

Lecture starts at 1:10pm
No quiz — free 100% on remaining quizzes

Hierarchical & network visualization

SI 649 W20: Information visualization

Matthew Kay, Assistant Professor, School of Information
& Computer Science and Engineering
University of Michigan

Portions of slides adapted from Eytan Adar

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This week

Lecture

COVID-19 update

Hierarchical and network visualization

Lab

Design jam: Hierarchical

COVID-19 grading update from Dean Finholt:

For MSI/MHI/MADS students, UMSI will adopt a policy similar to the approach announced earlier for undergraduate grading in the winter 2020 term — **courses offered Pass/No Record COVID** (where a pass is equal to a **C– or better**), faculty still enter letter grades for a course, **students will have the choice to “unmask” the P grade** in any course to reveal the underlying letter grade (students will be able to see the grade before deciding; this process is still under development but **requests to unmask must be made by July 1, 2020**), and **withdrawals in the winter term may be made up until April 21** and these withdrawals will not appear on the official transcript.

Remaining group project milestones

Initial implementation and demo (Apr 7, Apr 8)

Final presentation (Apr 19, Apr 20)

Final report (Apr 24)

For demos/presentations

Thanks everyone for last week!

I think screen-sharing on Zoom went well

Live presentation was pretty smooth, so we'll stick to it going forward (instead of pre-recorded video)

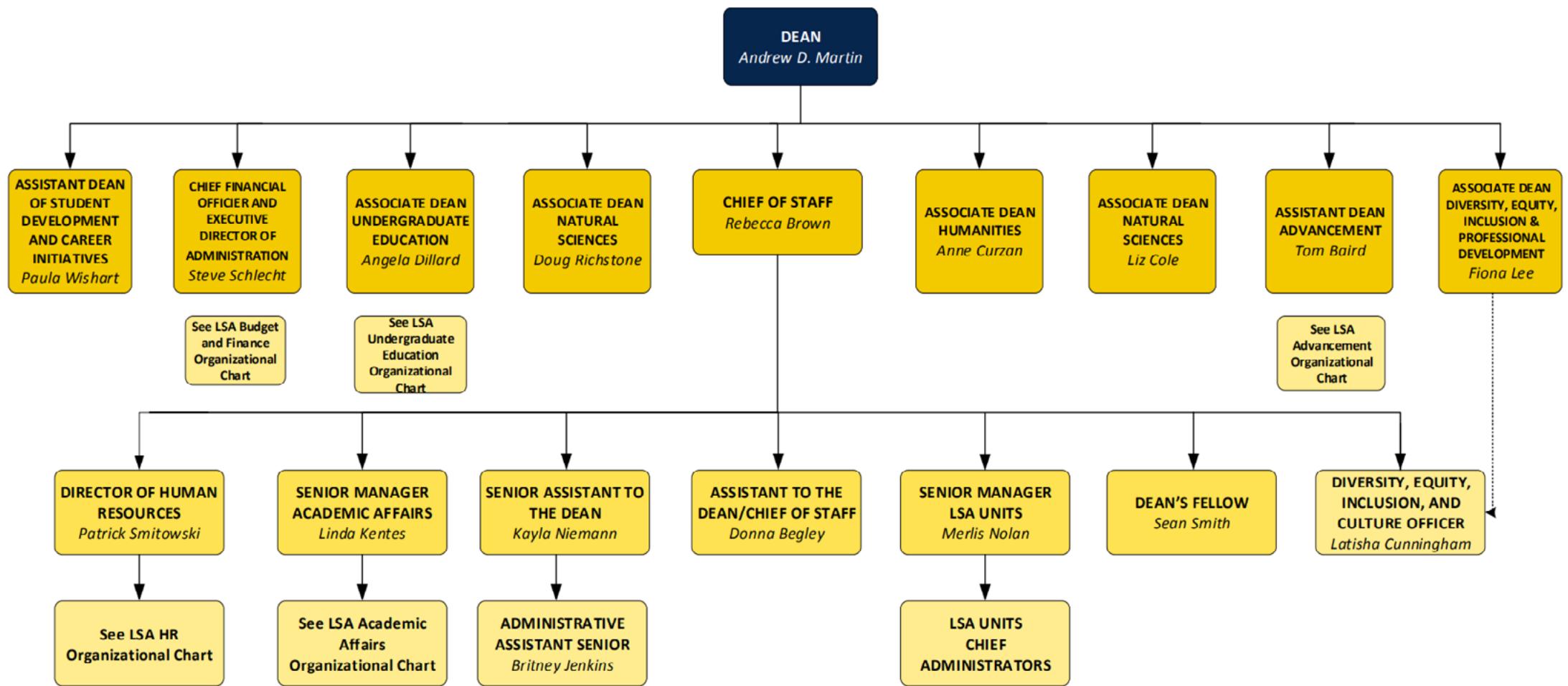
Design jam: Hierarchical

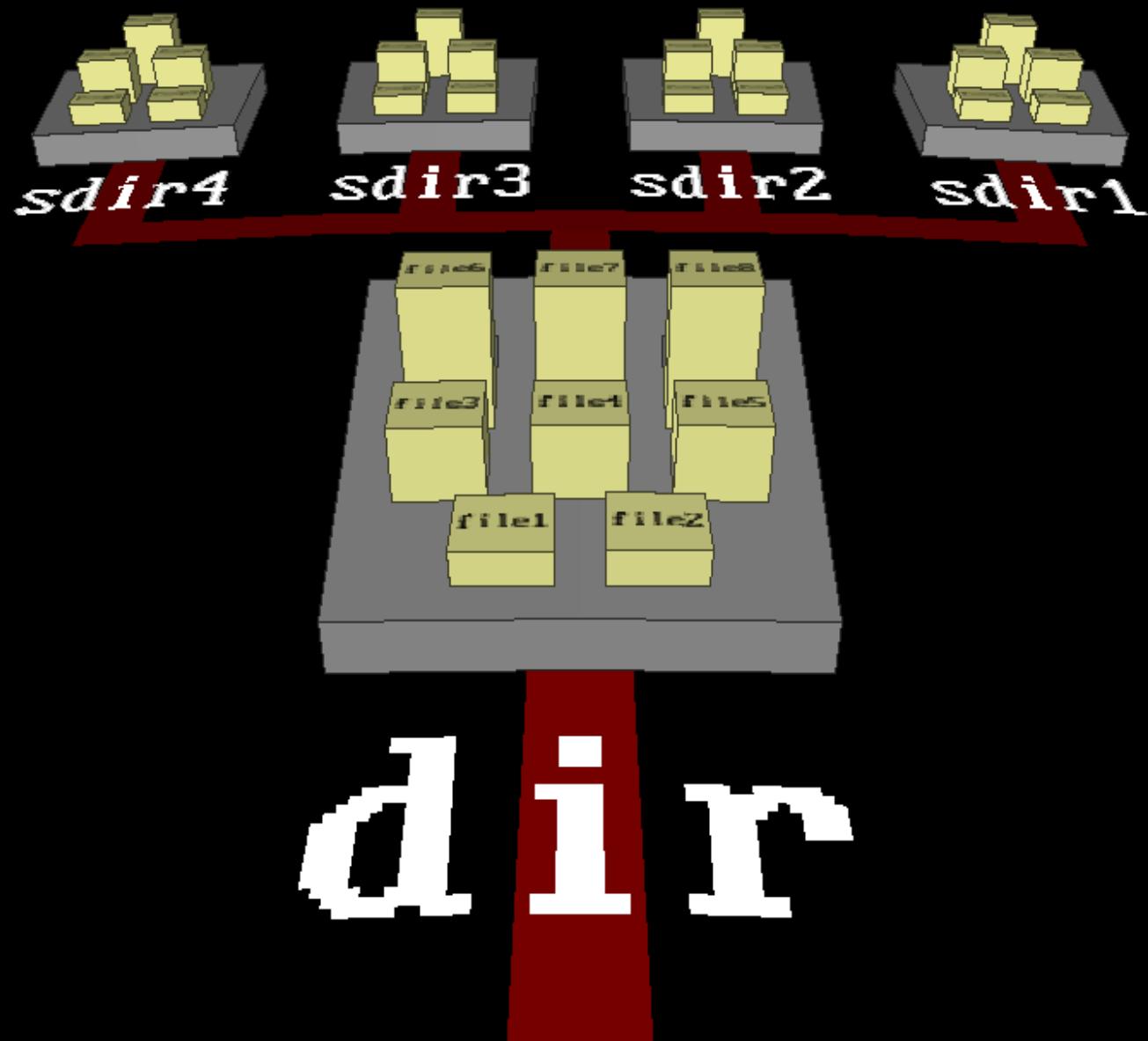
Find a time to meet with your group (likely **over video**)

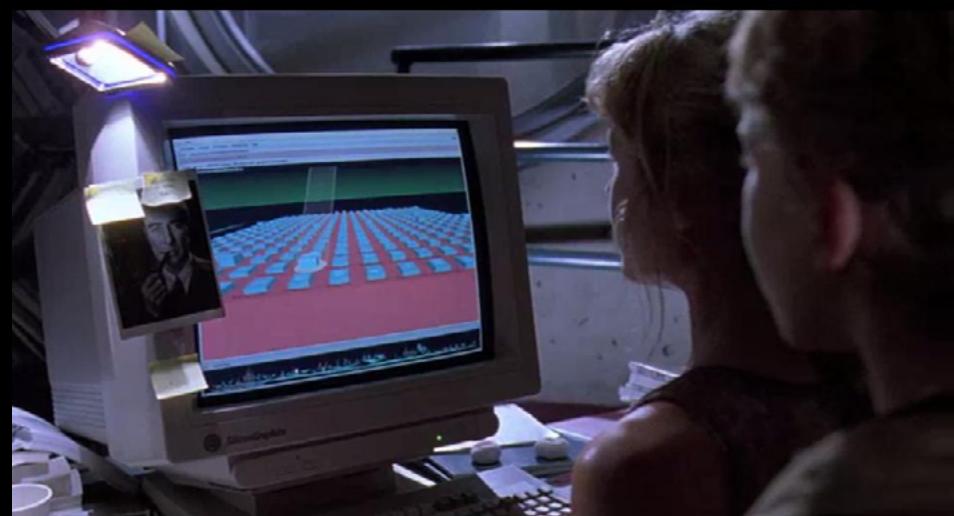
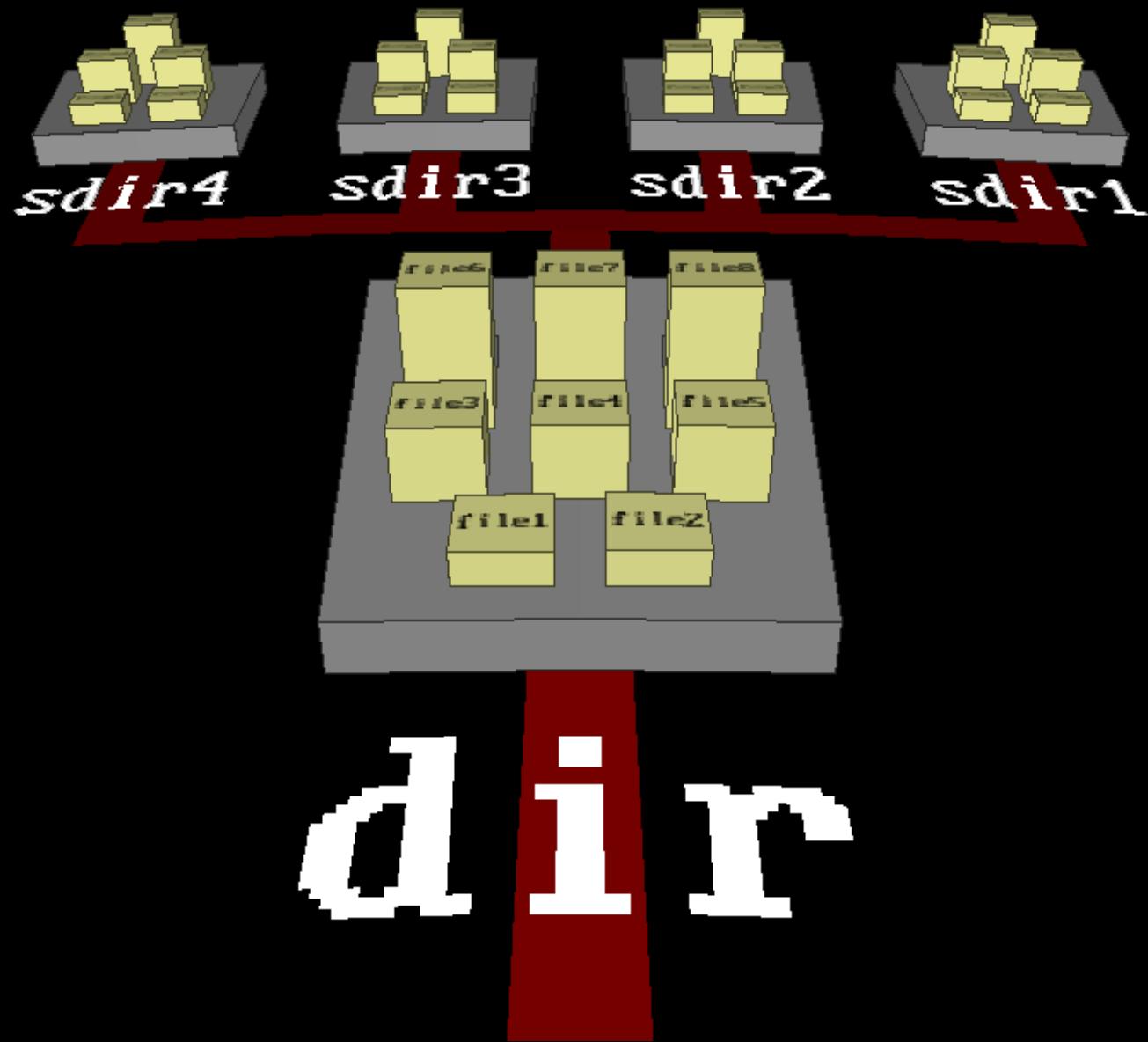
Licia will post instructions and materials for the lab on Slack

