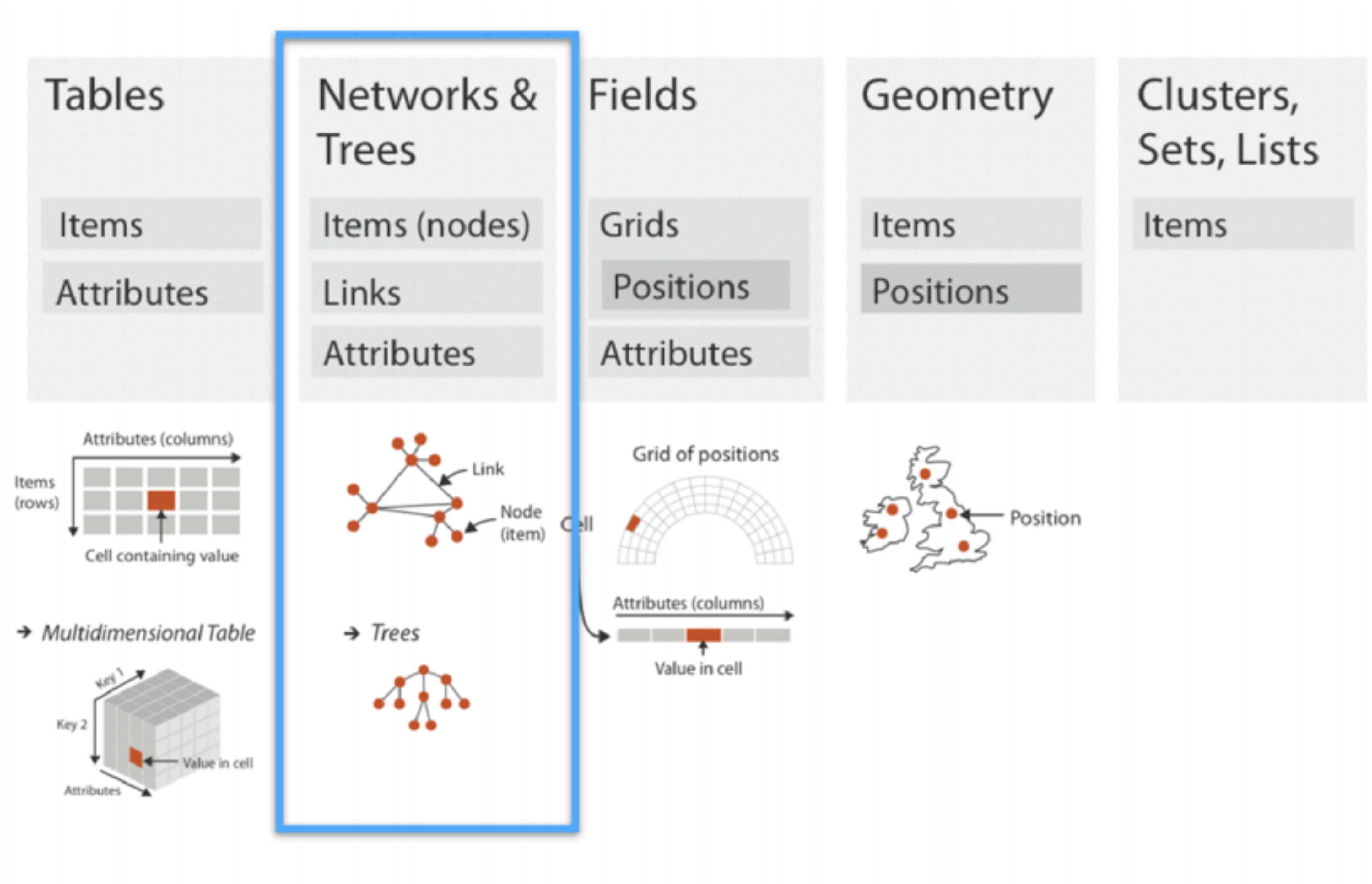
Relational Data

Hierarchies

CS444

Why hierarchies?



Tables
- Items
- Attributes

Networks & Trees
- Items (nodes)
- Links
- Attributes

Fields
- Grids
  - Positions
- Attributes

Geometry
- Items
- Positions

Clusters, Sets, Lists
- Items

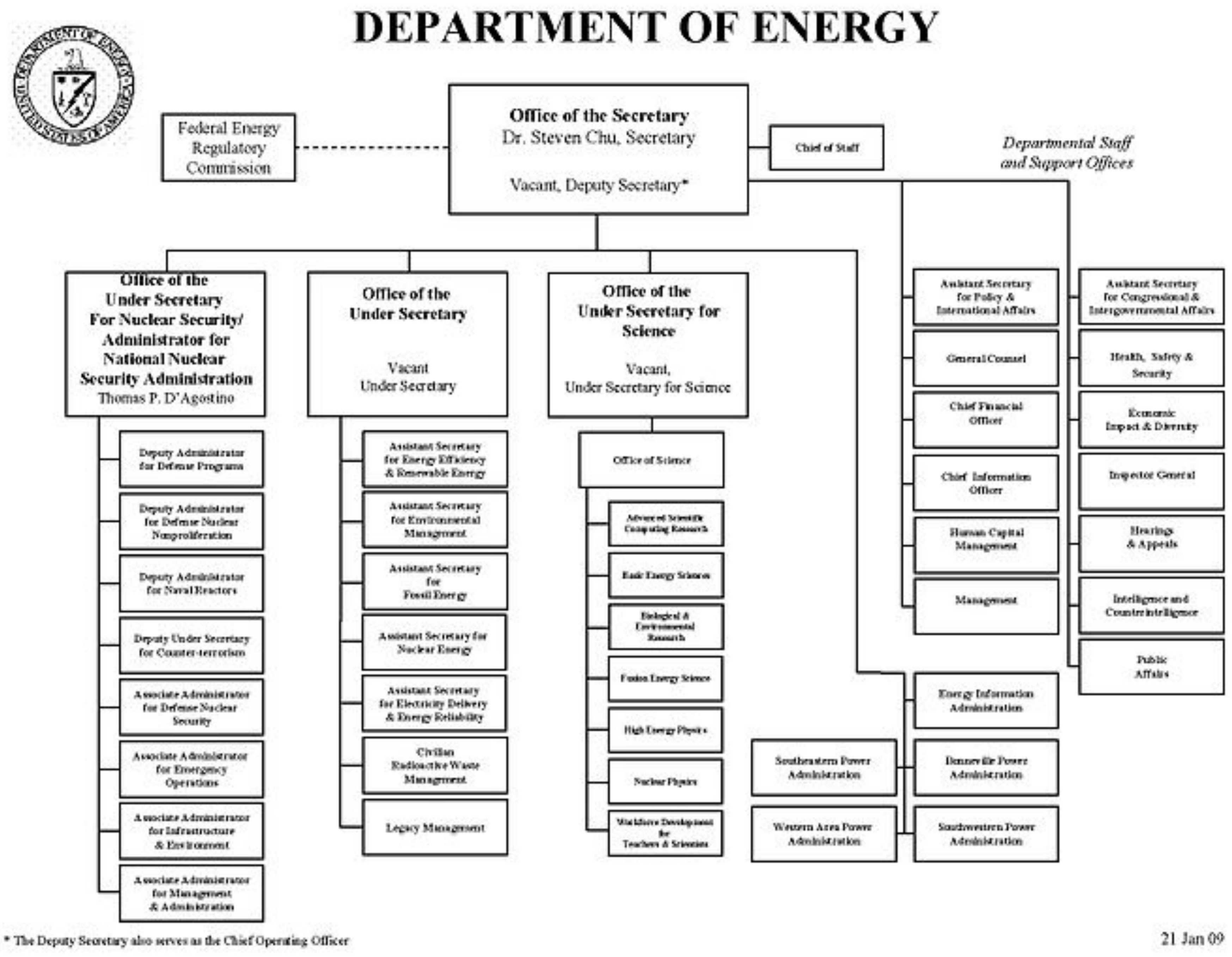
http://www.sci.utah.edu/~miriah/cs6630/lectures/L13-trees-graphs.pdf

Scatterplots; dot plots; line charts, etc.

Until now, our data points were “independent of one another”

In “relational data”, it’s the **relationship between points** that matters

- The reports-to relationship in an organization


DEPARTMENT OF ENERGY
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Dr. Steven Chu, Secretary
Vacant, Deputy Secretary*
Federal Energy Regulatory Commission
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Departmental Staff and Support Offices
Office of the Under Secretary For Nuclear Security/ Administrator for National Nuclear Security Administration
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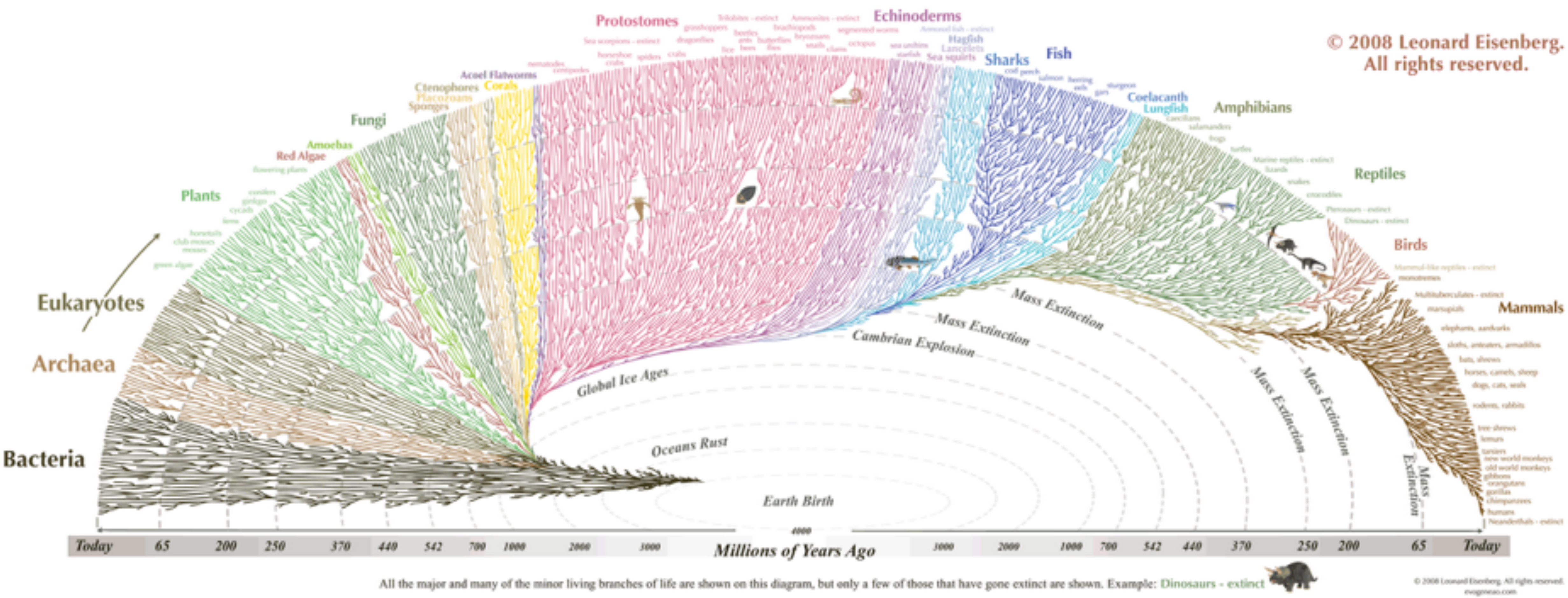
Workforce Development for Teachers & Scientists
Assistant Secretary for Policy & International Affairs
General Counsel
Chief Financial Officer
Chief Information Officer
Human Capital Management
Management
Assistant Secretary for Congressional & Intergovernmental Affairs
Health, Safety & Security
Economic Impact & Diversity
Inspector General
Hearings & Appeals
Intelligence and Counterintelligence
Public Affairs
Energy Information Administration
Southeastern Power Administration
Bonneville Power Administration
Western Area Power Administration
Southwestern Power Administration
* The Deputy Secretary also serves as the Chief Operating Officer
21 Jan 09



- The “tree of life”
  - evolution of species creates branching mechanism and “ancestor-of” relationship

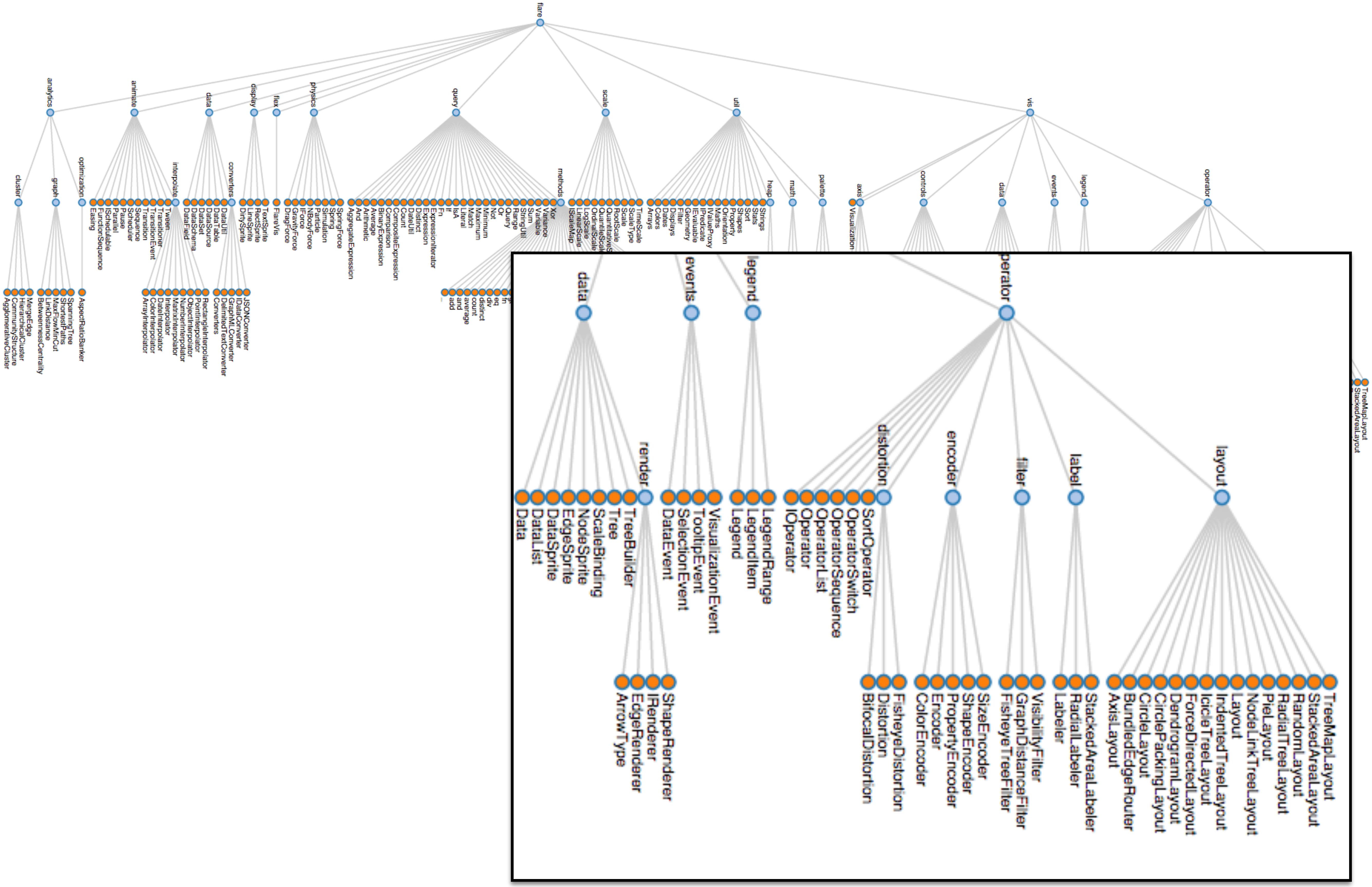
Tree Hierarchy

- Tree relation
  - if a is child of b and a is child of c, then:
    - b is child of c or c is child of b, but not both at the same time
- “Immediate boss is unique”

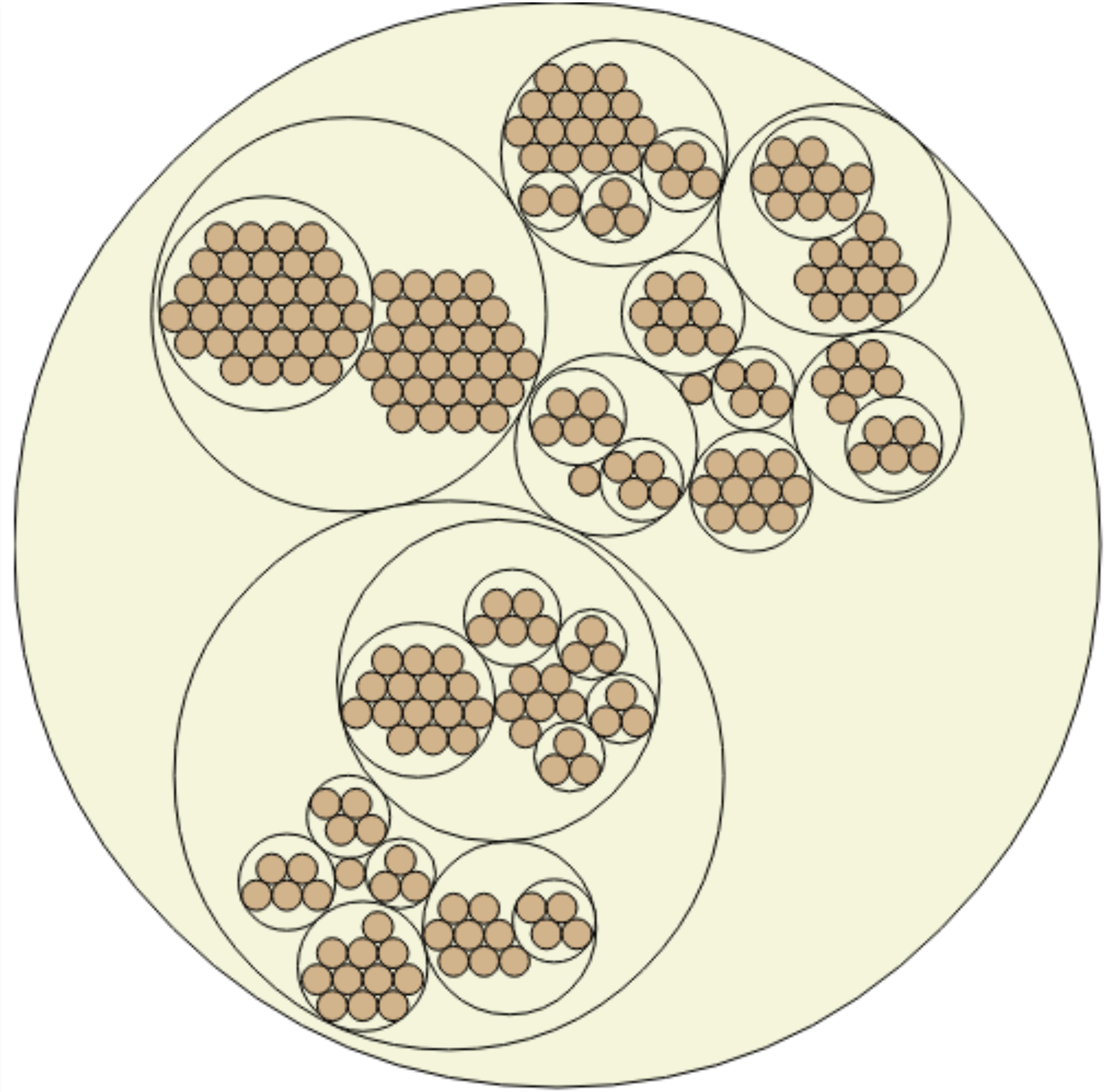
What do we want our drawings to show?

