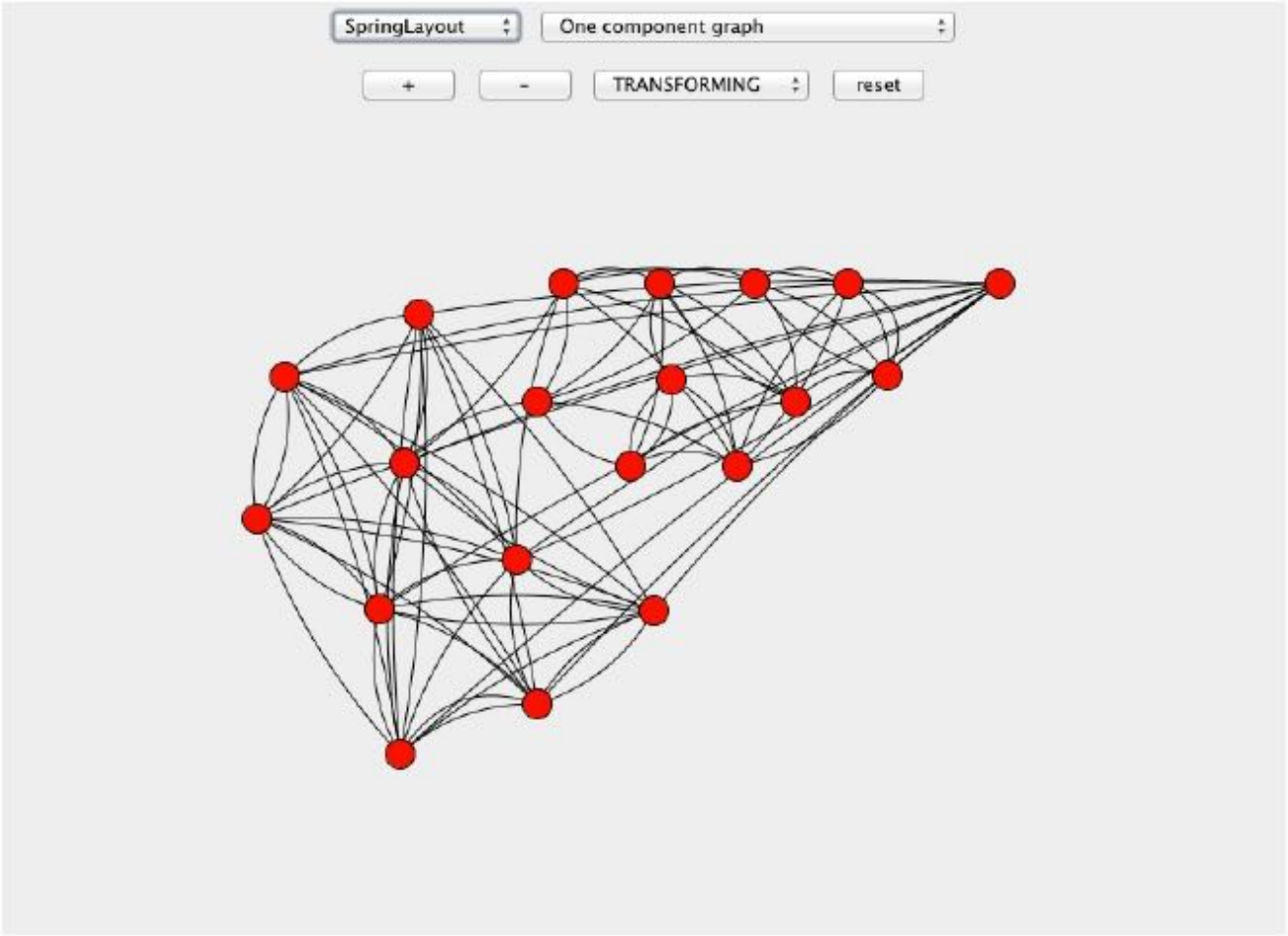
http://jung.sourceforge.net/applet/showlayouts2.html

JUNG Layouts



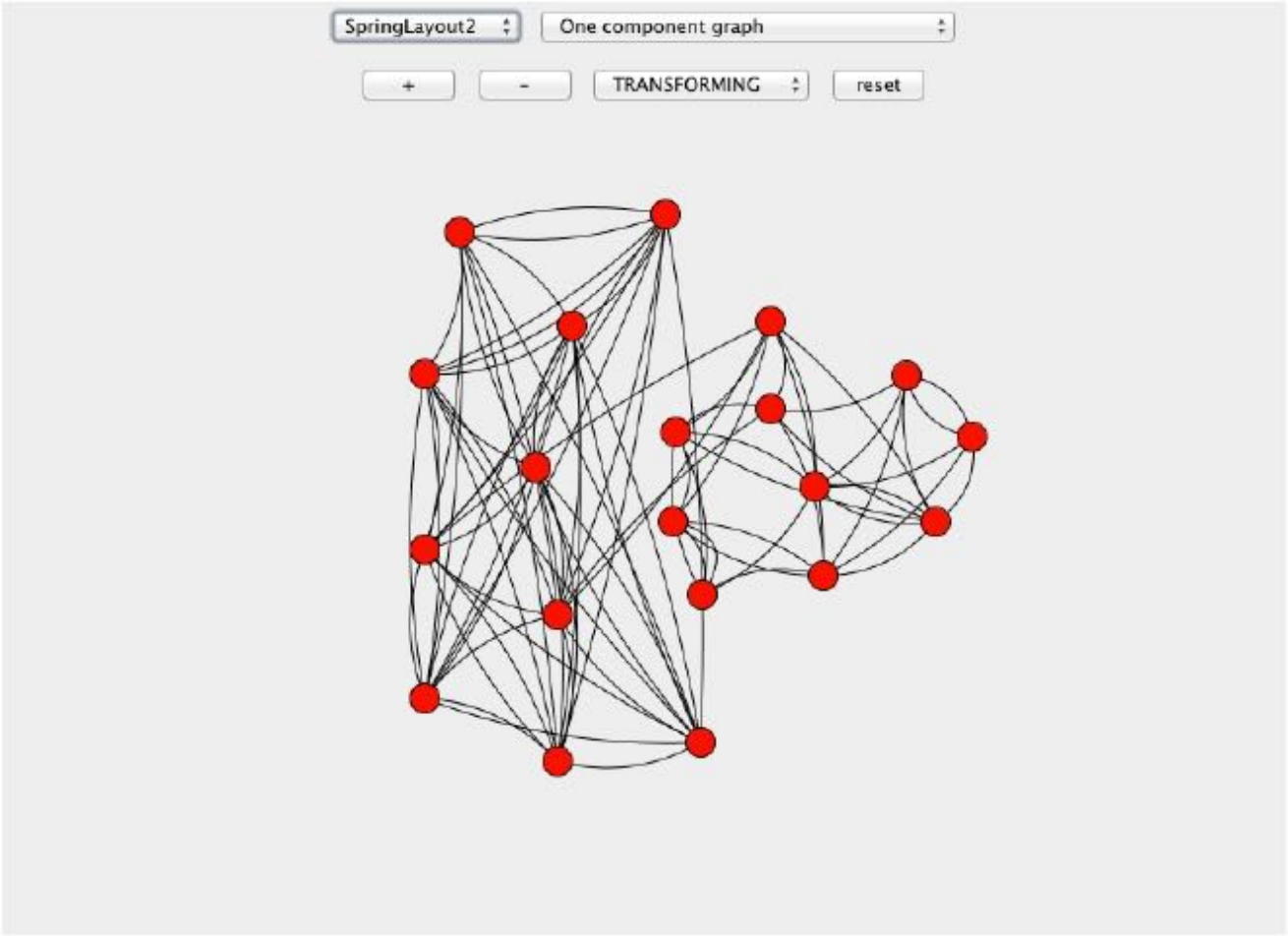
http://jung.sourceforge.net/applet/showlayouts2.html