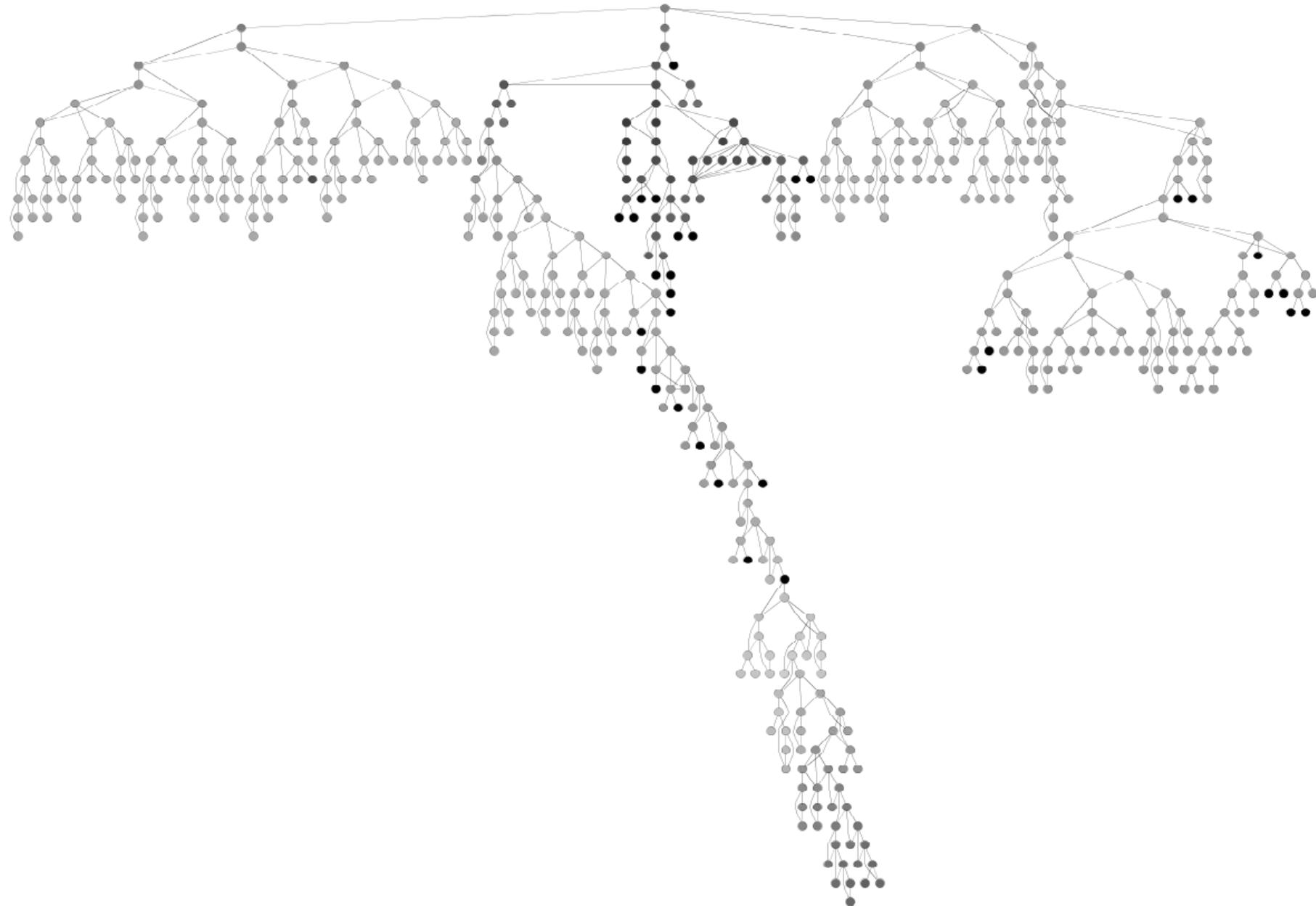
Hierarchical visualization

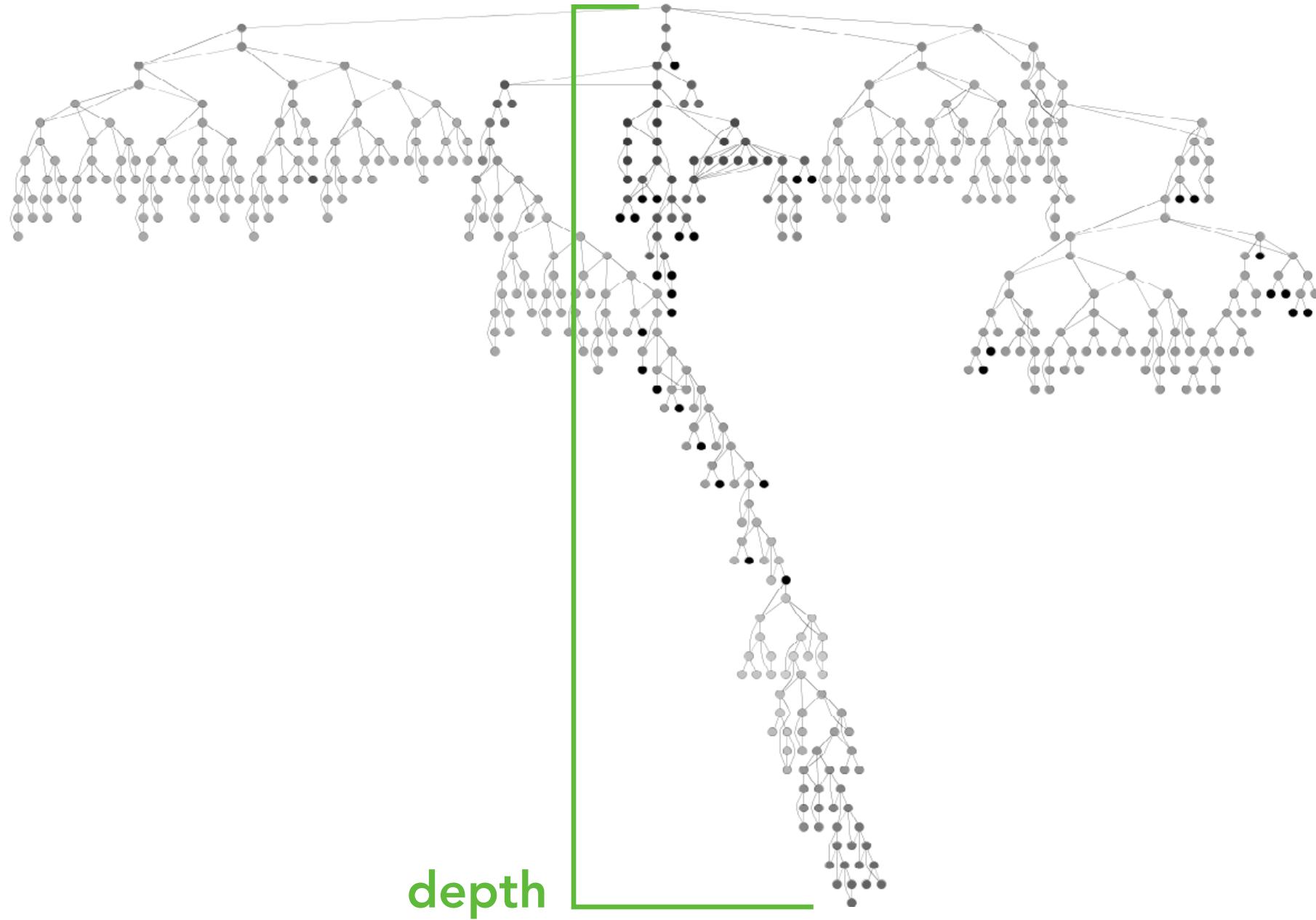
Office of the Dean

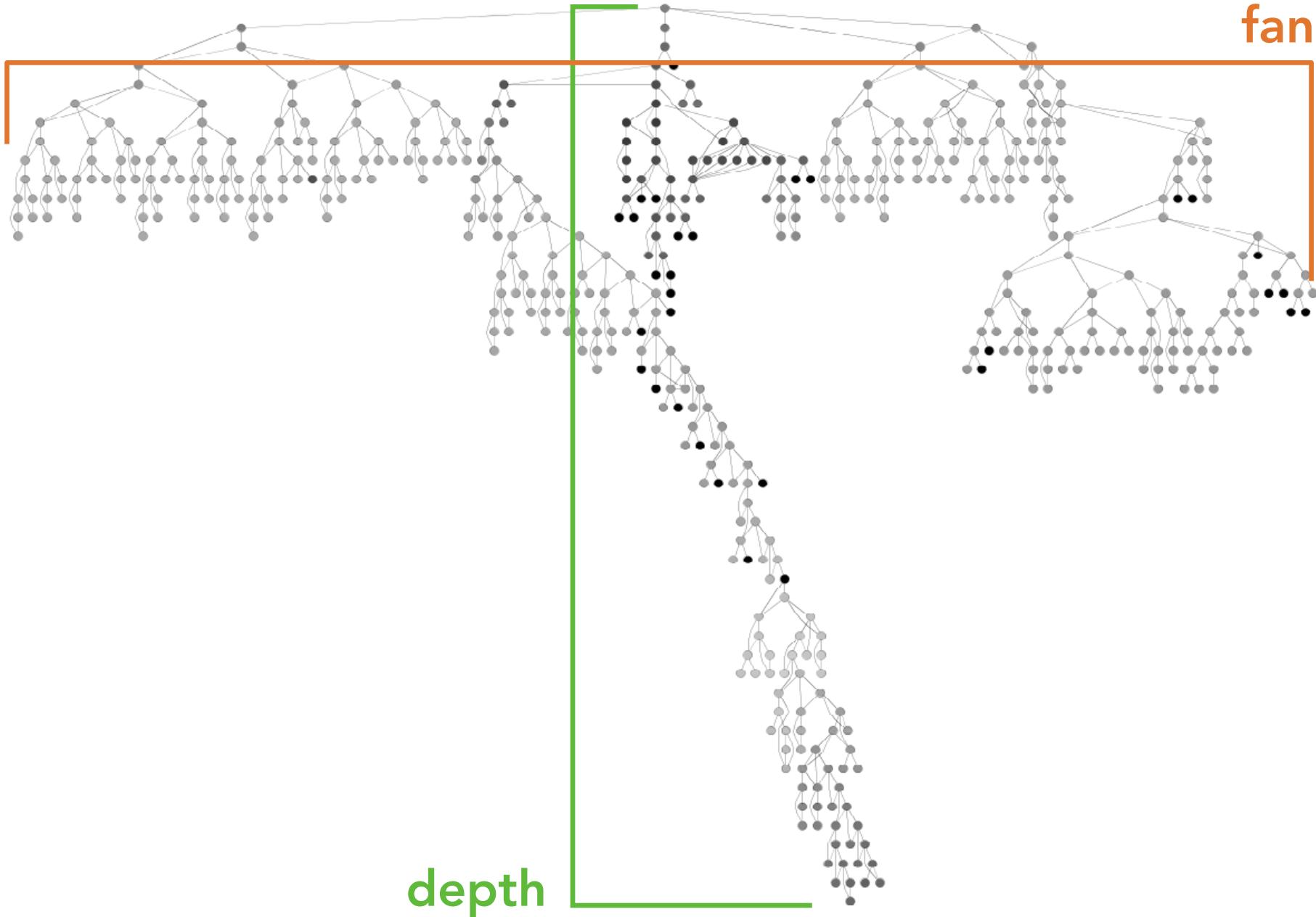




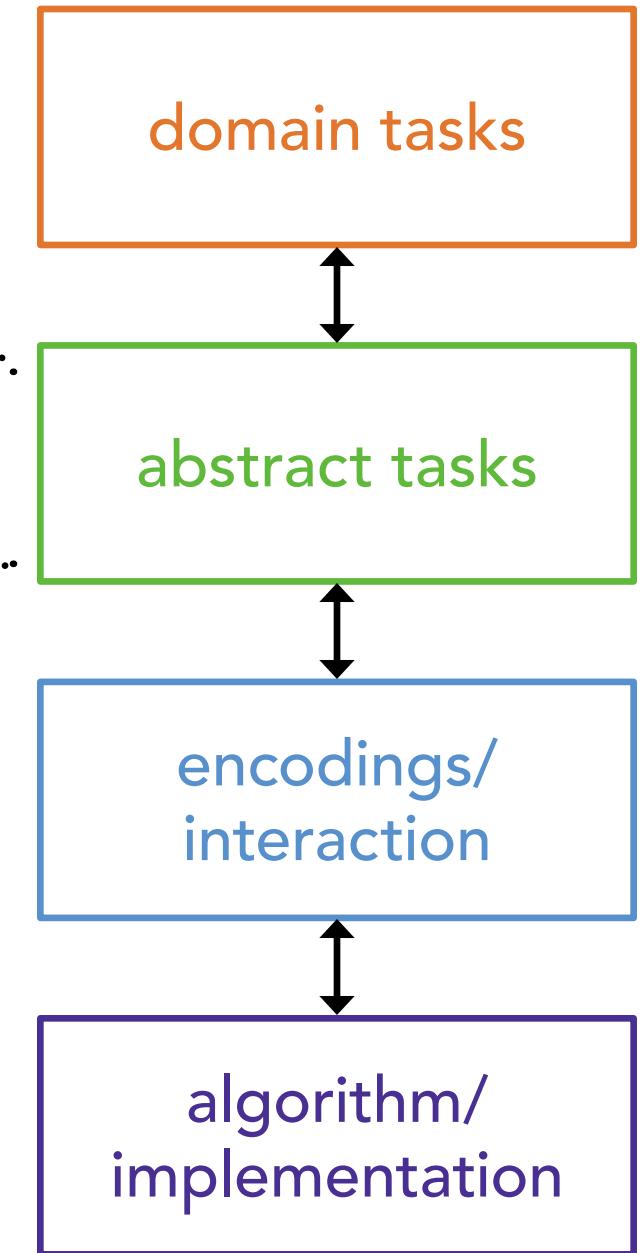








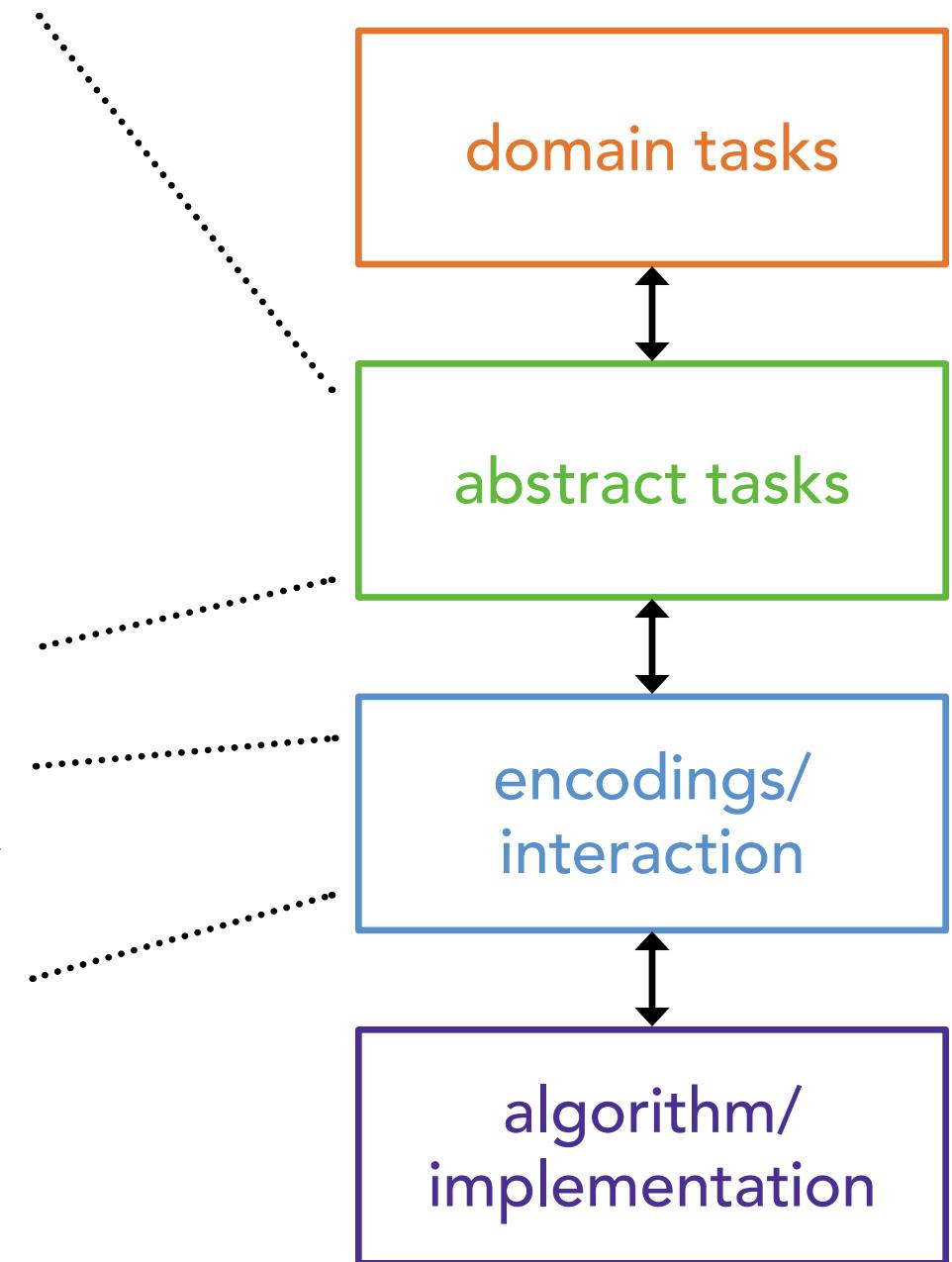
How much depth?
How much fanning?
How far are two nodes?
Trace a path between two nodes
How many subclasses of a node?
How far down the hierarchy?
Which subtree contains an entity?





- How much depth?
- How much fanning?
- How far are two nodes?
- Trace a path between two nodes
- How many subclasses of a node?
- How far down the hierarchy?
- Which subtree contains an entity?

