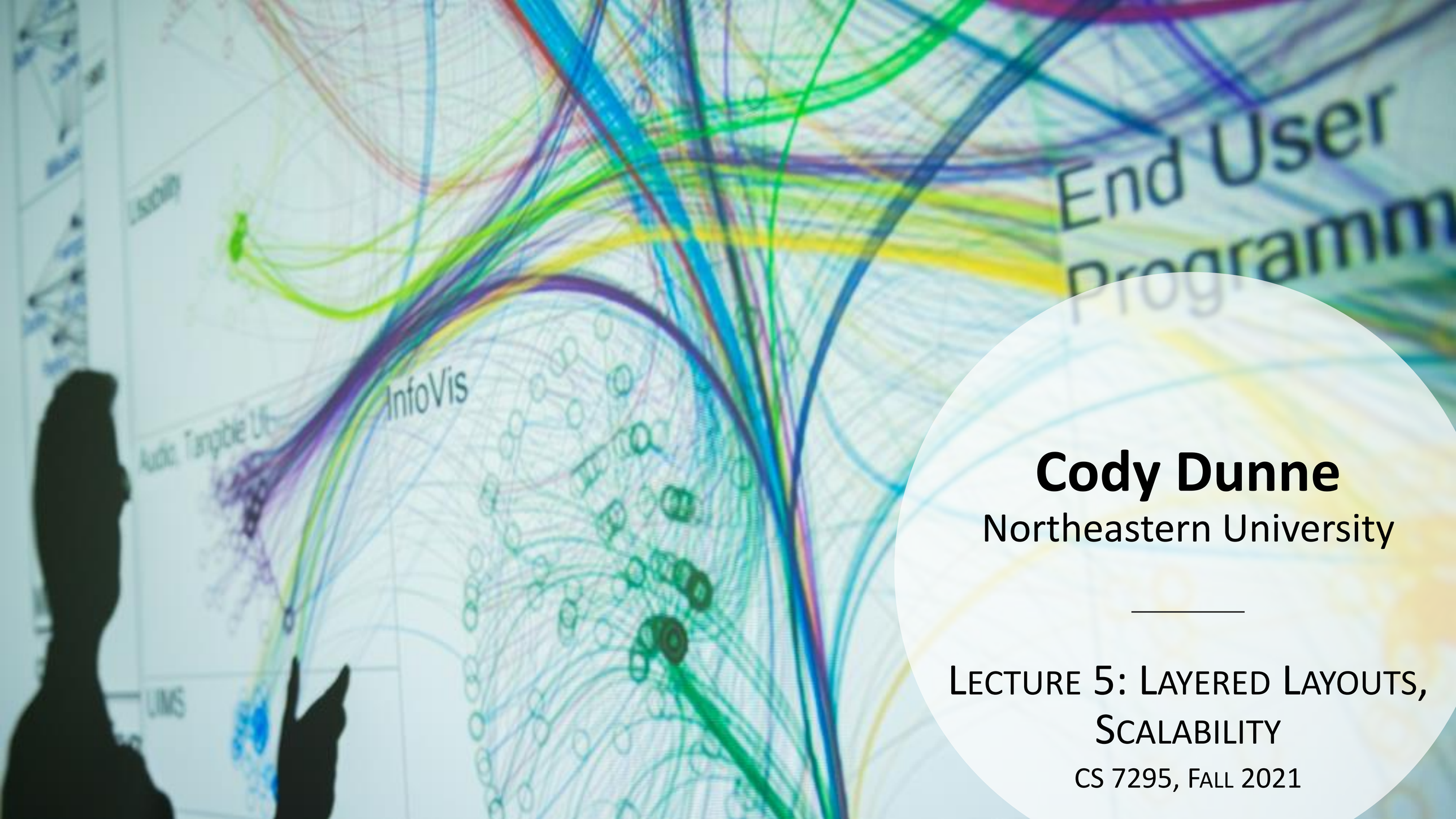


Cody Dunne
Northeastern University

Lecture 5: Layered Layouts, Scalability

CS 7295, Fall 2021

Course Homepage on Canvas

https://c.dunne.dev/cs7295f21/

(project details + assignments to be added)

Plan for Today

Discuss:

- Layered layouts
- Scalability

For next time:

W 2021-09-29

- !Optional! In-Class Pre-Pitch Feedback & Discussions

For W 2021-10-06:

- Project 1a — Initial Idea Pitches & Related Work (discussion post, presentation, PDF slides)

Checking In

PREVIOUSLY, ON CS 7295…

Sugiyama's Graph Drawing Rules

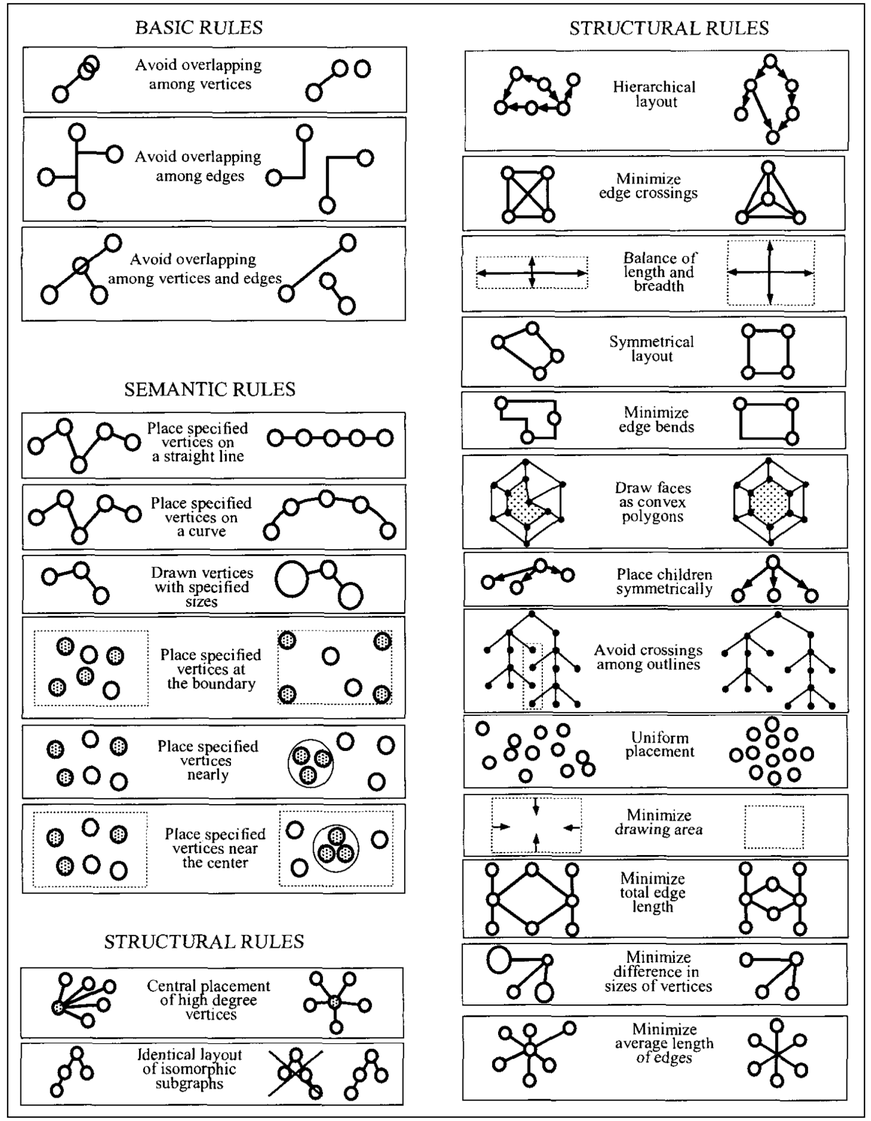


Figure 2.3.1. Simple examples of better (right) and worse (left) layouts.