JUNG Layouts



http://jung.sourceforge.net/applet/showlayouts2.html

JUNG Layouts



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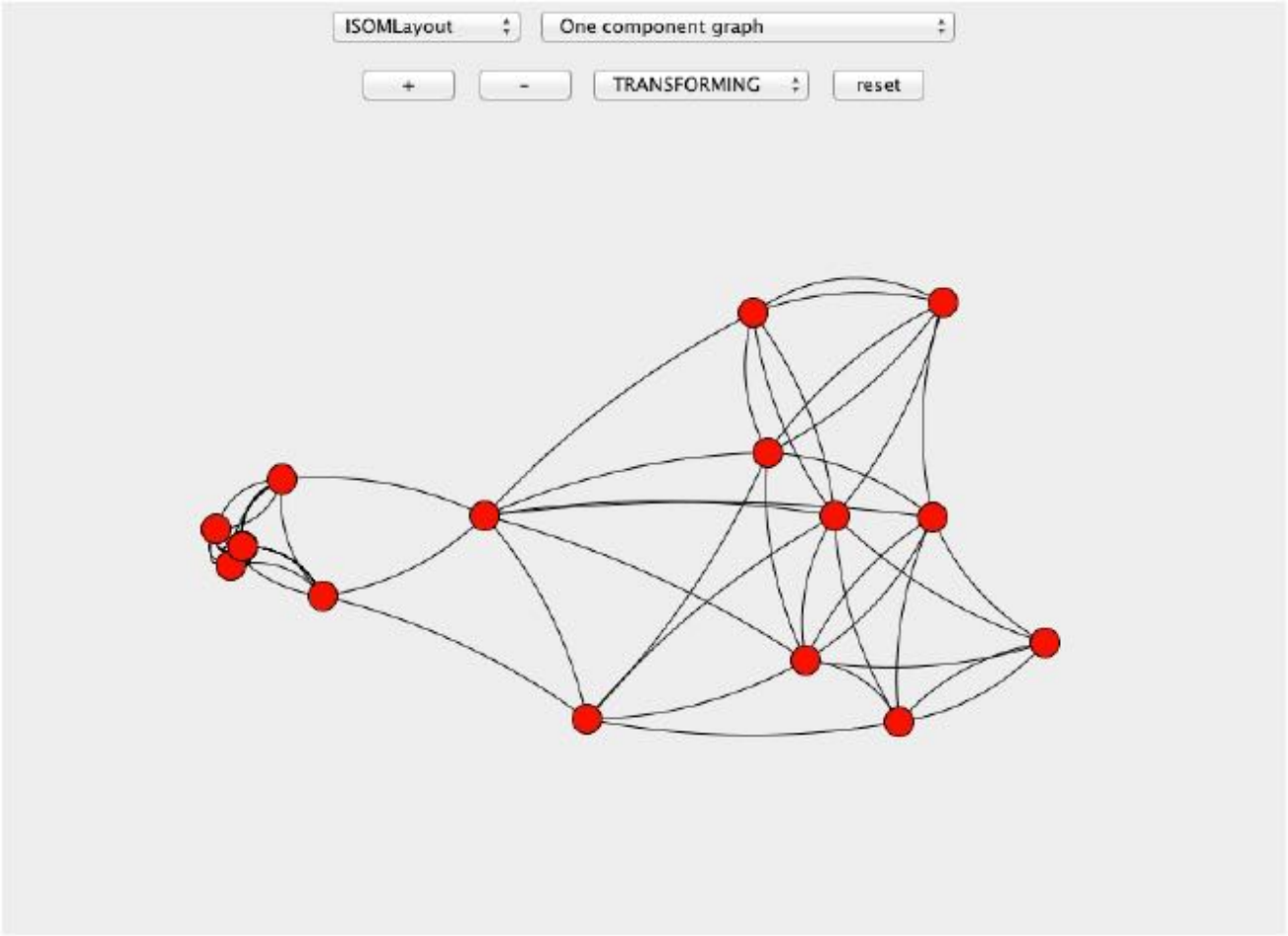
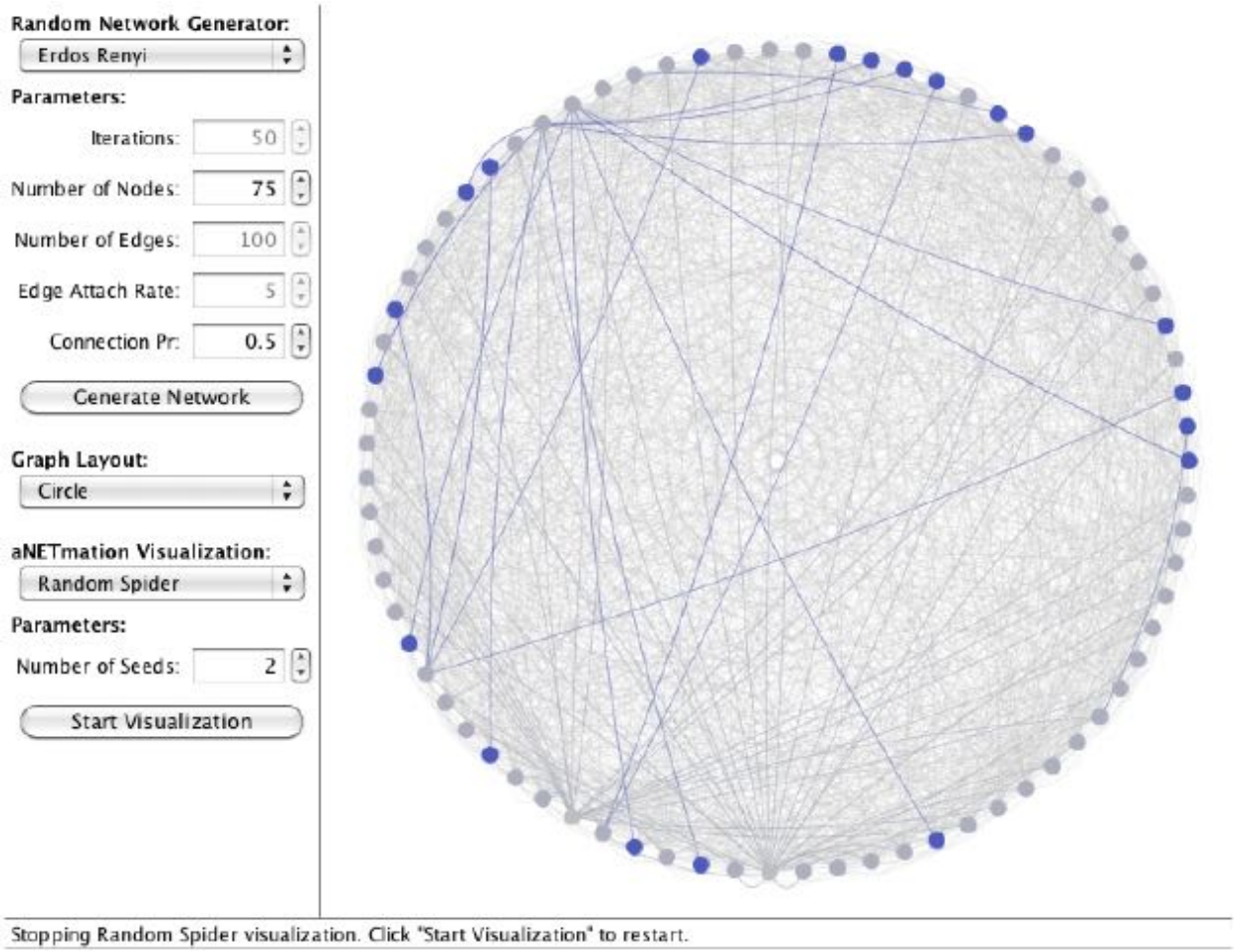
JUNG Layouts



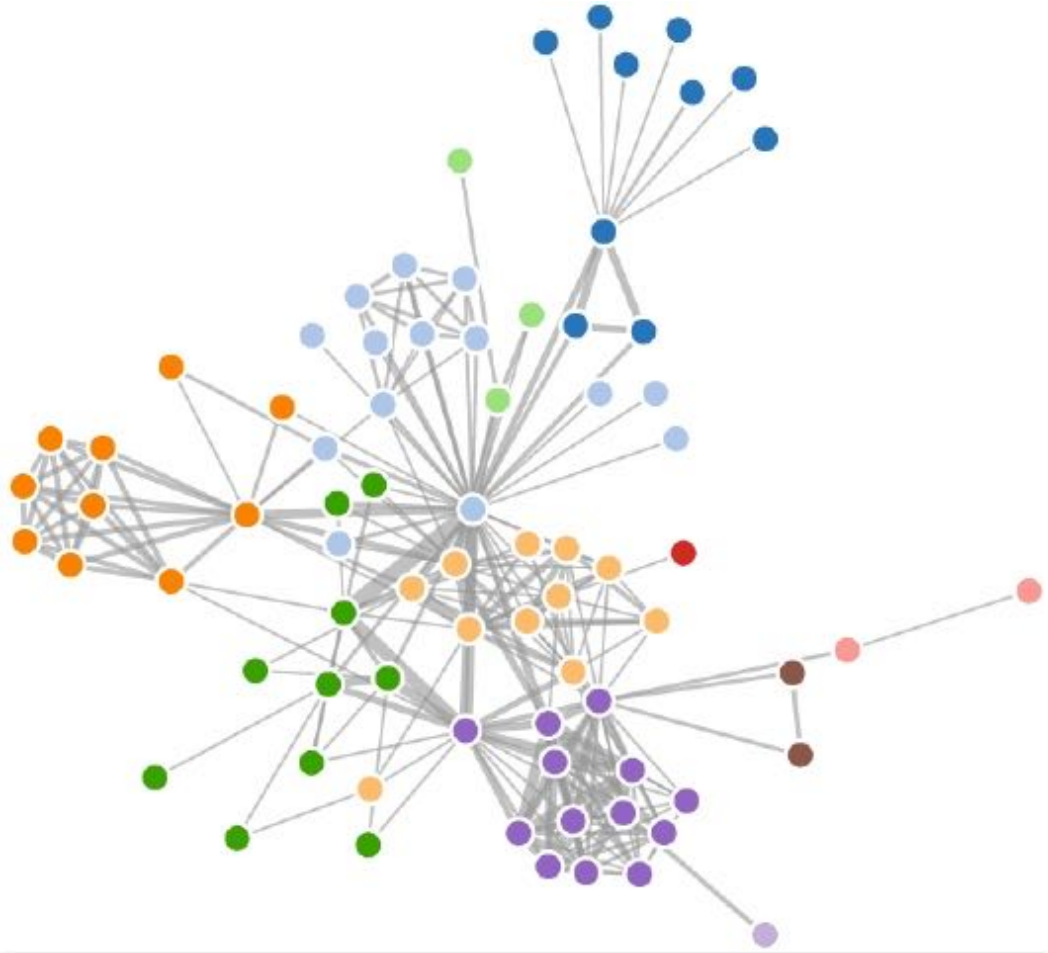
http://jung.sourceforge.net/applet/showlayouts2.html

aNETmation



http://www.phien.org/ucdavis/grad/projects/anetmation/

Force Directed Layout in D3



http://bl.ocks.org/mbostock/4062045

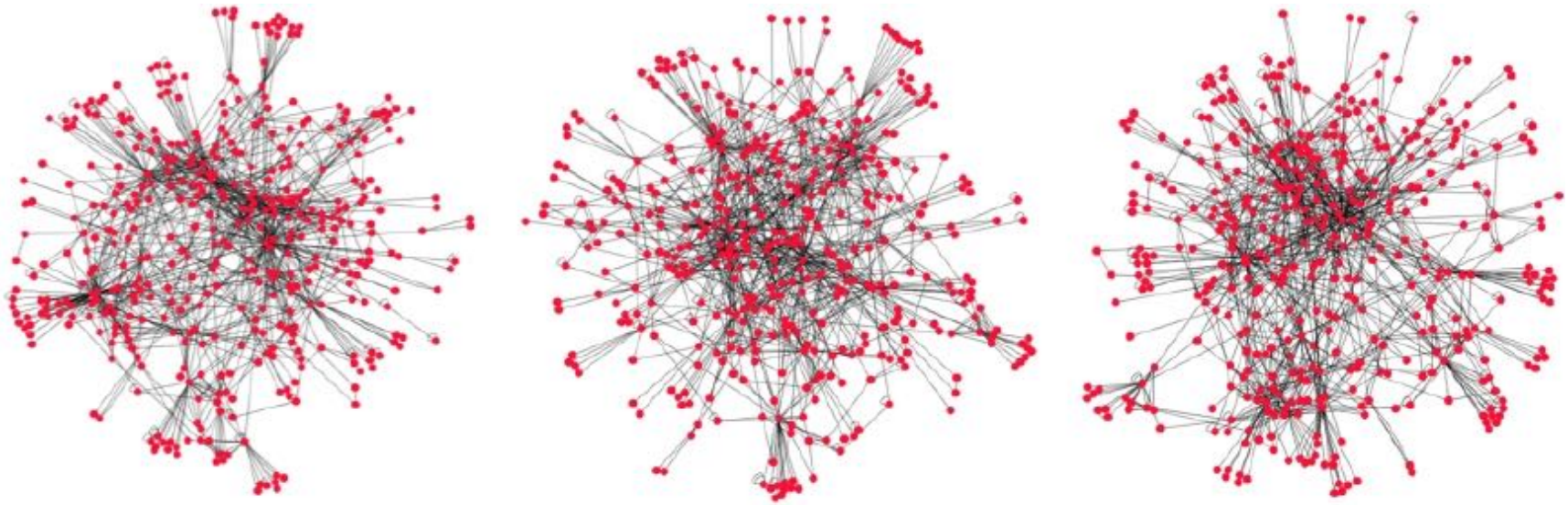
HIVE PLOTS

Hive Plots

- What are hive plots?
  - Network layout algorithm using per-node network properties for no deplacement
  - A radially-arranged parallel coordinate plot
- Why use hive plots?
  - Repeatable, comparable network layouts
  - Shows network properties with topology