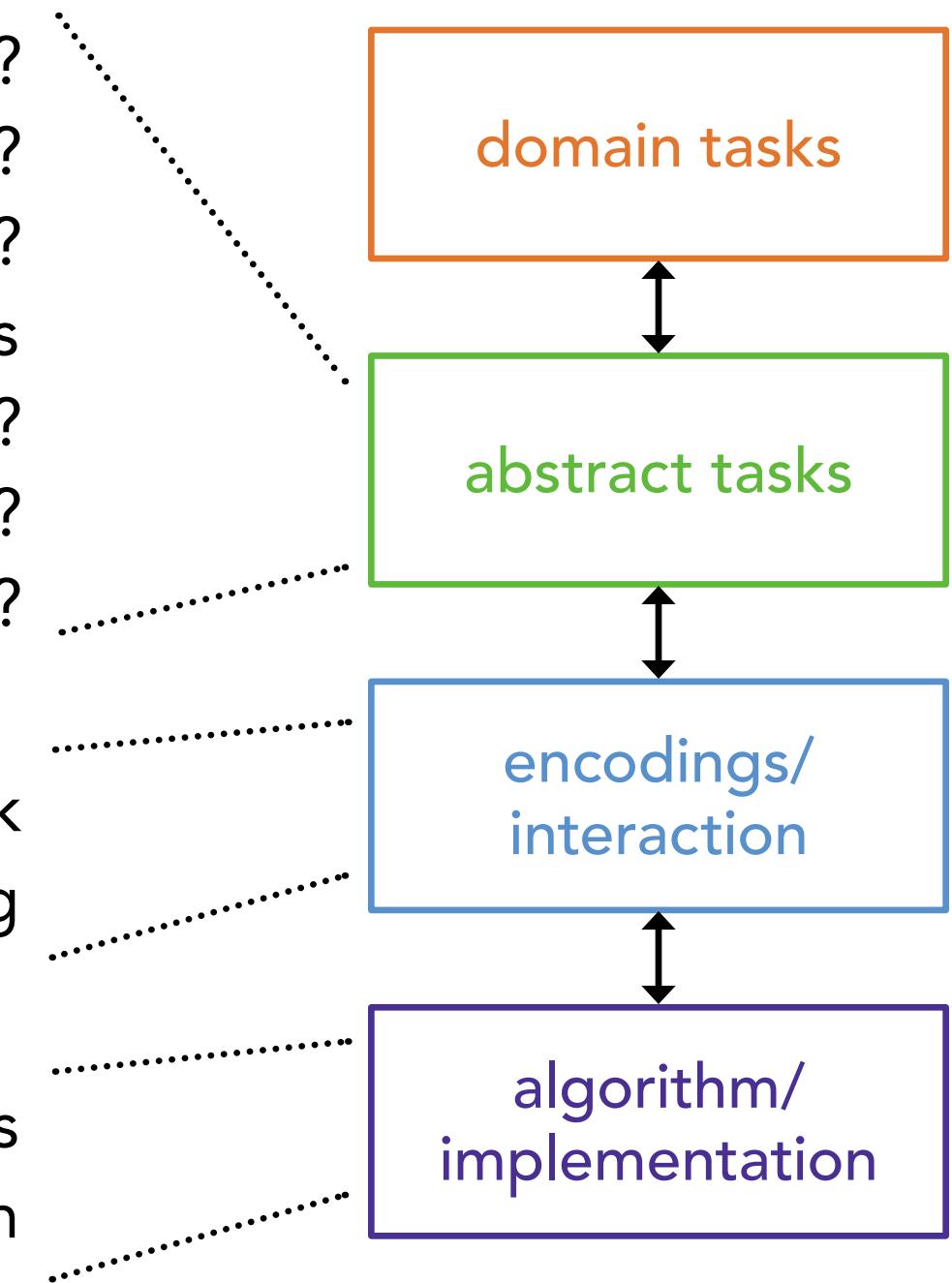
Node-link
Space-filling





Dealing with excessive fan / depth
Layouts
Node-link
Space-filling

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Node-link
Space-filling

Layouts
Dealing with excessive fan / depth

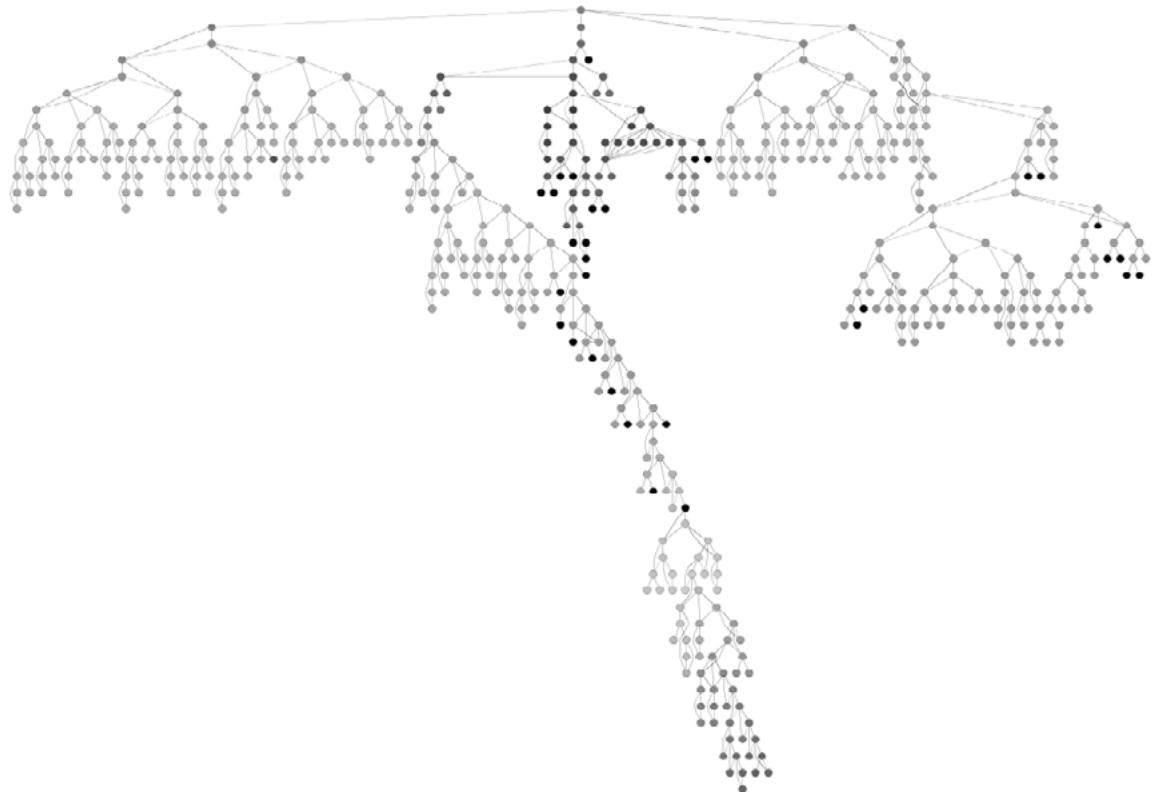
domain tasks

abstract tasks

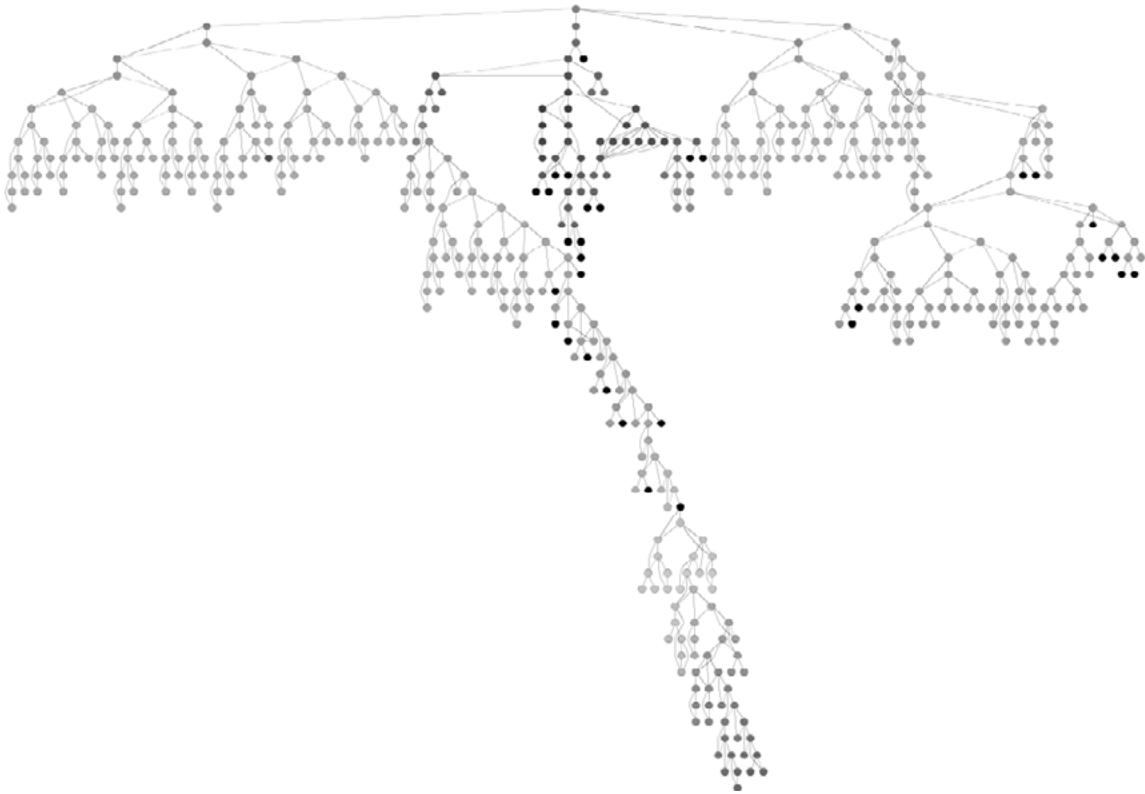
encodings/
interaction

algorithm/
implementation

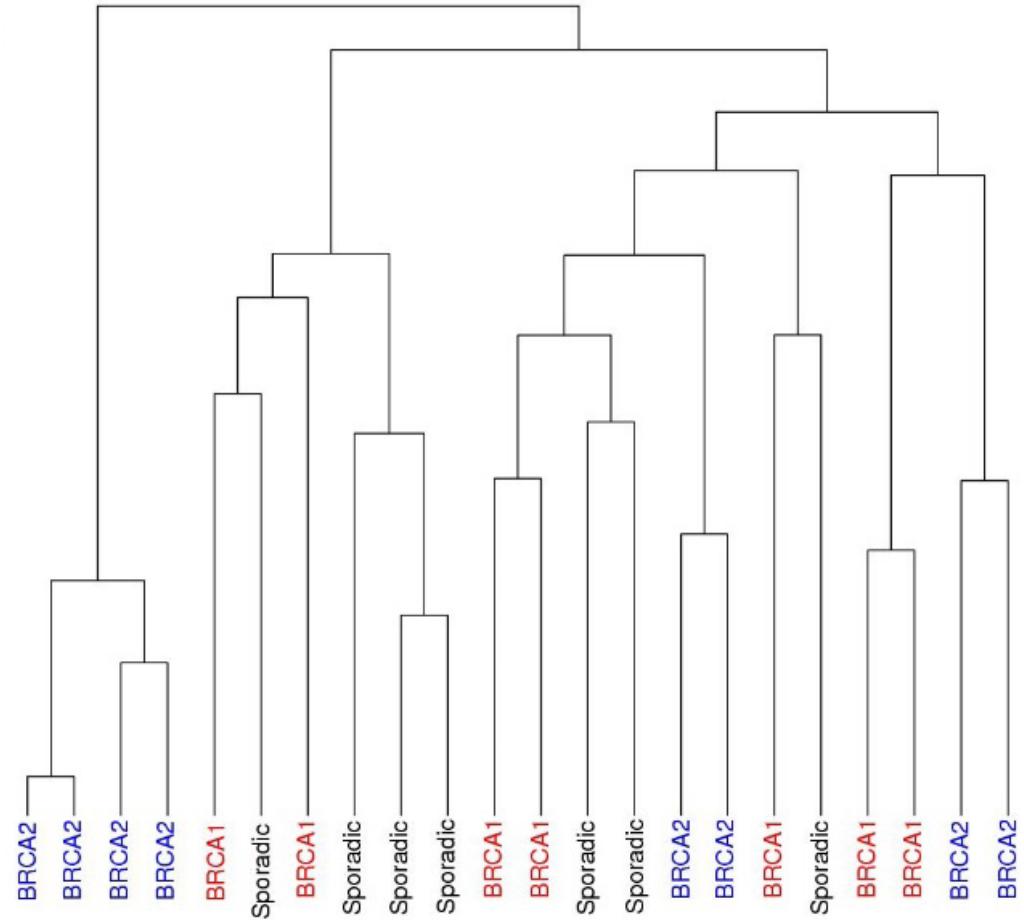
Layout: Top-down



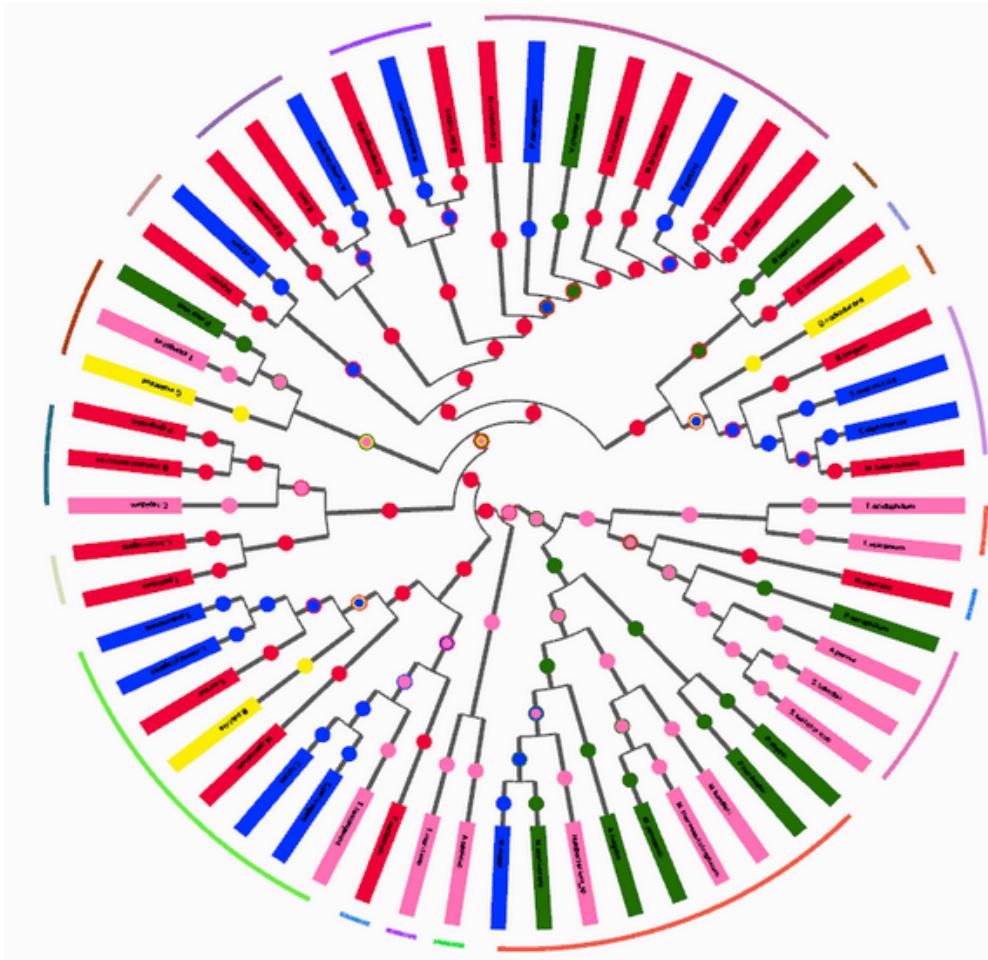
Layout: Top-down



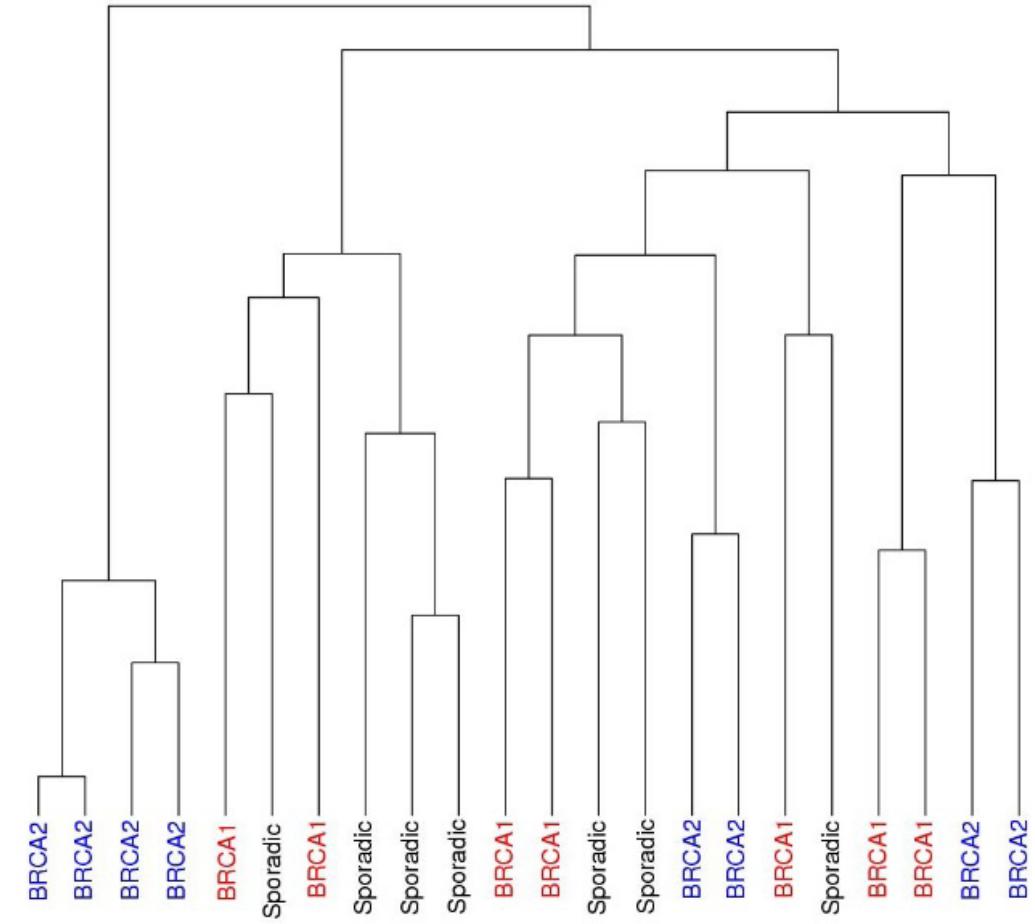
Bottom-up



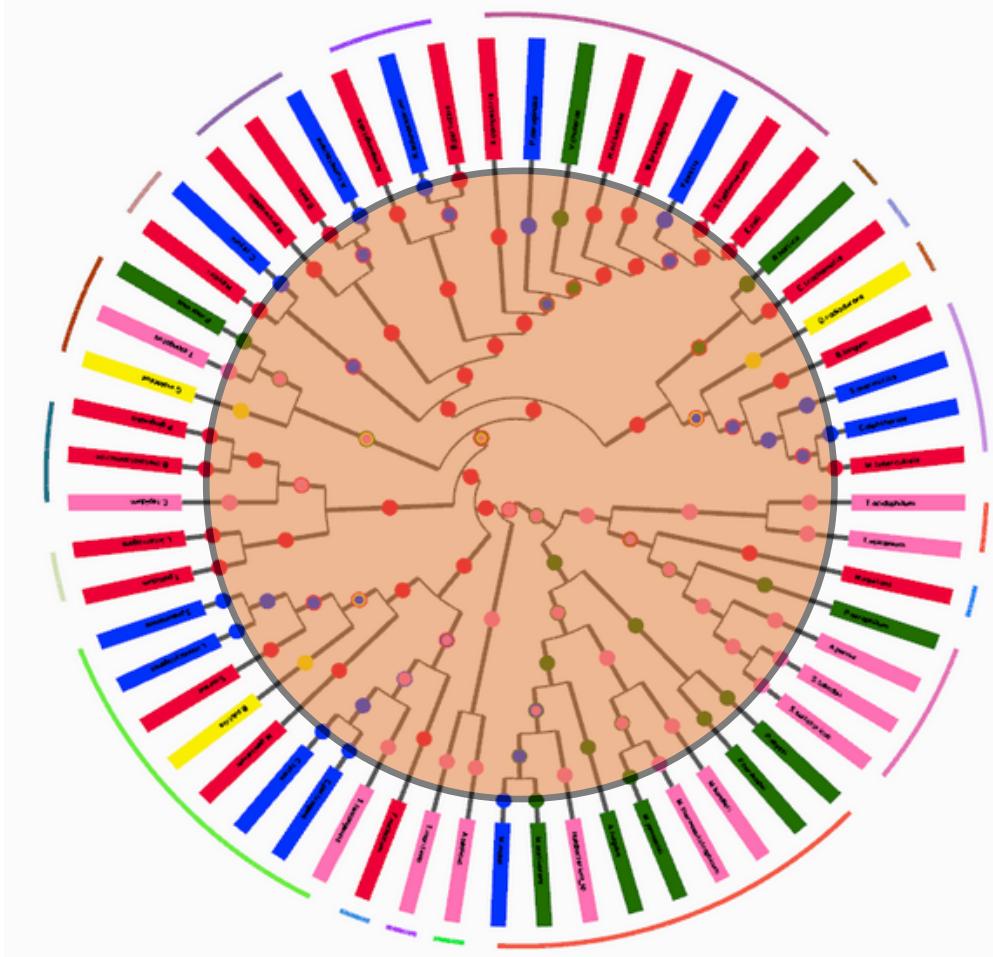
Bottom-up (radial)



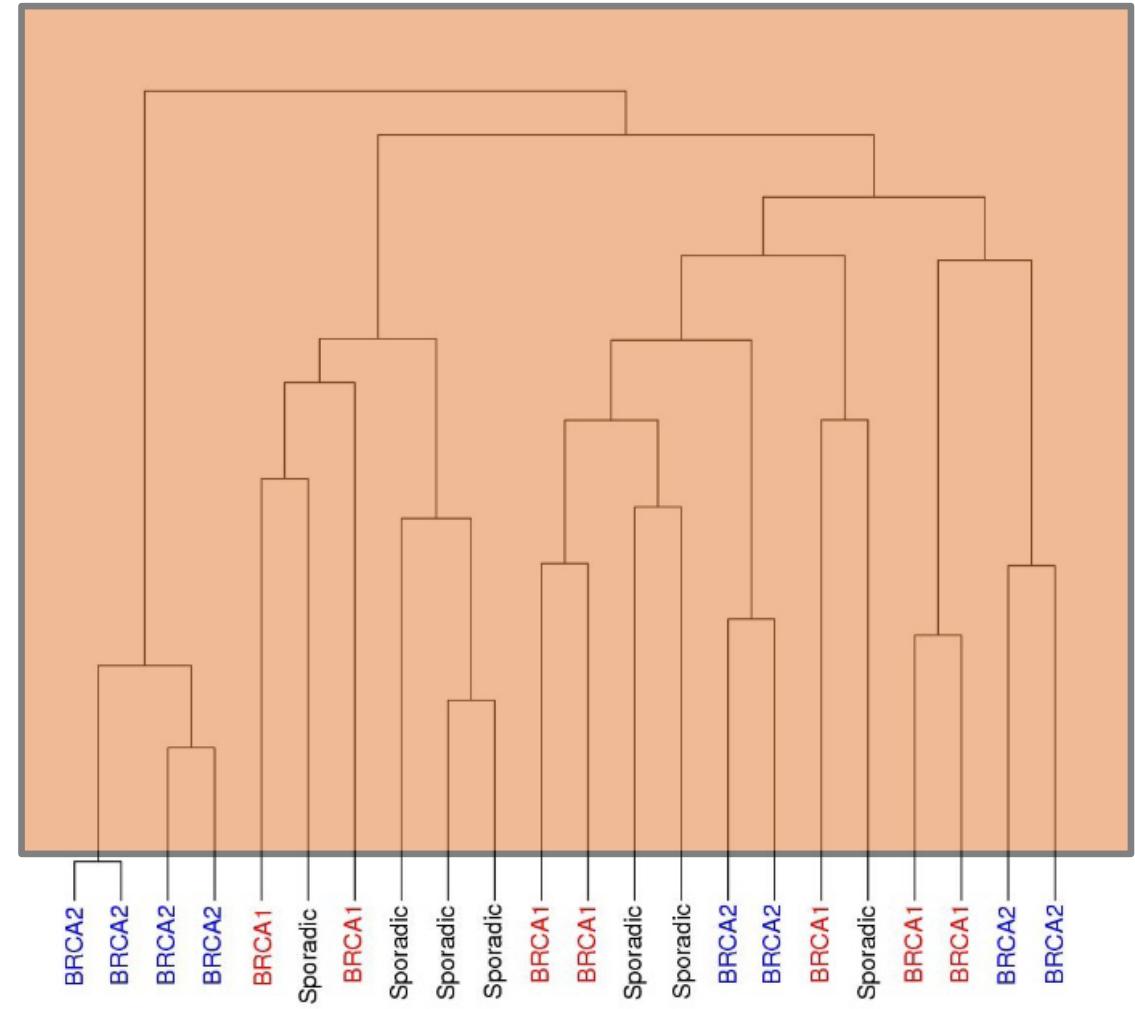
Bottom-up



Bottom-up (radial)



Bottom-up



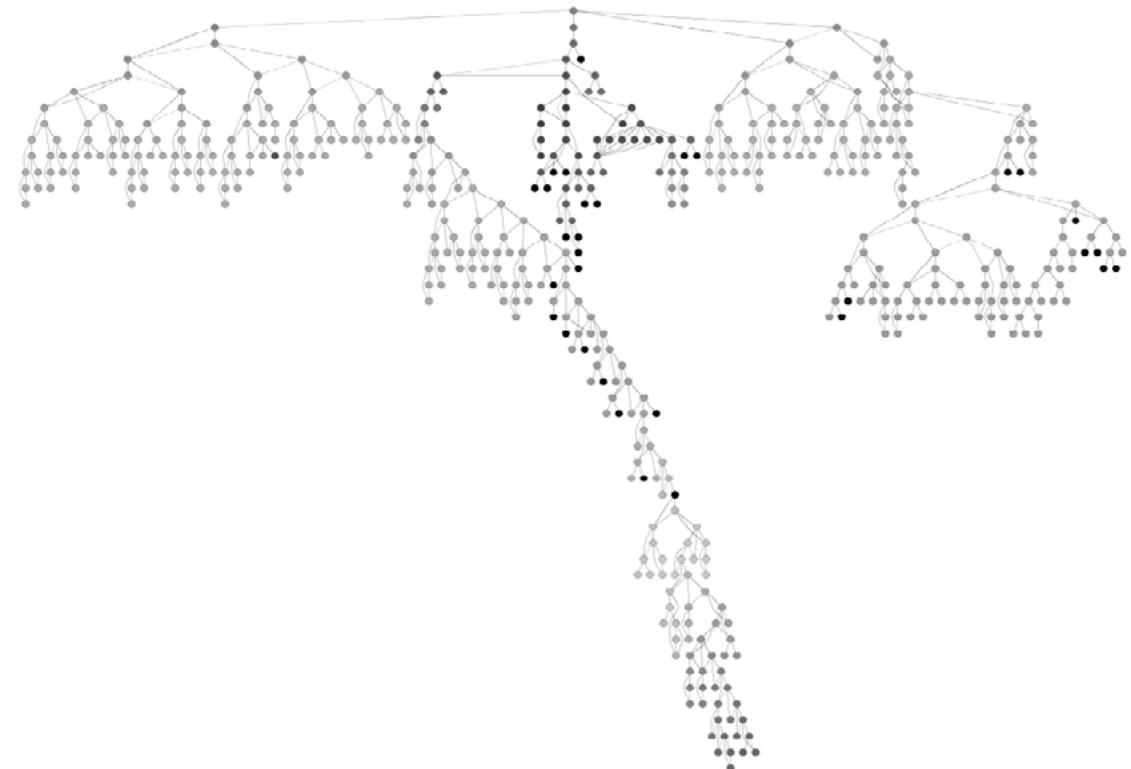
Layouts: top-down versus bottom up

Are leaf nodes important?

What is the balance of interior to exterior nodes?

Dealing with excessive fan / depth

Often use some
combination of
layout + interaction

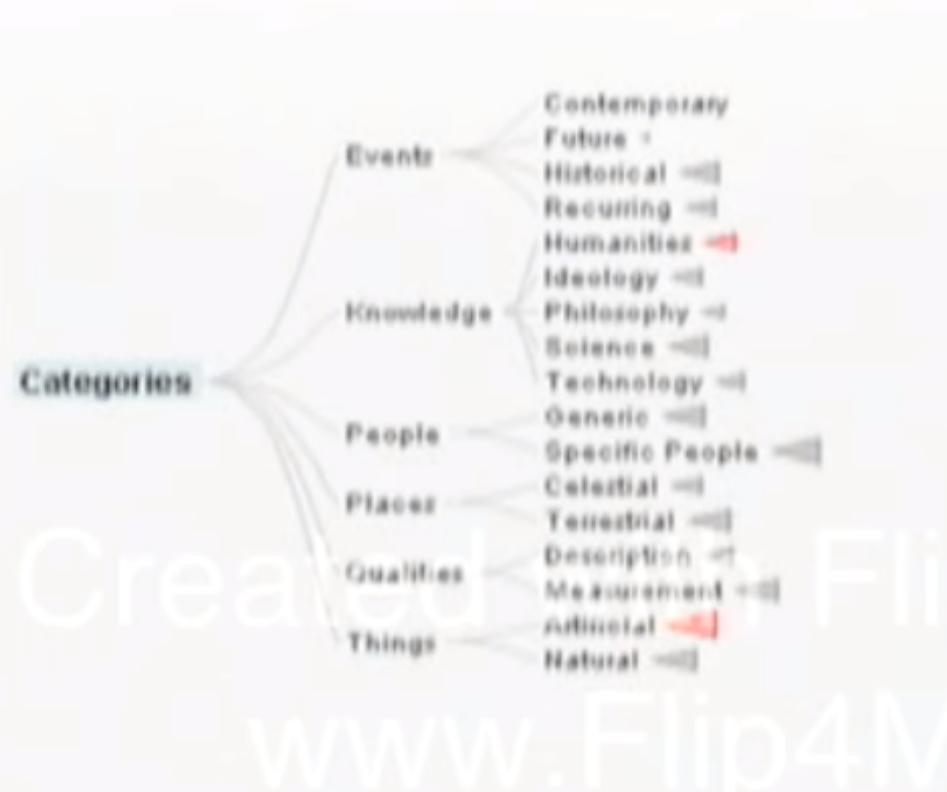


Excessive fan/depth: DOI trees

Use semantic zoom
(elaboration)

Animation to maintain context

Problems?