TYPE	DRAWING RULES	CLASSIFI-CATION AXES
Semantic Rules	1. A specified sequence of vertices is placed on a straight line.	USLB
	2. A specified sequence of vertices is placed on a specified curve.	USLB
	3. Vertices are drawn with a specified size.	UMLB
	4. A specified set of vertices is placed at the boundary of the drawing.	NTLB
	5. A specified set of vertices are drawn near to each other.	NTLB
	6. A specified set of vertices is placed near the center.	NTLB
	7. An upper limit to the number of edge crossings is specified.	NTLB
	8. An upper limit to the number of edge bends is specified.	NSLF
	9. The lengths of specified edge have a specified upper limit.	NMLF
Structural Rules	1. Vertices of high degree are placed near the center.	UTLB
	2. Isomorphic subgraphs are always drawn identically.	USGB
	3. The vertices of isomorphic subgraphs are always placed identically.	USGB
	4. Hierarchical structure is clearly shown vertically or horizontally.	NTGH
	5. The number of edge crossings is minimized.	NTGB
	6. The ratio of length to breadth of the drawing area is balanced.	NSGB
	7. Symmetry is clearly shown.	NSGB
	8. The number of edge bends is minimized (using straight lines wherever possible).	NSGB
	9. The number of faces drawn as convex polygons is maximised.	NSLH
	10. Children of a vertex are symmetrically placed.	NMGH
	11. Crossings among outlines are eliminated. (see Figure 3.2.7)	NMGB
	12. The density of the placement and the routing is uniform.	NMGB
	13. The drawing area is minimized.	NMGB
	14. The total edge length is minimized.	NMGB
	15. The difference in sizes of vertices is minimized.	NMGF
	16. The average length of edges is minimized.	NMGF
	17. The difference between the length of contours of vertices and the length of edges is maximized.	NMGF
	18. The differences in edge lengths is minimized.	NMGF
	19. The length of the longest edge is minimized.	NMLF
	20. Vertices on the boundary are placed with uniform density.	NMLF

Table 2.3.1. Drawing rules.

Drawing rules can be classified using the following axes. A classification according to these 4 axes is noted in the right hand column of Table 2.3.1.

(1) Whether the solution to a rule can be obtained uniquely (U), or not (N).

(2) Whether the rule is topological (T) (specifying only the placement relationship between elements), shape-oriented (S) (specifying the direction also), or metric (M) (specifying distances as well).

(3) Whether the rule applies globally, to the whole drawing (G), or locally, only to a part of the drawing (L).

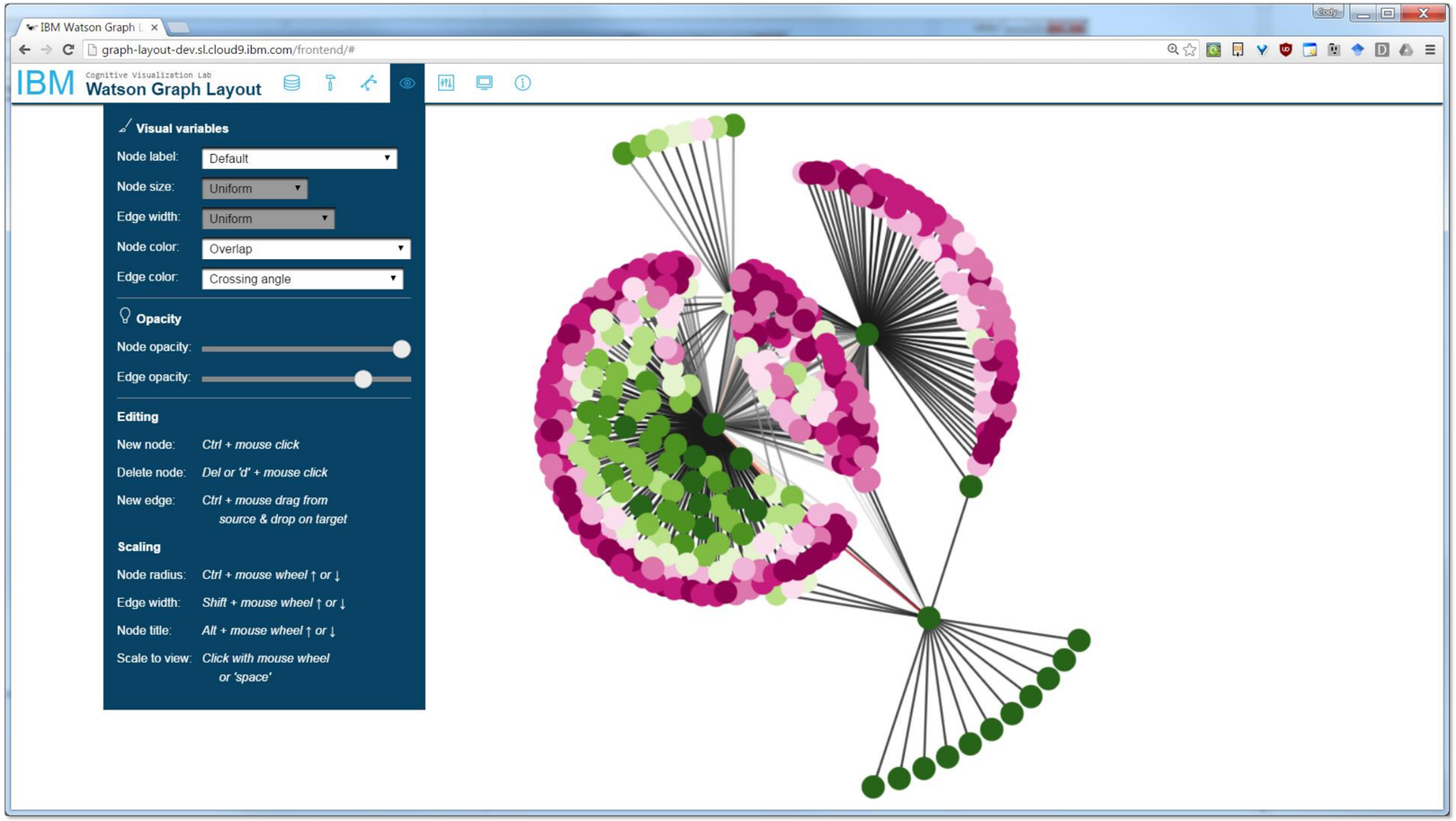
(4) Whether the rule is hierarchical (H), or flat (F), or both (B).

[Sugiyama, 2002]

Dunne et al.’s Readability Metrics

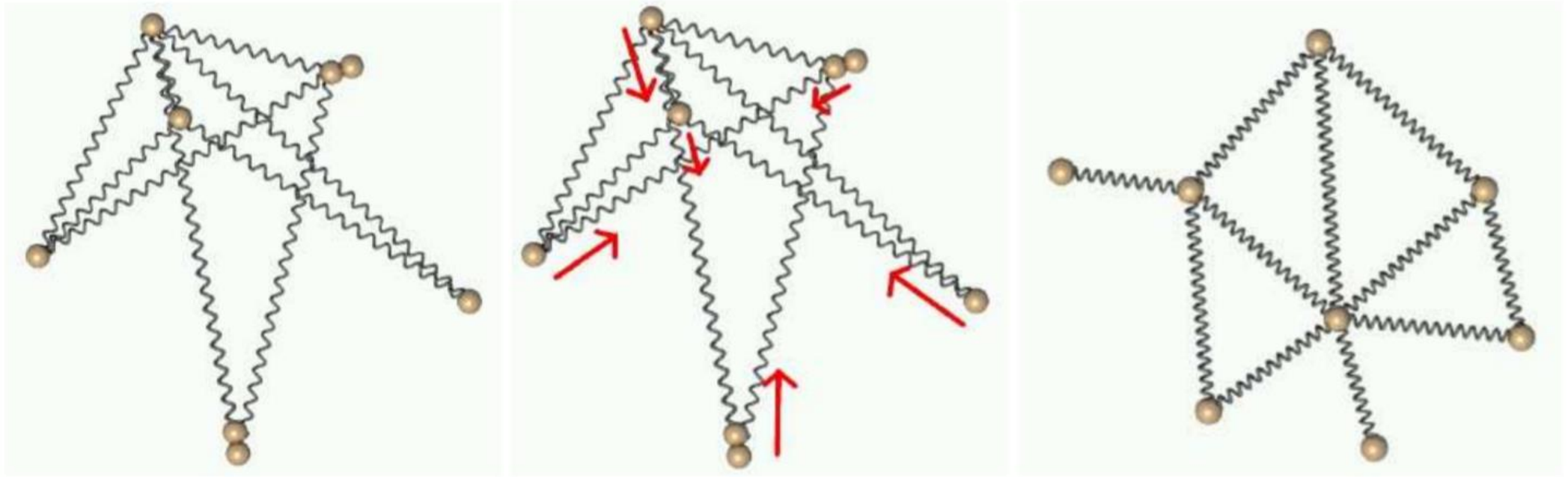
- Distance coherence
- Edge crossing angle
- Edge crossing
- Angular resolution (correction of deviation formula in Gove 2018)
- Node overlap
- Edge tunnel
- Group overlap
- Drawing space used