http://www.hiveplot.net/

Motivation

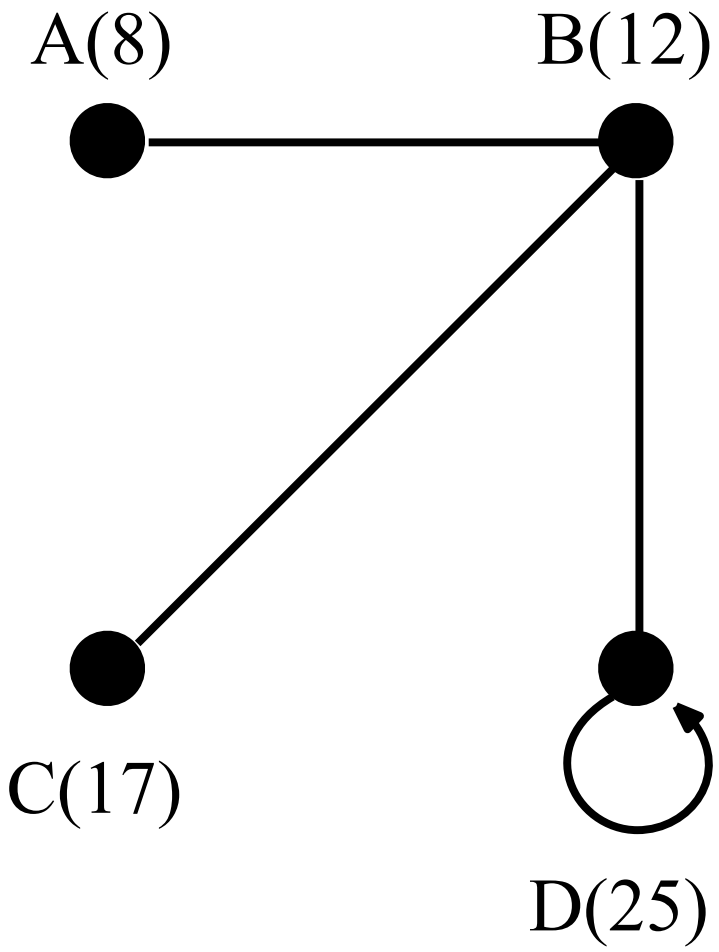


Subset of the human protein-protein interaction network rendered by Cytoscape. Each visualization uses the same layout (spring embedded), using the previous as a starting point.

Rual et al., *Nature* **437**(7062):1173-8.

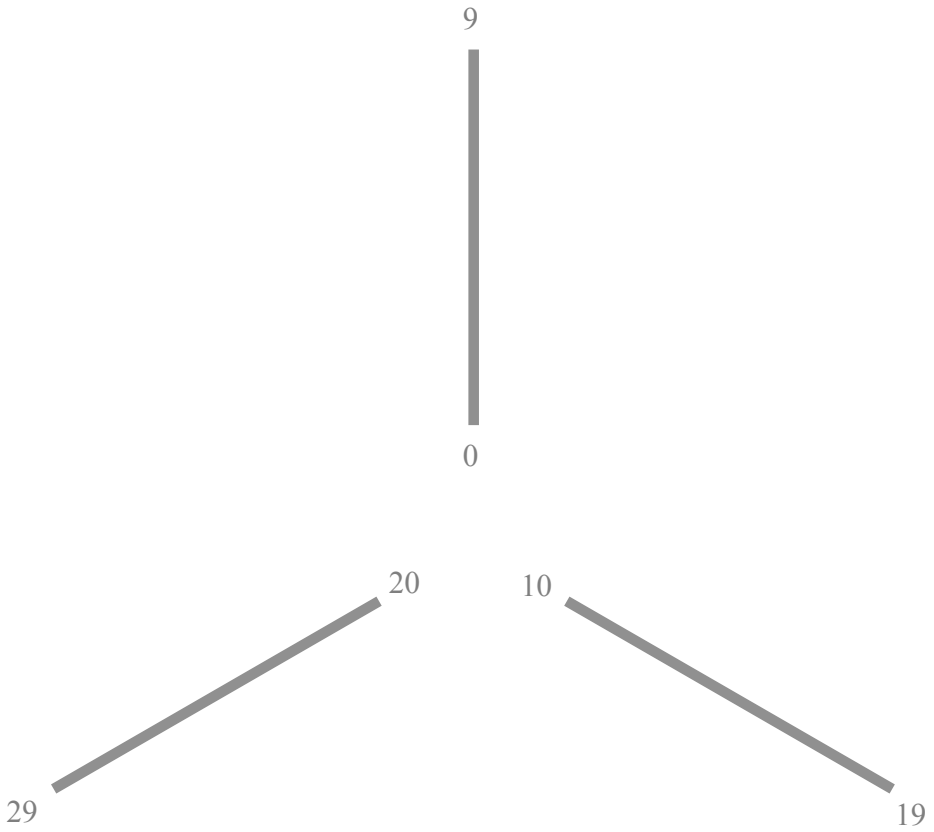
http://www.hiveplot.net/talks/hive-plot.pdf

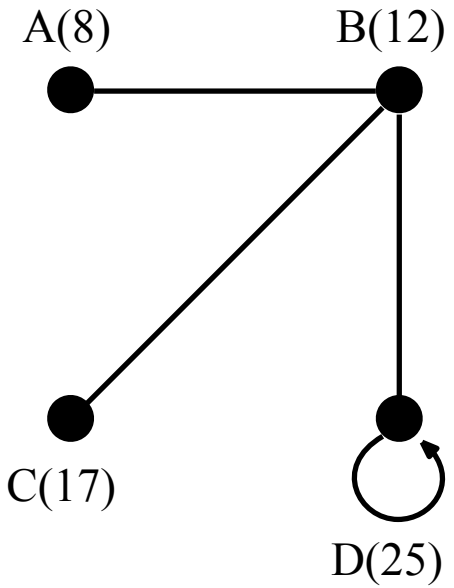
Initial Network



Simple network with node weights and a self-loop.

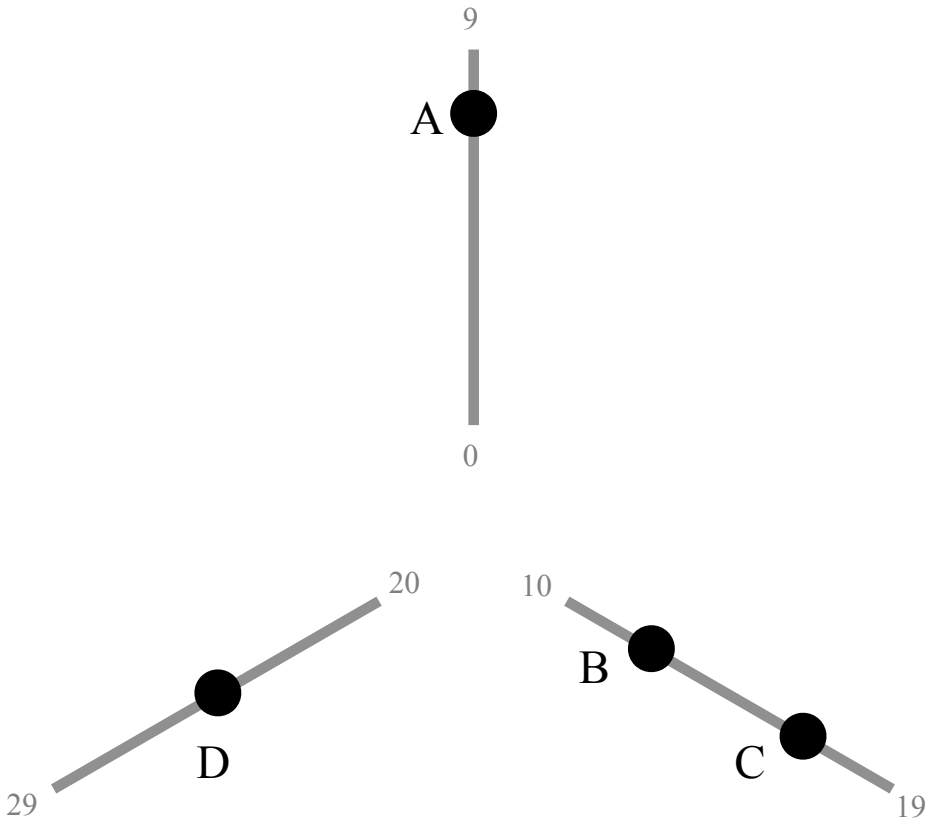
Axis Layout

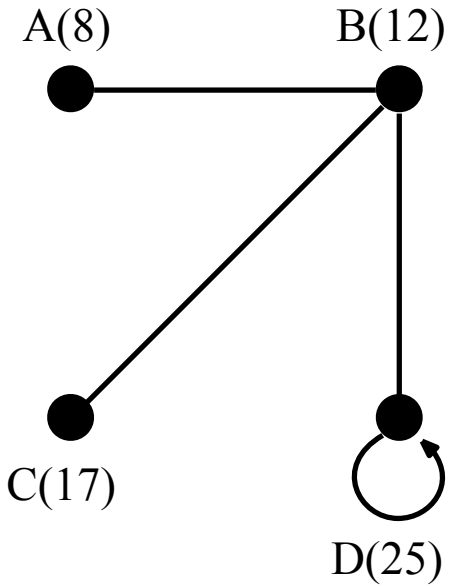




Three axis bars guarantee no edge crossings across axes. Divide node weight range between axes.