<https://www.youtube.com/watch?v=RTQ0N4QY0yc>

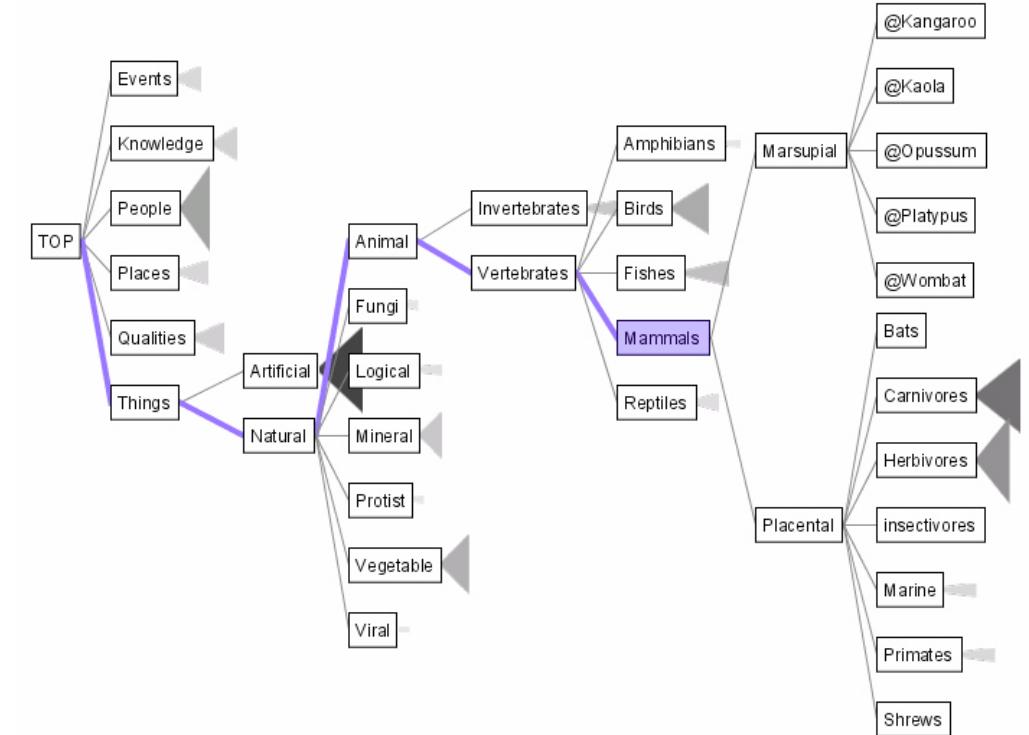
SpaceTrees

Stepped animation

General idea:
focus + context

<http://www.cs.umd.edu/hcil/spacetree/>

JavaScript example: [https://philogb.github.io/jit/static/v20/Jit/
Examples/Spacetree/example1.html](https://philogb.github.io/jit/static/v20/Jit/Examples/Spacetree/example1.html)

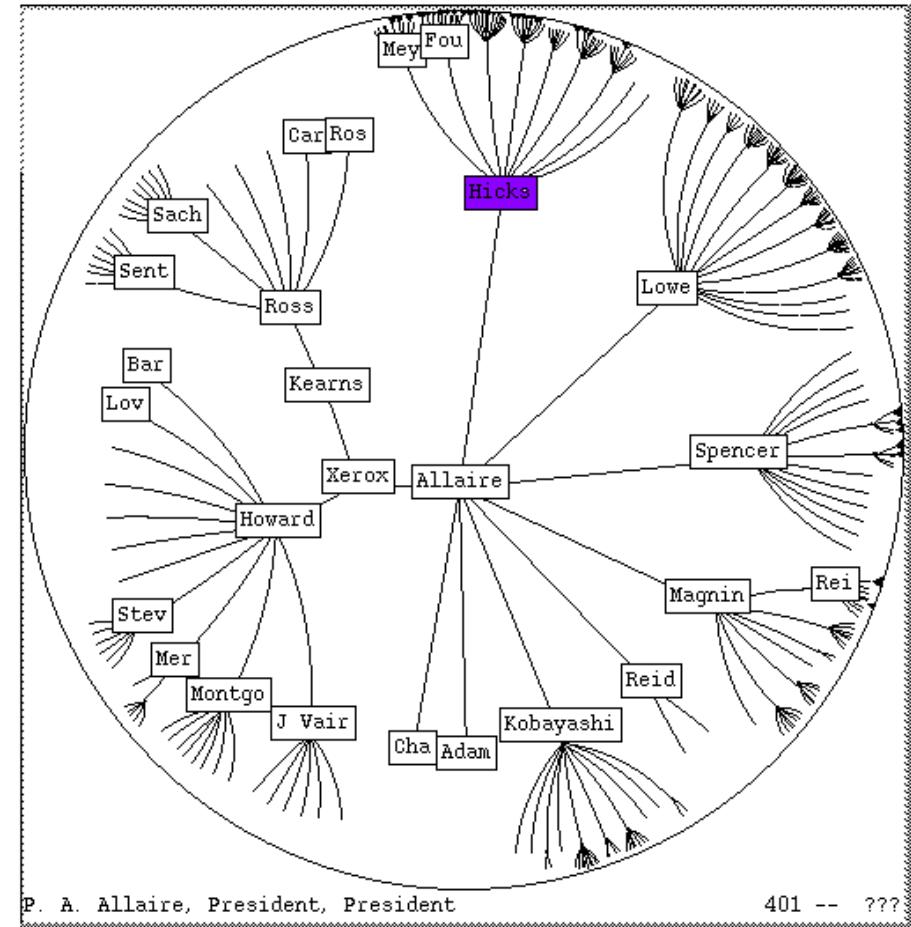


Hyperbolic Trees

Different approach to scale:
Plot in **hyperbolic space**

Automatically gives
focus + context

https://www.youtube.com/watch?v=fhbQy_NCwWI

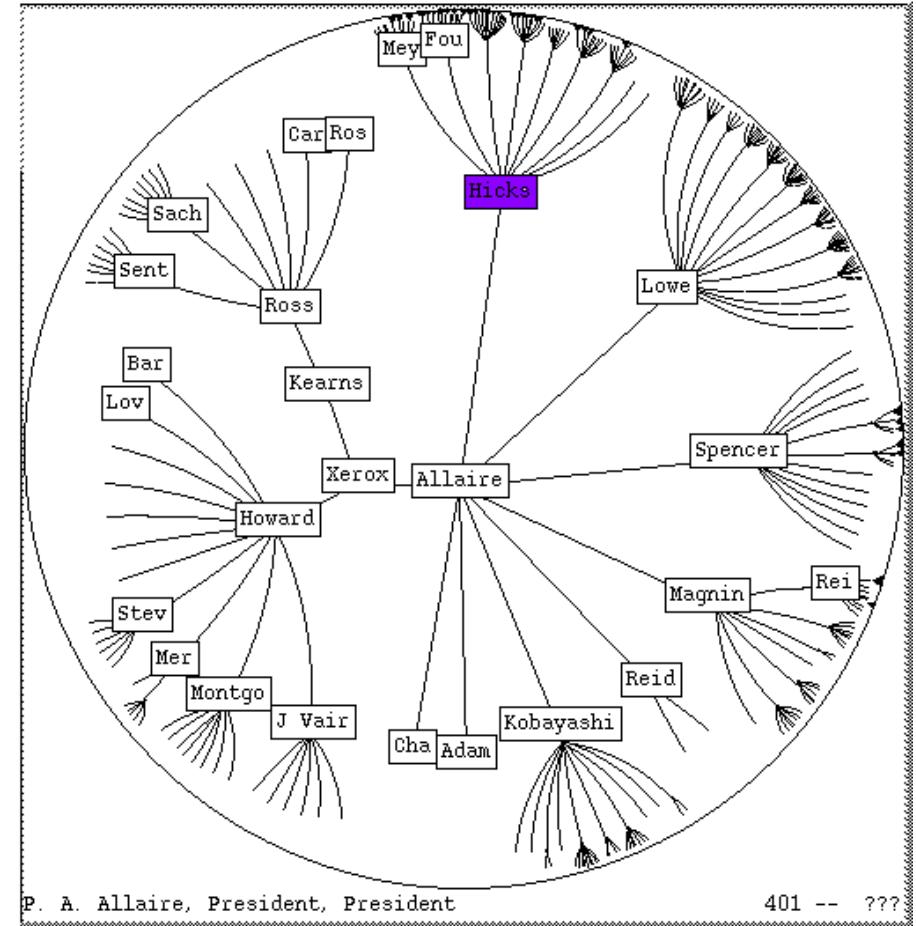


Hyperbolic Trees

Though now Euclidean
distance do not hold

Can be disorienting

(issues with any distortion
technique; e.g. fish-eye)

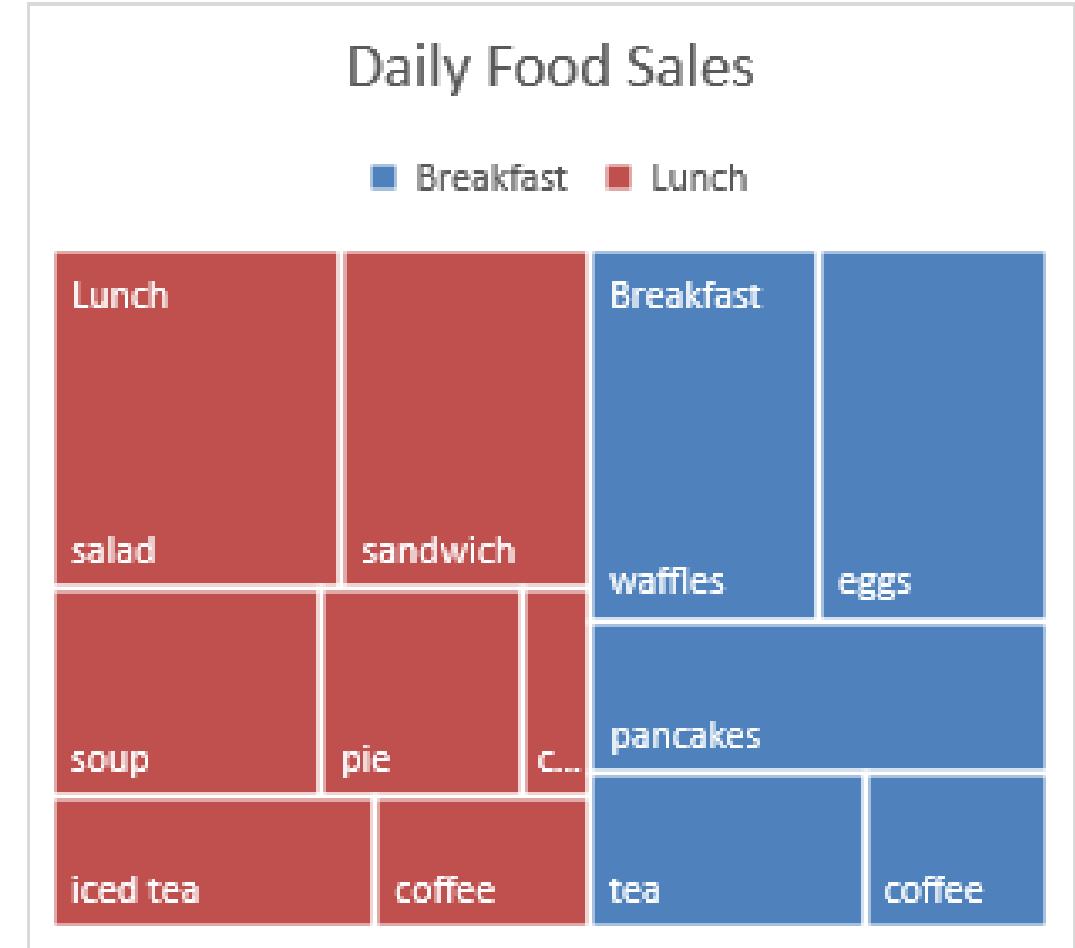


TreeMaps

Space-filling

Quantitative variable -> size

Subtree size (cumulative)
is made salient



TreeMaps

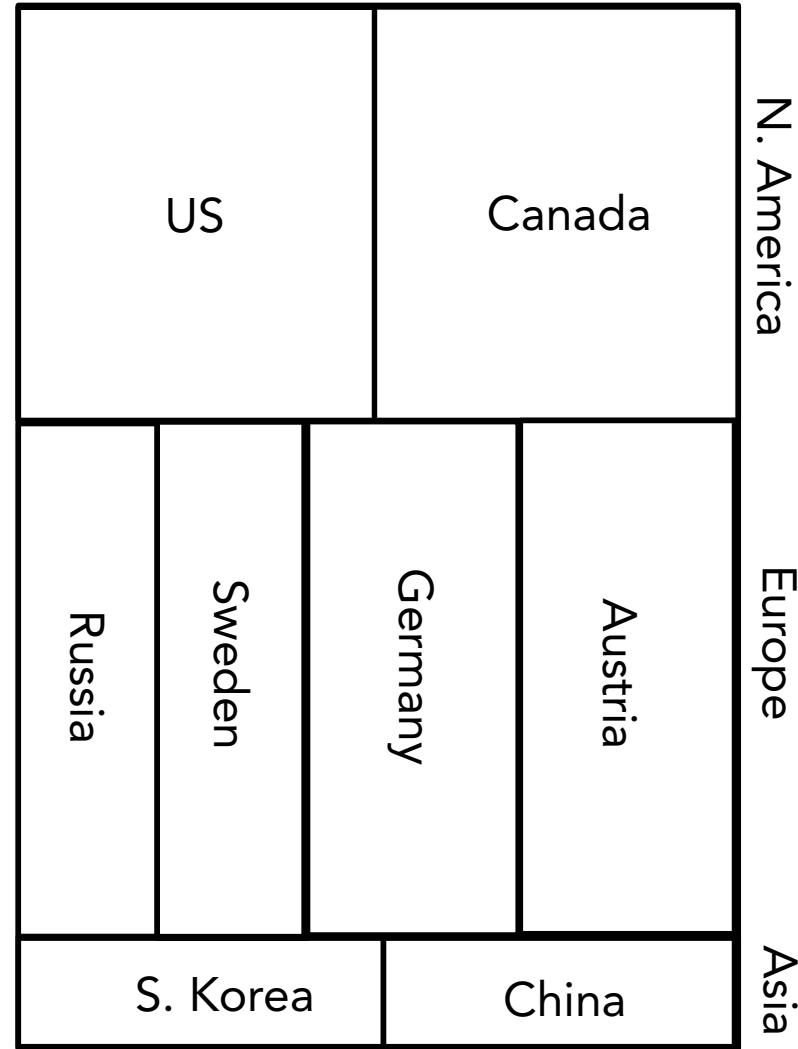
- World (1000)
 - North America (400)
 - United States (200)
 - Canada (200)
 - Europe (500)
 - Germany (150)
 - Austria (150)
 - Russia (100)
 - Sweden (100)
 - Asia (100)
 - S. Korea (50)
 - China (50)

Basic algorithm

```
Draw() {  
    1. Change orientation from parent  
    2. For all datum at level,  
        make rectangle, scaled to size  
    3. Call Draw() on children (if any)  
}
```

TreeMaps

- World (1000)
 - North America (400)
 - United States (200)
 - Canada (200)
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 - Germany (150)
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 - Russia (100)
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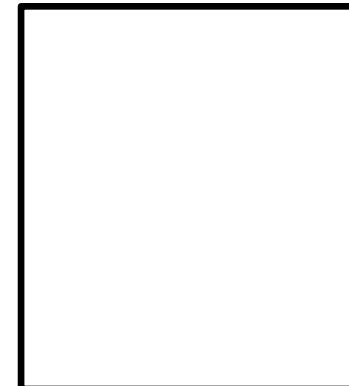


TreeMaps: Possible issues?

TreeMaps: perception and aesthetics

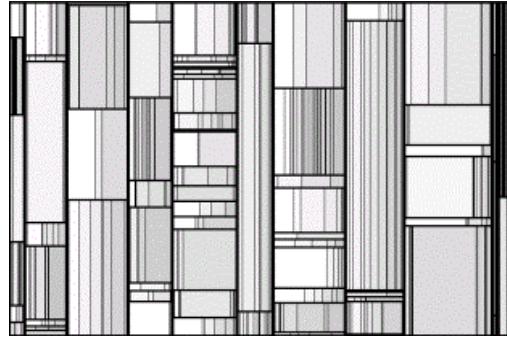


These may not be visually appealing...

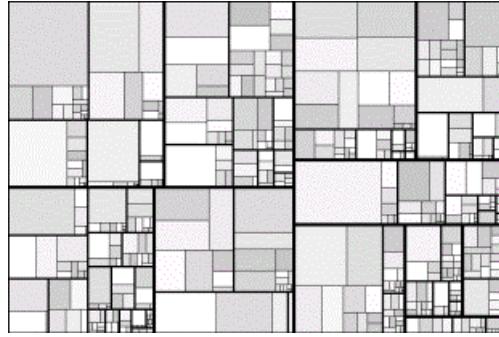


Which has larger area?

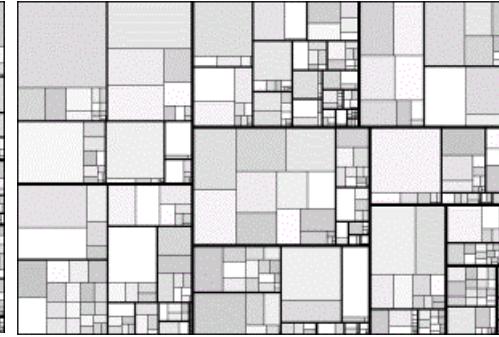
TreeMaps: perception and aesthetics



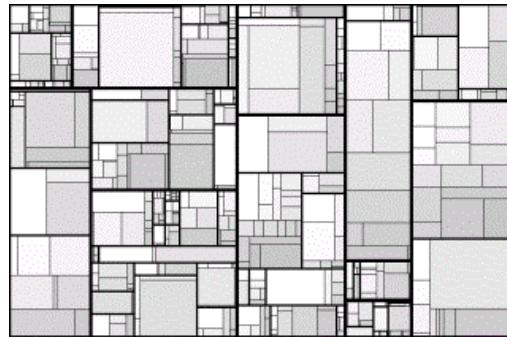
Slice-and-dice



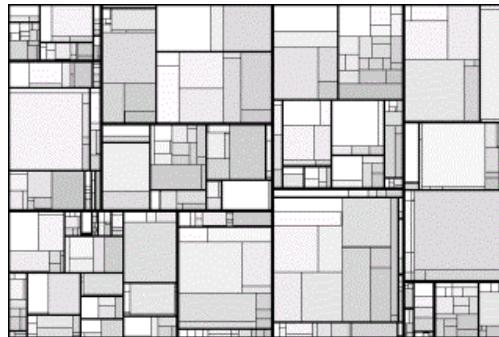
Cluster



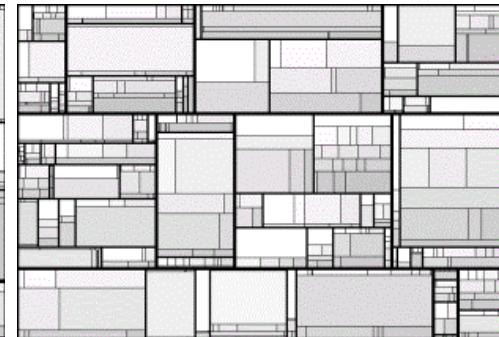
Squarified



Pivot-by-middle



Pivot-by-size

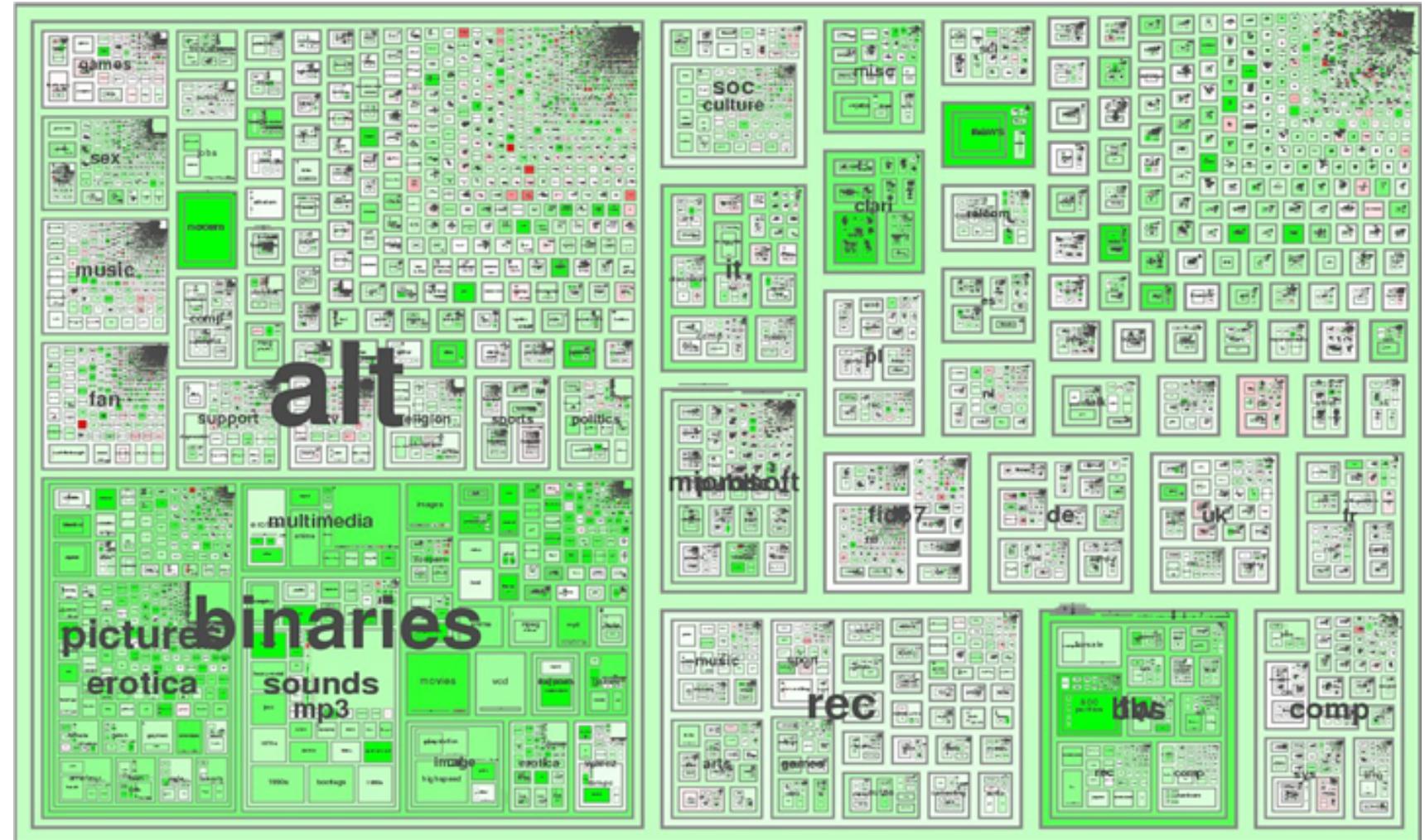


Strip

Bederson et al, 2002

TreeMaps: structure

Can be
hard to see
structure



TreeMaps: pros and cons

Combines 2 attributes (color + area); area is **cumulative**

But **structure** can be lost

Aesthetics?