- Who reports to whom
    - … and **who doesn’t**
- How big are “sub-organizations”
- …?

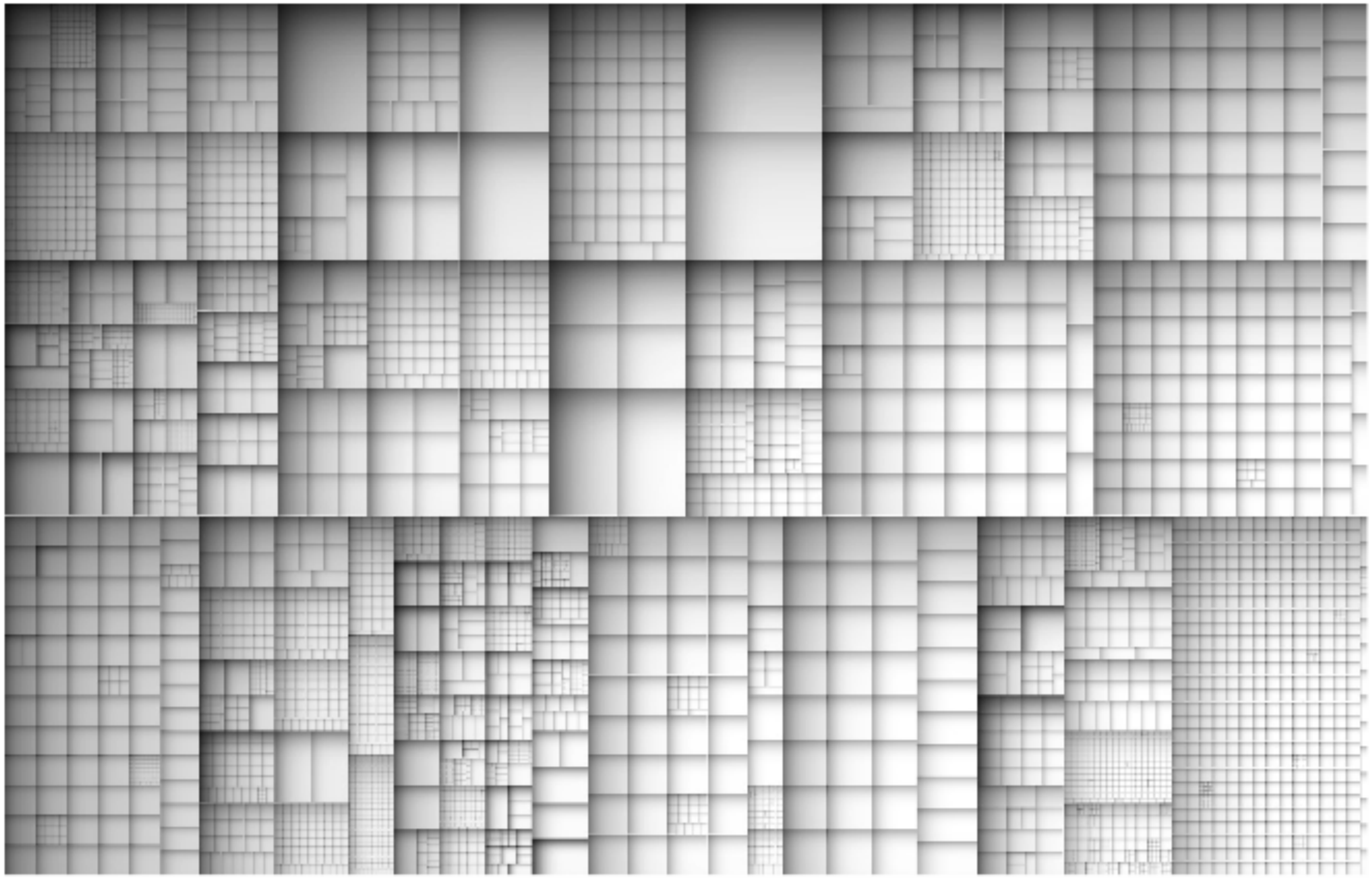
Many different ways to visualize trees



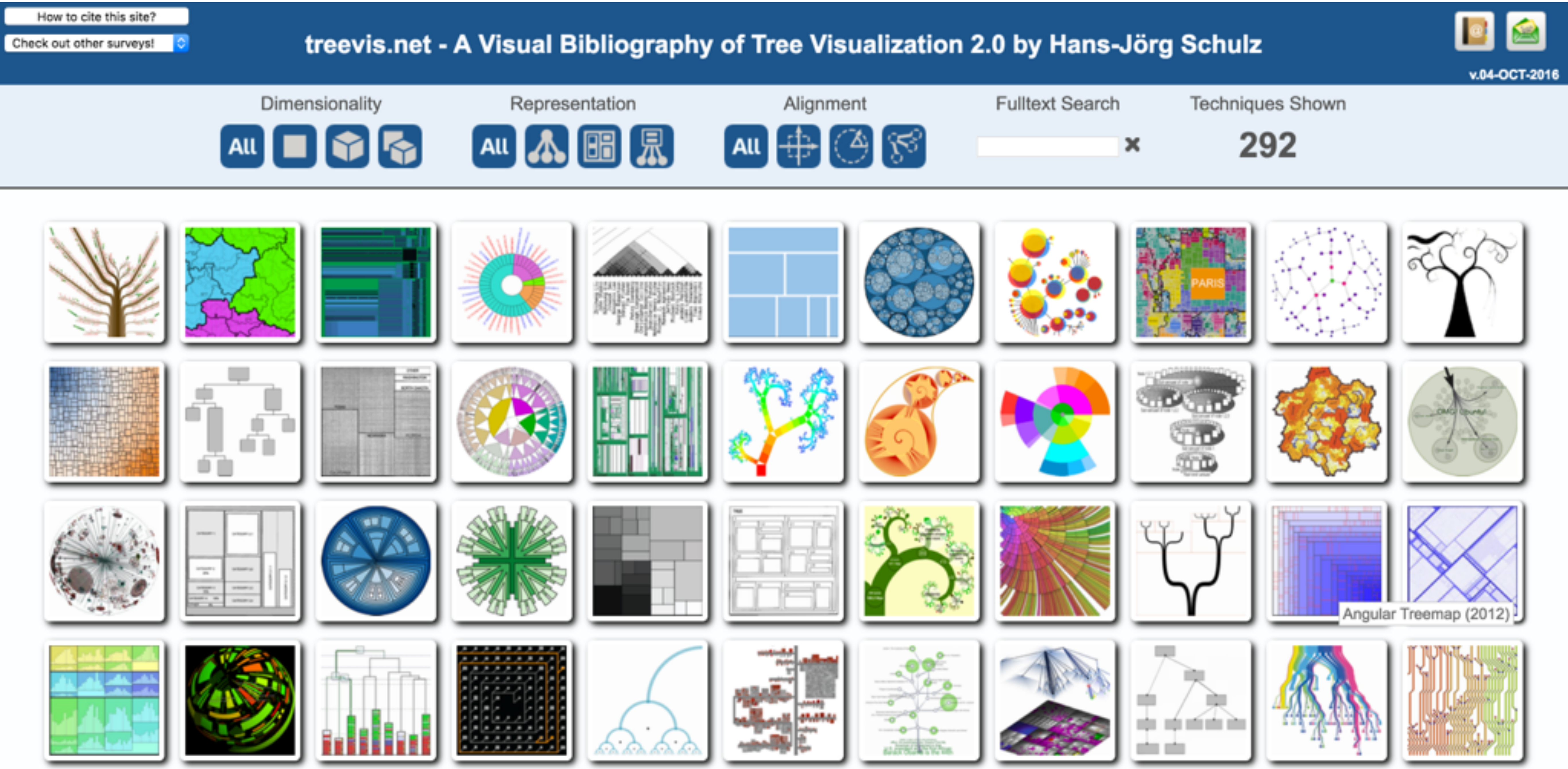
http://homes.cs.washington.edu/~jheer/files/zoo/ex/hierarchies/tree.html



http://jsfiddle.net/VividD/WDCpq/8/



http://www.cs.rug.nl/svcg/SoftVis/ViewFusion


treevis.net - A Visual Bibliography of Tree Visualization 2.0 by Hans-Jörg Schulz

v.04-OCT-2016

Techniques Shown: 292

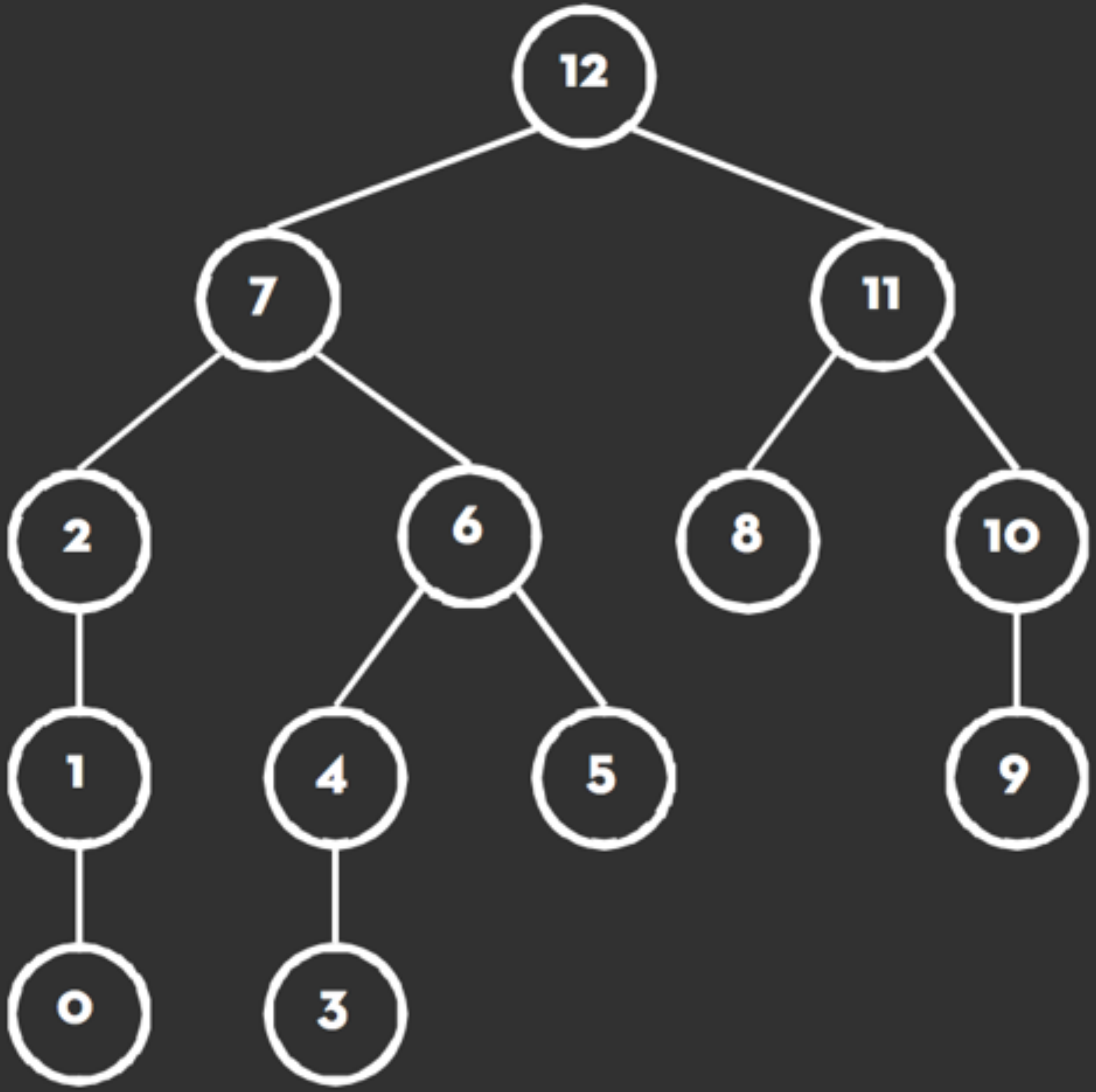
http://treevis.net

Reingold-Tilford tree drawing

- All of the before, plus:
- Don’t waste horizontal space
- If tree is symmetric, so should be the drawing

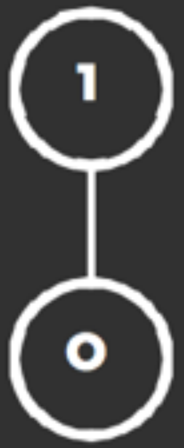
http://hci.stanford.edu/courses/cs448b/f11/lectures/CS448B-20111110-GraphsAndTrees.pdf

Reingold-Tilford Algorithm

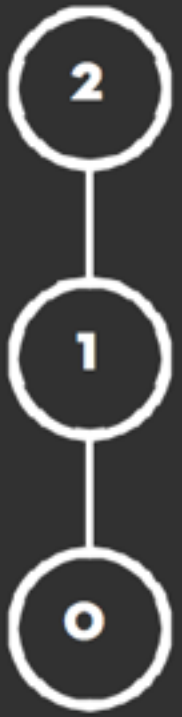


Reingold-Tilford Algorithm

Reingold-Tilford Algorithm



Reingold-Tilford Algorithm



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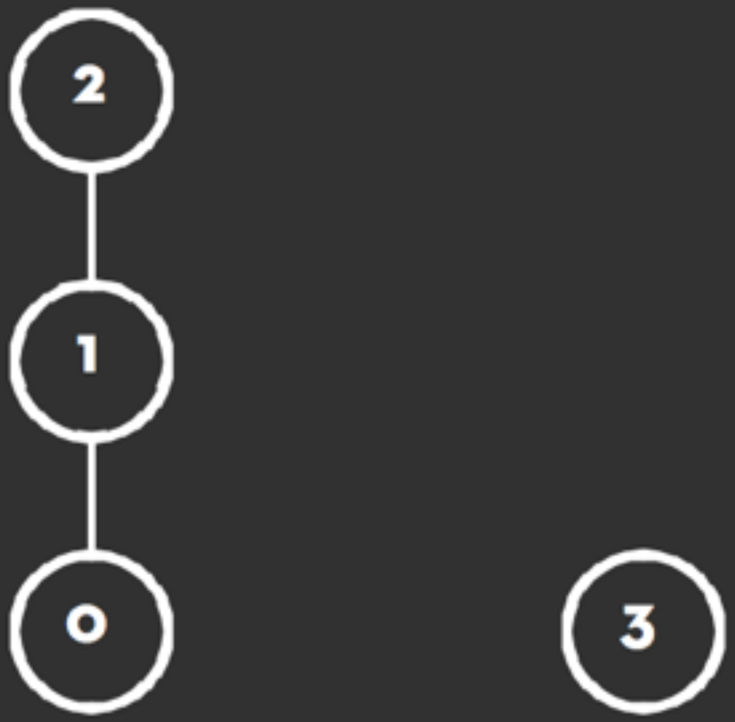

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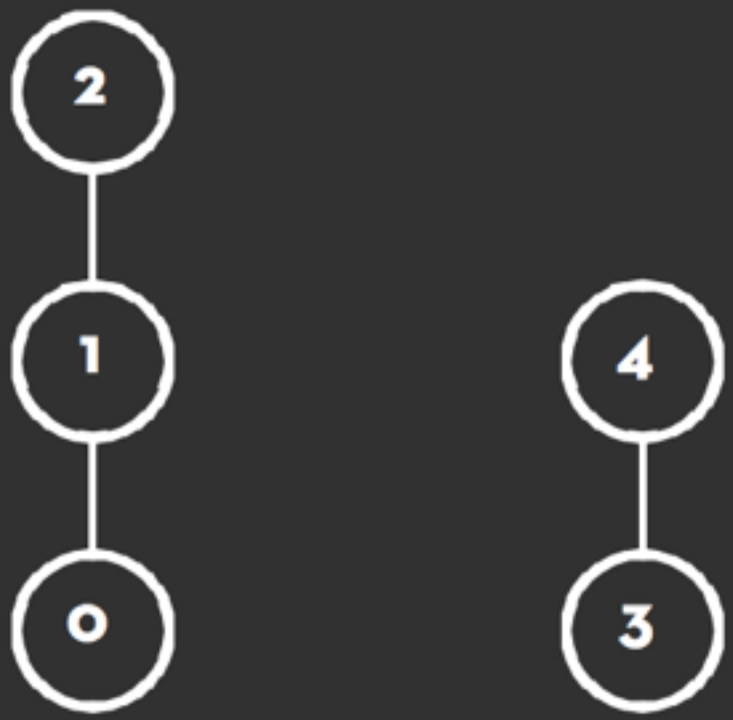