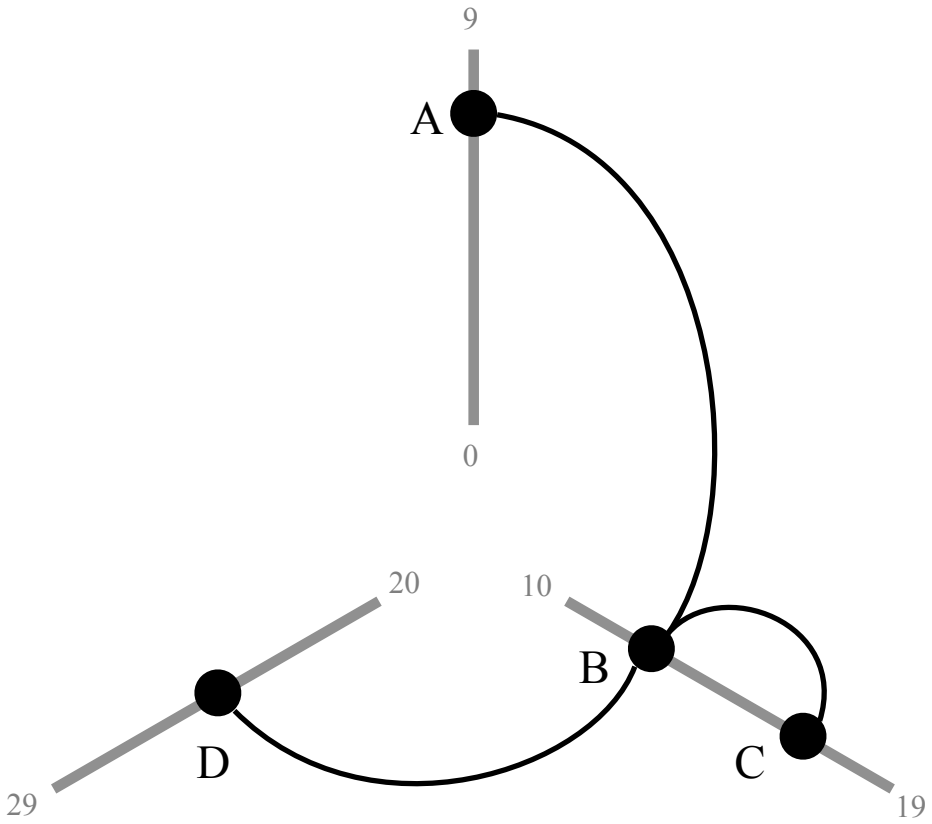
Node Layout

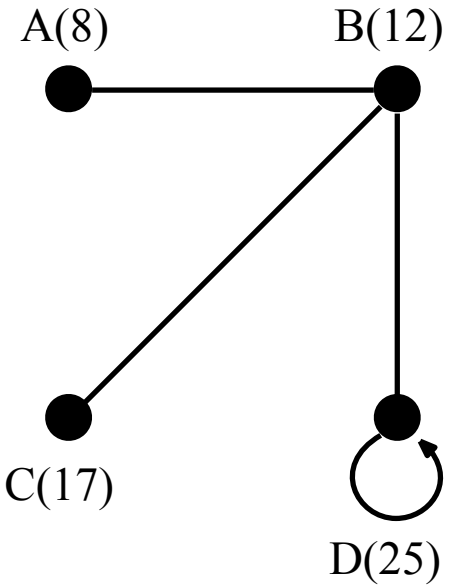




Place nodes on axis lines according to weight.

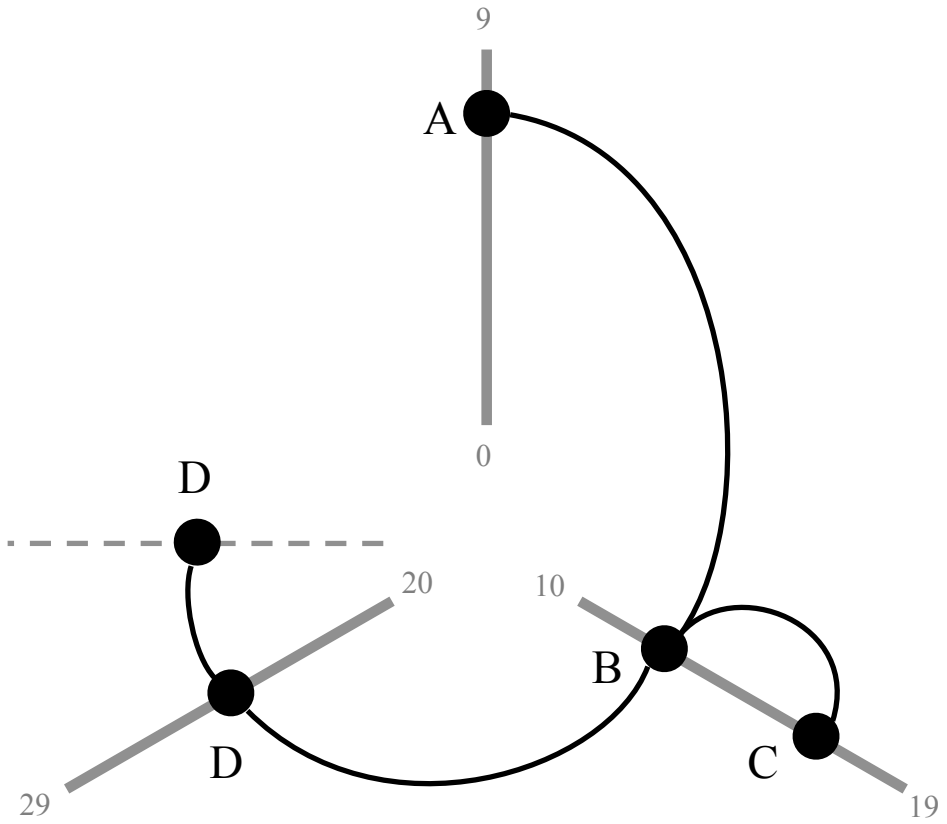
Edge Layout

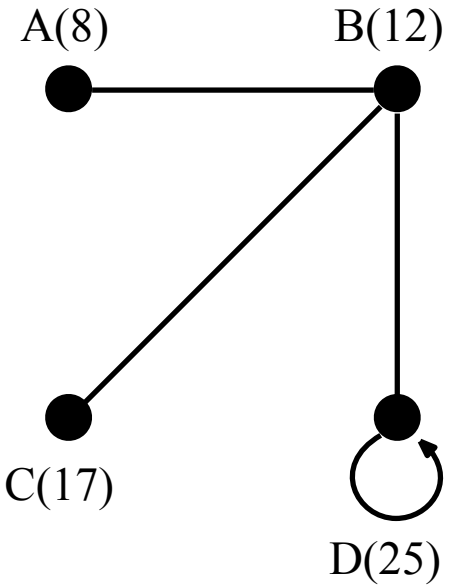




Connect nodes together accordingly.