Comparisons can be hard if squashed

Circular TreeMaps

Structure improved

More space required

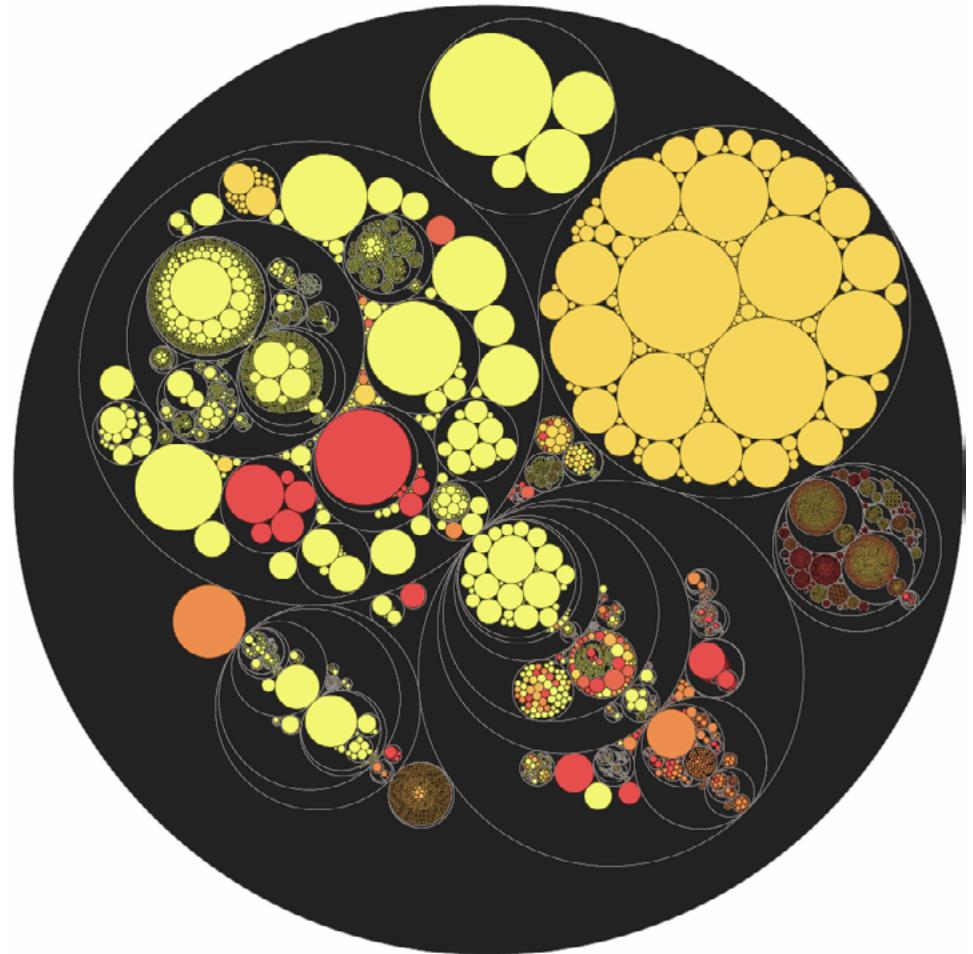
D3 examples:

Normal TreeMaps:

<http://bl.ocks.org/ganeshv/6a8e9ada3ab7f2d88022>

Circular:

<http://bl.ocks.org/mbostock/7607535>



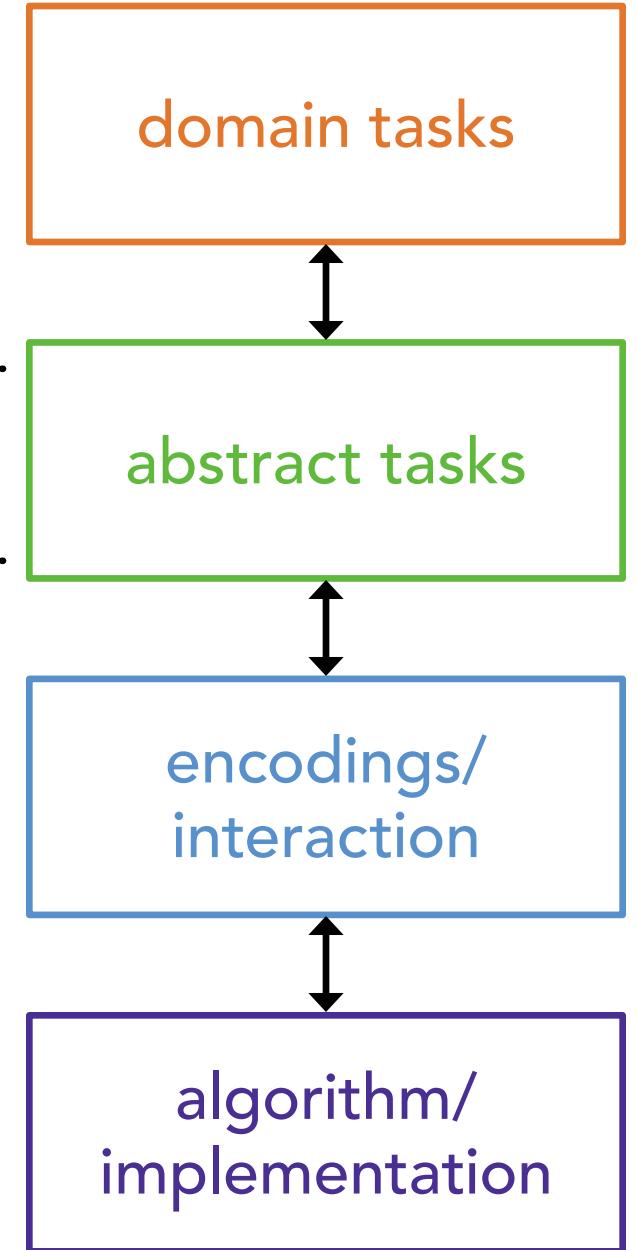
Hierarchical vis

Broad classes: **Node-link** and **space-filling**

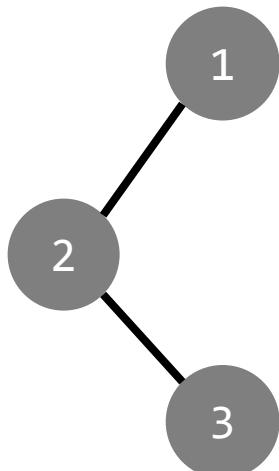
Layouts and **focus + context** can help with scale

Network visualization

How far are two nodes?
Trace a path between two nodes
Find neighbors, clusters, cliques, bridges

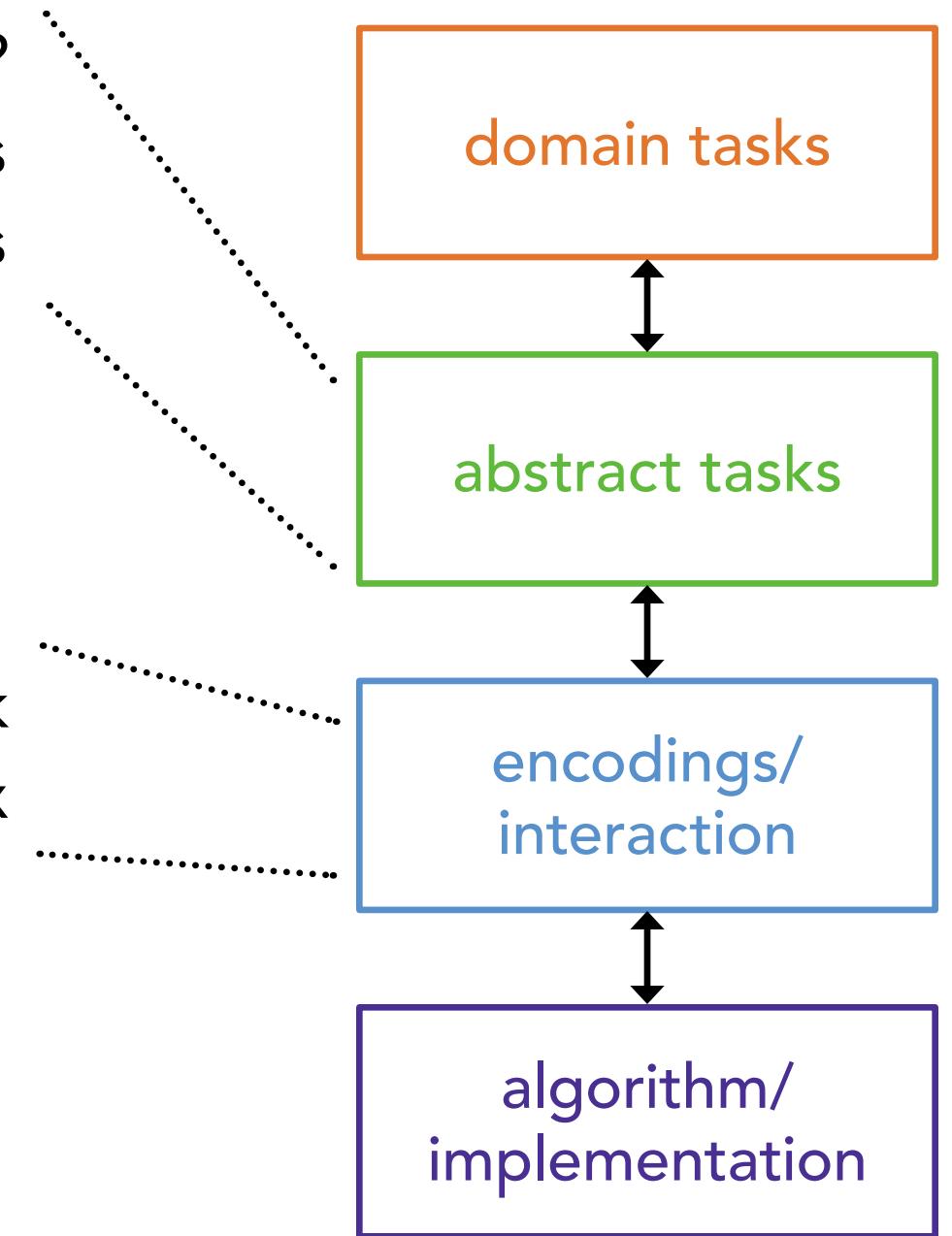


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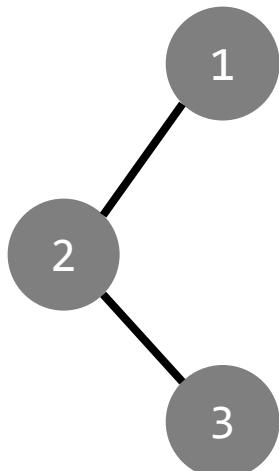


	1	2	3
1	0	1	0
2	1	0	1
3	0	1	0

Node-link
Matrix

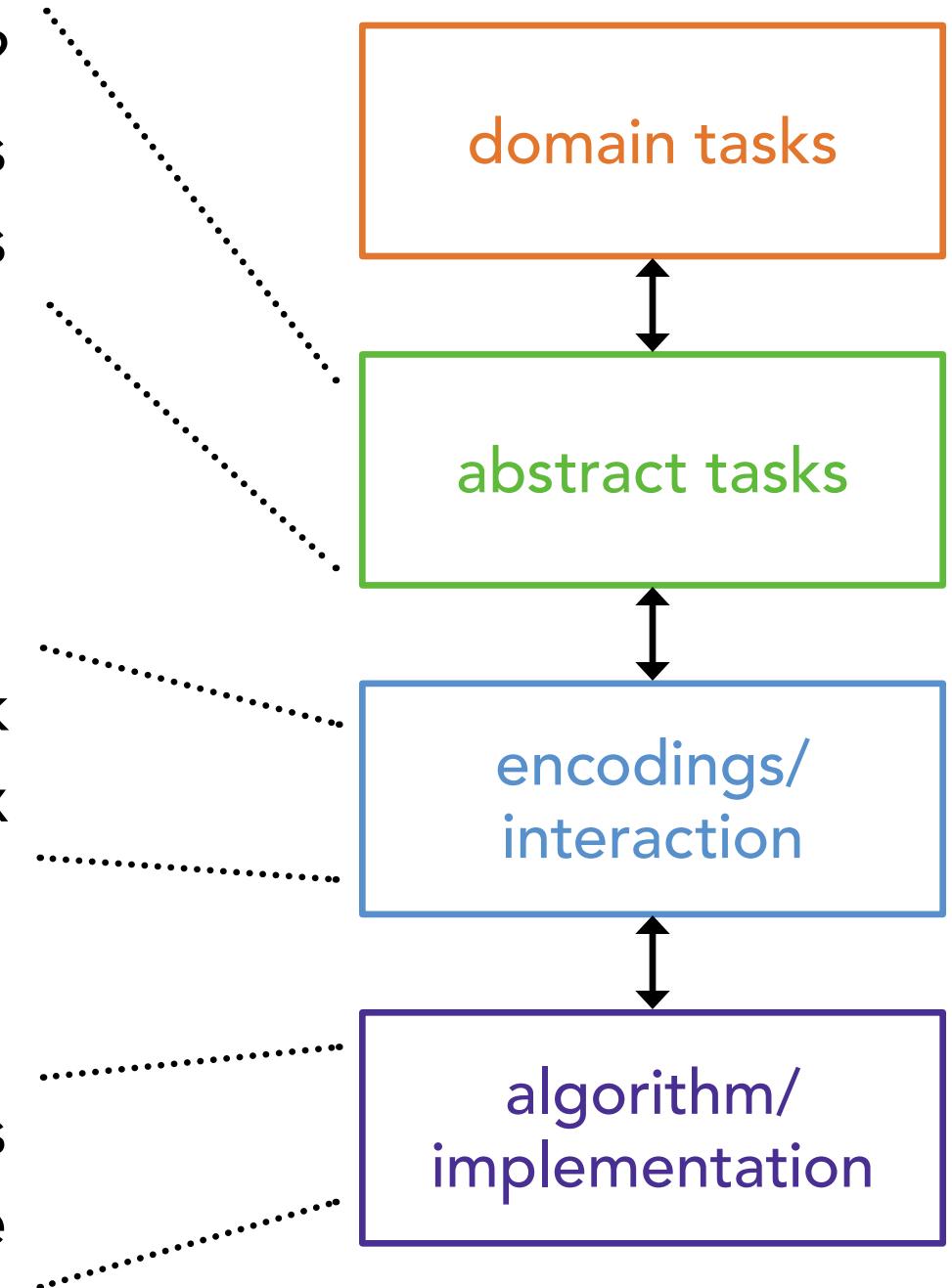


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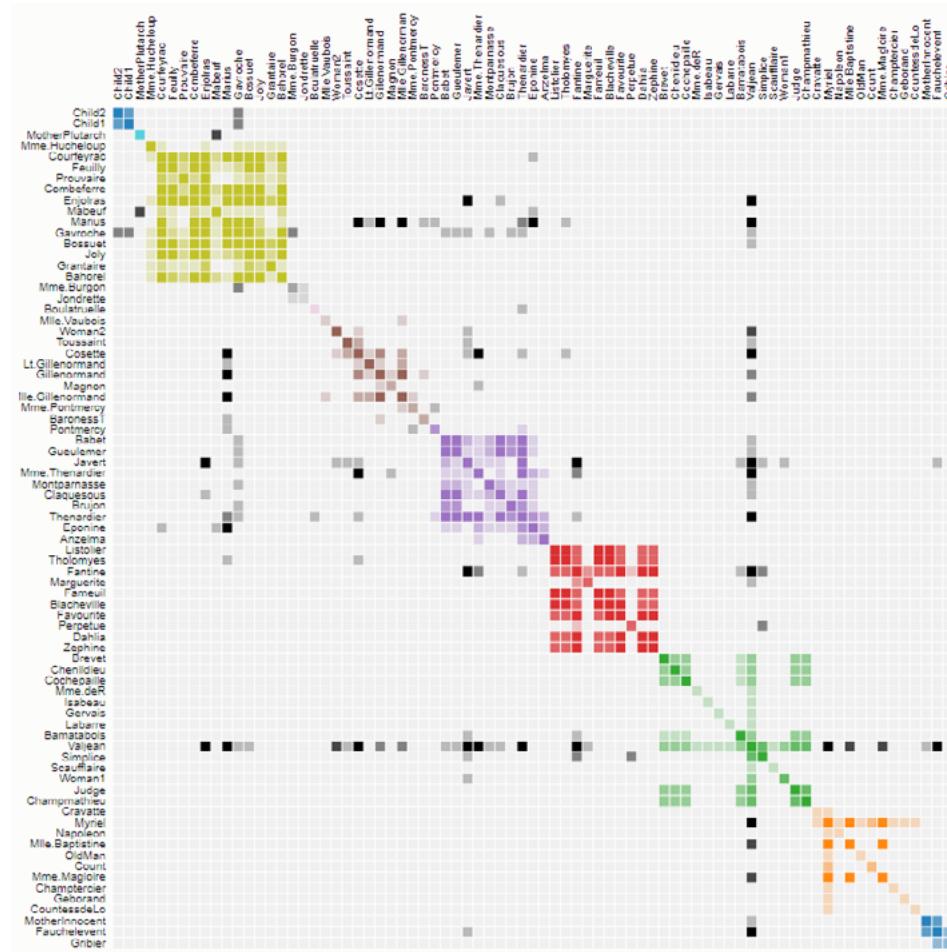
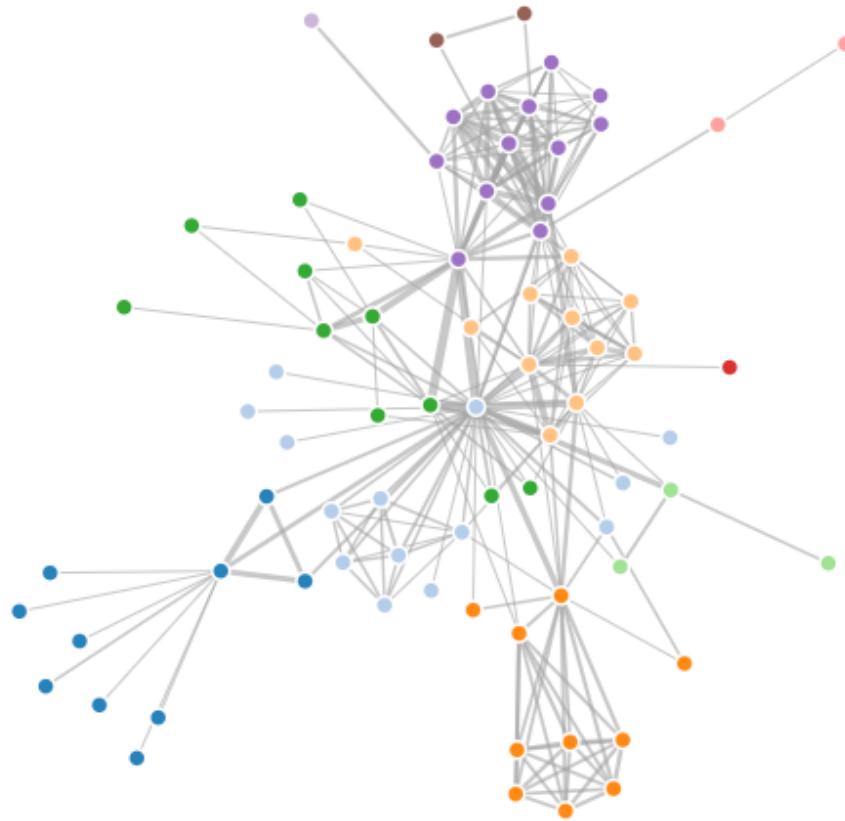


	1	2	3
1	0	1	0
2	1	0	1
3	0	1	0

Node-link
Matrix
Layouts
Scale



Node-link vs adjacency matrix



Node-link vs adjacency matrix

Tasks?

Find neighbors (next door and further; count / find set)

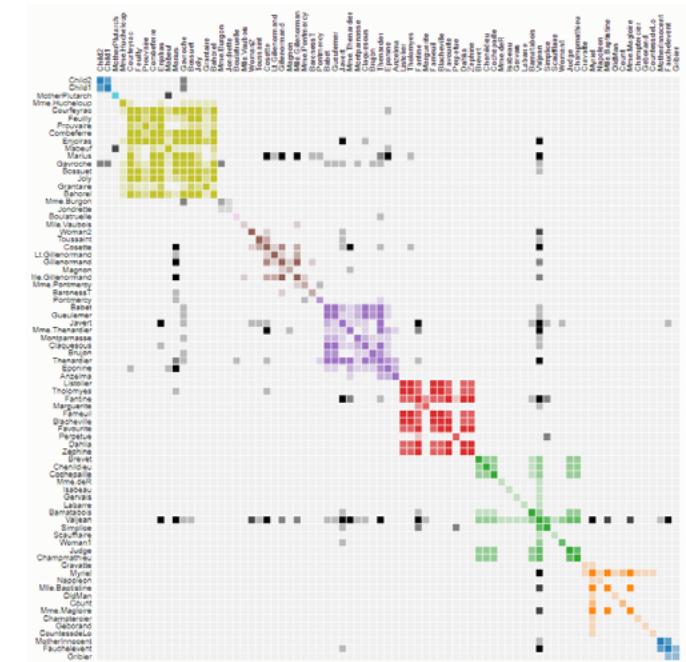
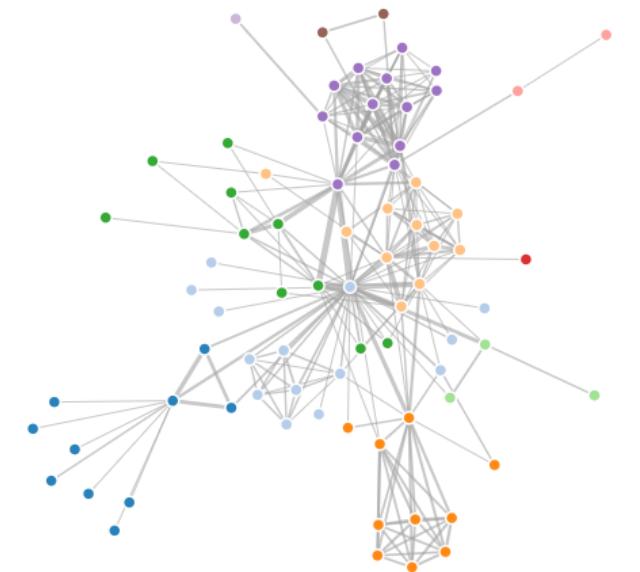
Find common neighbors to some nodes

Find clusters, bridges, connected components

Find nodes/edges with specific values/types

Follow a path

Sparse data or dense data?



Network vis: what's the problem?