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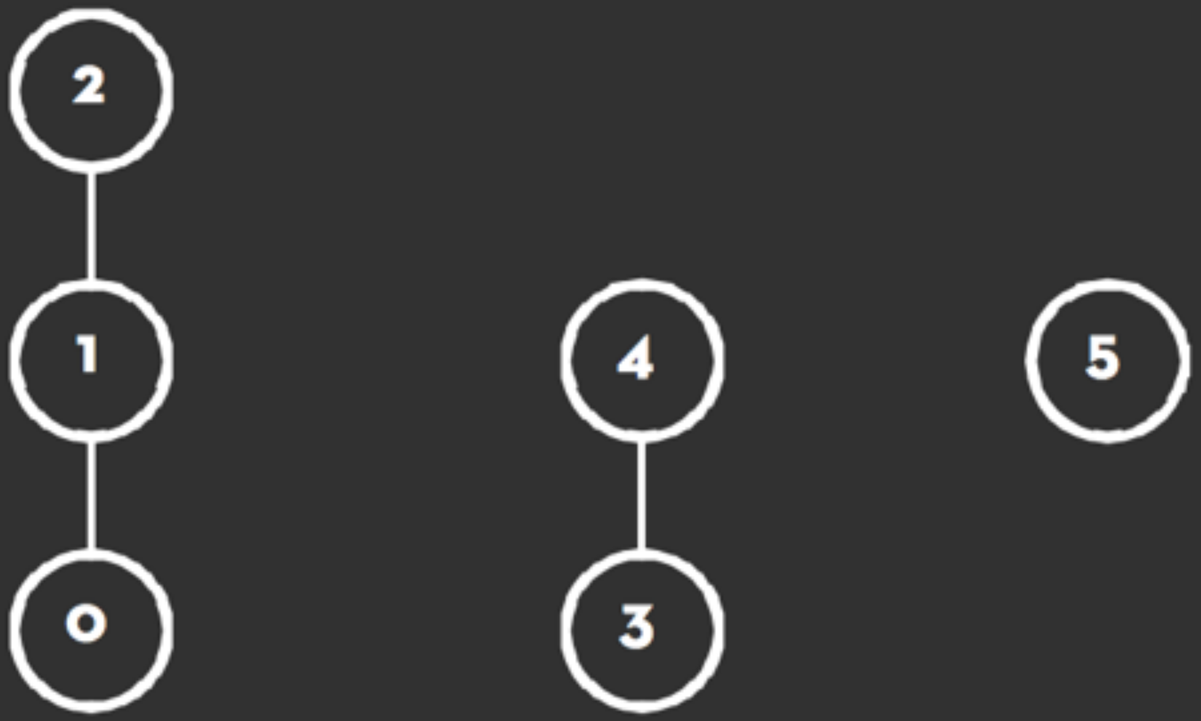
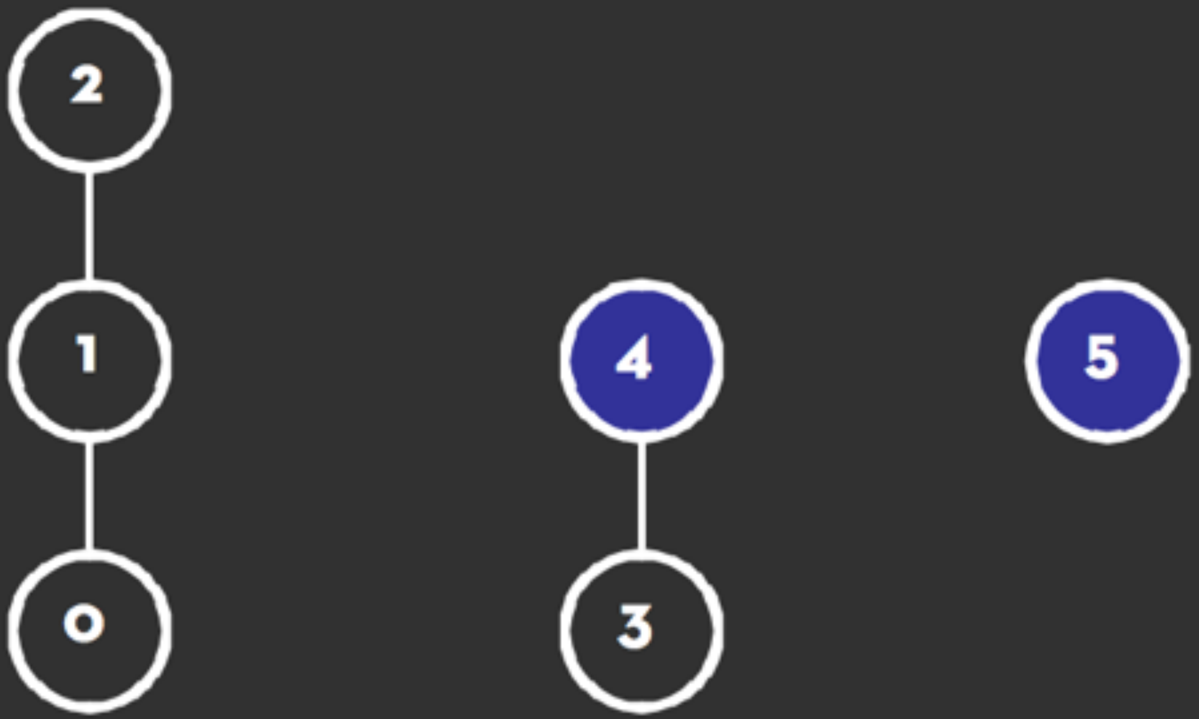
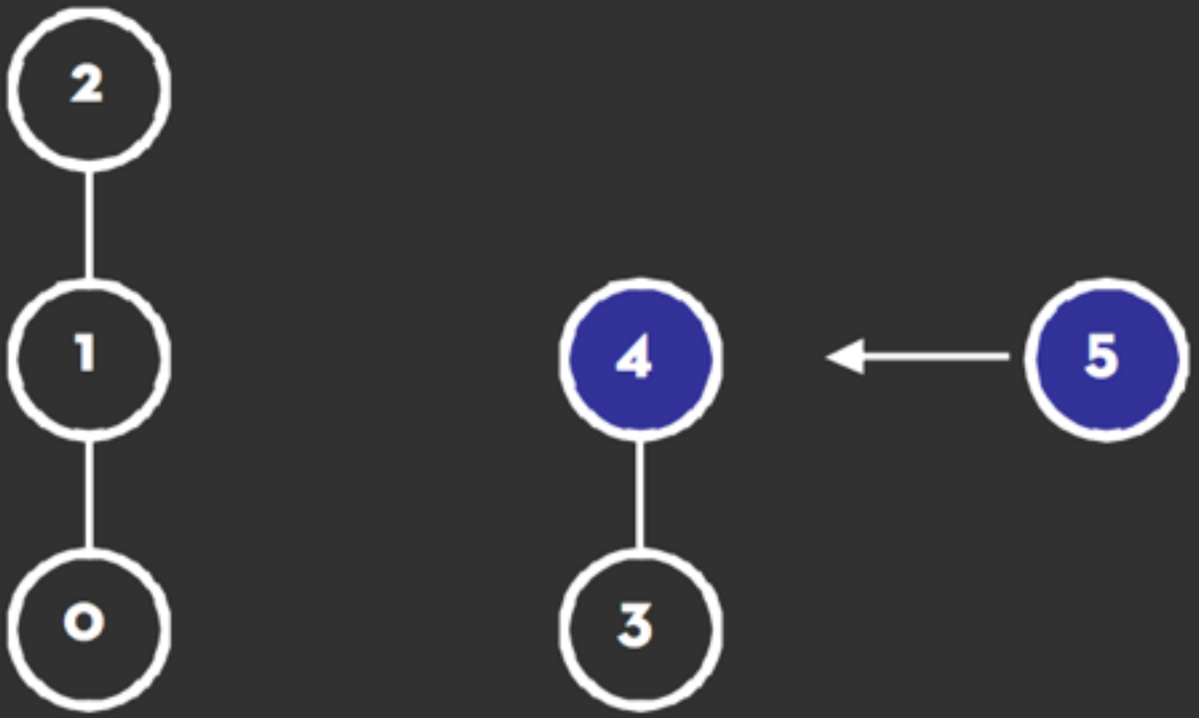


Reingold-Tilford Algorithm



Reingold-Tilford Algorithm



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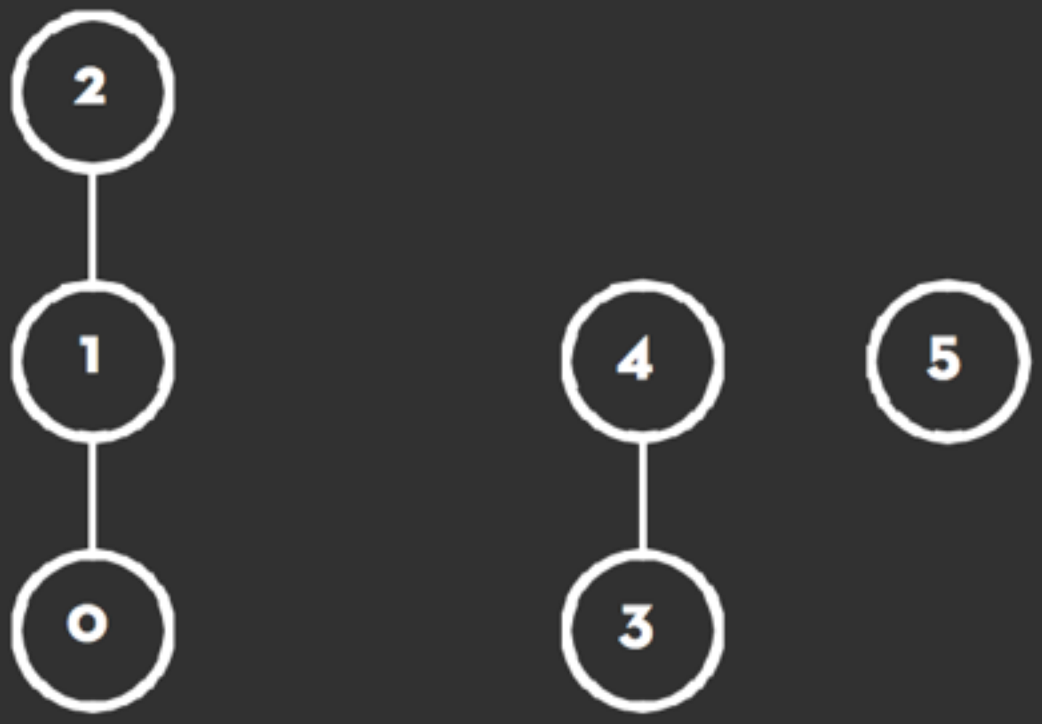

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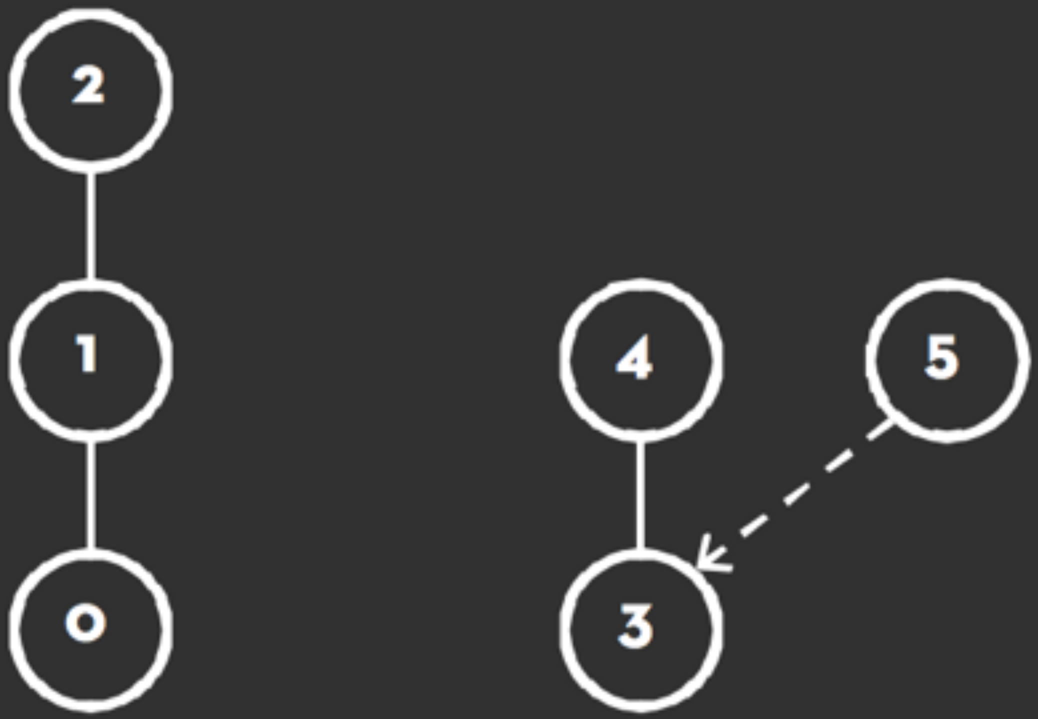

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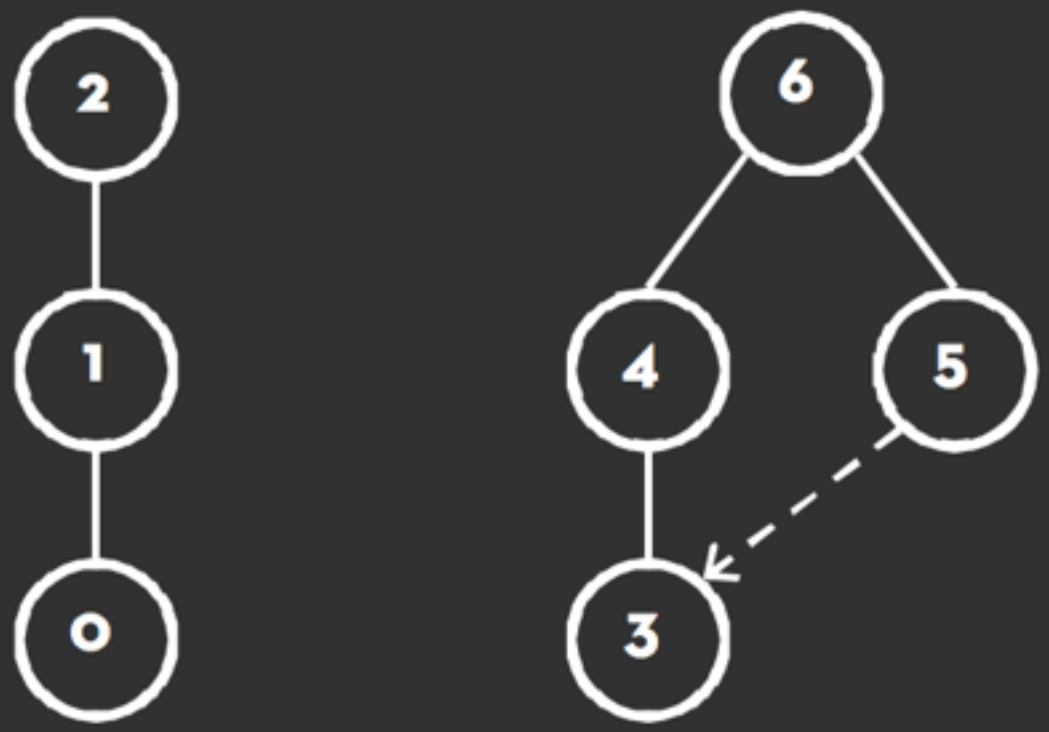

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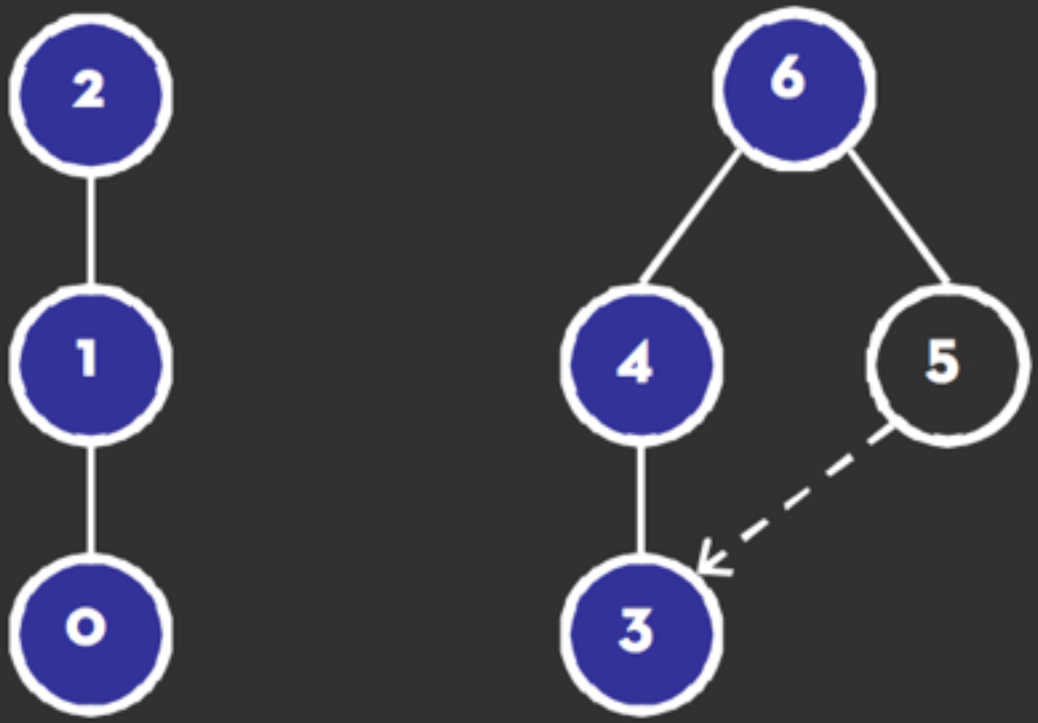