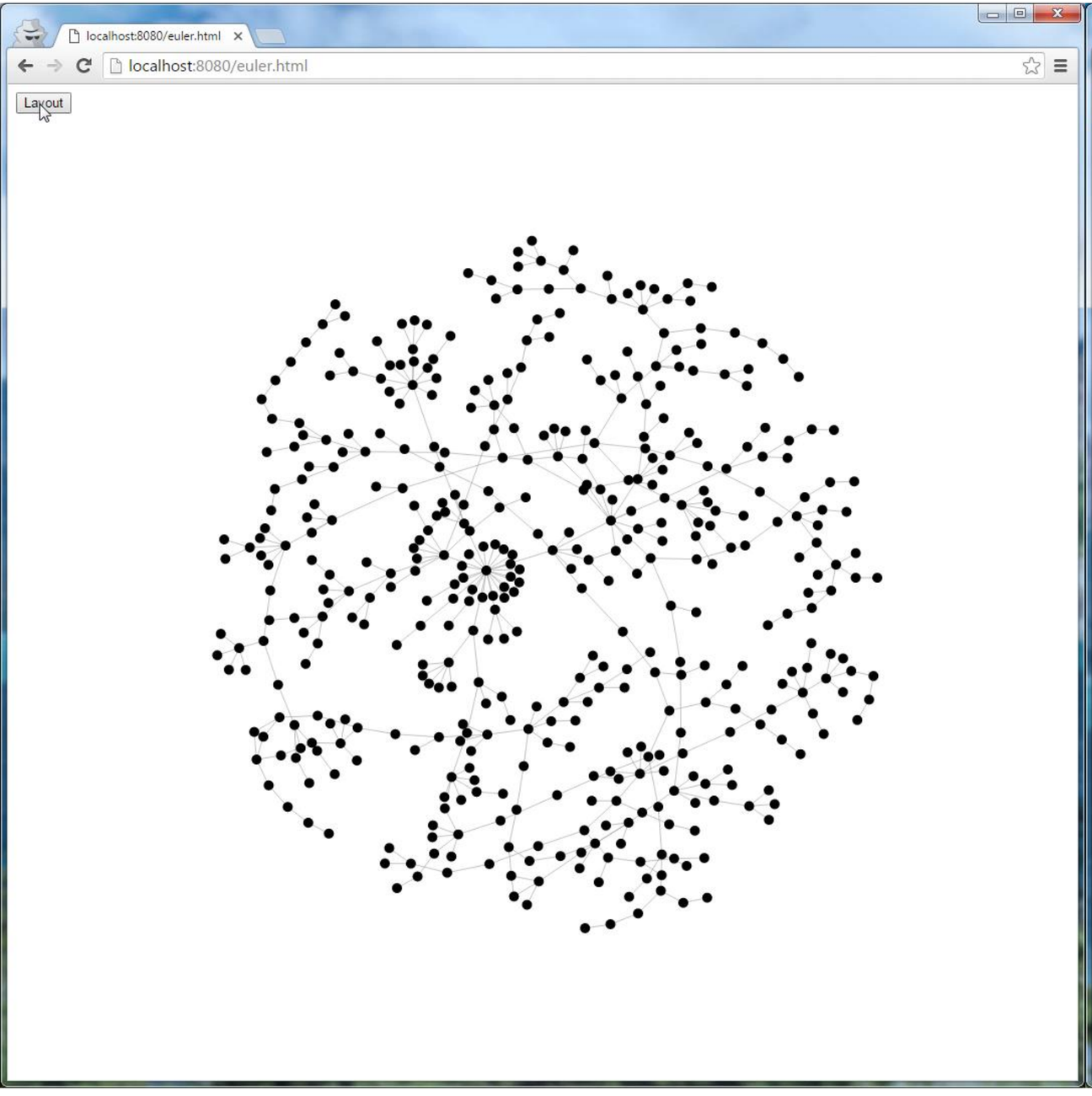
Global & Local!