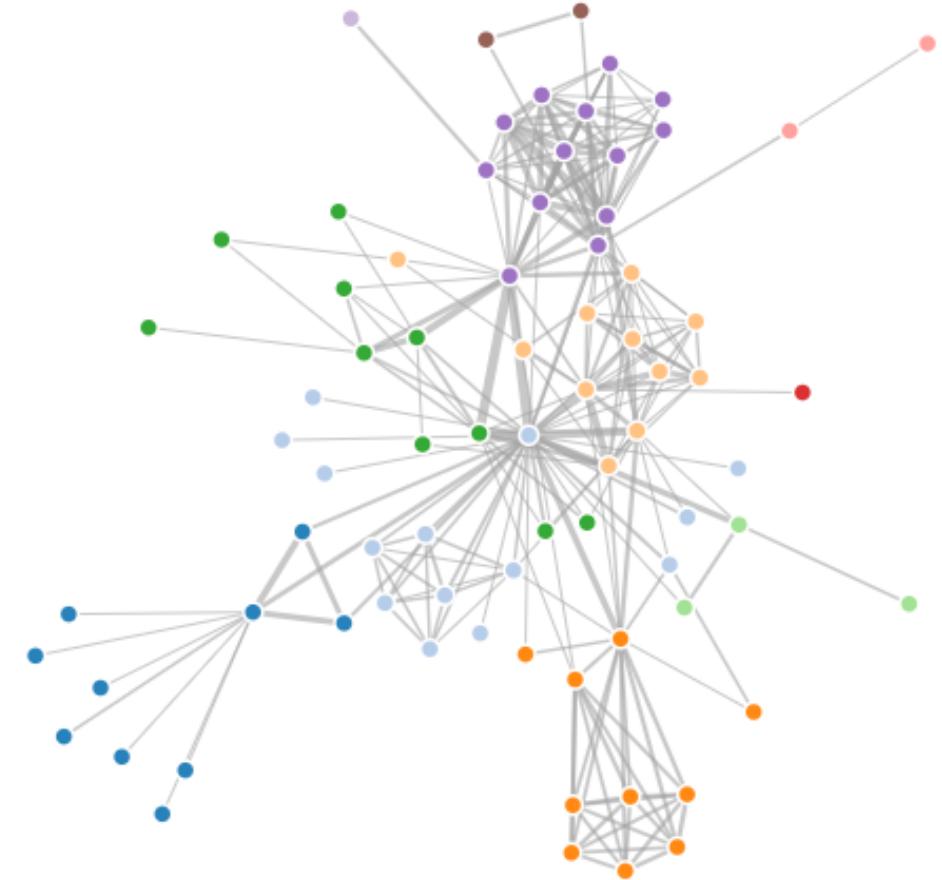
Shneiderman criteria for effective network vis

Is every node visible?

Can you count degree of every node?

Can you follow every link from source to dest?

Can you identify clusters and outliers?



Network vis: the problem is **scale**

Shneiderman criteria for effective network vis

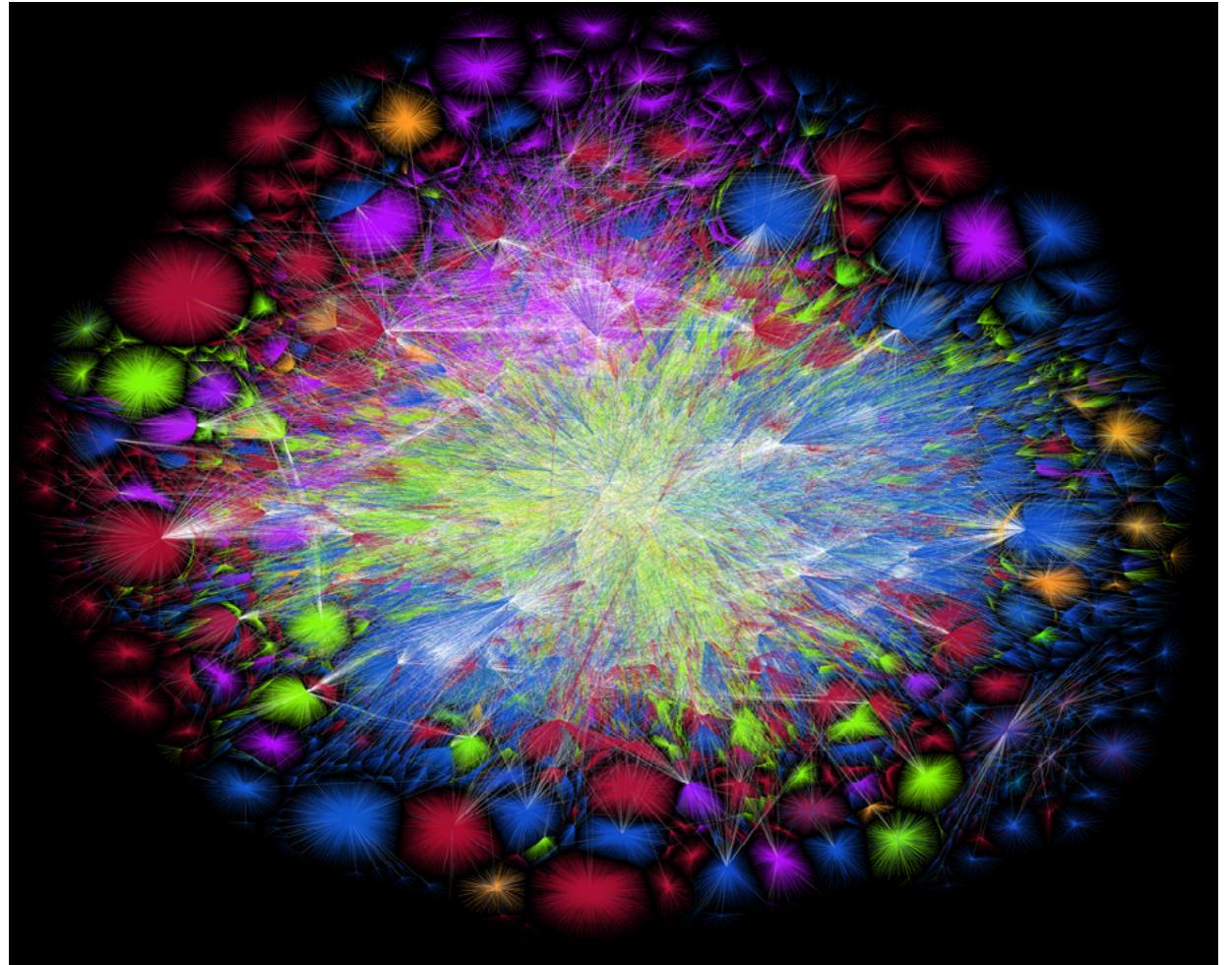
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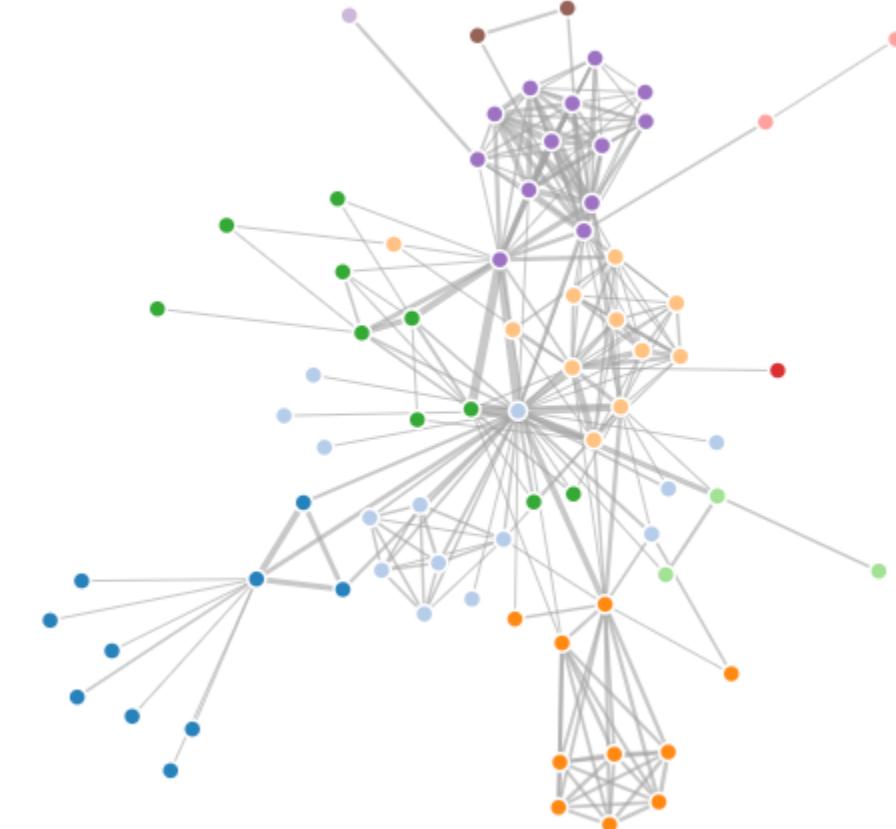
(OPTE Internet Map)



Boosting effectiveness: Layout

Force-directed layout

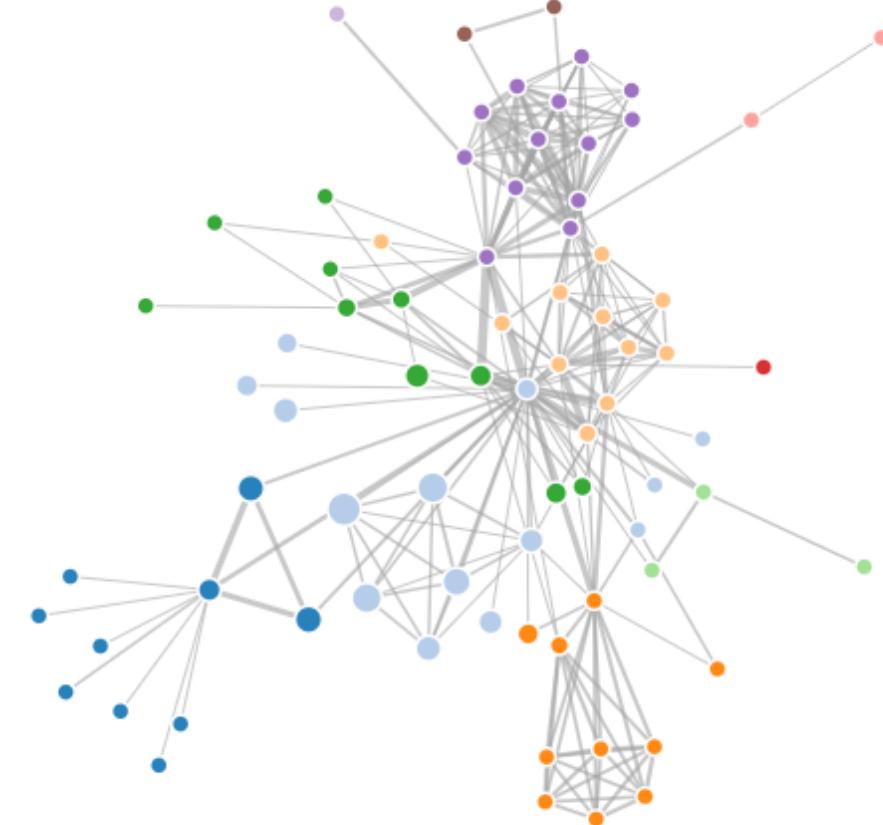
<https://bl.ocks.org/mbostock/4062045>



Boosting effectiveness: Focus + context

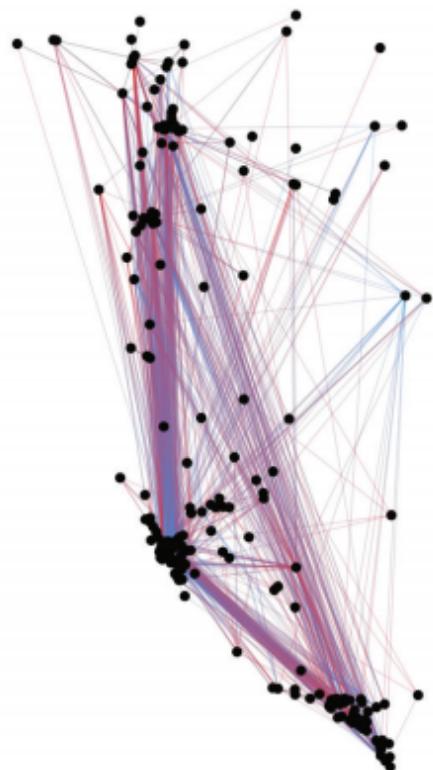
Force-directed layout +
fish-eye

<https://bost.ocks.org/mike/fisheye/>



Boosting effectiveness: layout: edge bundling

(Selassie, Heller and Heer, Divided Edge Bundling for Directional Network Data, 2011)



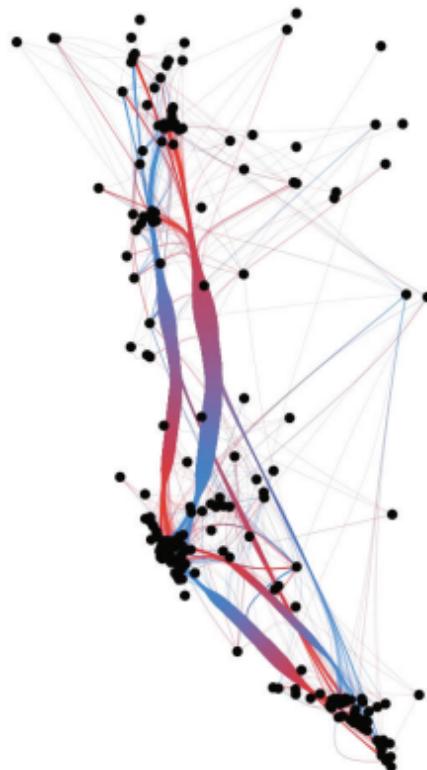
(a) Unbundled



(b) Clustered to metro areas



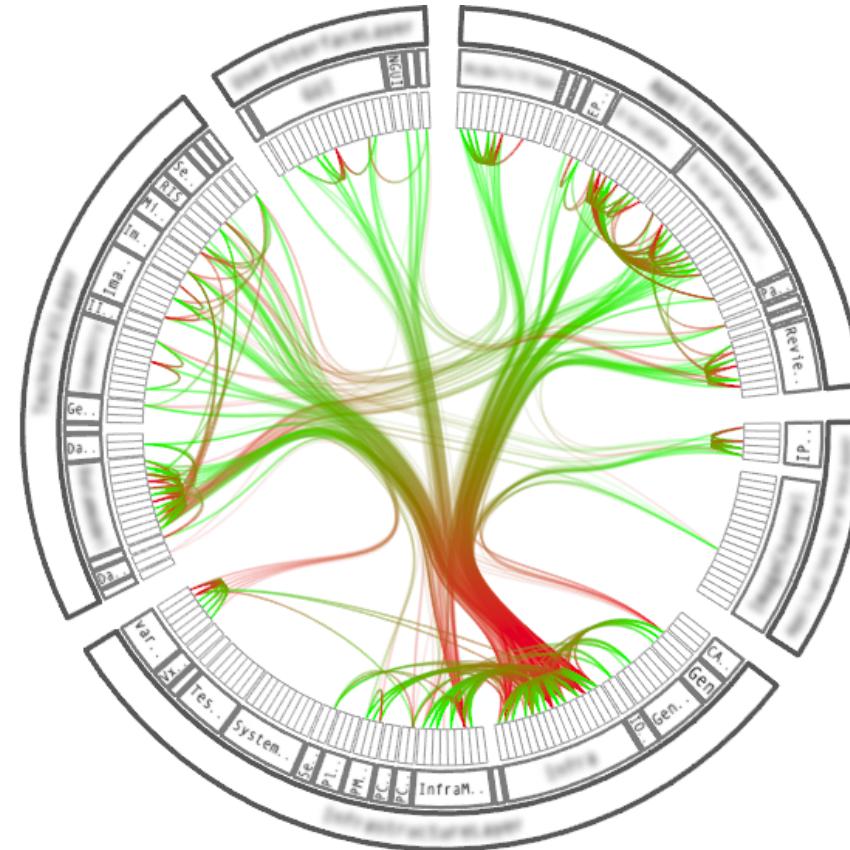
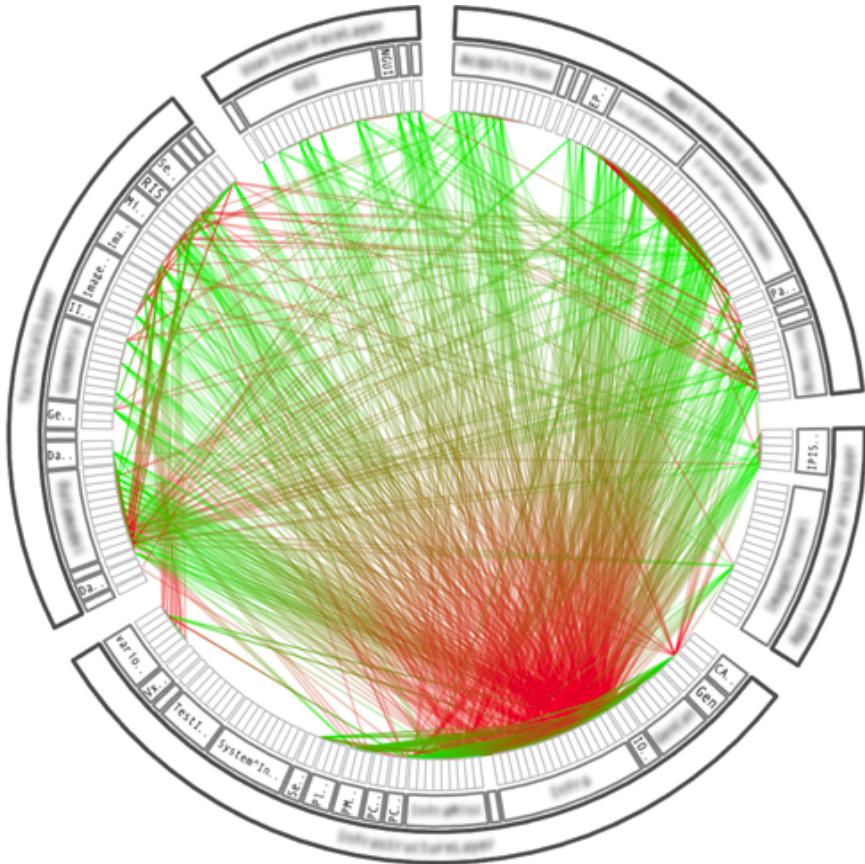
(c) Force-directed edge bundling



(d) Divided edge bundling

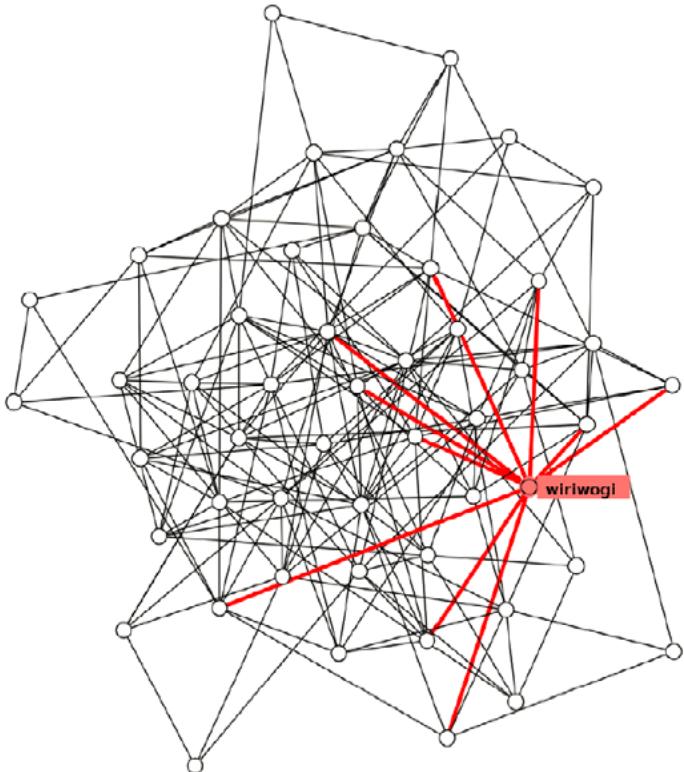
Boosting effectiveness: layout: edge bundling

(Holten, Hierarchical Edge Bundles: Visualization of Adjacency Relations in Hierarchical Data)



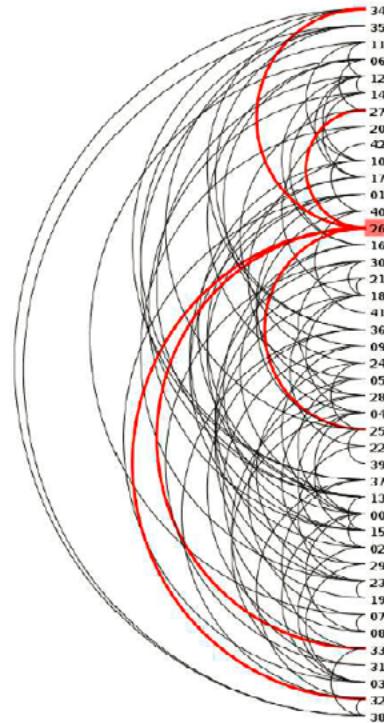
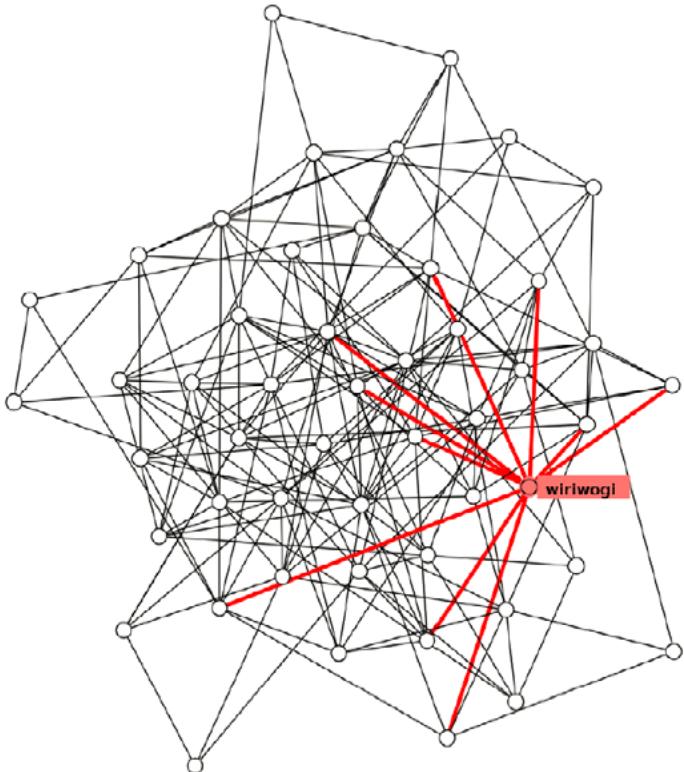
Node linearization