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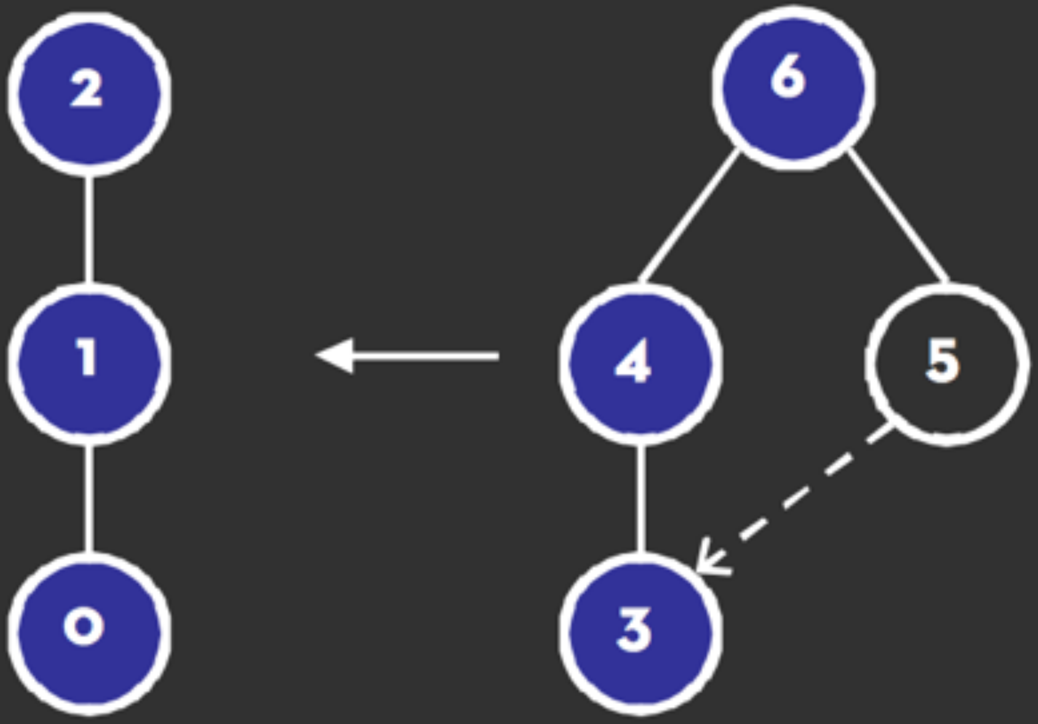

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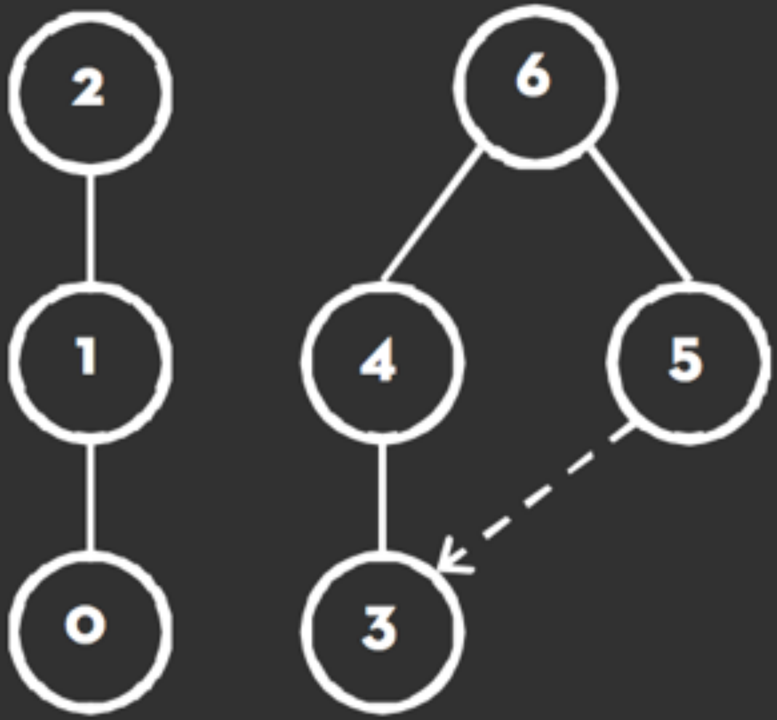

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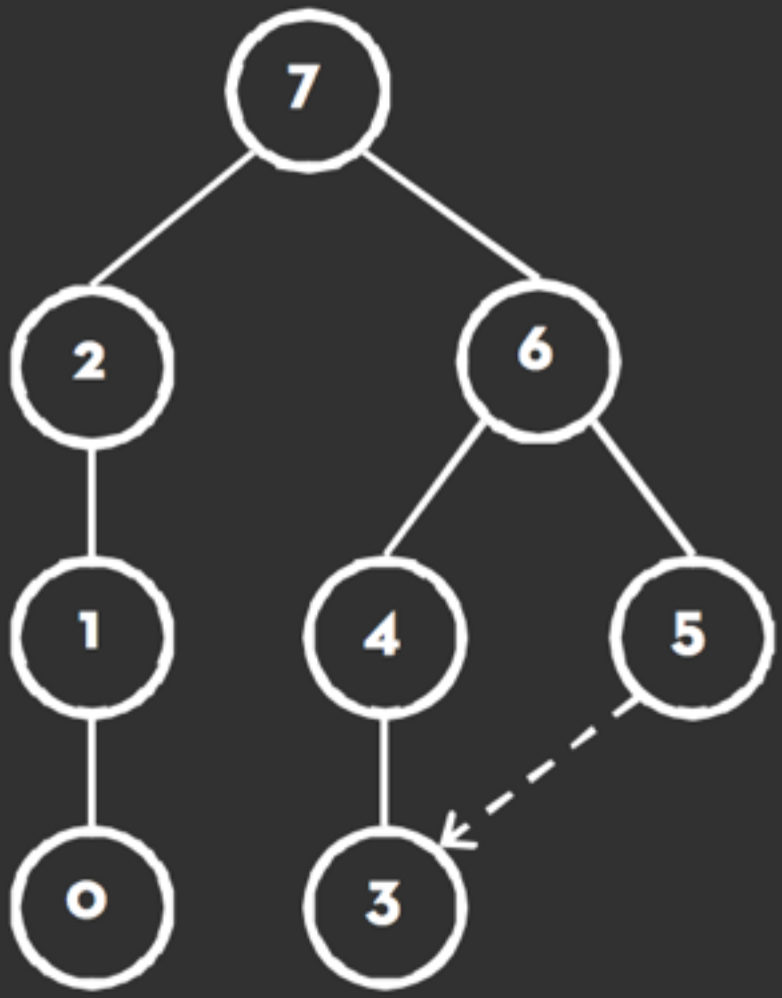

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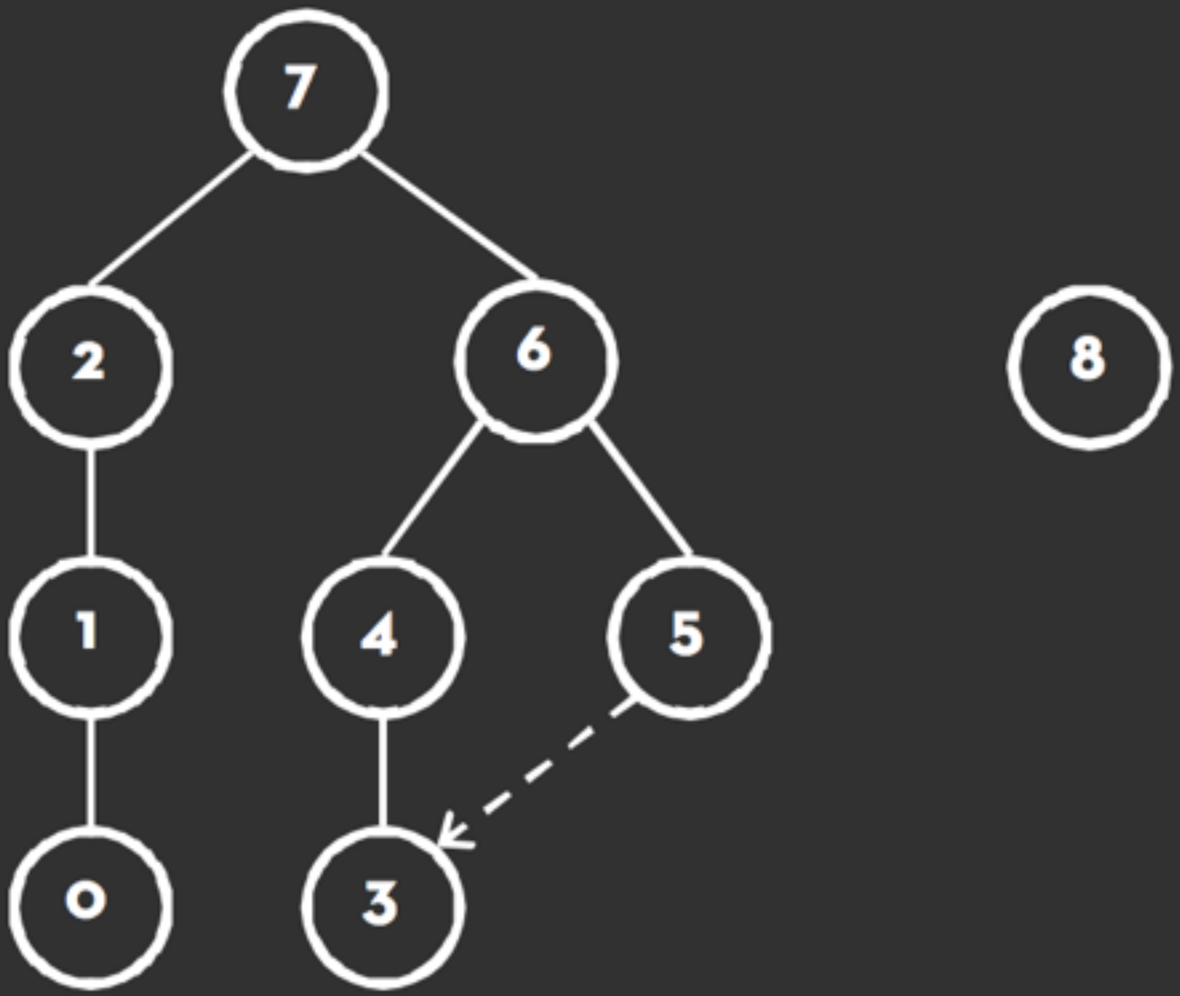

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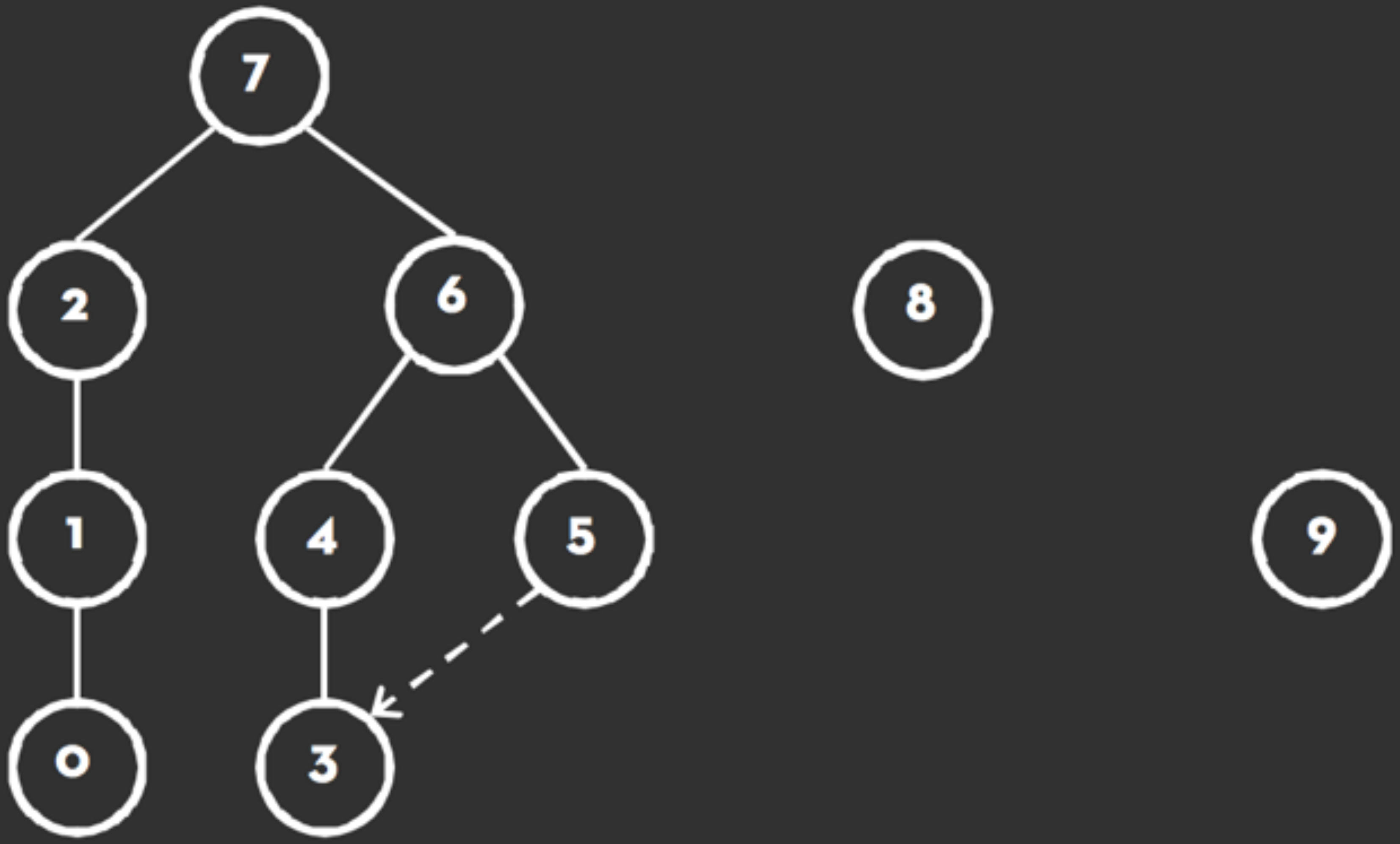

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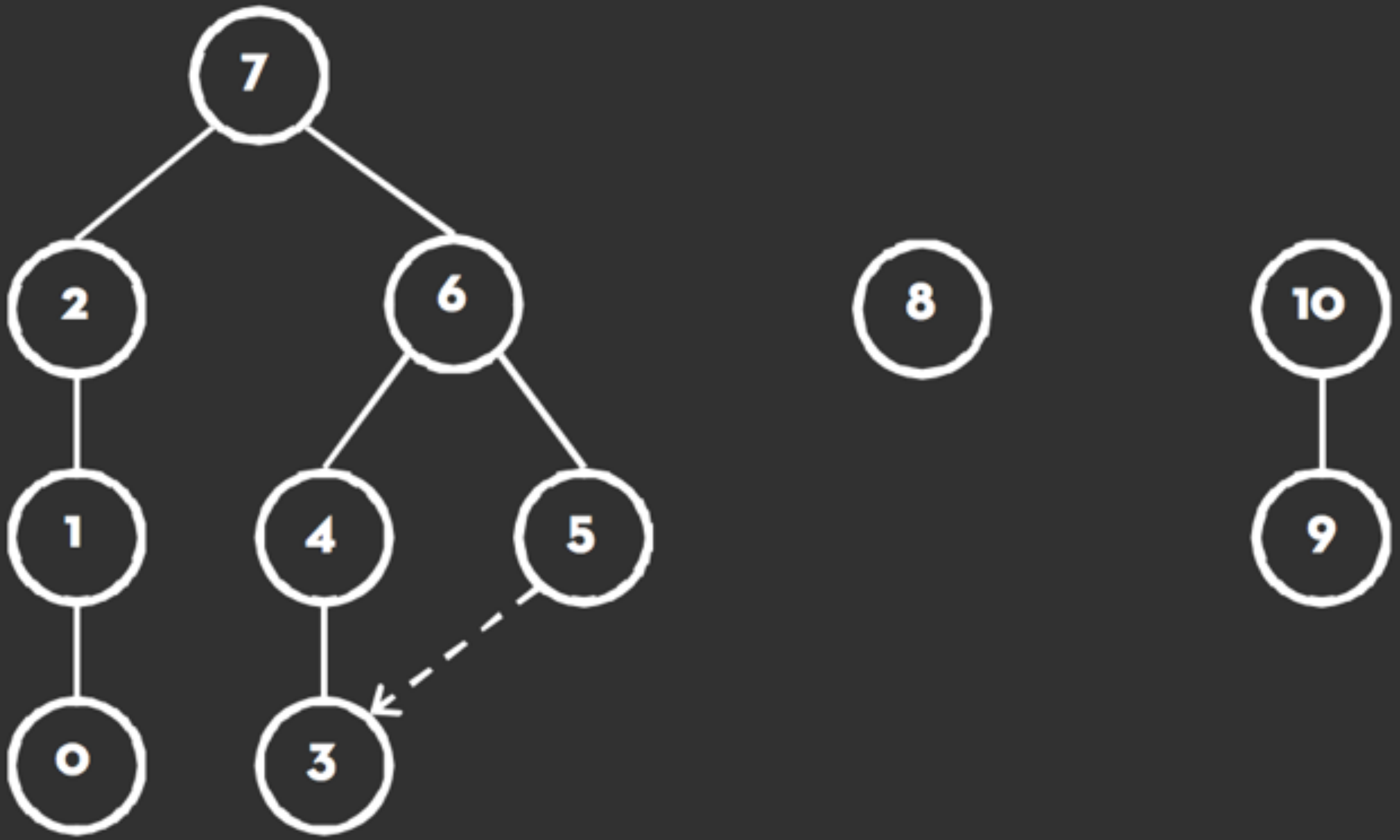