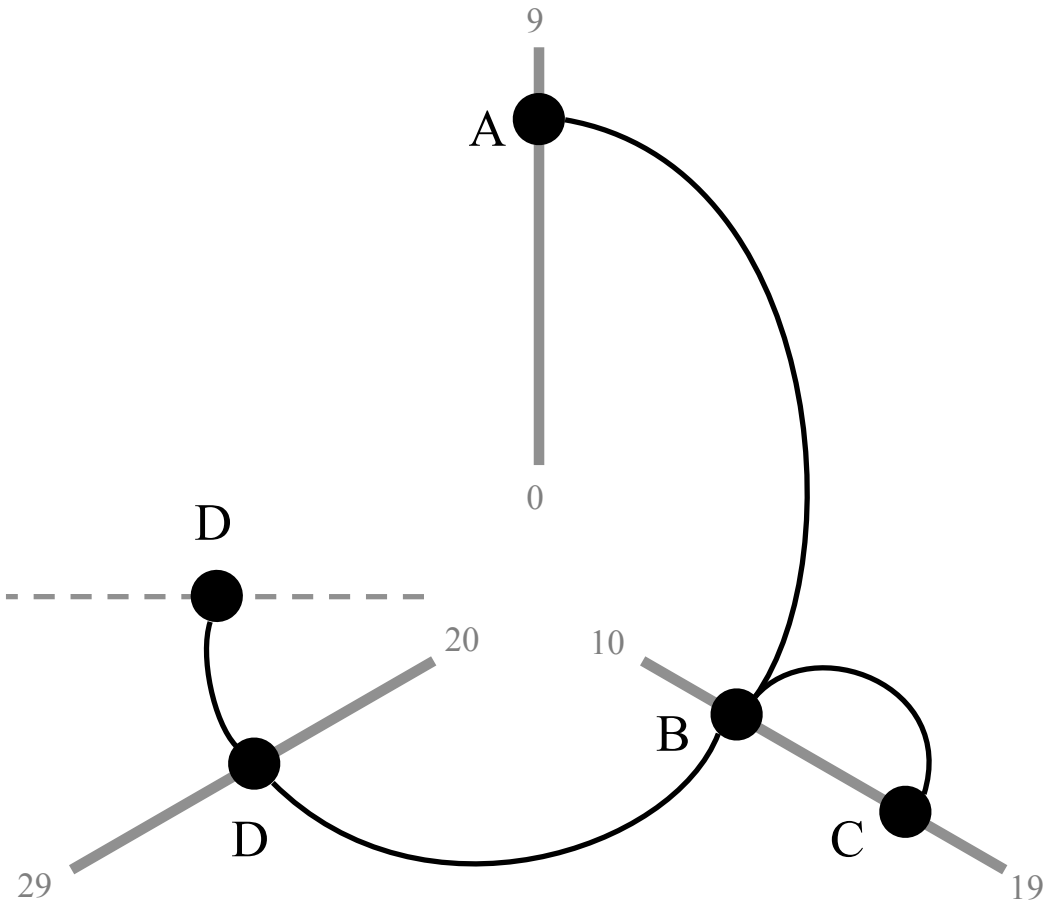
Self Loops



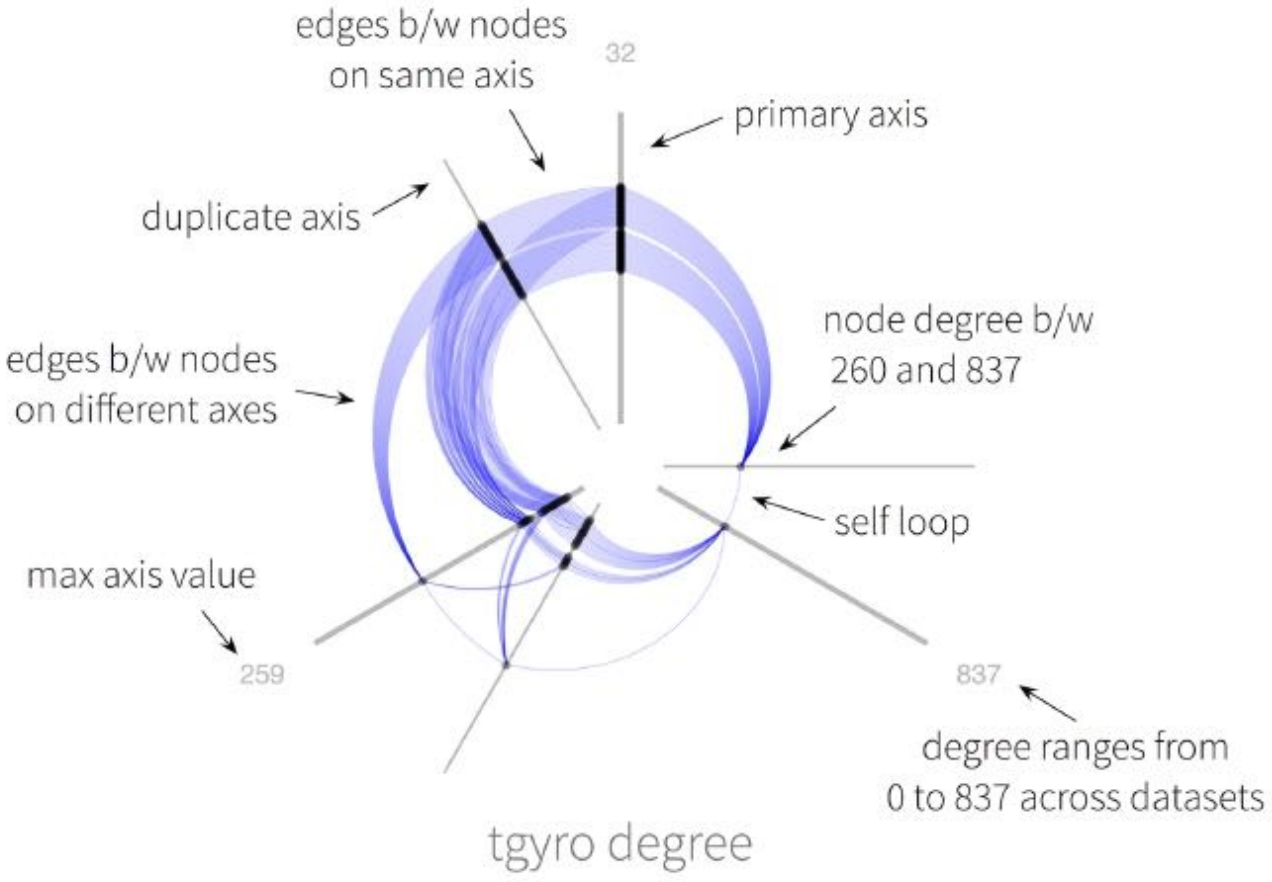


Clone axis lines to show self-loops in network.

Final Layout

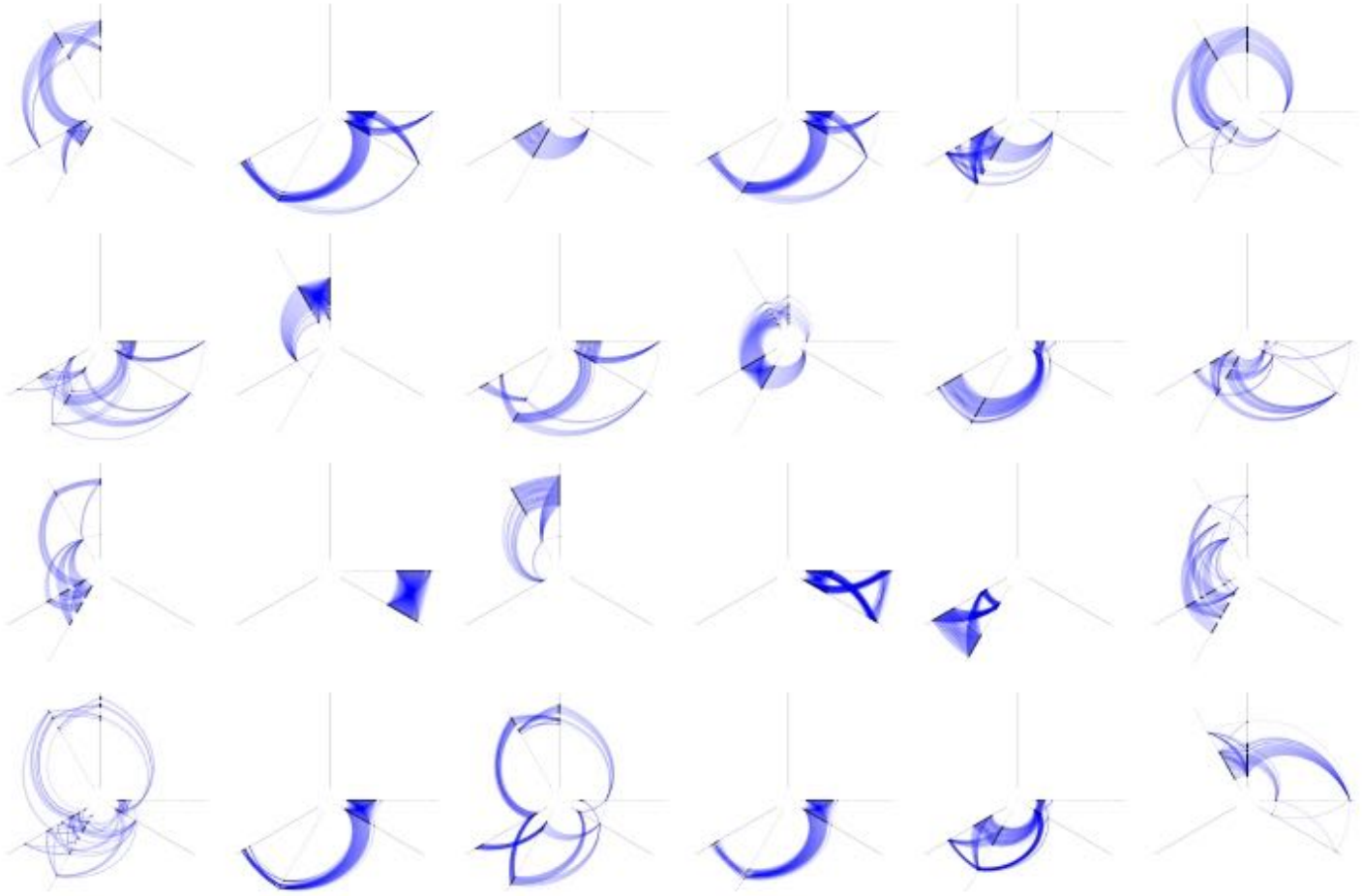


Hive Plots



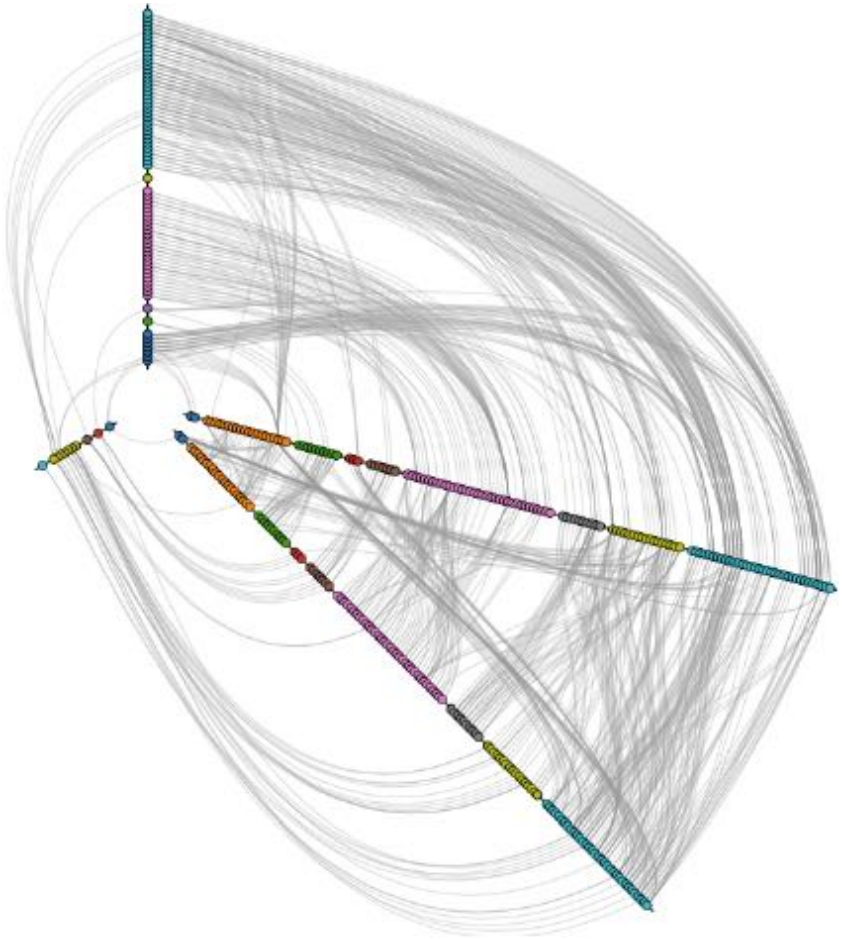
http://dl.acm.org/citation.cfm?id=2379698