[McGuffin, Simple Algorithms for Network Visualization: A Tutorial, 2012]



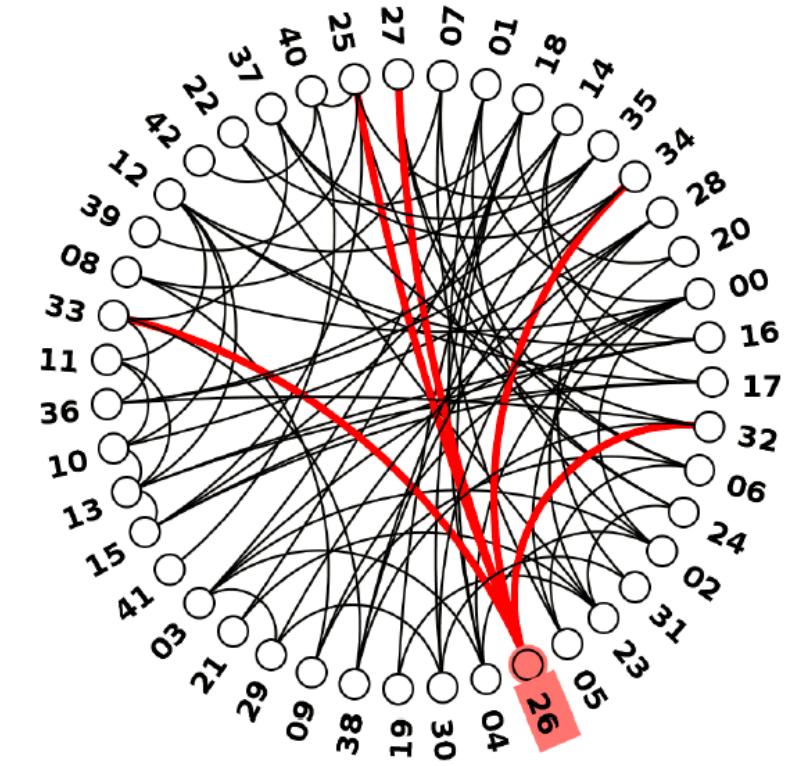
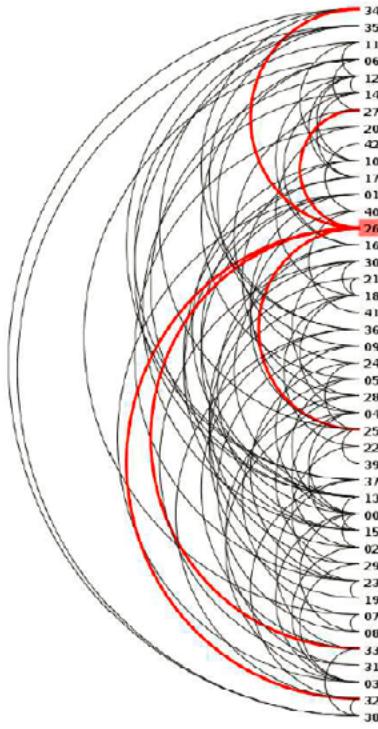
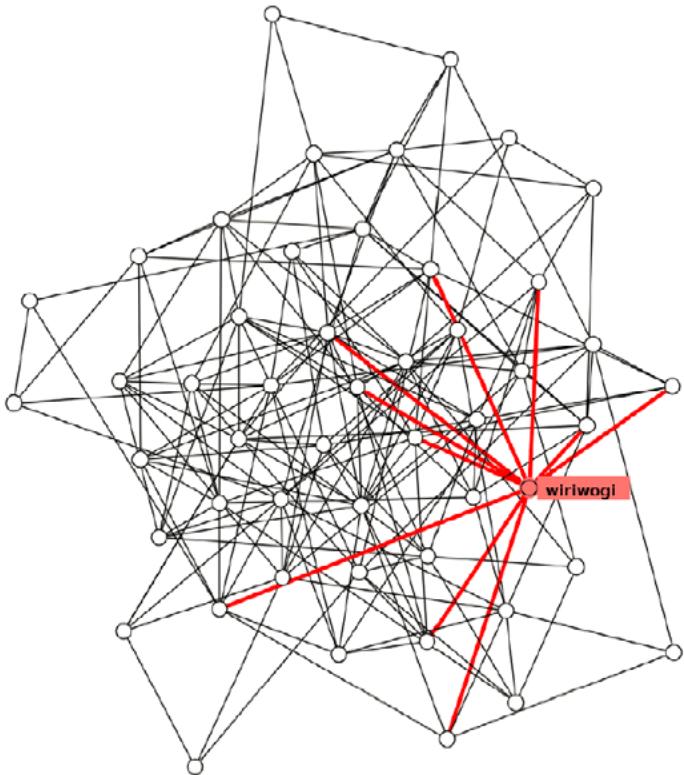
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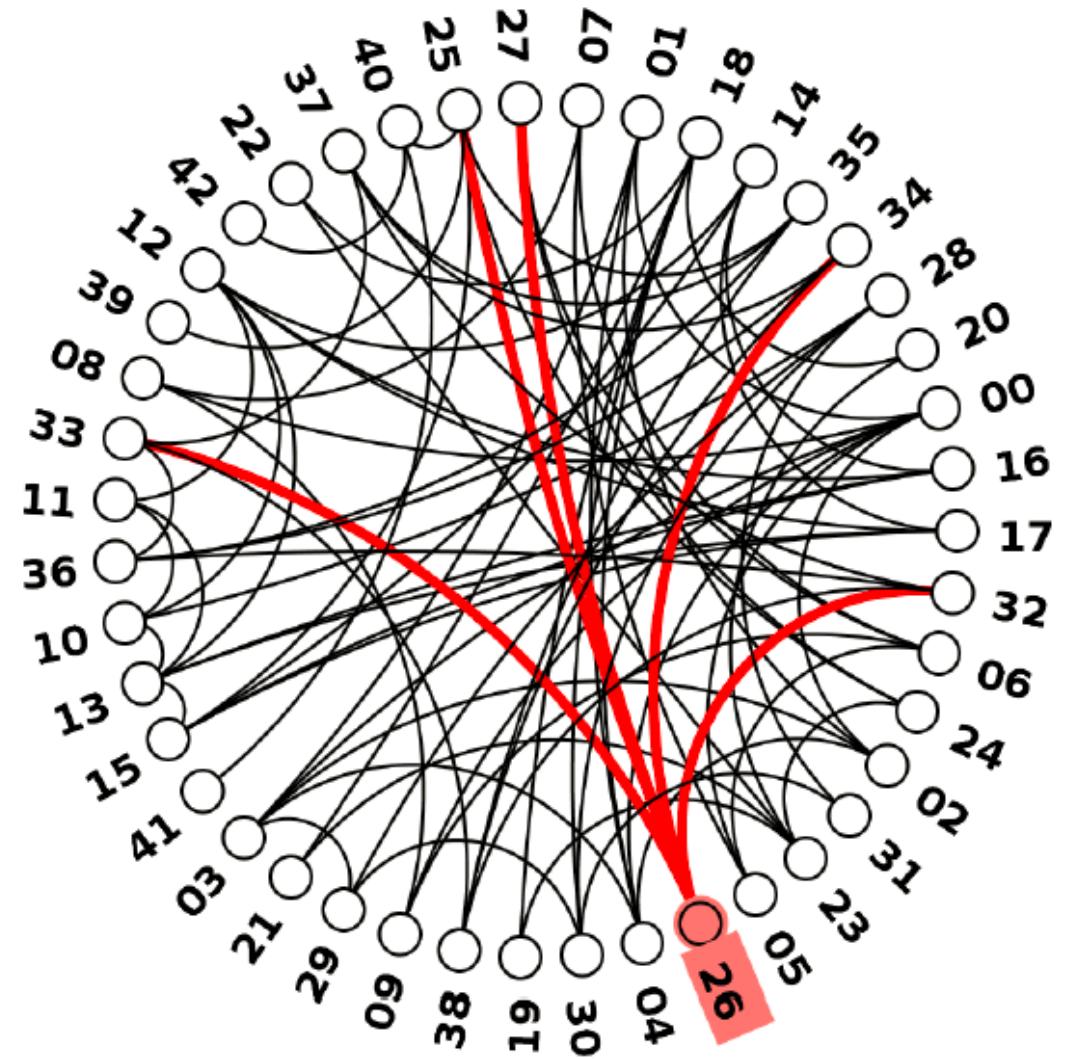
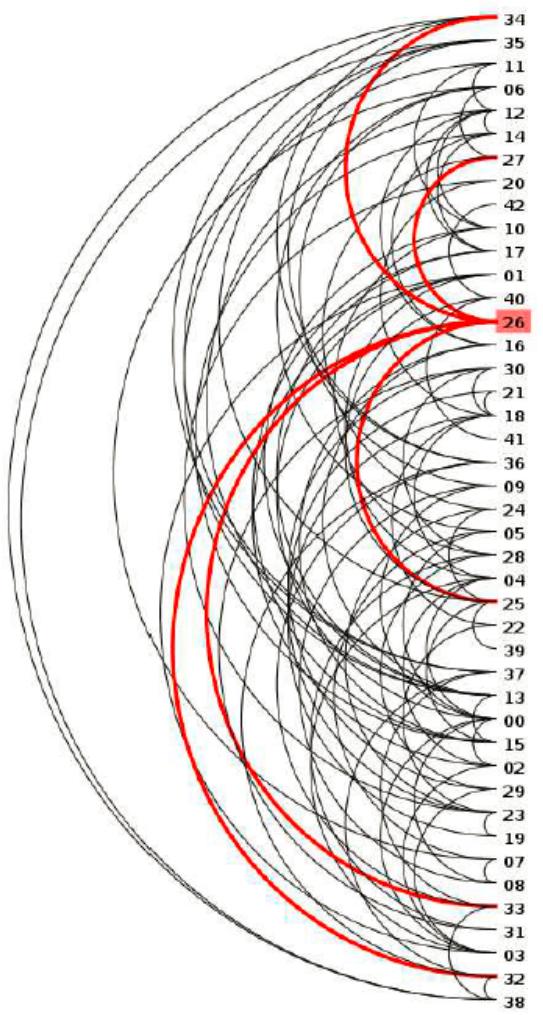
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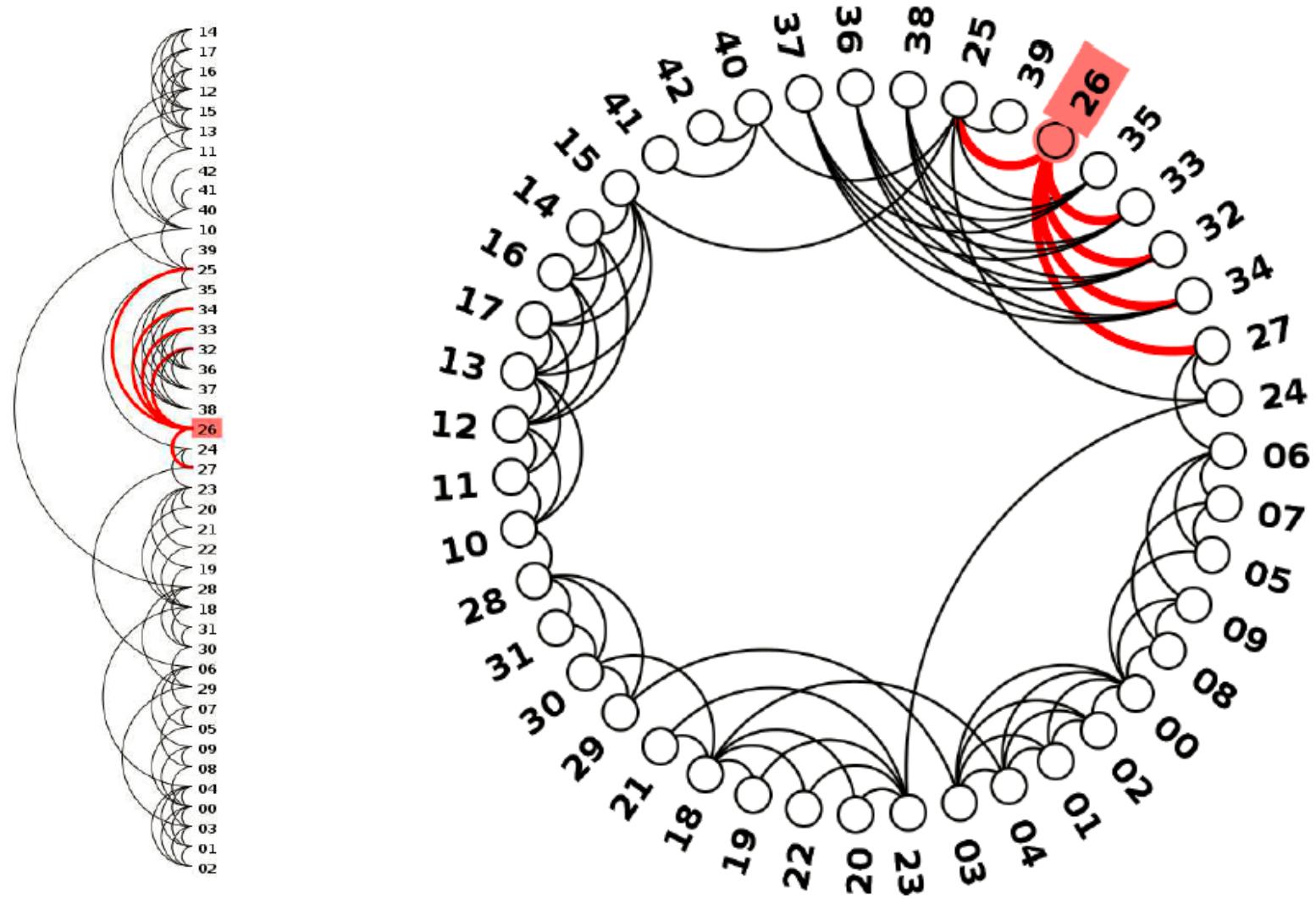
Node linearization

[McGuffin]



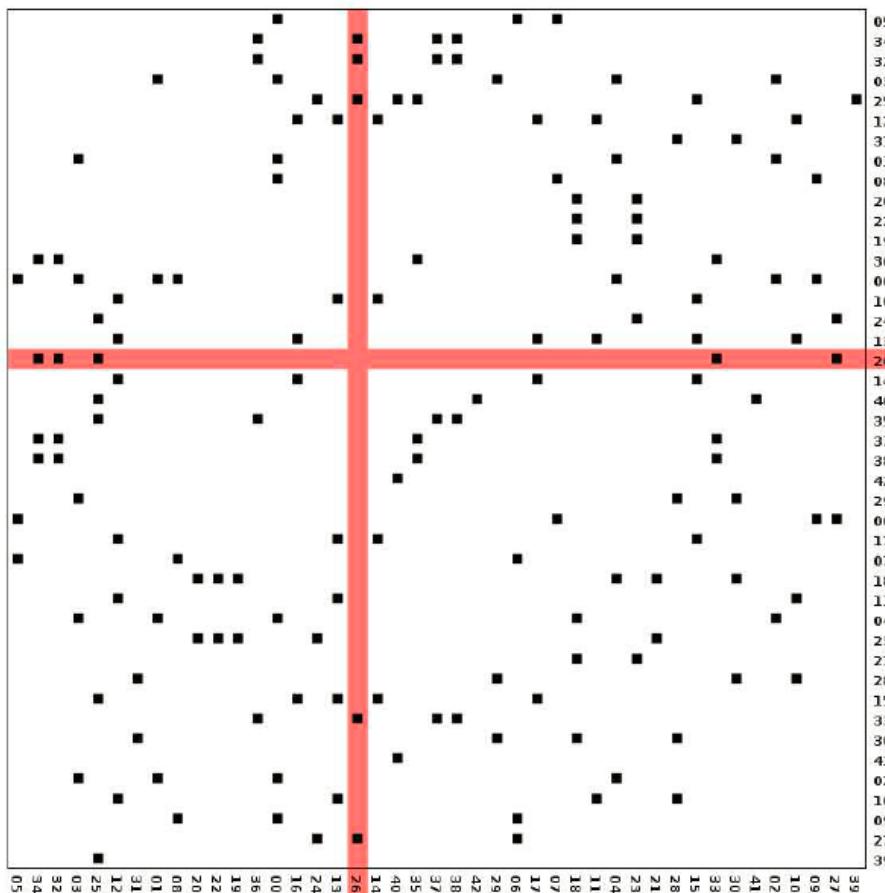
Node linearization: Barycentric order

[McGuffin]



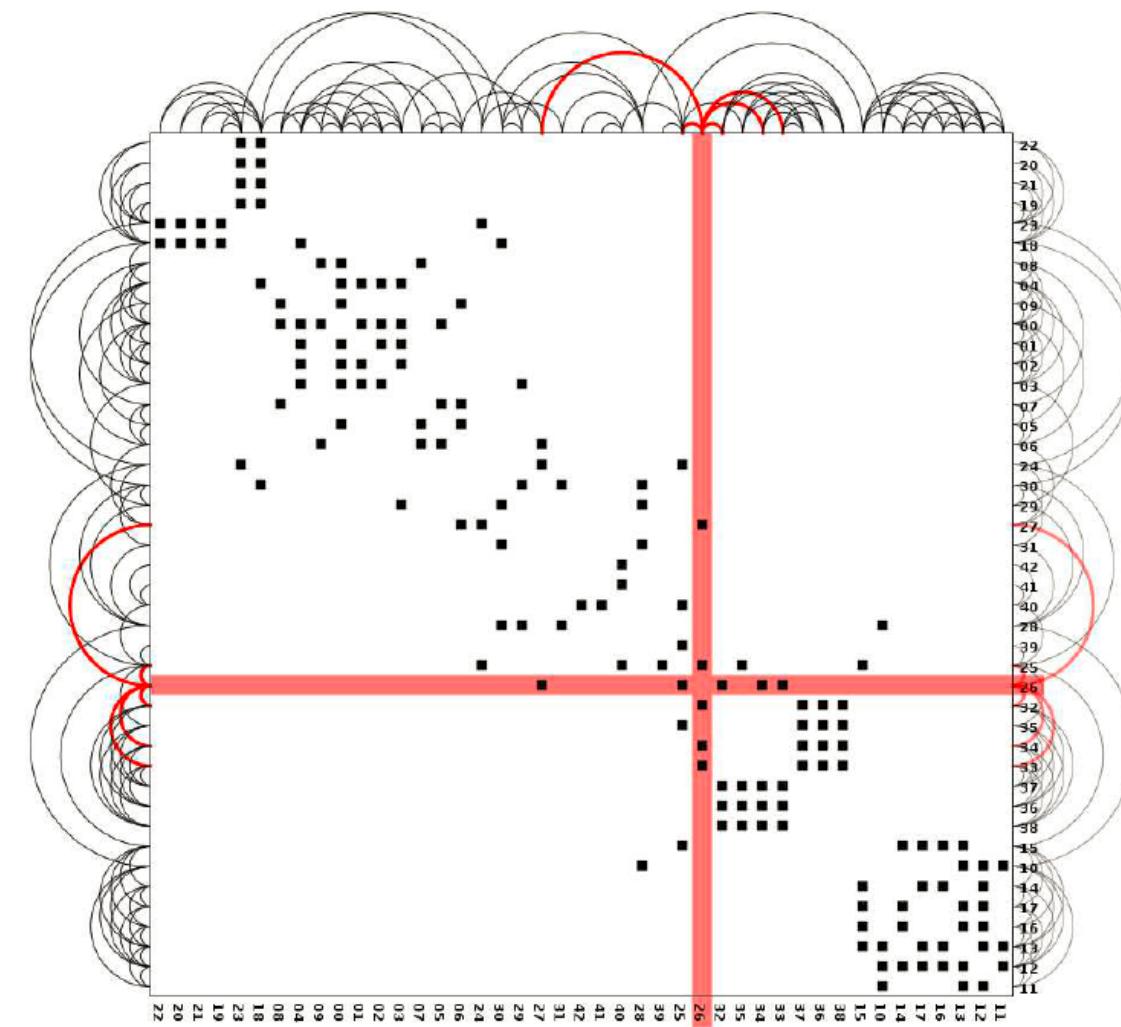
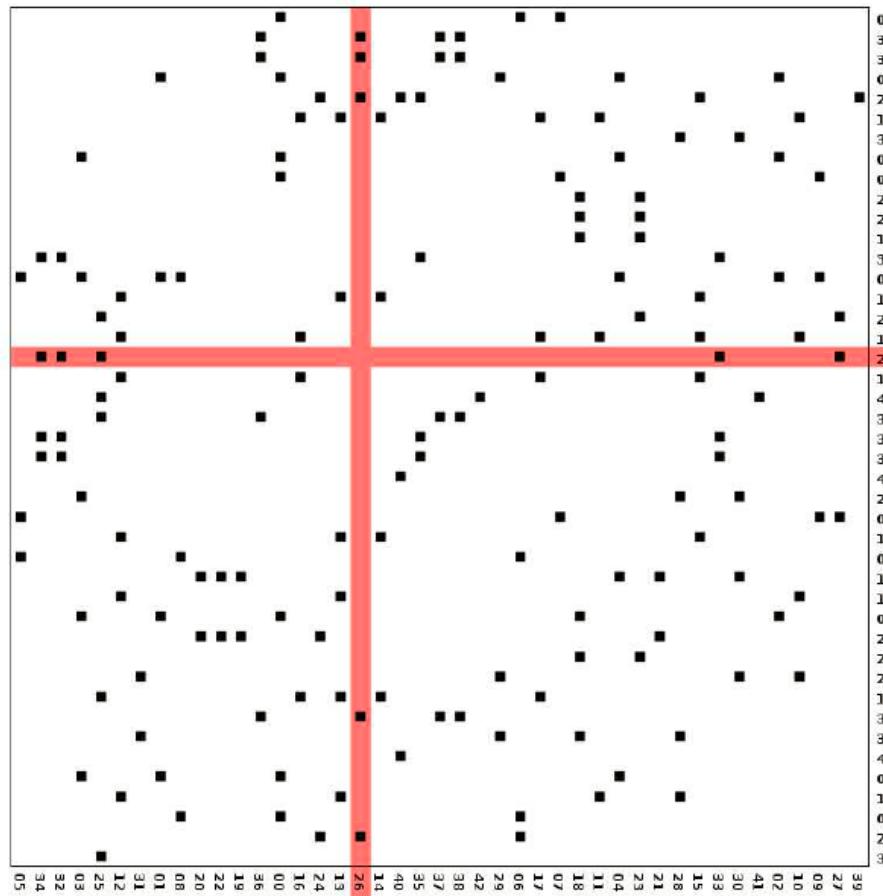
Node linearization: Barycentric order