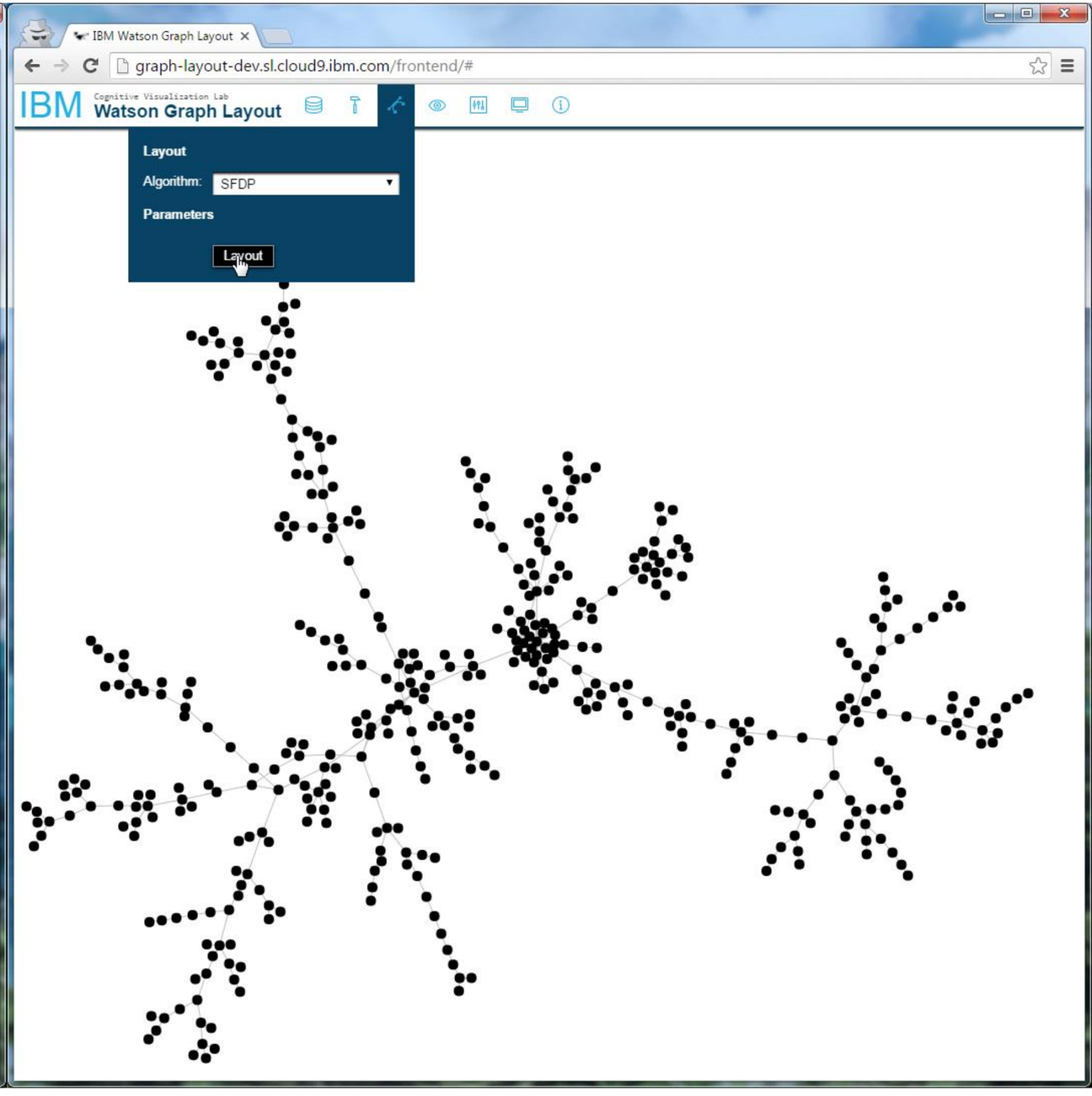


Dunne et al., 2015

Force-Directed Algorithms




localhost:8080/euler.html
localhost:8080/euler.html
Layout

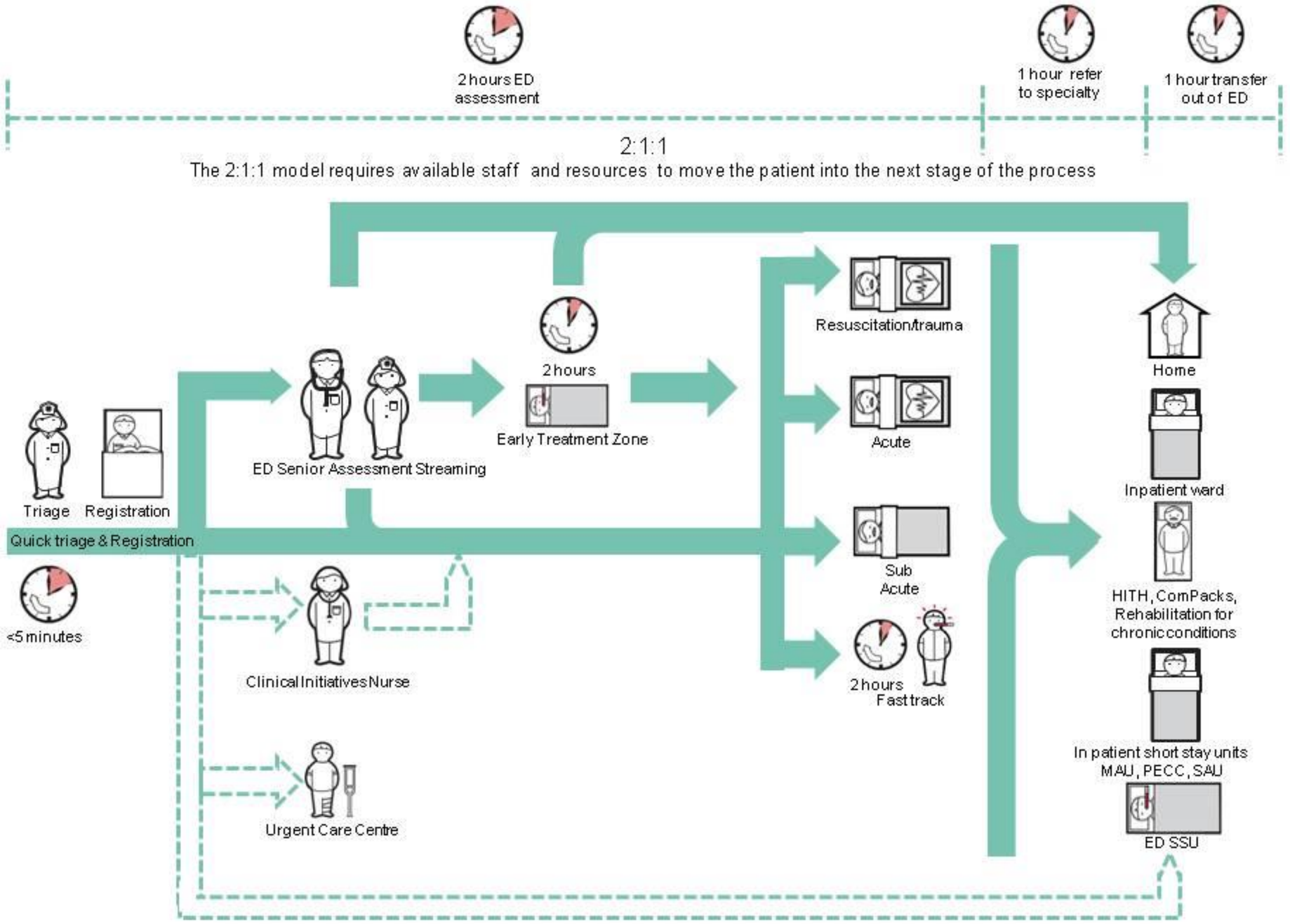

IBM Watson Graph Layout
graph-layout-dev.sl.cloud9.ibm.com/frontend/#
IBM
Cognitive Visualization Lab
Watson Graph Layout
Layout
Algorithm:
SFDP
Parameters
Layout

Now, on CS 7295…

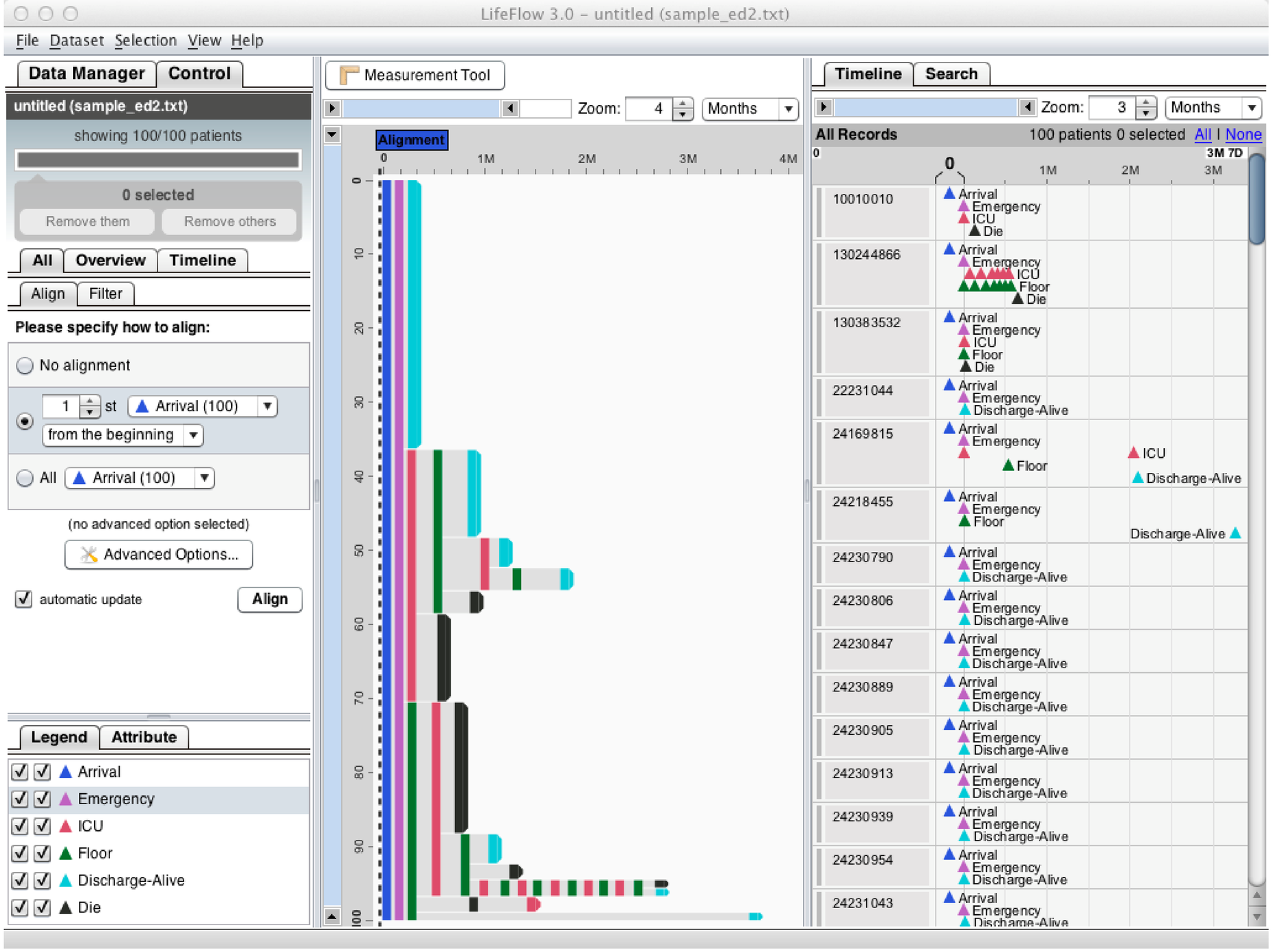
Hall of Fame?

or

Hall of Shame?