Hive Panels



http://dl.acm.org/citation.cfm?id=2379698

Hive Plots in D3

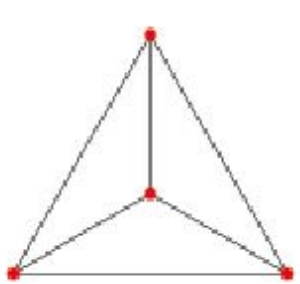


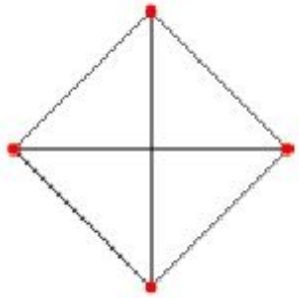
http://bost.ocks.org/mike/hive/

EDGE LAYOUT

Edge Crossings

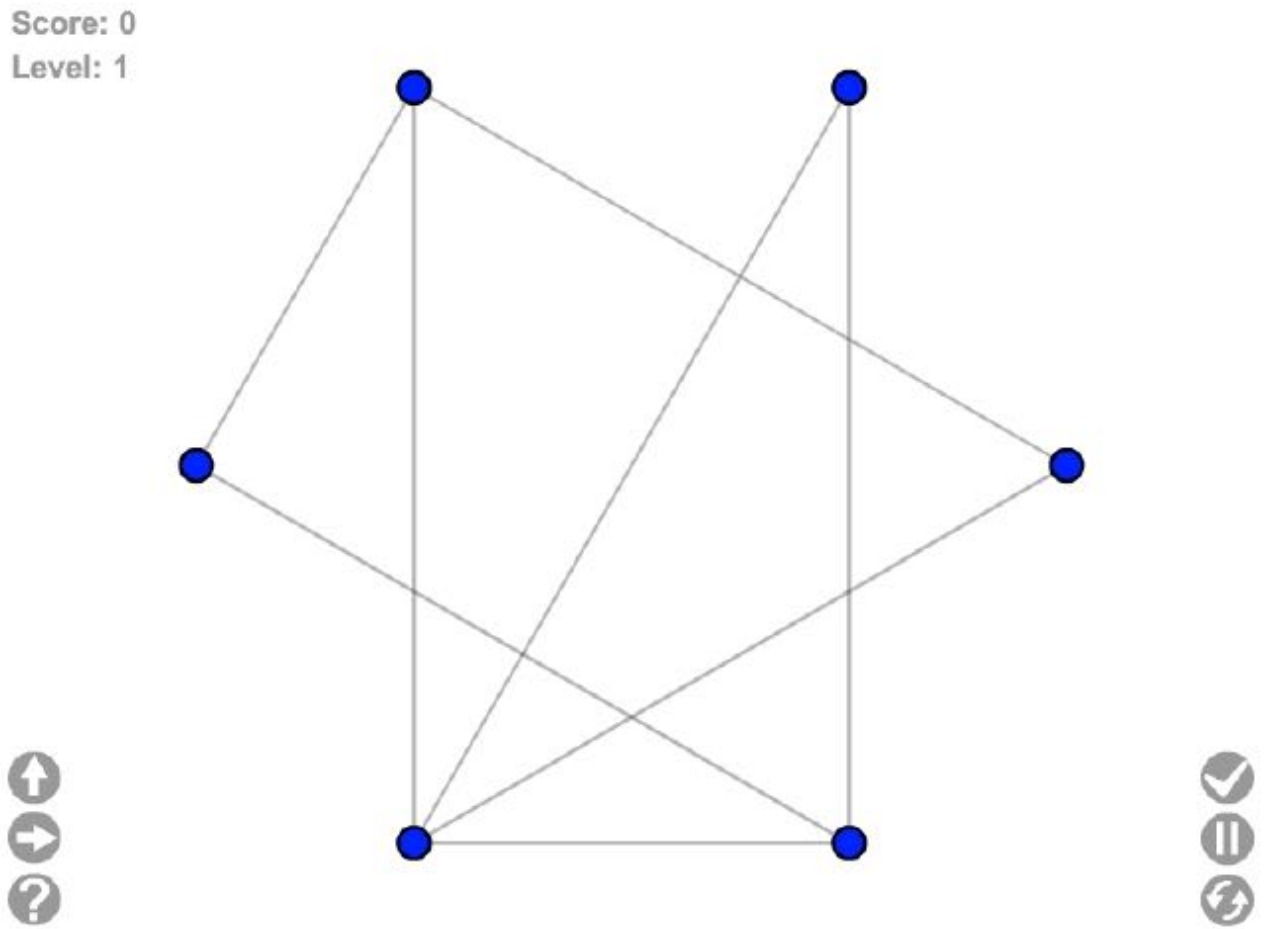
- Planar Graph
  - "A graph is planar if it can be drawn in a plane without graph edges crossing."
- If the graph is not planar, it is impossible to draw without edge crossings.
- Trees are planar graphs.





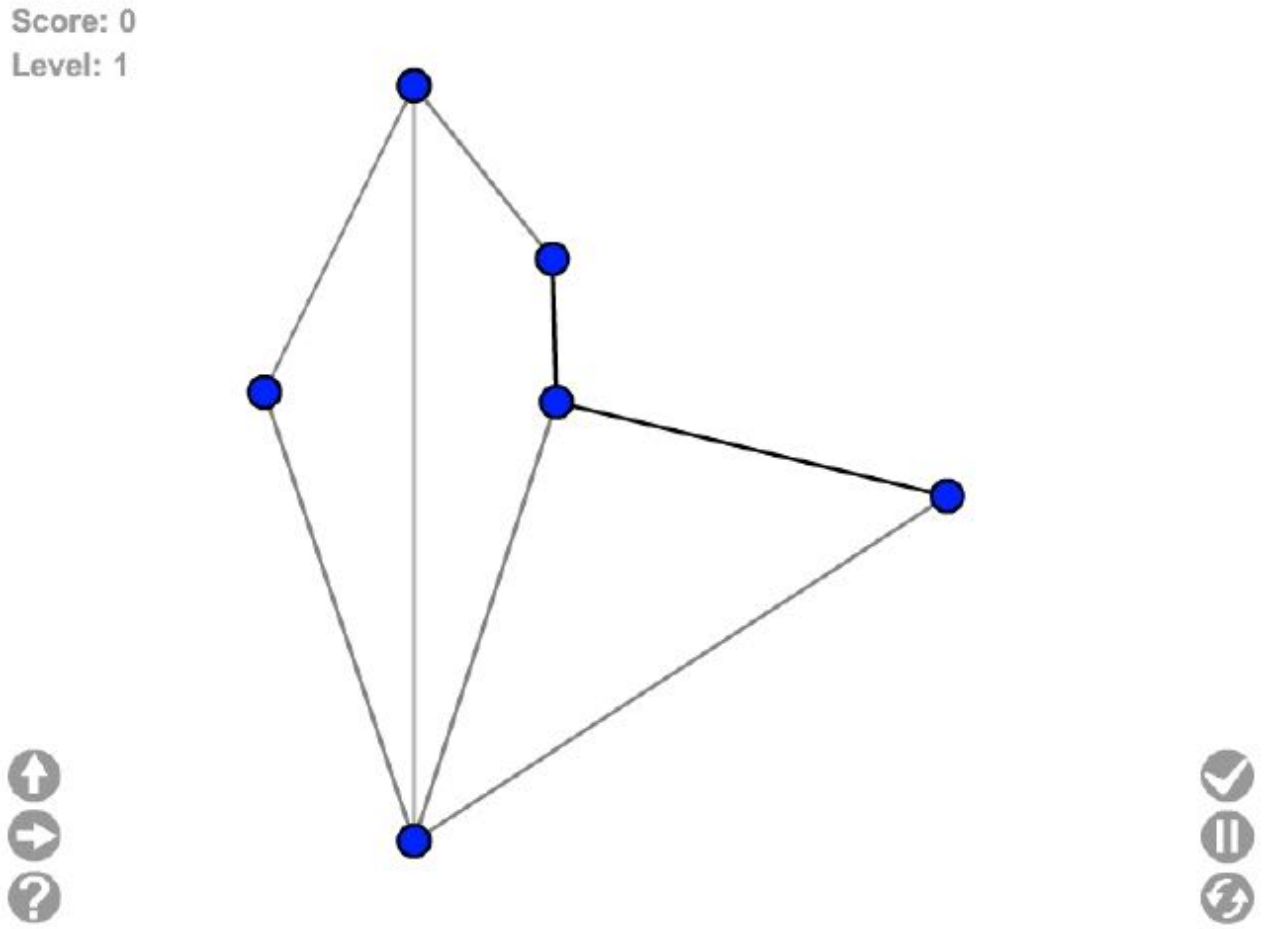
http://mathworld.wolfram.com/PlanarGraph.html