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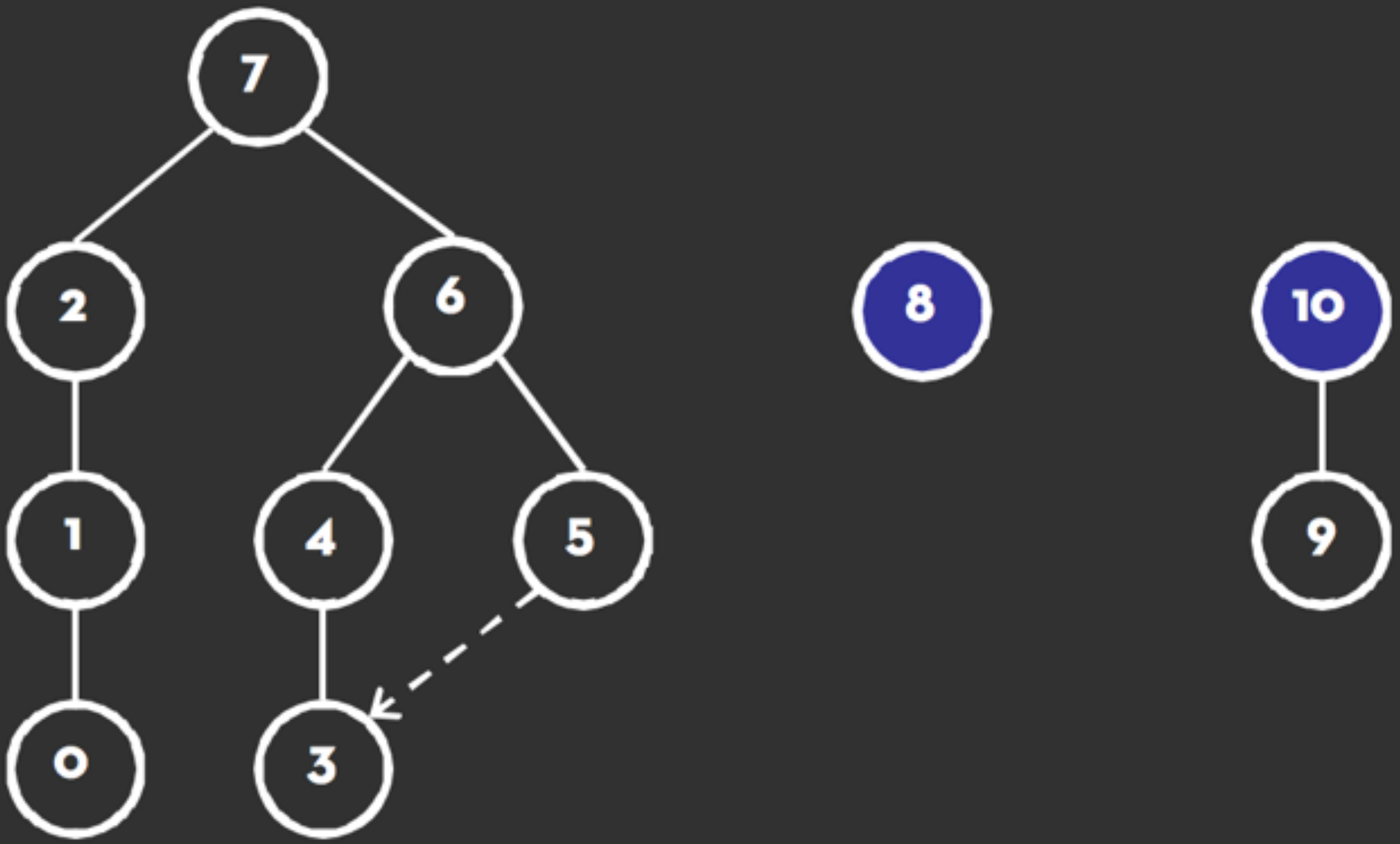

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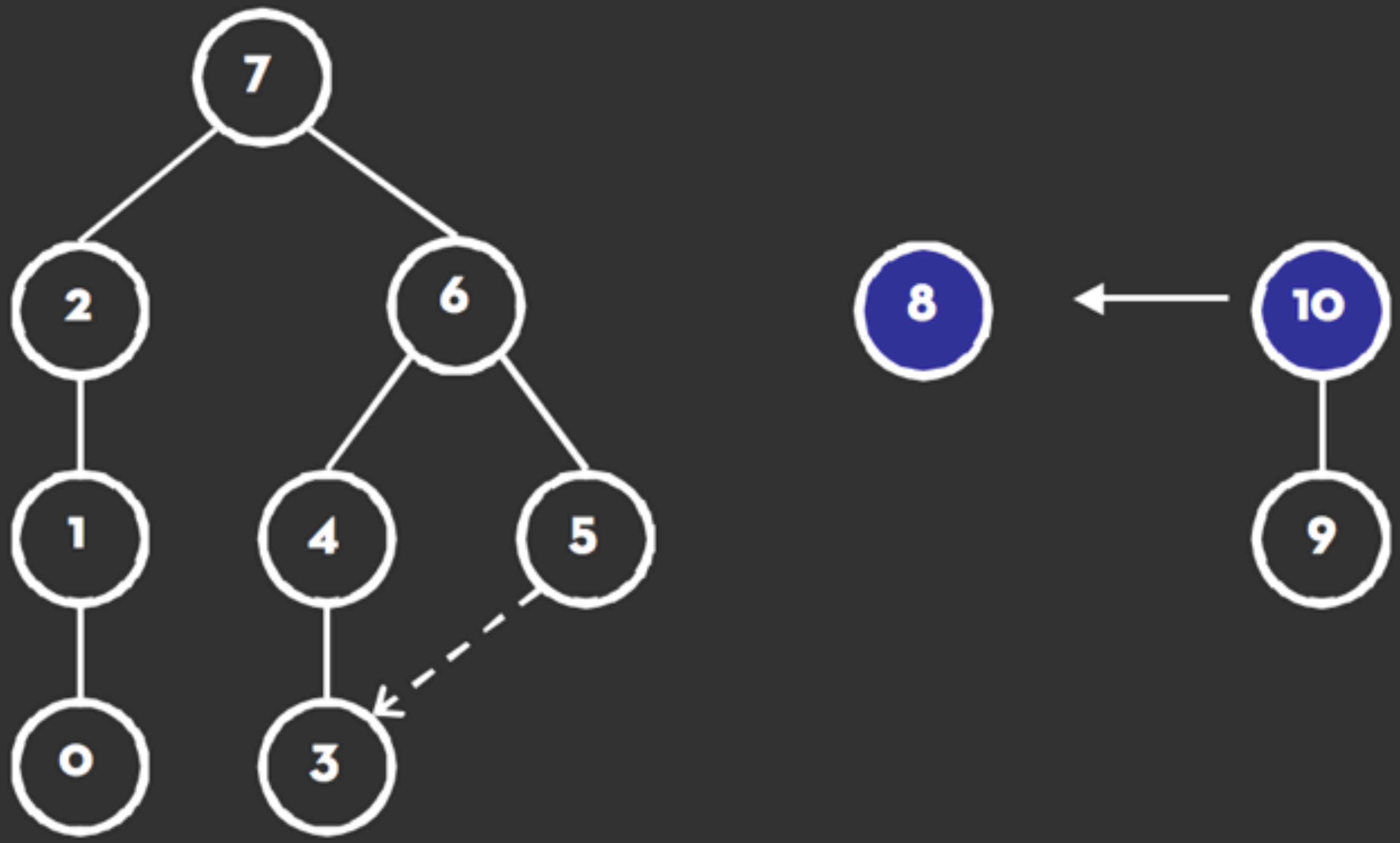

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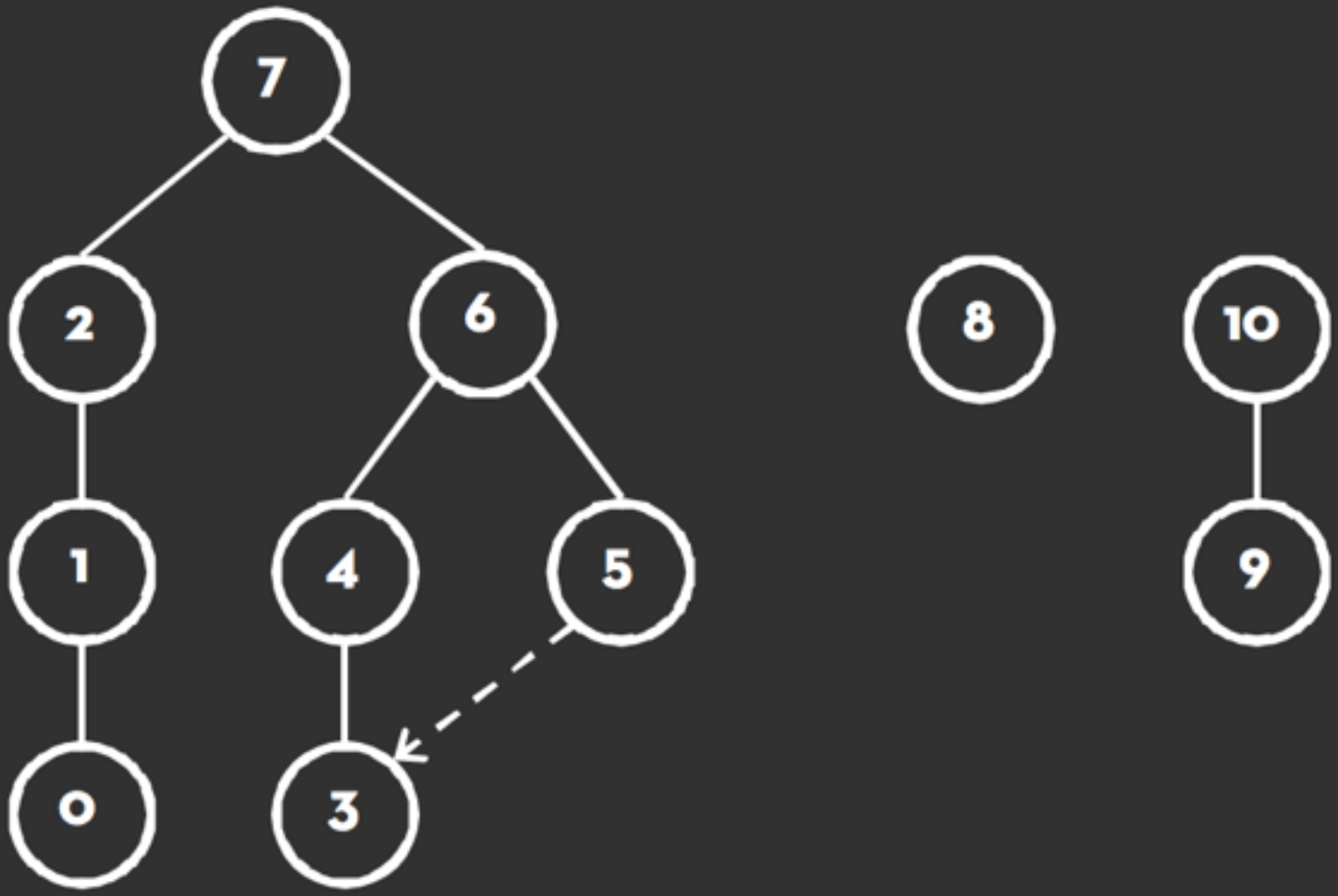

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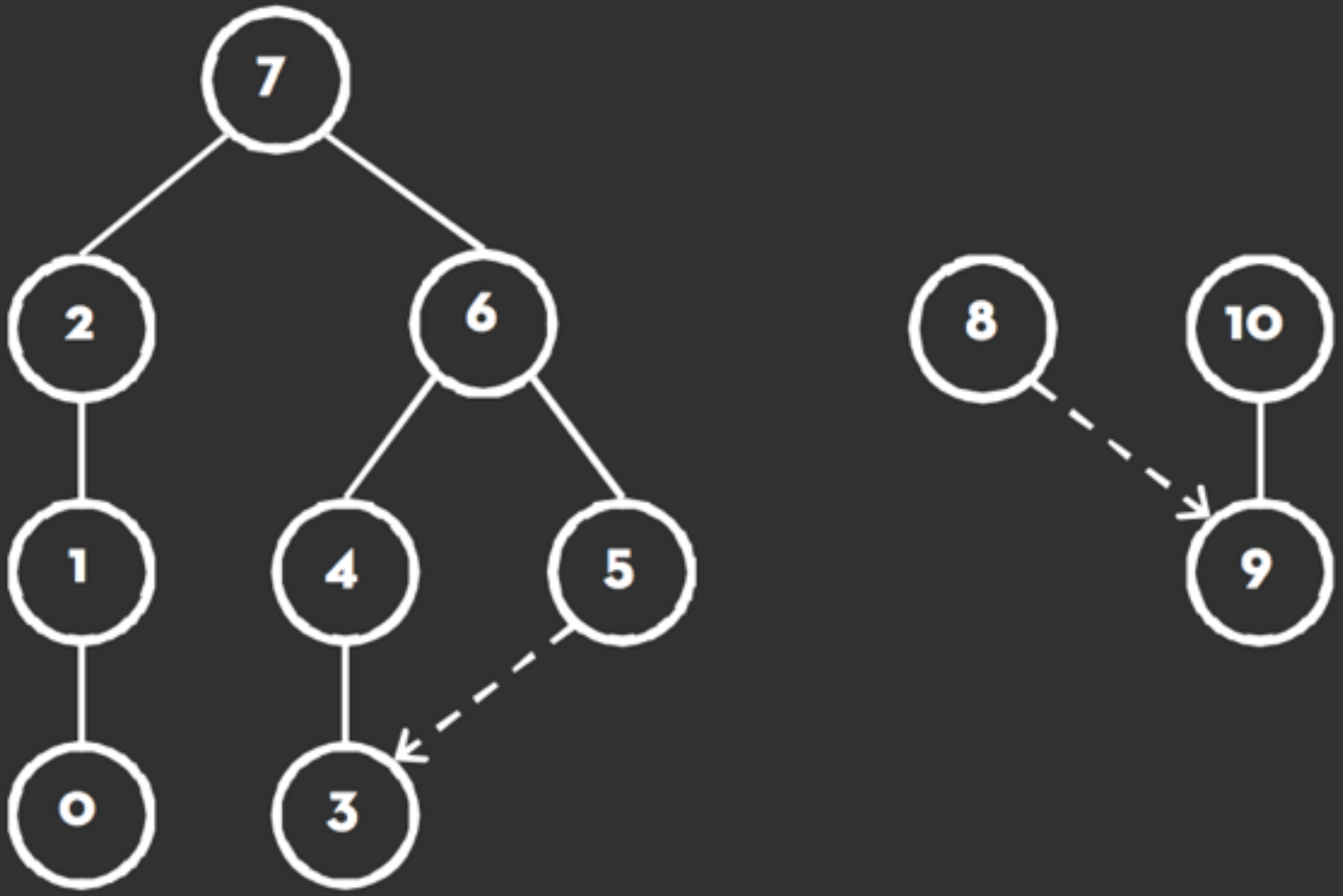

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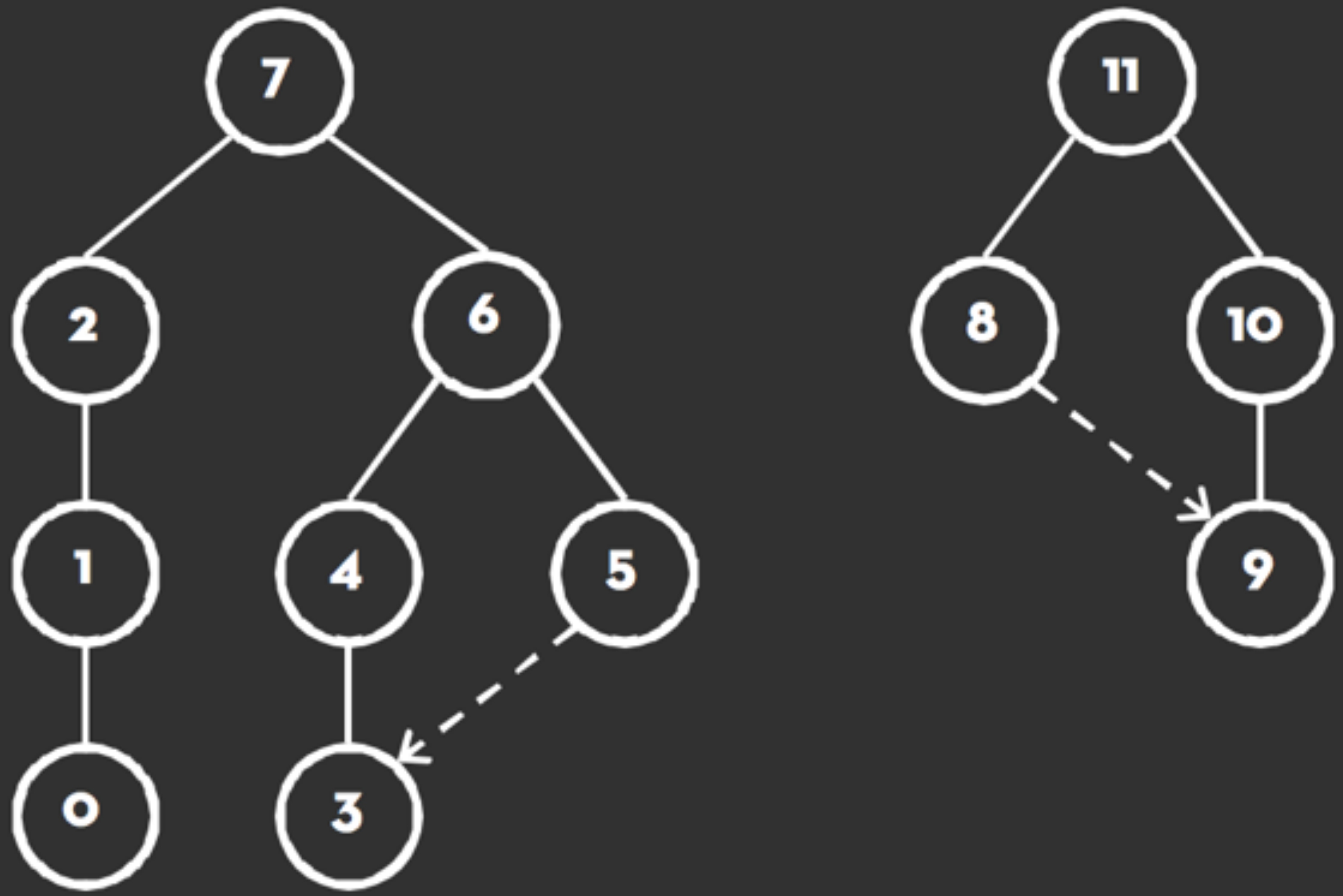