NSW Health, 2021



[Wongsuphasawat et al., 2011](#) 13

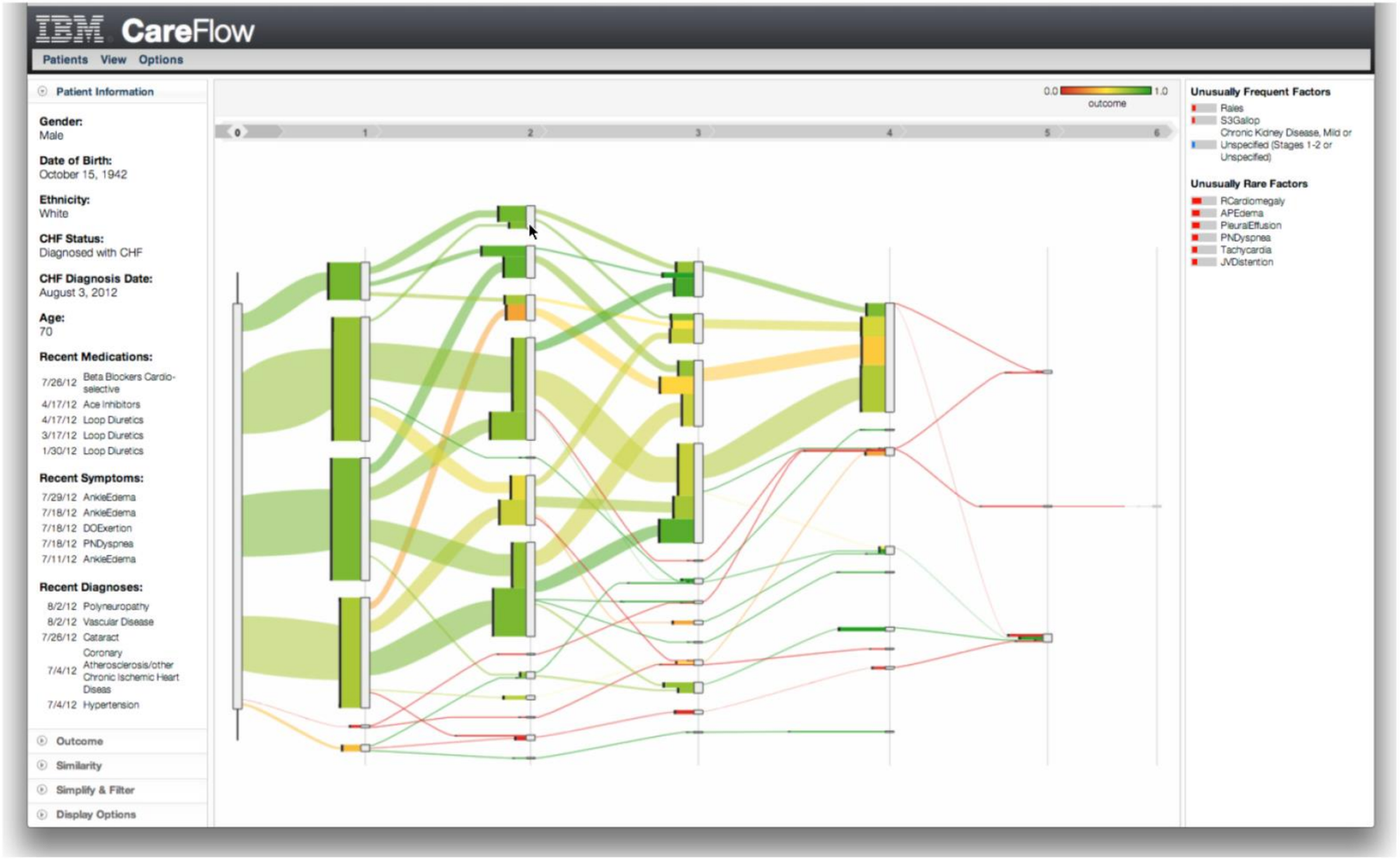


Figure 2: CareFlow's visual interface. The left panel displays a summary of the patient's relevant medical history. The center panel displays a visualization of the care plans of the 300 most similar patients. The right panel displays the factors associated with a selected subset of patients.

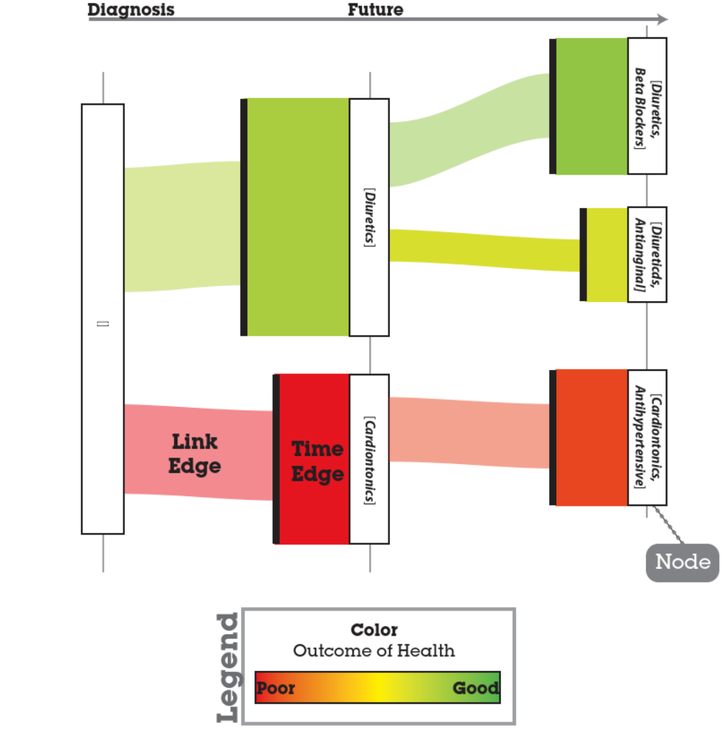
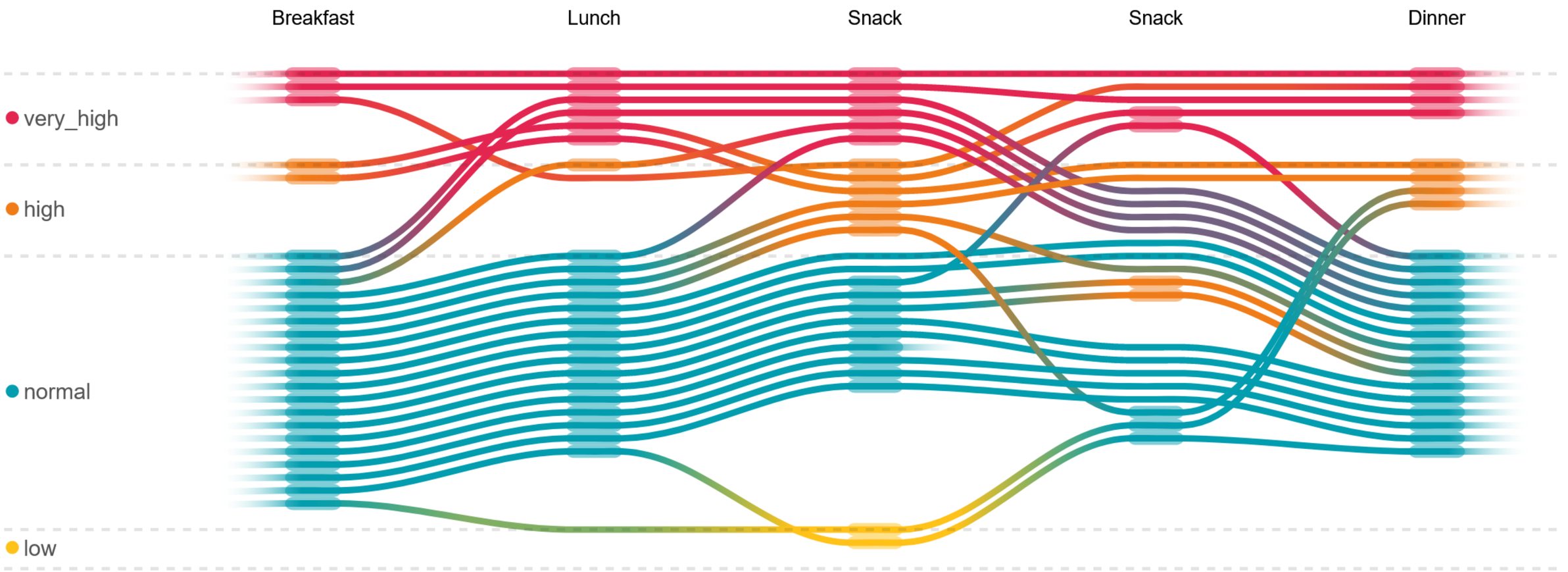