Planarity Game



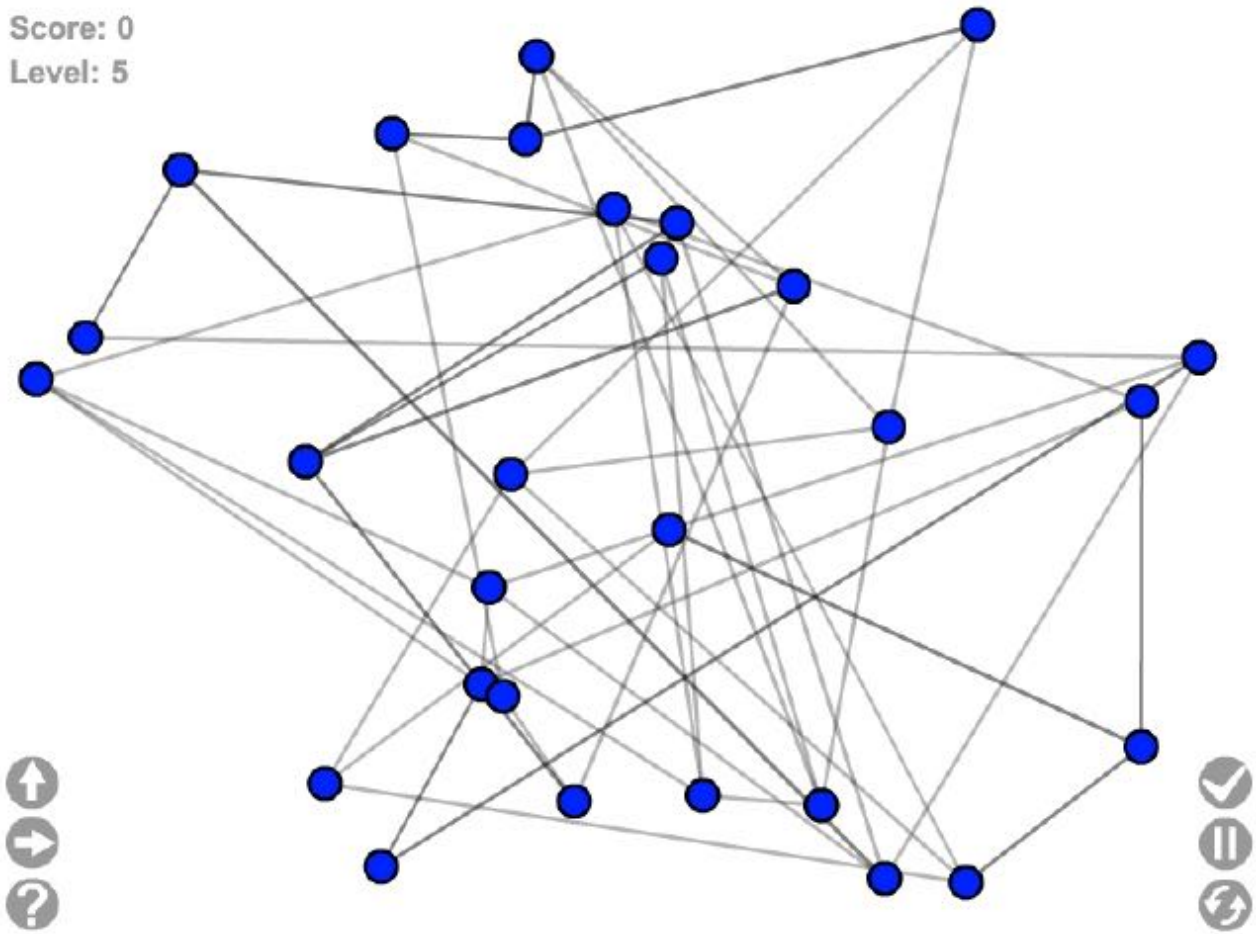
http://www.planarity.net/

Planarity Game



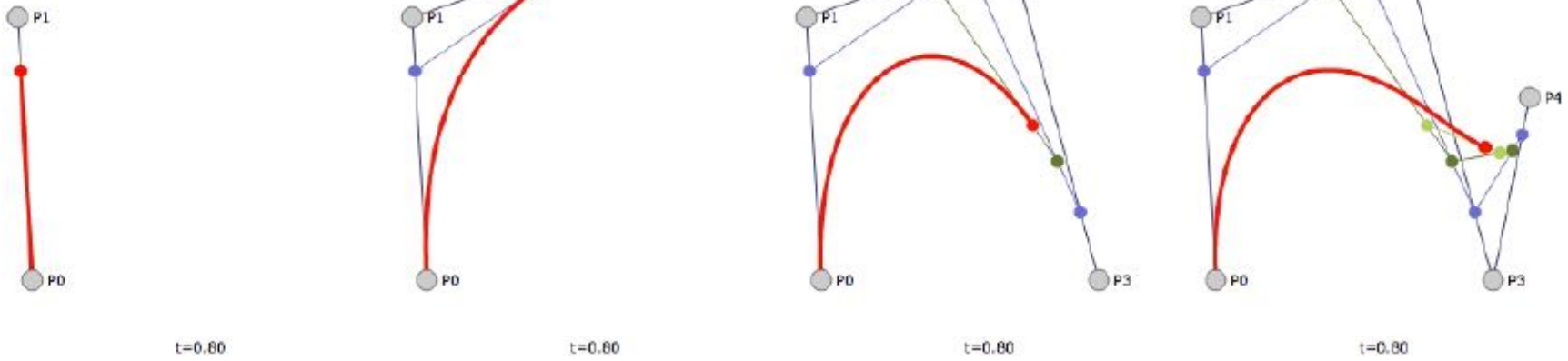
http://www.planarity.net/

Planarity Game



http://www.planarity.net/

Curved Edges



http://www.jasondavies.com/animated-bezier/

Edge Bundling

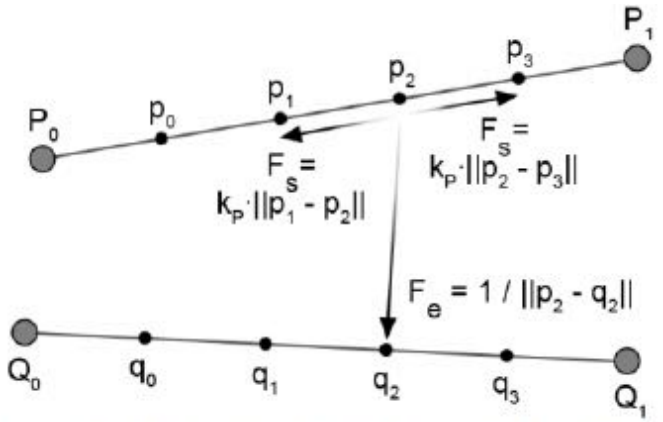


Figure 1: *Two interacting edges P and Q. The spring forces* $\mathbf{F_s}$ *and the electrostatic force* $\mathbf{F_e}$ *that are exerted on subdivision point* p_2 *by* p_1, p_3, *and* q_2 *are shown.*

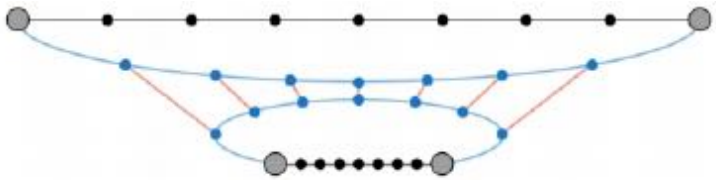


Figure 4: *Bundling edges that differ considerably in length can result in noticeable stretching and curving of short edges. Original edges, curved edges and attracting forces are shown in black, blue, and red, respectively.*

https://www.win.tue.nl/vis1/home/dholten/papers/forcebundles_eurovis.pdf

Edge Bundling

Danny Holten & Jarke J. van Wijk / Force-Directed Edge Bundling for Graph Visualization

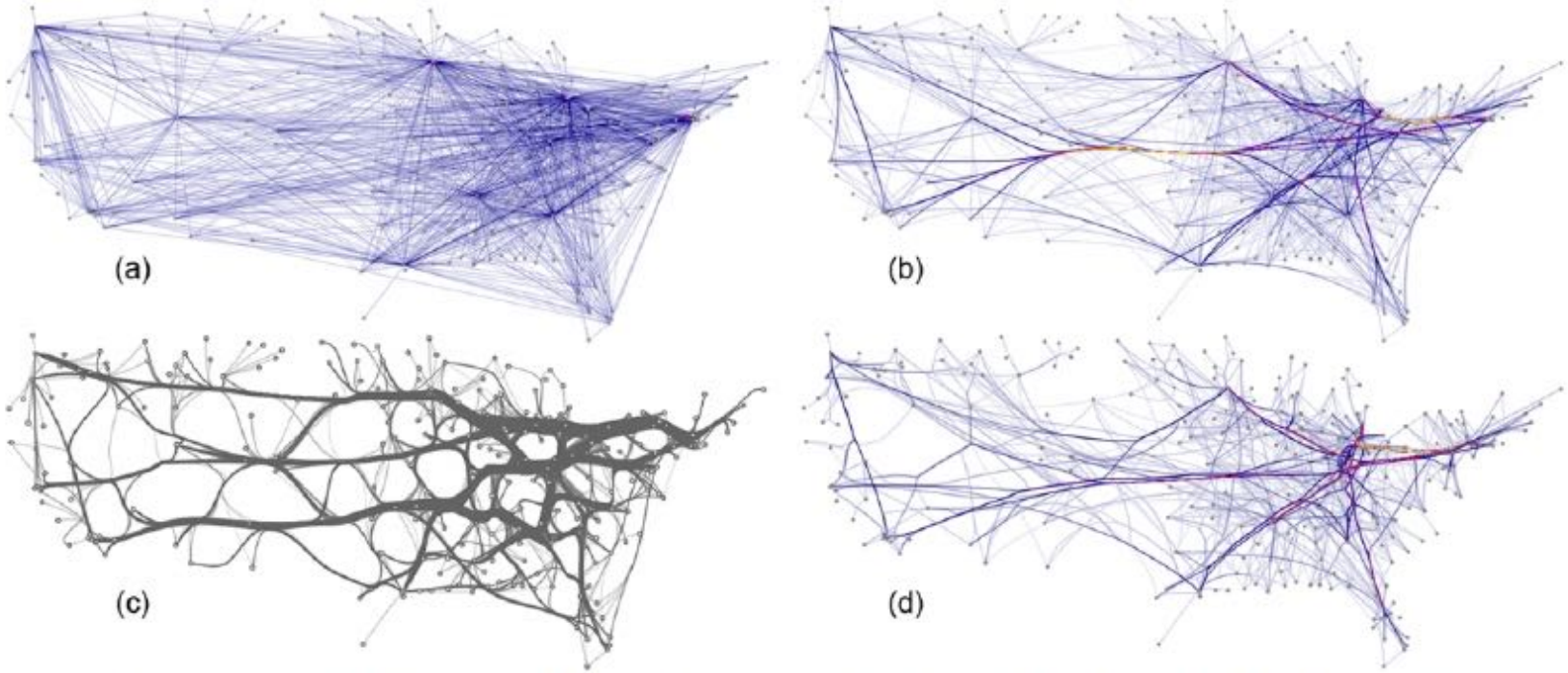
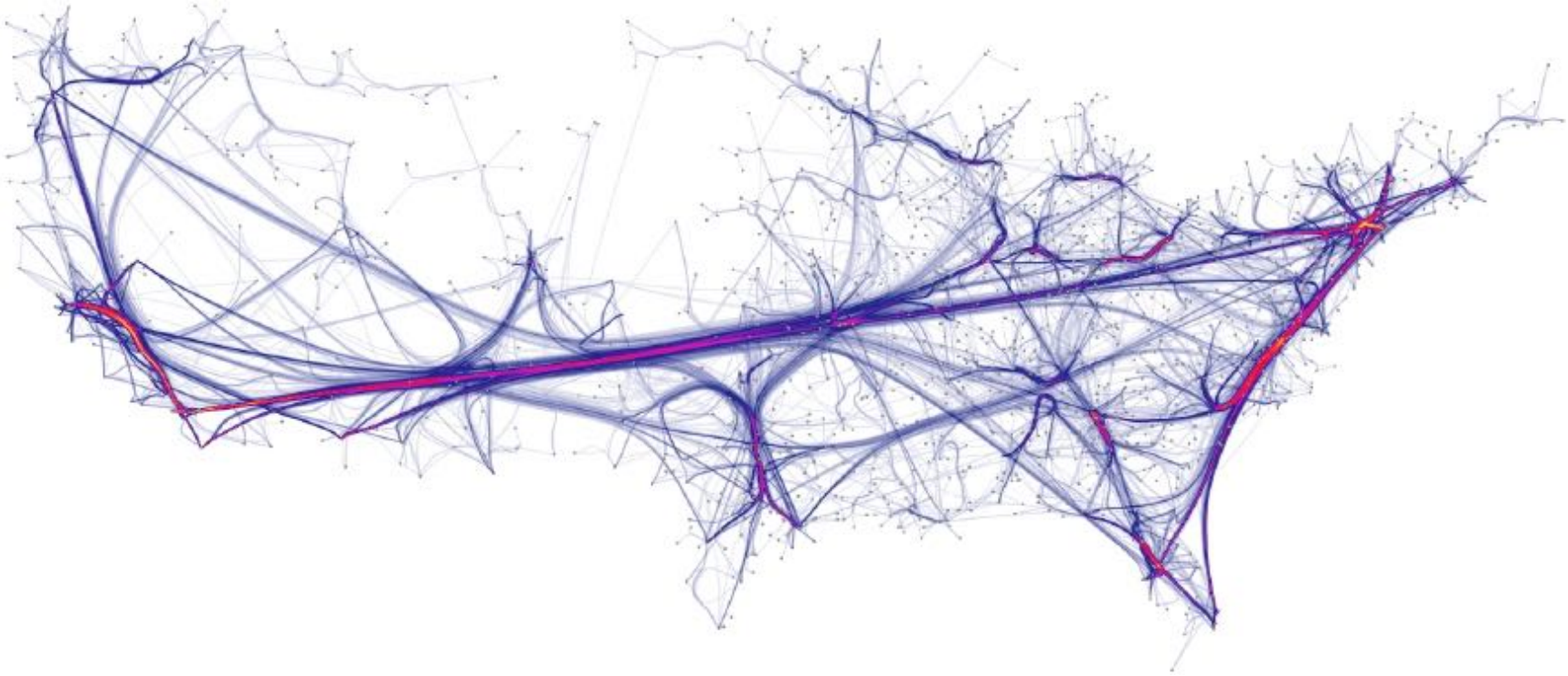