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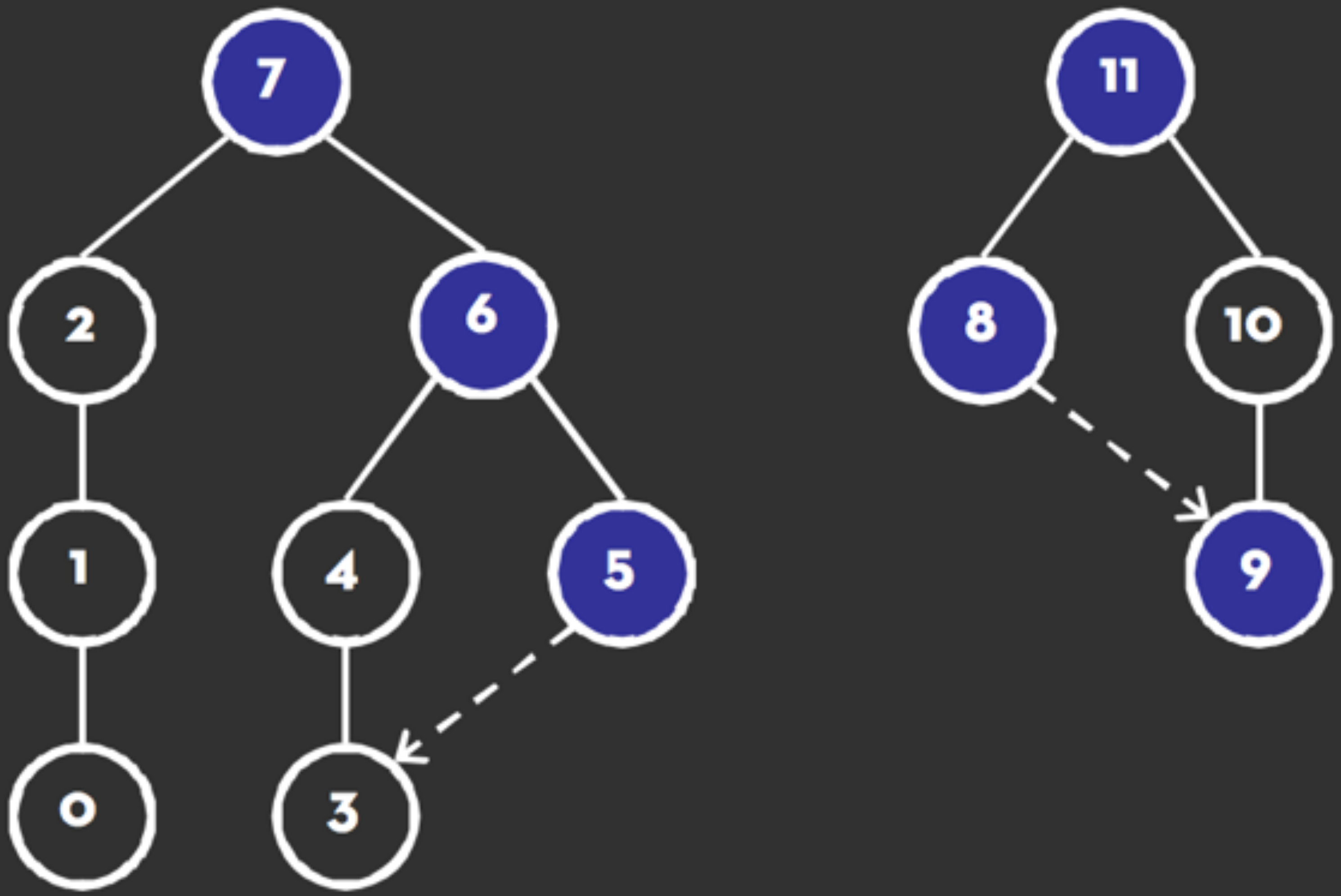

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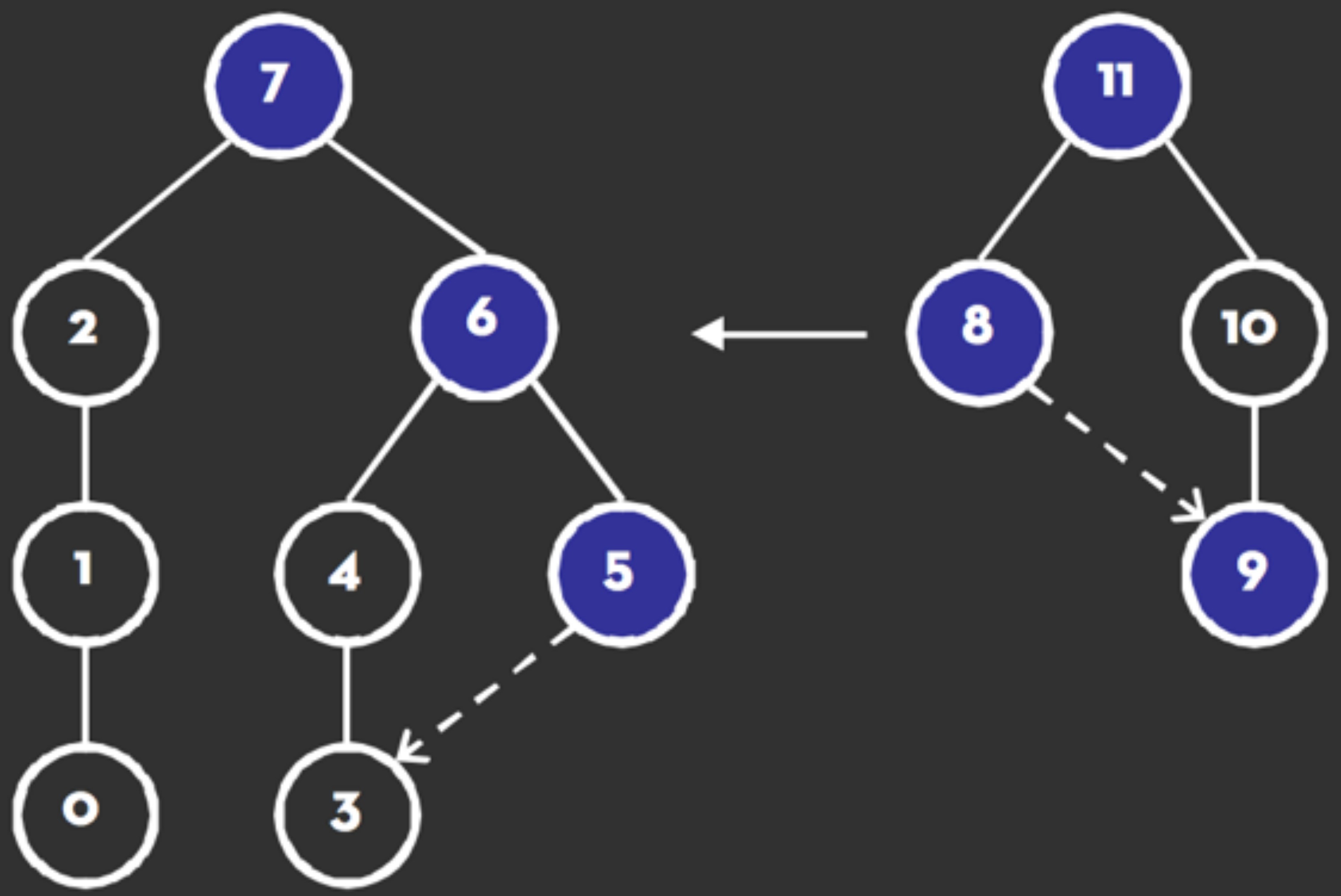

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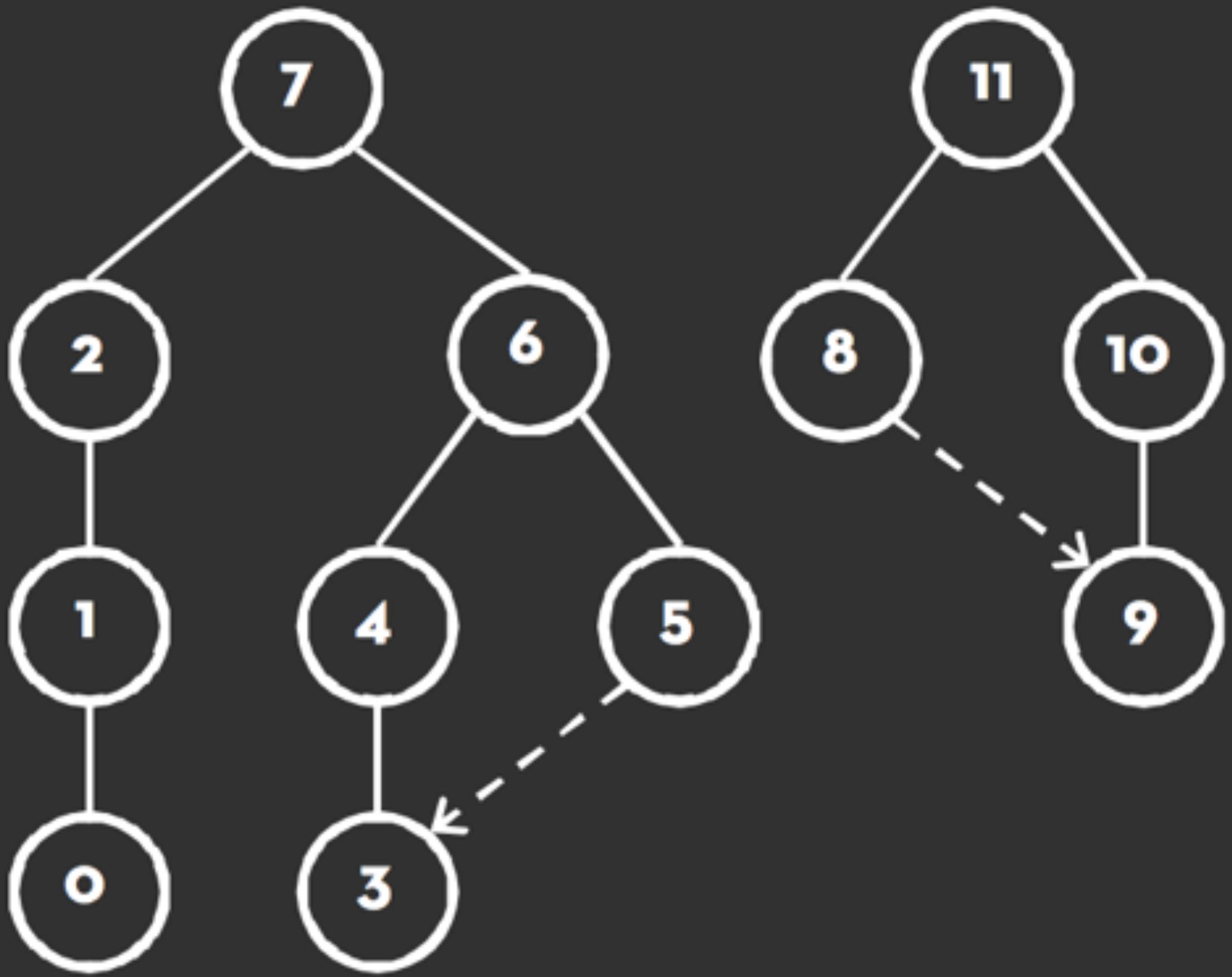

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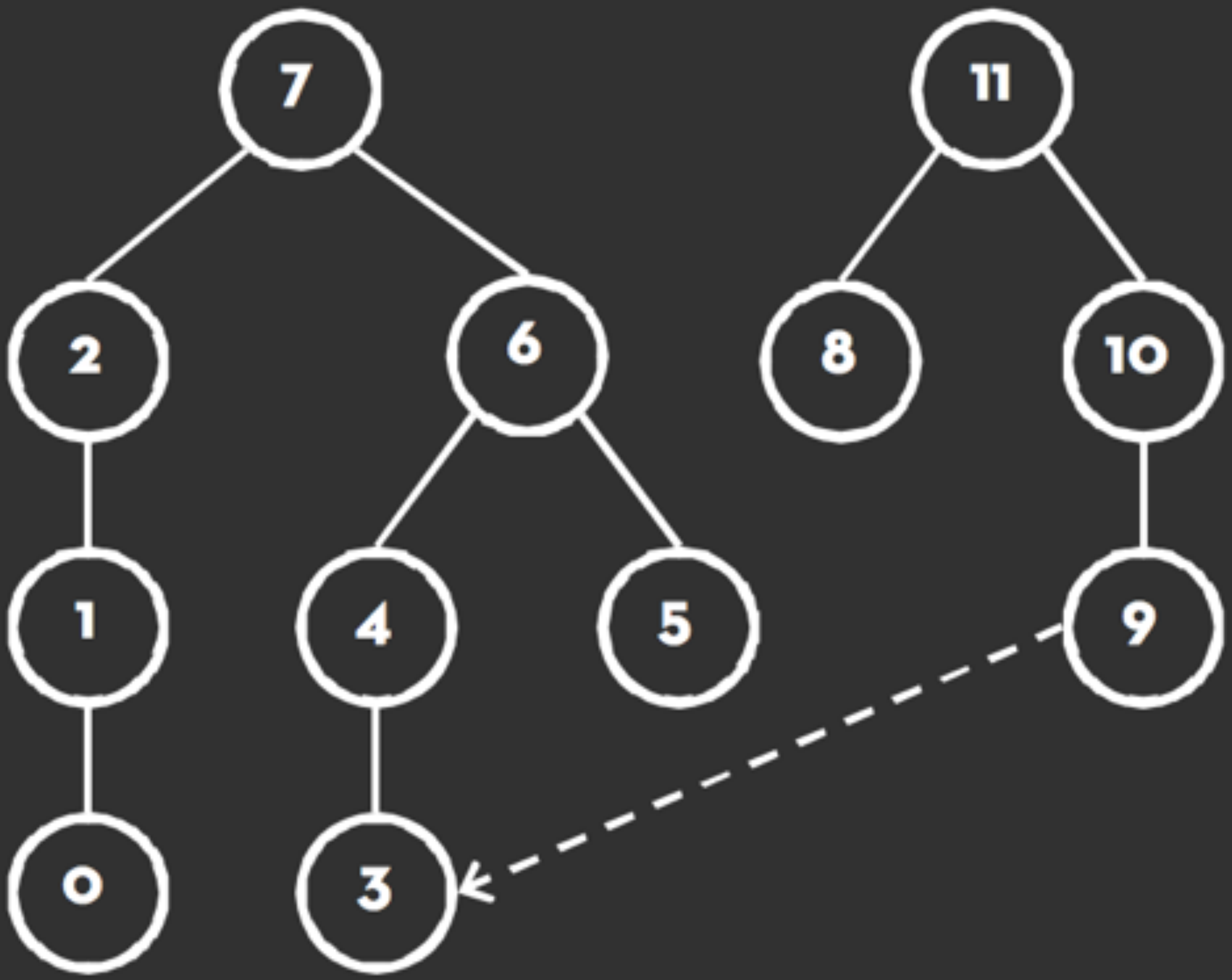