Figure 1: The visual encoding of care plans in CareFlow. The height of nodes represents the number of patients. The width of time edges represents the average duration of treatments. Color represents the average patient outcome.

Figure 3: Doctors can choose to automatically highlight the care plan that leads to the best outcomes for patients.



Di Bartolomeo et al, 2020

10m

In-Class Drawing: Hierarchical Layout

INSTRUCTIONS:

Aim of the assignment:
Try your hand at manually creating a layered graph drawing.

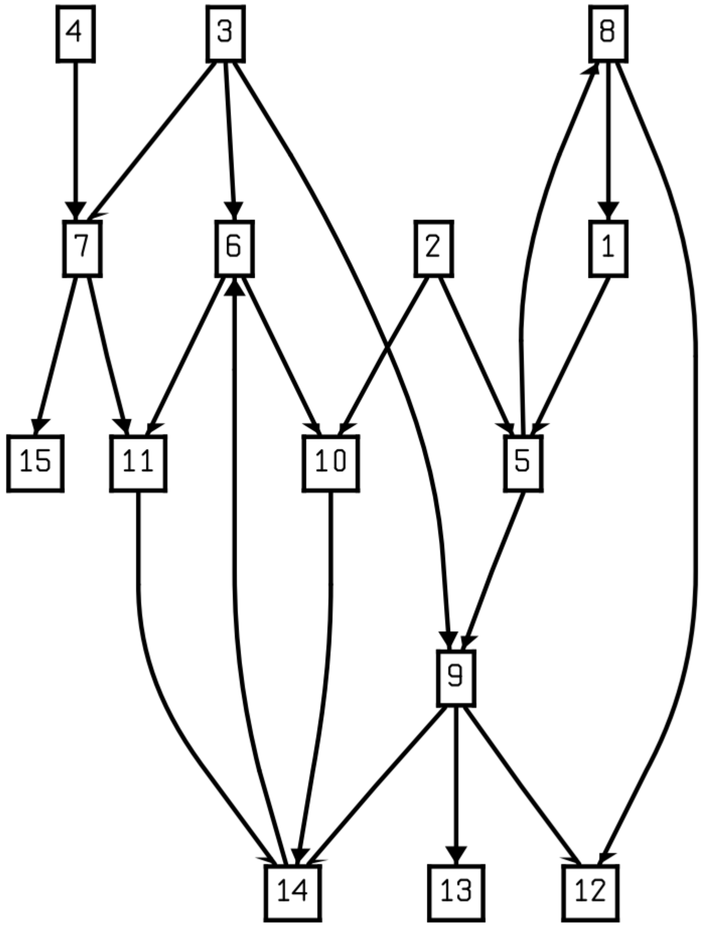
Instructions:
Individually create a layered graph drawing that illustrates the hierarchy of the directed graph shown in the table at right. Use paper + writing implements. You may need to try multiple times to get a layout you like.

If you complete the drawing to your satisfaction, create your own supplemental data for each edge/node and encode it using the marks & channels you've learned about.

Node	In-Degree	Out-Degree
1	1	1
2	0	2
3	0	3
4	0	1
5	2	2
6	2	2
7	2	2
8	1	2
9	2	3
10	2	1
11	2	1
12	2	0
13	1	0
14	3	1
15	1	0

Source	Target
1	5
2	5
2	10
3	6
3	7
3	9
4	7
5	8
5	9
6	10
6	11
7	11
7	15
8	1
8	12
9	12
9	13
9	14
10	14
11	14
14	6

Reading—Sugiyama Layout

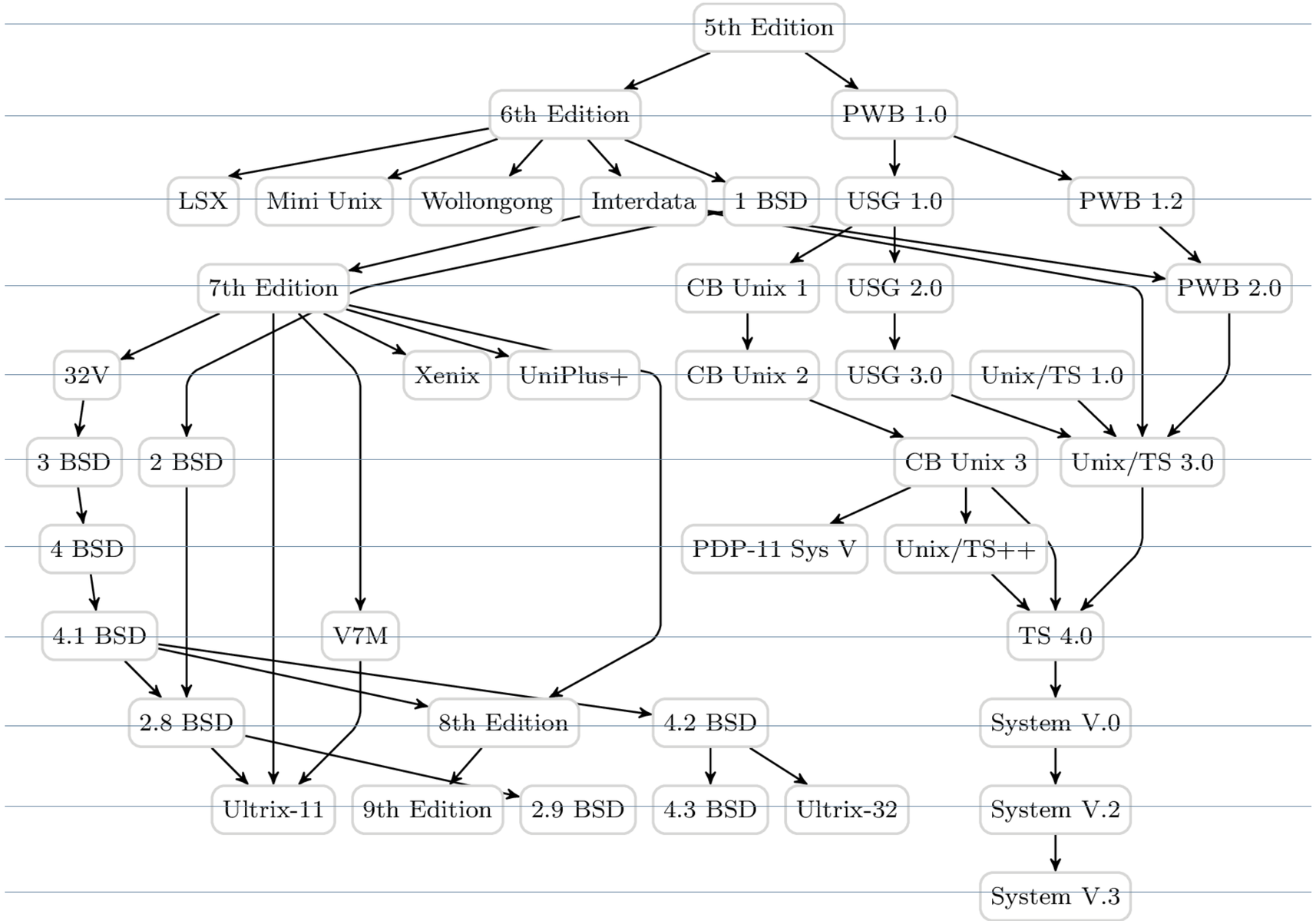


1. Cycle removal (optional)
2. Layer assignment (can assign manually)
3. Node ordering within layers / crossing reduction (can constrain)
4. Assigning node coordinates, drawing edges