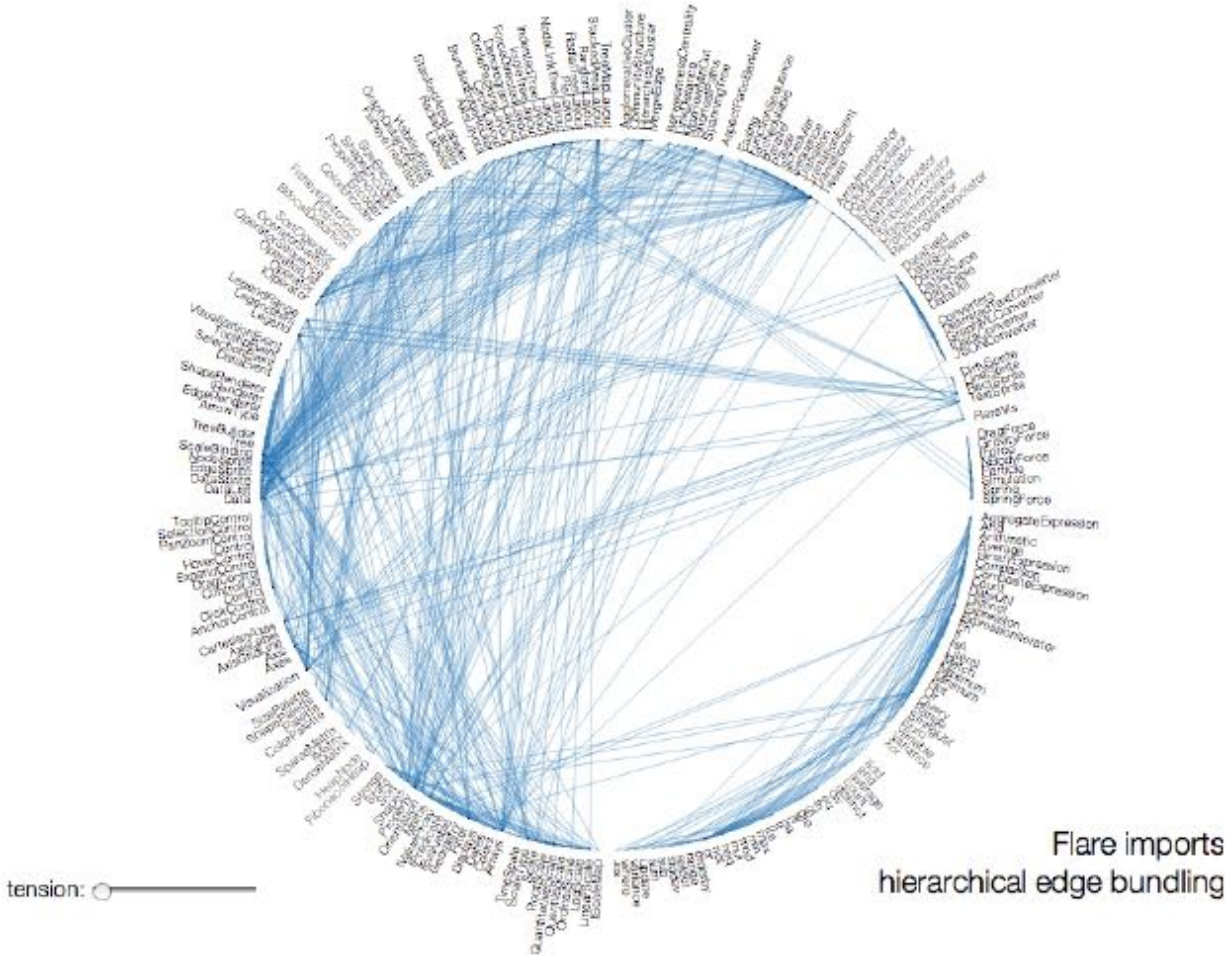
Figure 7: *US airlines graph (235 nodes, 2101 edges) (a) not bundled and bundled using (b) FDEB with inverse-linear model, (c) GBEB, and (d) FDEB with inverse-quadratic model.*

https://www.win.tue.nl/vis1/home/dholten/papers/forcebundles_eurovis.pdf

Edge Bundling

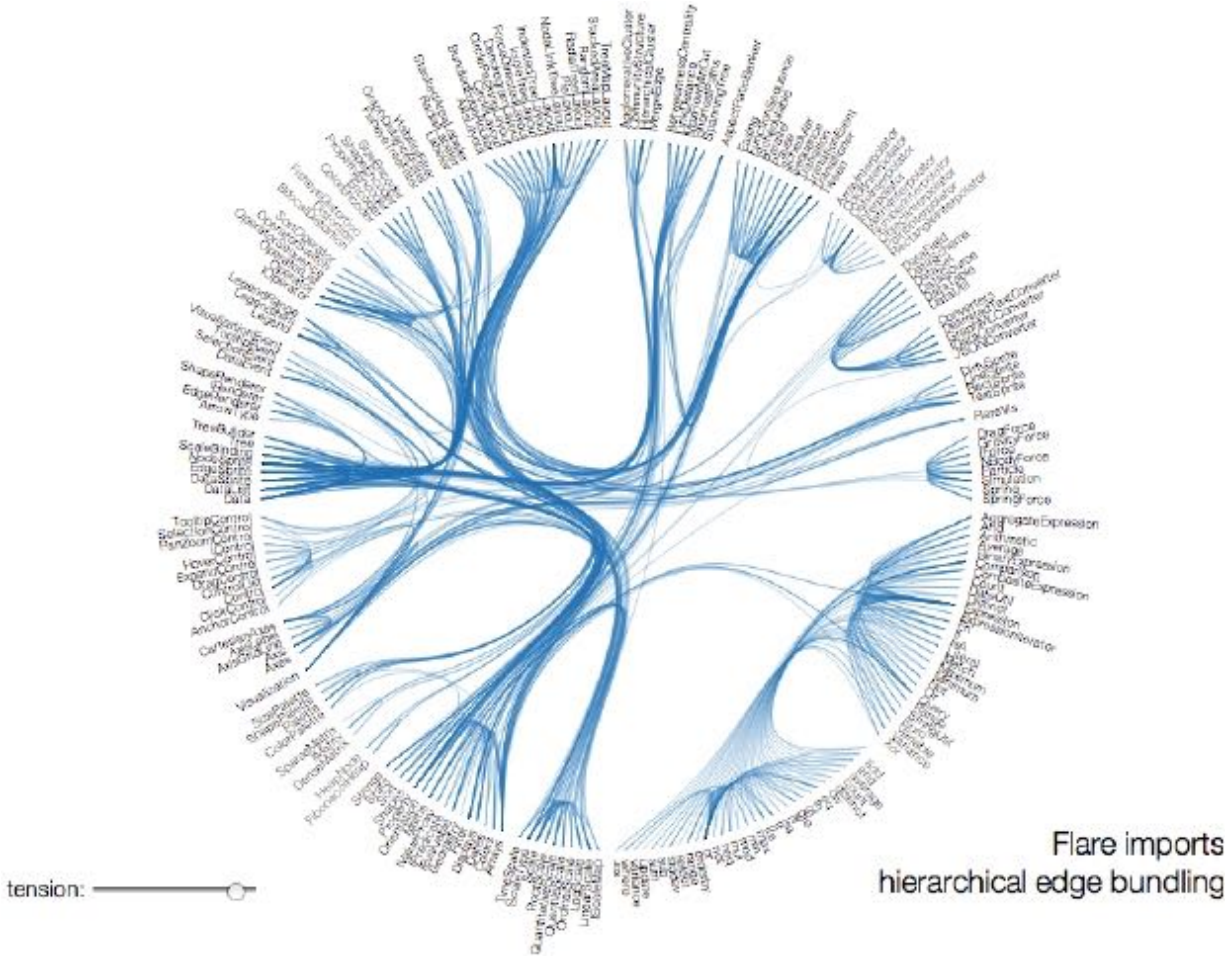


Edge Bundling



http://mbostock.github.io/d3/talk/20111116/bundle.html

Edge Bundling



http://mbostock.github.io/d3/talk/20111116/bundle.html

QUESTIONS?

Thanks to
Sophie J. Engle
San Francisco University
for ideas, suggestions, slides, links, and much other stuff