[McGuffin]



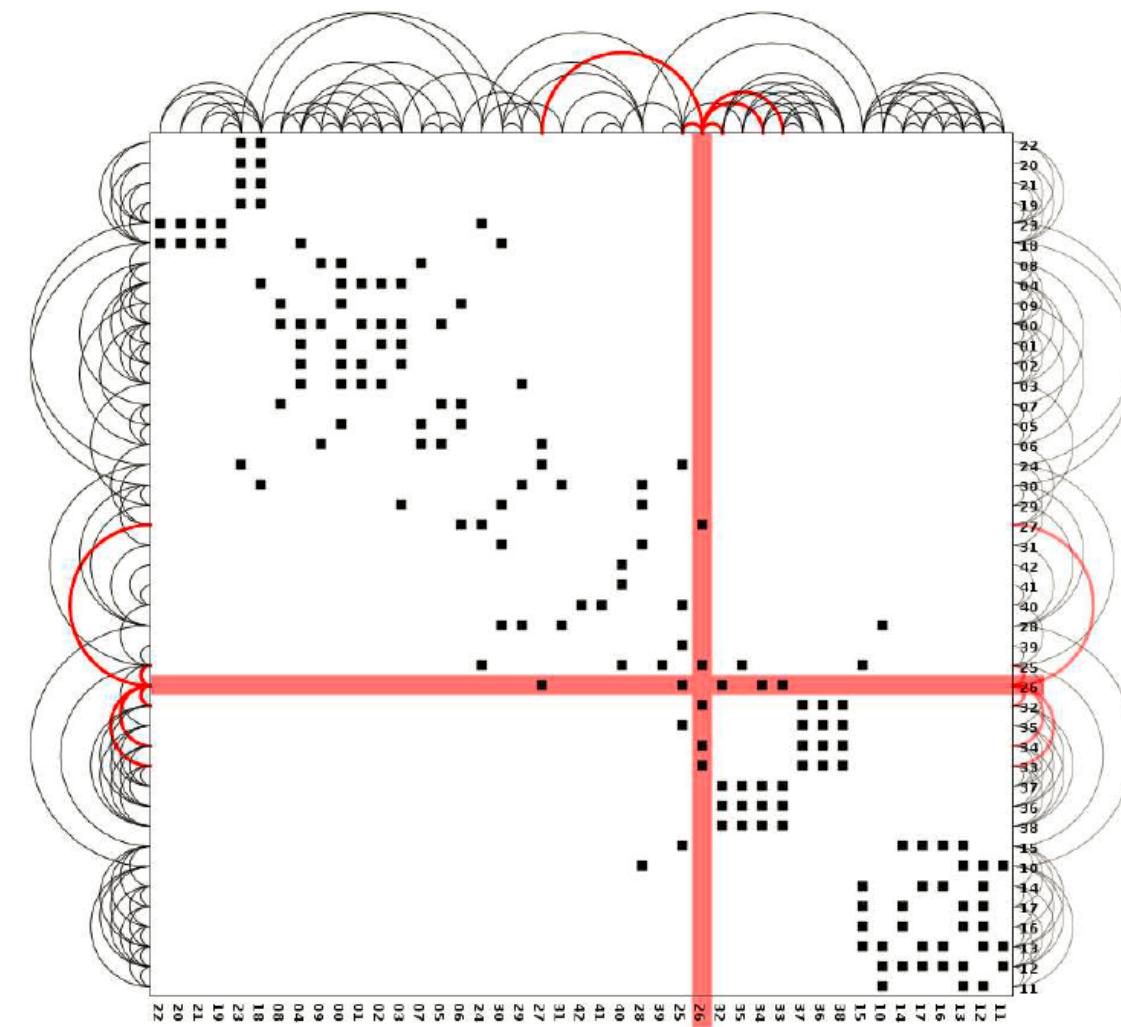
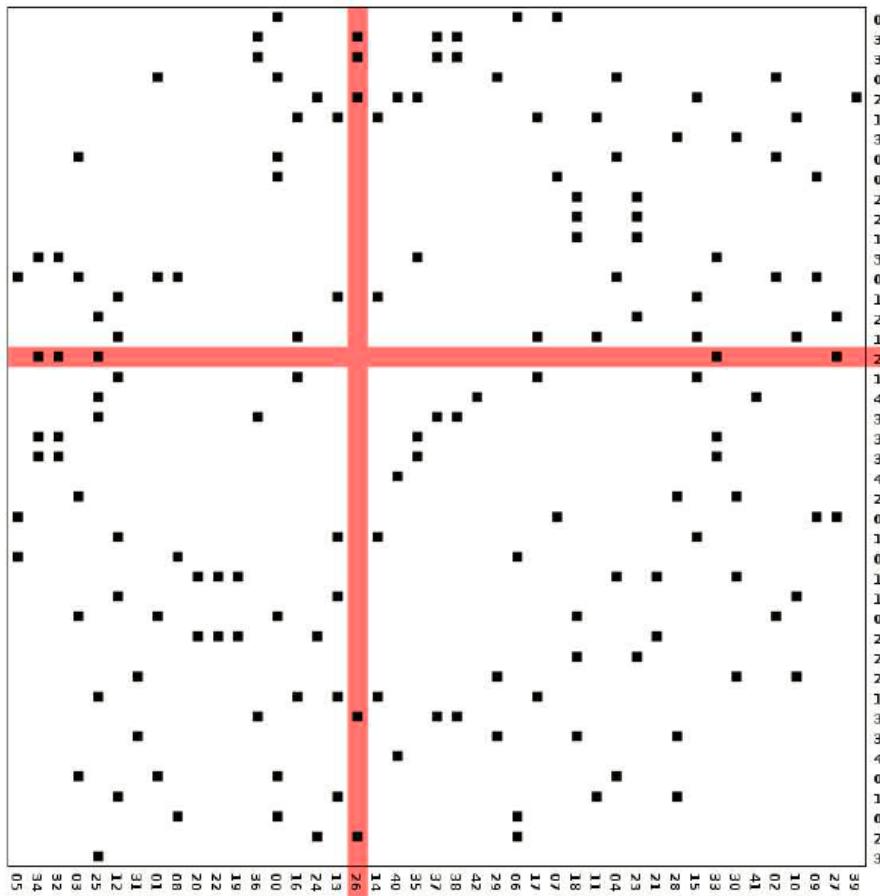
Node linearization: Barycentric order

[McGuffin]



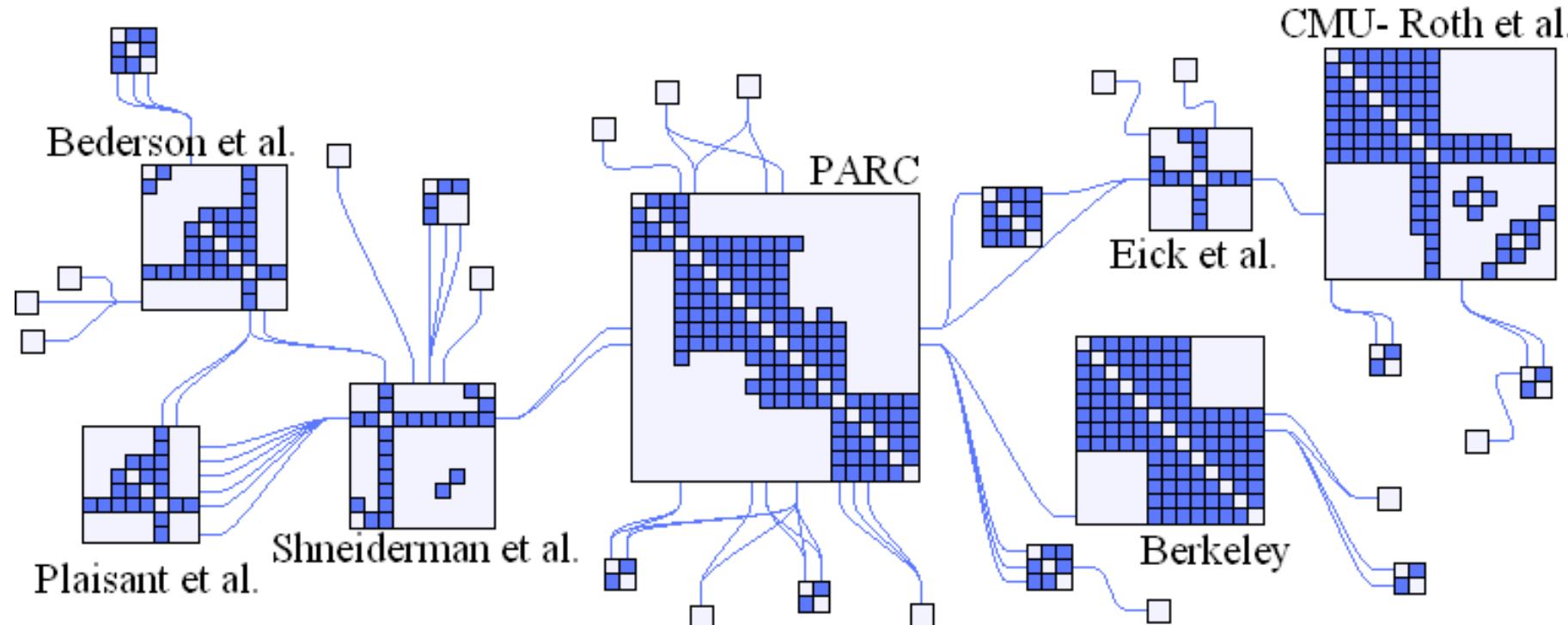
(also node-link + matrix example: MatLink)

[McGuffin]



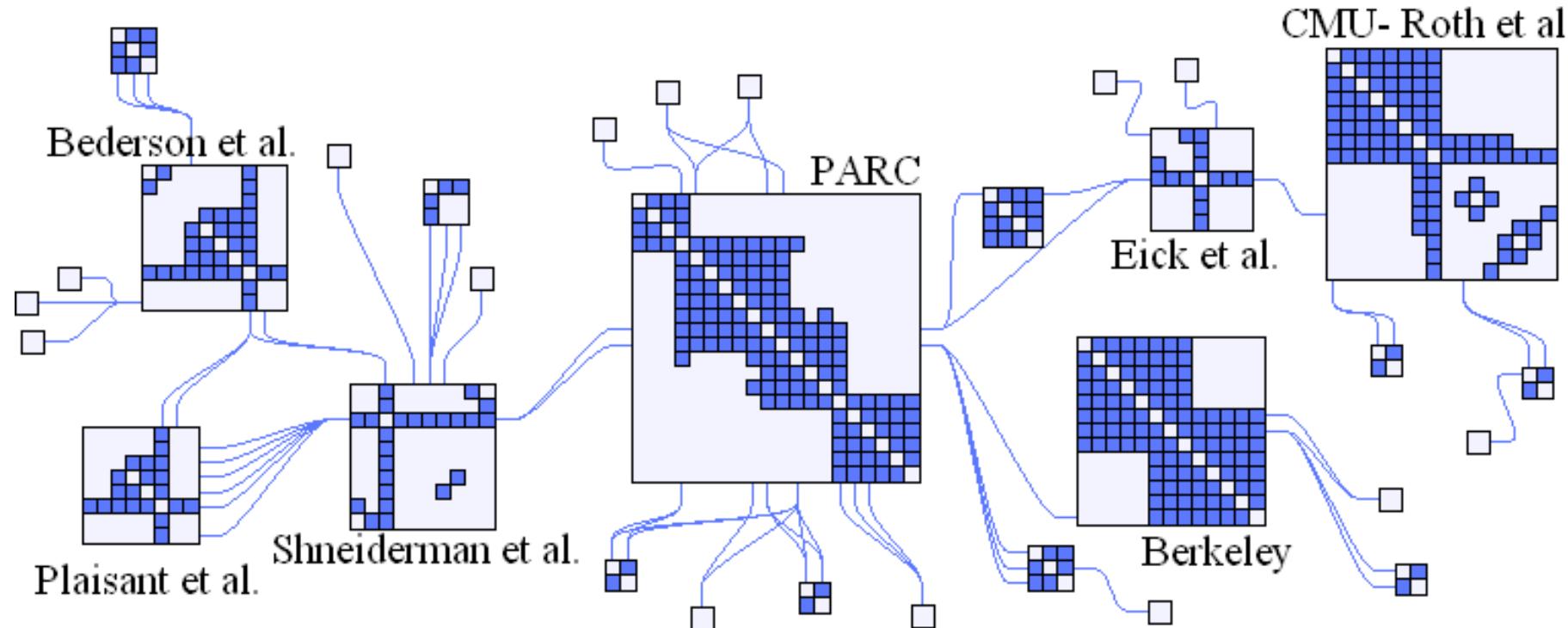
NodeTrix: the other way around

Riche et al, <http://www.aviz.fr/Research/Nodetrix>, <https://www.youtube.com/watch?v=7G3MxyOcHKQ>



NodeTrix: the other way around

Riche et al, <http://www.aviz.fr/Research/Nodetrix>, <https://www.youtube.com/watch?v=7G3MxyOcHKQ>

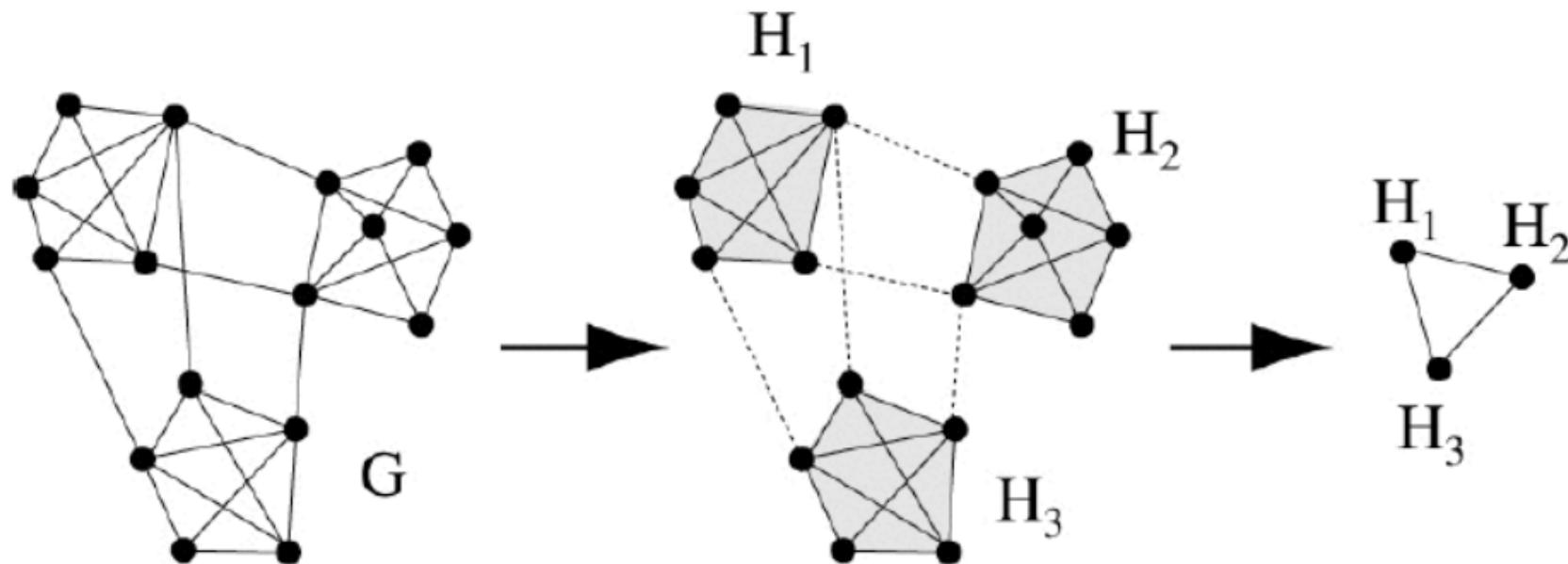


What would a novice's experience of this system be?

Boosting effectiveness: Data reduction

(Auber et al. Multiscale Visualization of Small World Networks)

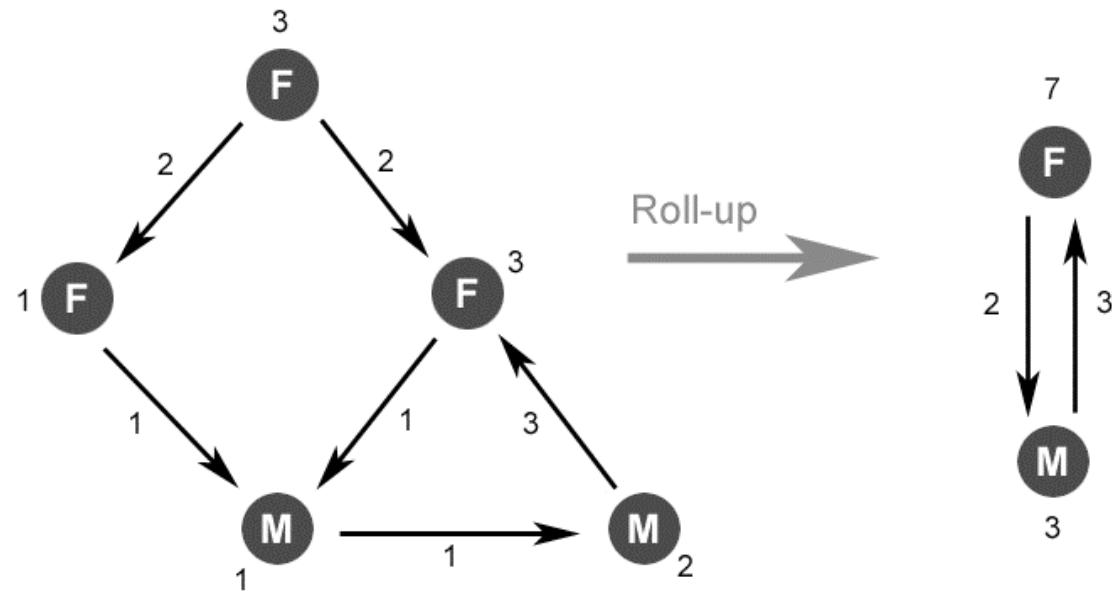
Coarsening



Boosting effectiveness: Data reduction

(Wattenberg, Visual Exploration of Multivariate Graphs)

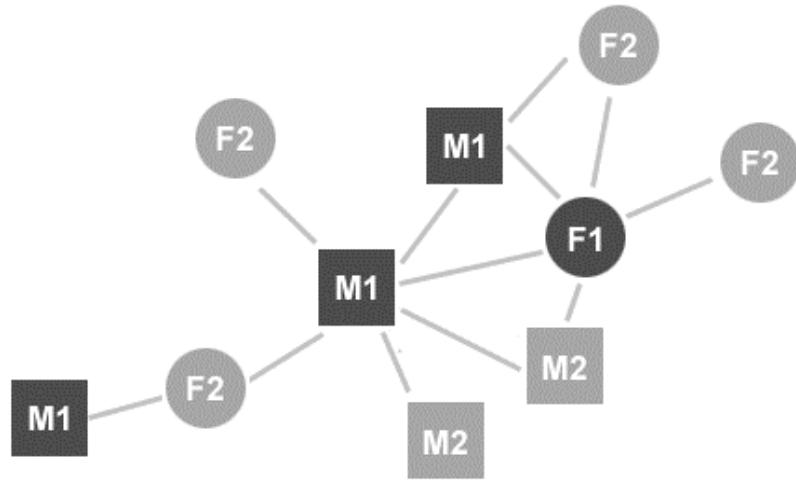
Pivot Graphs



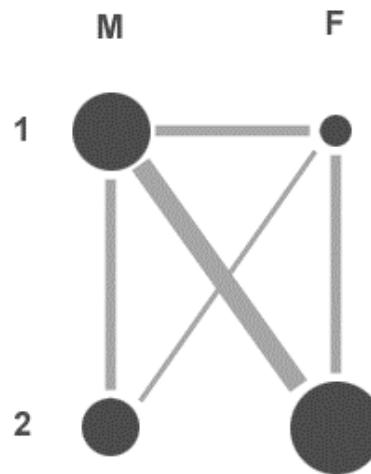
Boosting effectiveness: Data reduction

(Wattenberg, Visual Exploration of Multivariate Graphs)

Pivot Graphs



Node and Link Diagram



PivotGraph Roll-up

Hierarchical & network vis

Scale is a big issue

Boost effectiveness through layout, focus + context, reconfiguration...