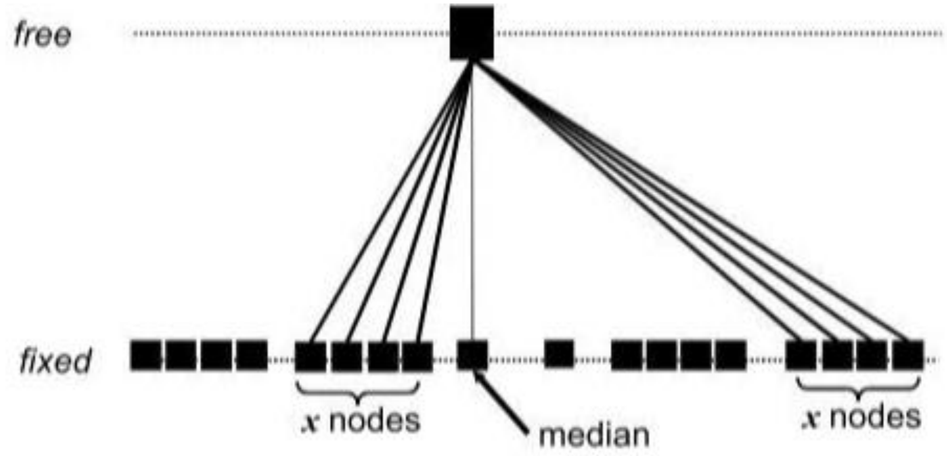
Let's recreate in NodeXL…

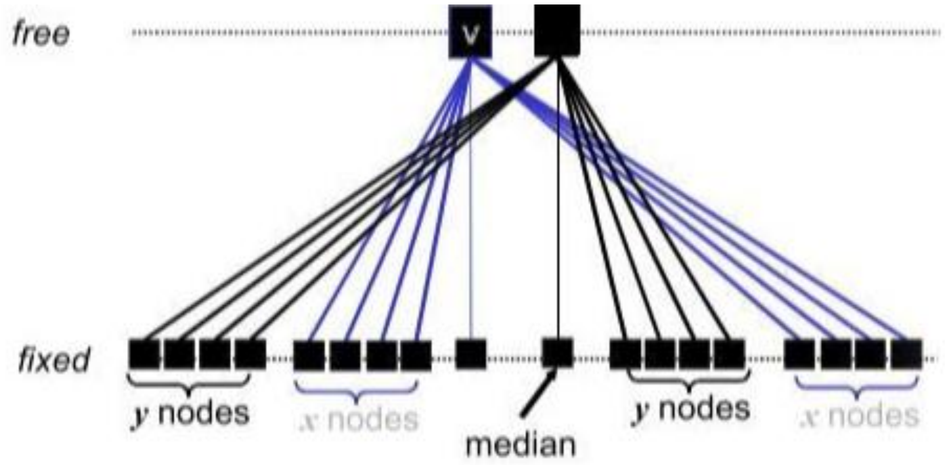
Bastert & Matuszewski, 2001

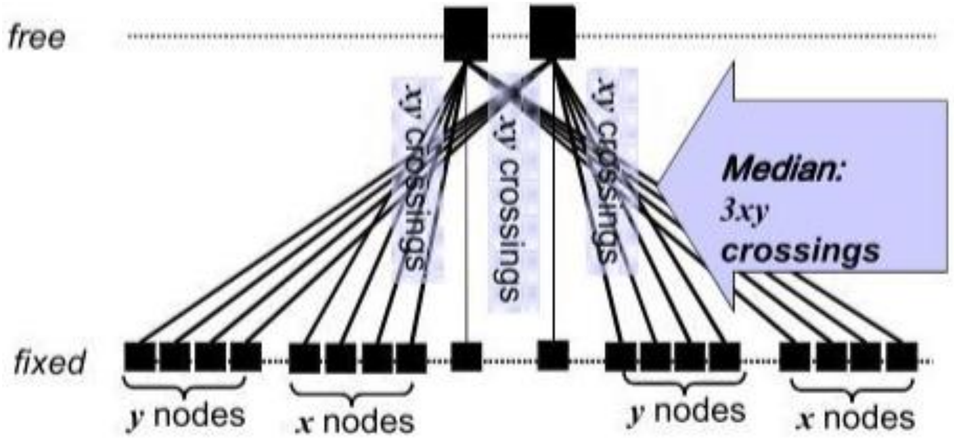
Back-and-Forth Sweeps

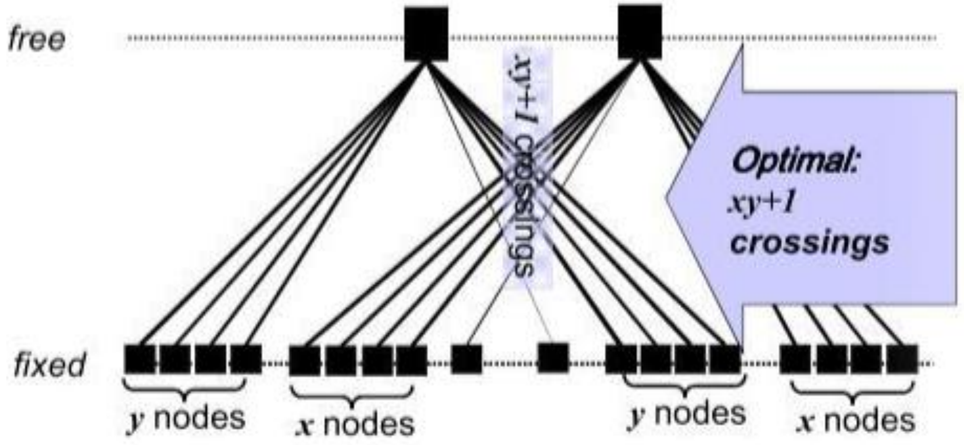


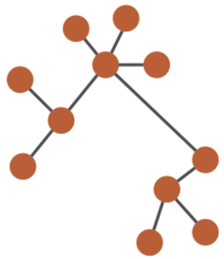
Median Heuristic











Scale Problems...

- Quickly run out of space!
- Tree breadth often grows exponentially
- Layout algorithms are slow and heuristics
- Slow rendering
- Solutions:

- scrolling or panning
- filtering or zooming
- aggregation & simplification
- faster but tricker rendering approaches