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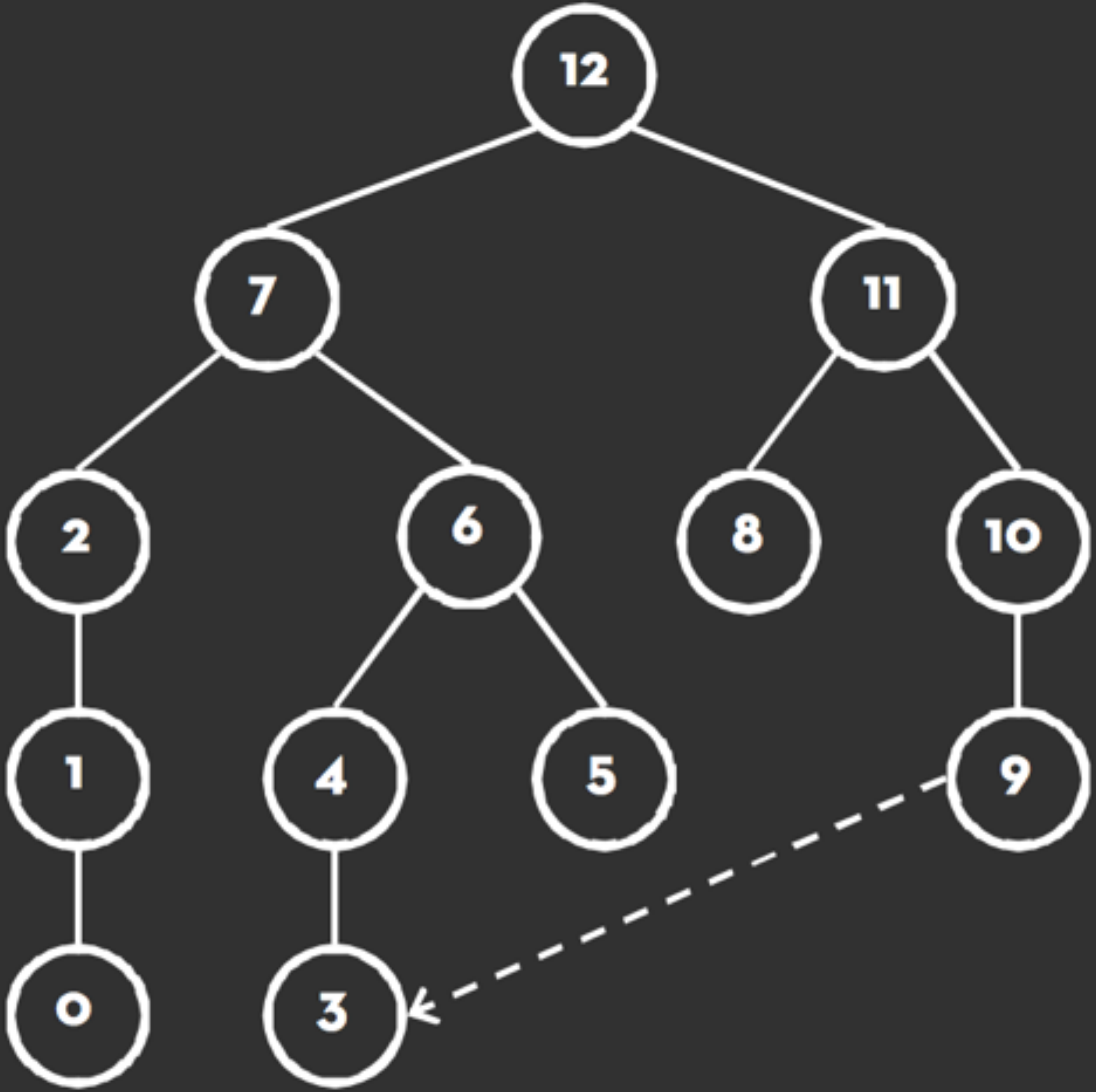
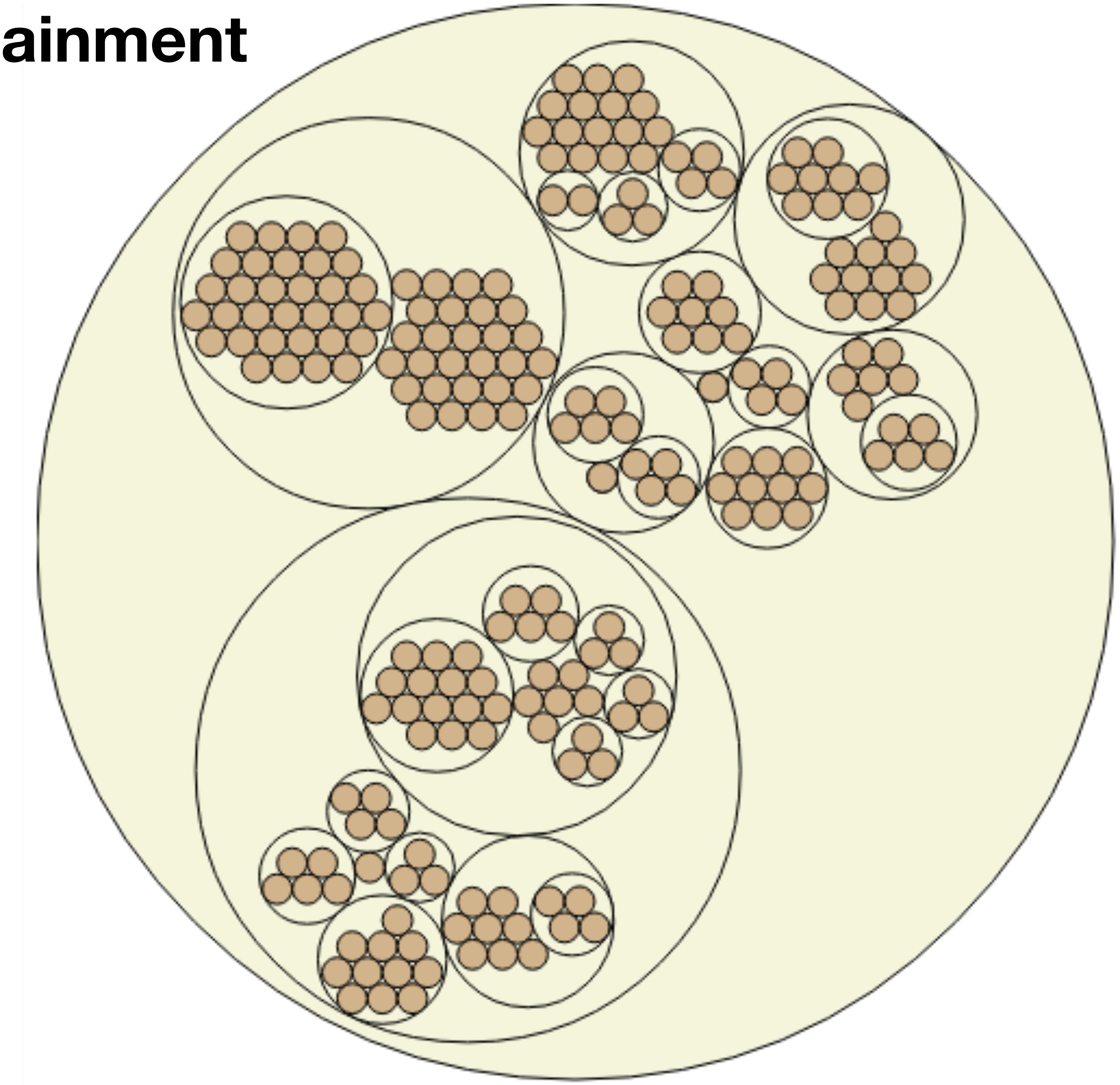


Reingold-Tilford Algorithm

- Bottom-up tree traversal
- y-coord is the depth of the node, x-coords are “locally defined” (so first is arbitrary)
- merge trees
    - push right tree as close as possible to left tree (this is where the contour comes in)
    - position **shifts** saved at each node
    - parent nodes are centered above direct children
- Final top-down pass to convert shifts to positions

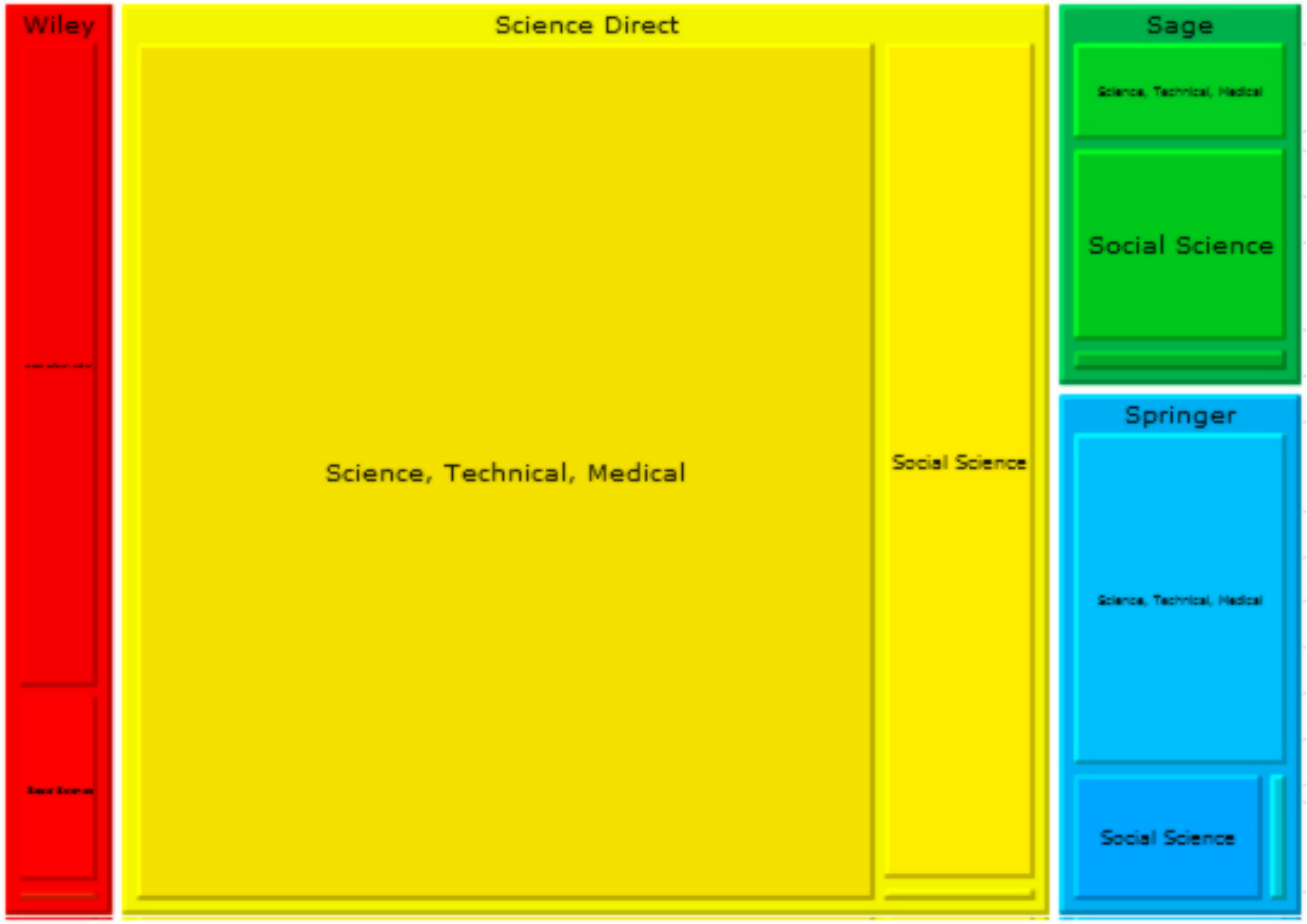
Bubble Charts

- Represent **hierarchy** by **containment**
- Let's work out a simple algo!



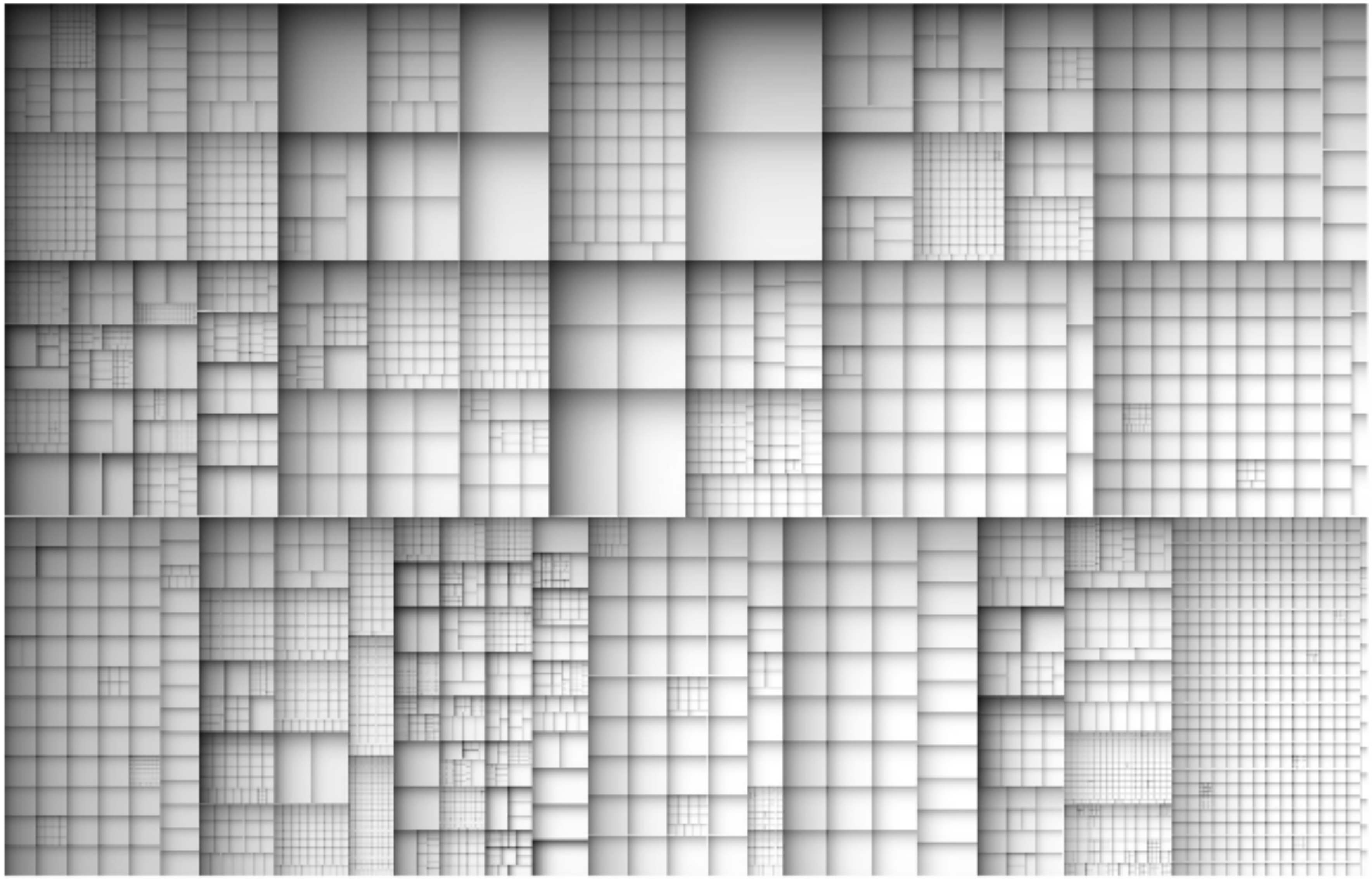
Treemaps

- Represent **hierarchy** by **containment**,
  - … and **sizes** by **areas**
- Let’s work out a simple algo!