Graph Viewer Test

www.yasiv.com/graphs#HB/blckhole

Yasiv About Contact... More Visualizations... vivagraph.js Tweet

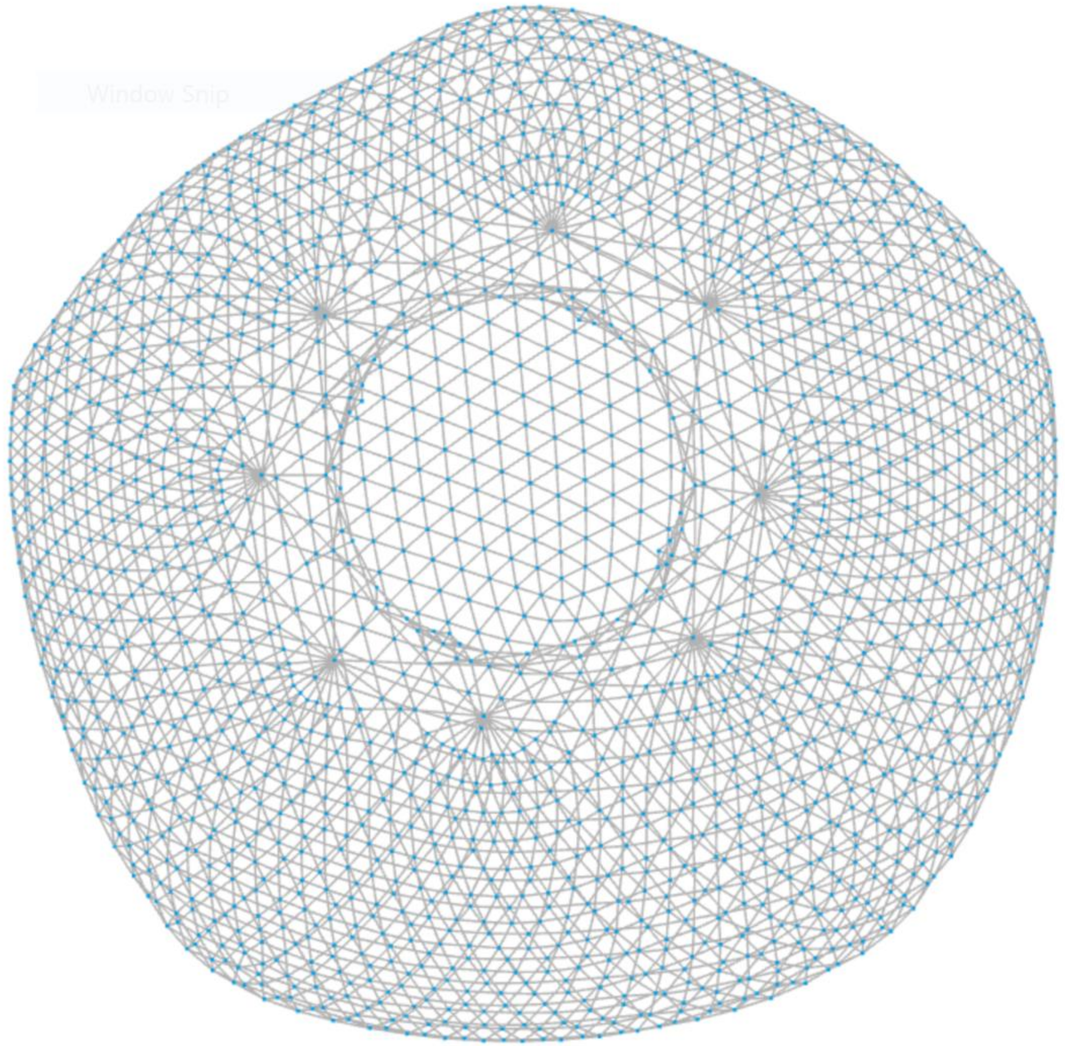
Choose Graph:

FAVORITE GRAPHS

- HB/blckhole
- Bai/rw5151
- HB/bcsstm13
- HB/jagmesh6
- HB/watt_1
- HB/lshp1882
- HB/plat1919
- HB/bcsstk26
- Bai/dw256A
- Bai/tols2000
- Bai/dw1024
- Bai/rdb2048
- Pajek/CSphd
- GHS_indef/laser

BAI

- bfwa398
- bfwa62
- bfwb398
- bfwb62
- bfwb782
- bwm200
- cdde1
- cdde2
- cdde3
- cdde4
- cdde5
- cdde6
- ck104
- ck400
- ck656
- dw256A



Pause layout

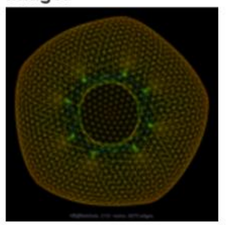
Layout Settings

Spring Coeff:	0.0008
Spring Length:	30
Gravity Coeff:	-1.2
Drag Coeff:	0.009
Theta Coeff:	0.8

Reset to default

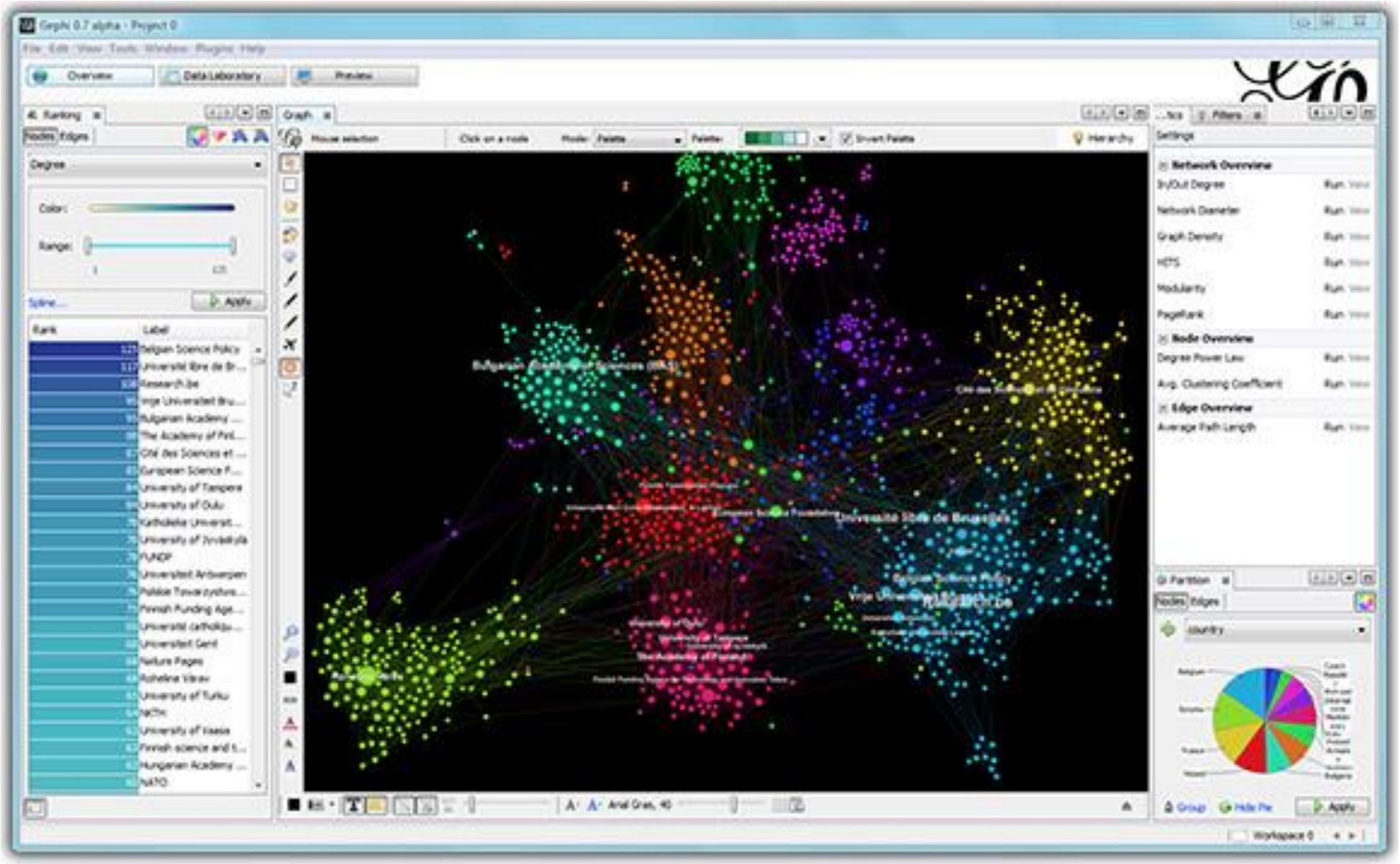
HB/blckhole

Nodes: 2121
Edges: 6370
Image:



Use mouse wheel to zoom in/zoom out

Yasiv.com



For Next Time & Communication

Homepage: https://c.dunne.dev/cs7295f21/
(project details + assignments to be added)

For next time:

W 2021-09-29
- !Optional! In-Class Pre-Pitch Feedback & Discussions

For W 2021-10-06:
- Project 1a — Initial Idea Pitches & Related Work (discussion post, presentation, PDF slides)

Everyday Required Supplies:
- 5+ colors of pen/pencil
- White paper
- Laptop and charger

Use Canvas Discussions for general questions, email the instructor for questions specific to you.