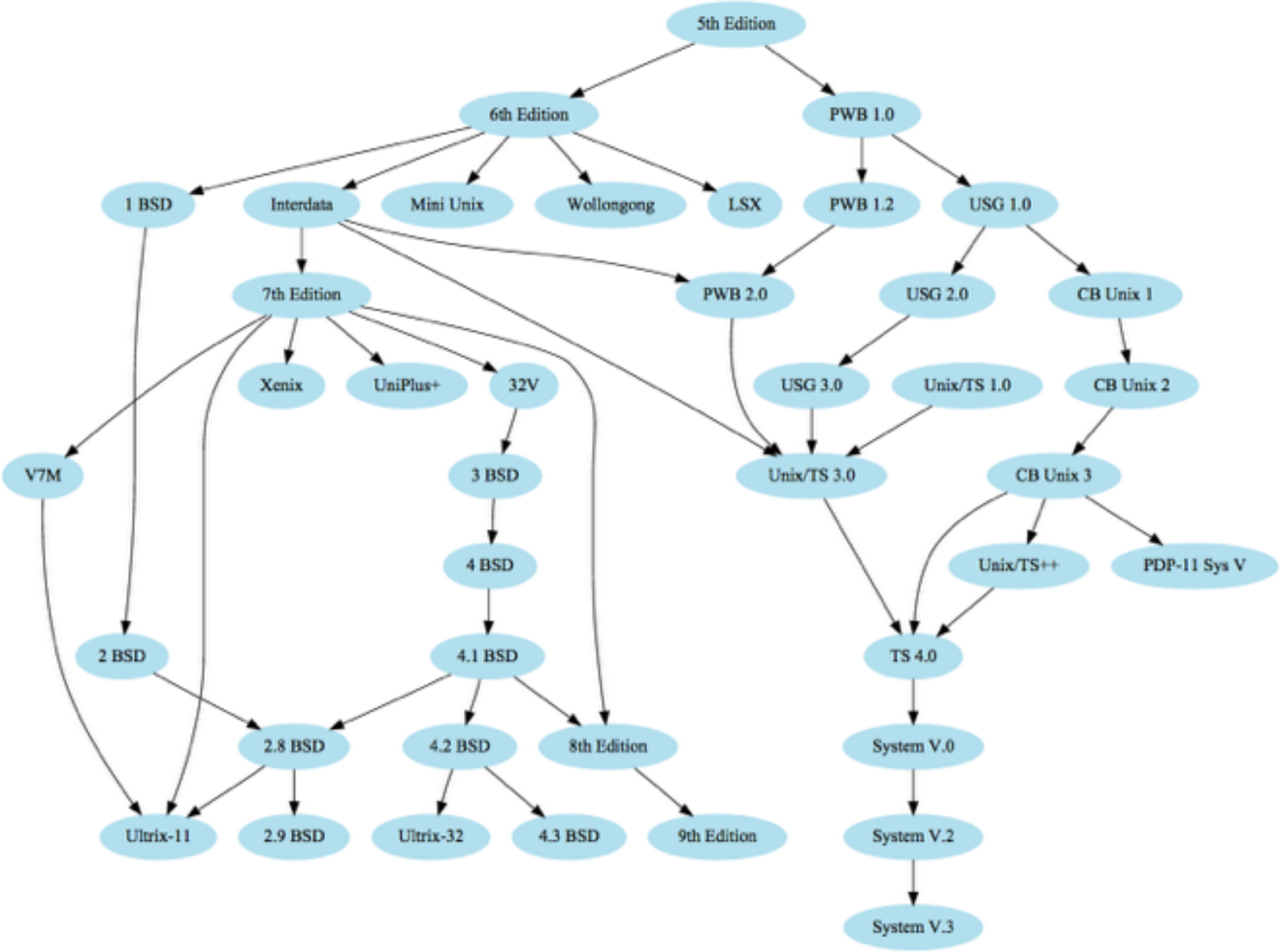
Squarified Treemaps

- A little harder, tries to make square shapes



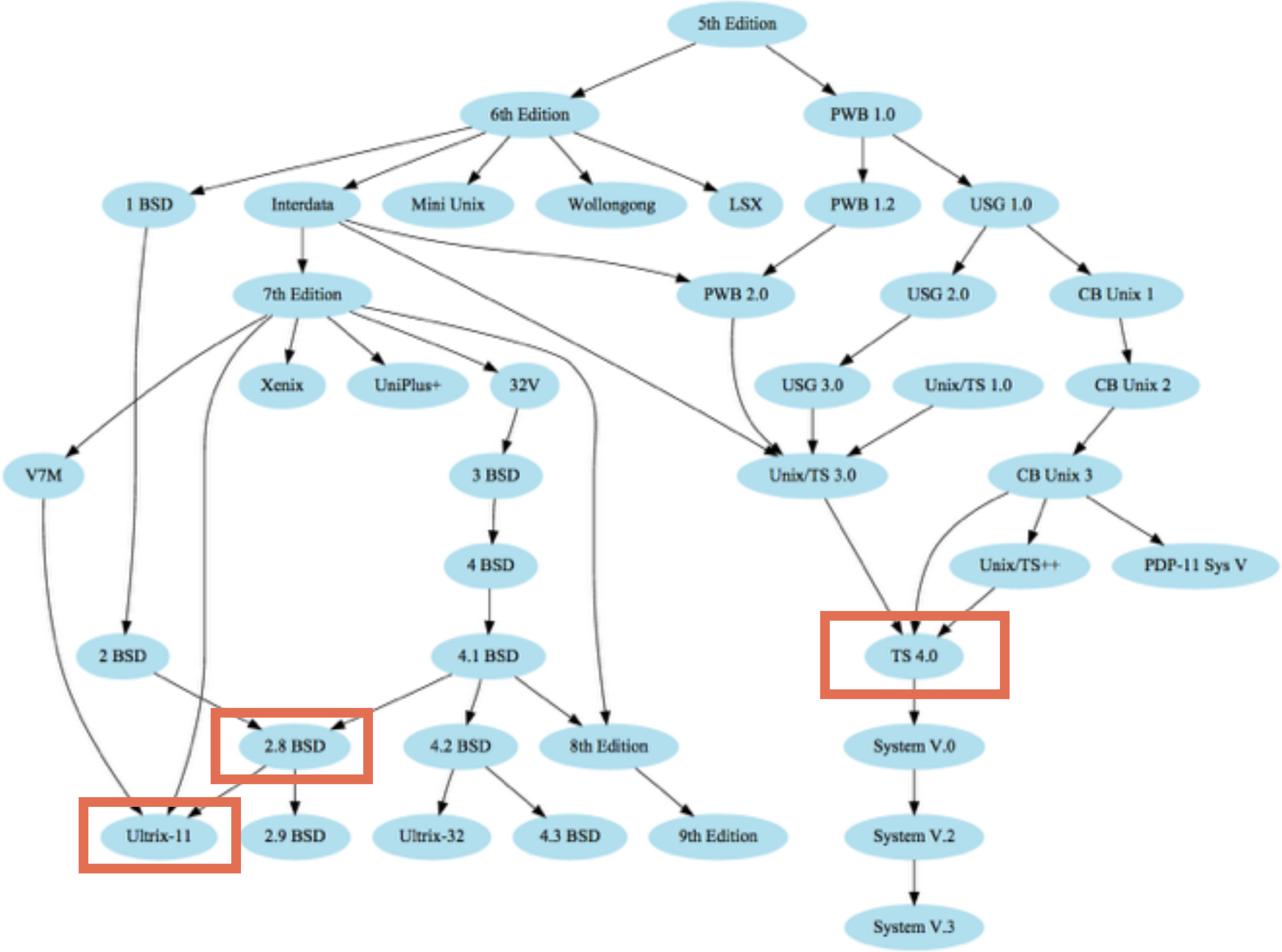
Not all Hierarchies are Trees

The evolution of UNIX



http://www.graphviz.org/Gallery/directed/unix.svg

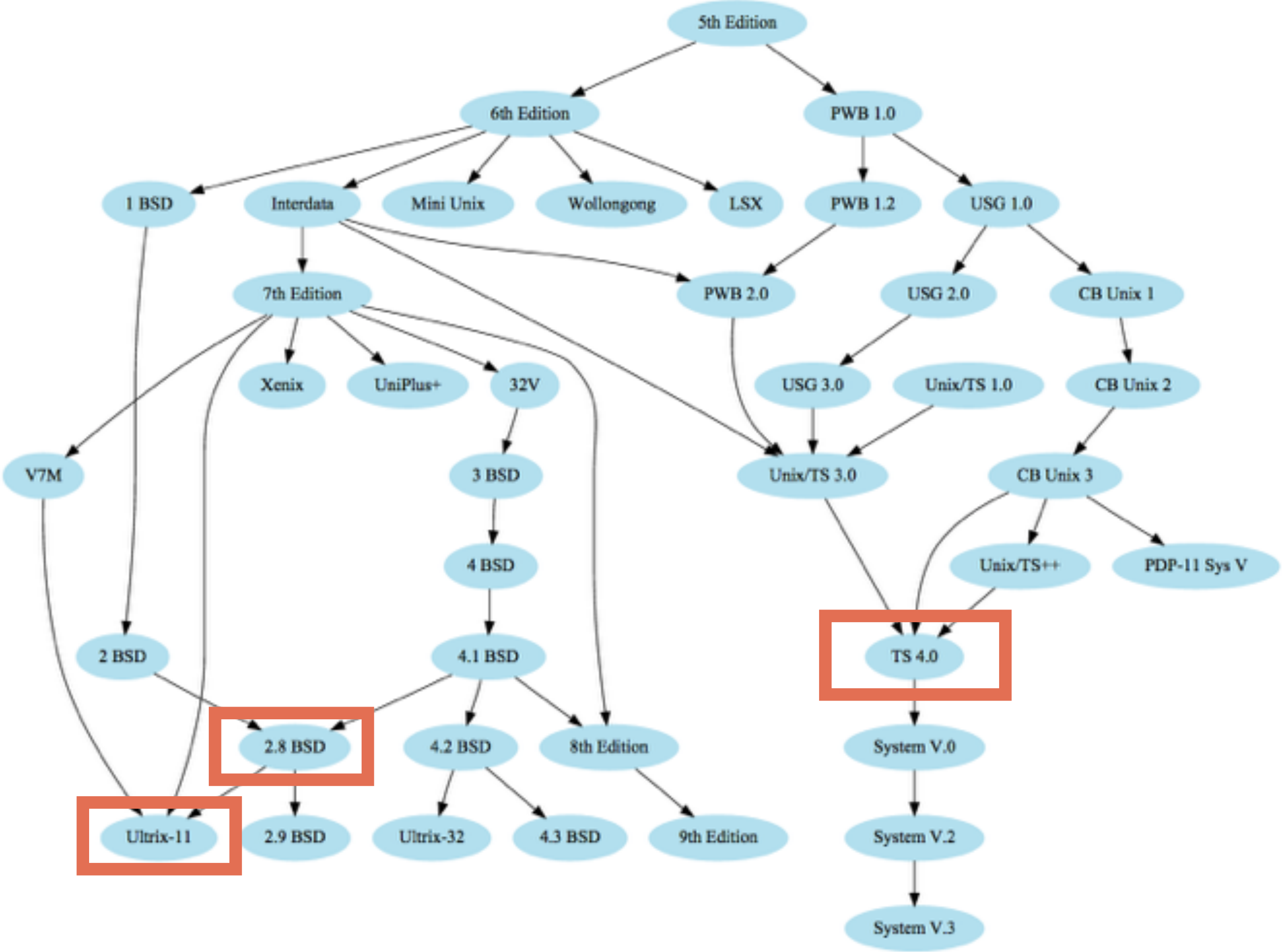
The evolution of UNIX



http://www.graphviz.org/Gallery/directed/unix.svg

Directed, Acyclic Graphs

- Like a hierarchy, but "direct ancestor" is not unique



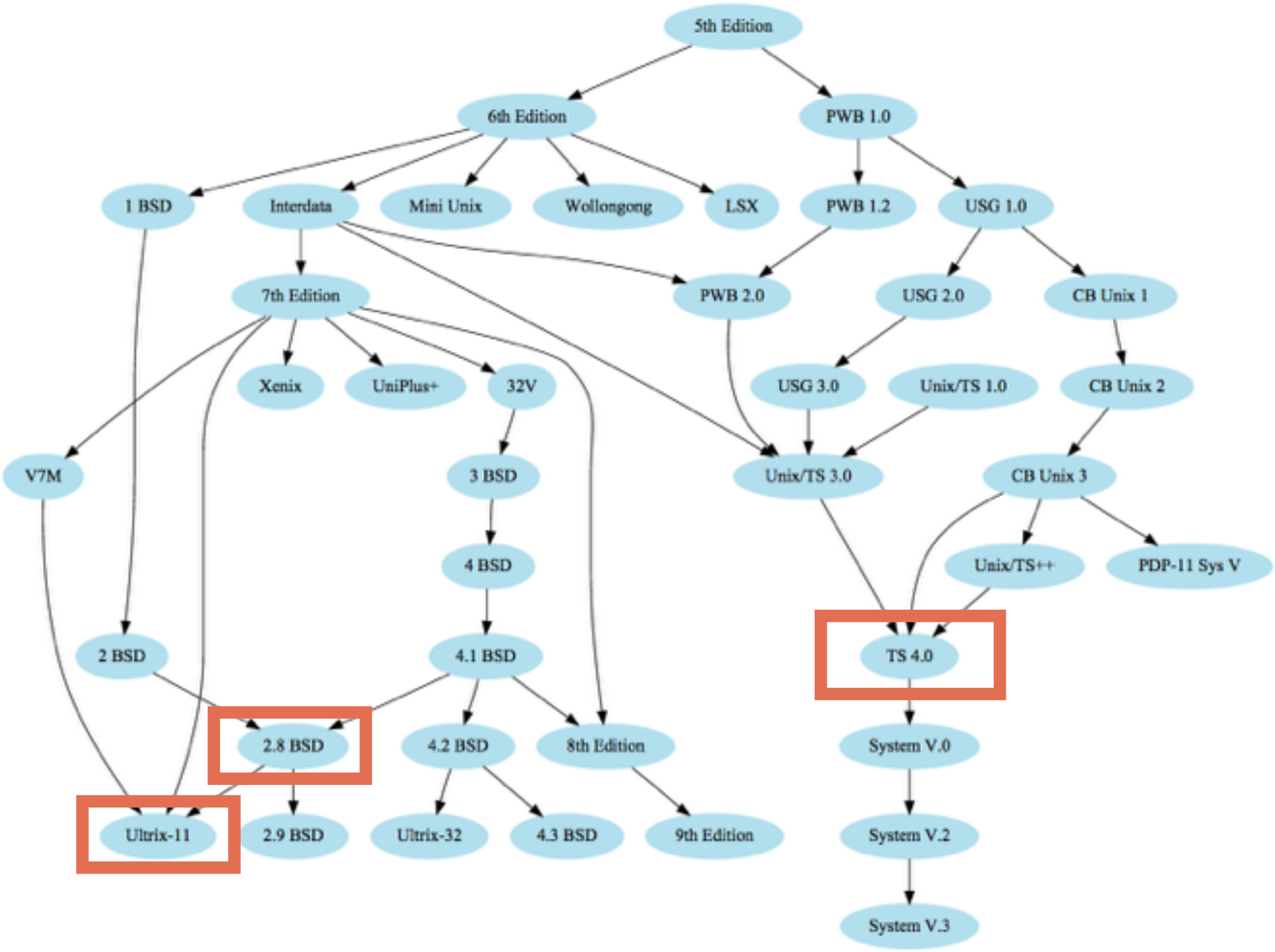
Given what we know about tree drawing, how do we draw a DAG?

Let’s draw a DAG

- Compute **rank**: height of node
    - Requirement: if aRb, height(a) > height(b)
- Order nodes of same rank to minimize crossings
    - Route edges

- Gansner et al., *A Technique for Drawing Directed Graphs.* http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=221135

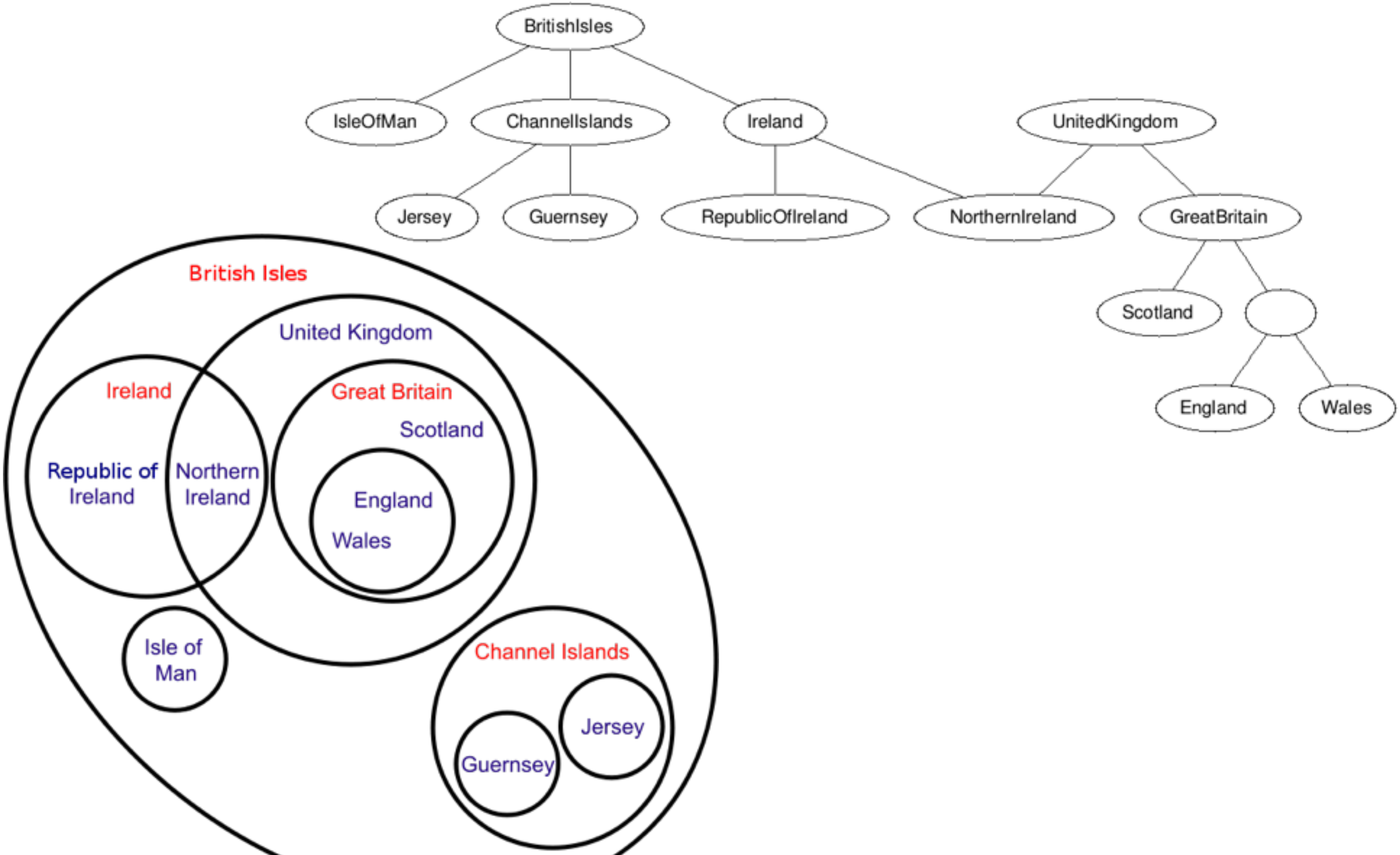
Let’s draw a DAG



- Gansner et al., *A Technique for Drawing Directed Graphs.* http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=221135

Given what we know about treemaps, can we draw a DAG?

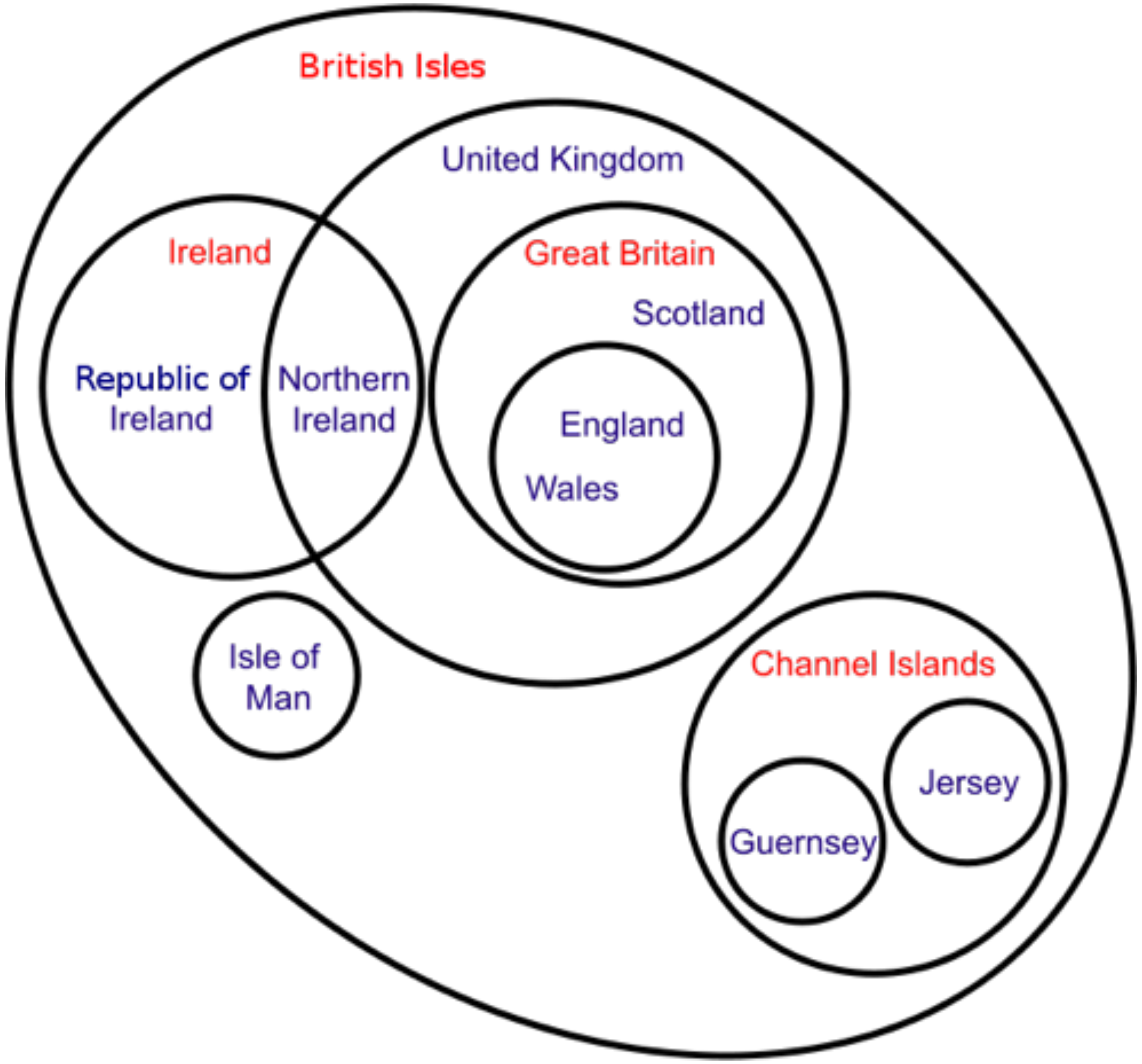
Euler Diagrams (Venn Diagrams)



Euler Diagrams

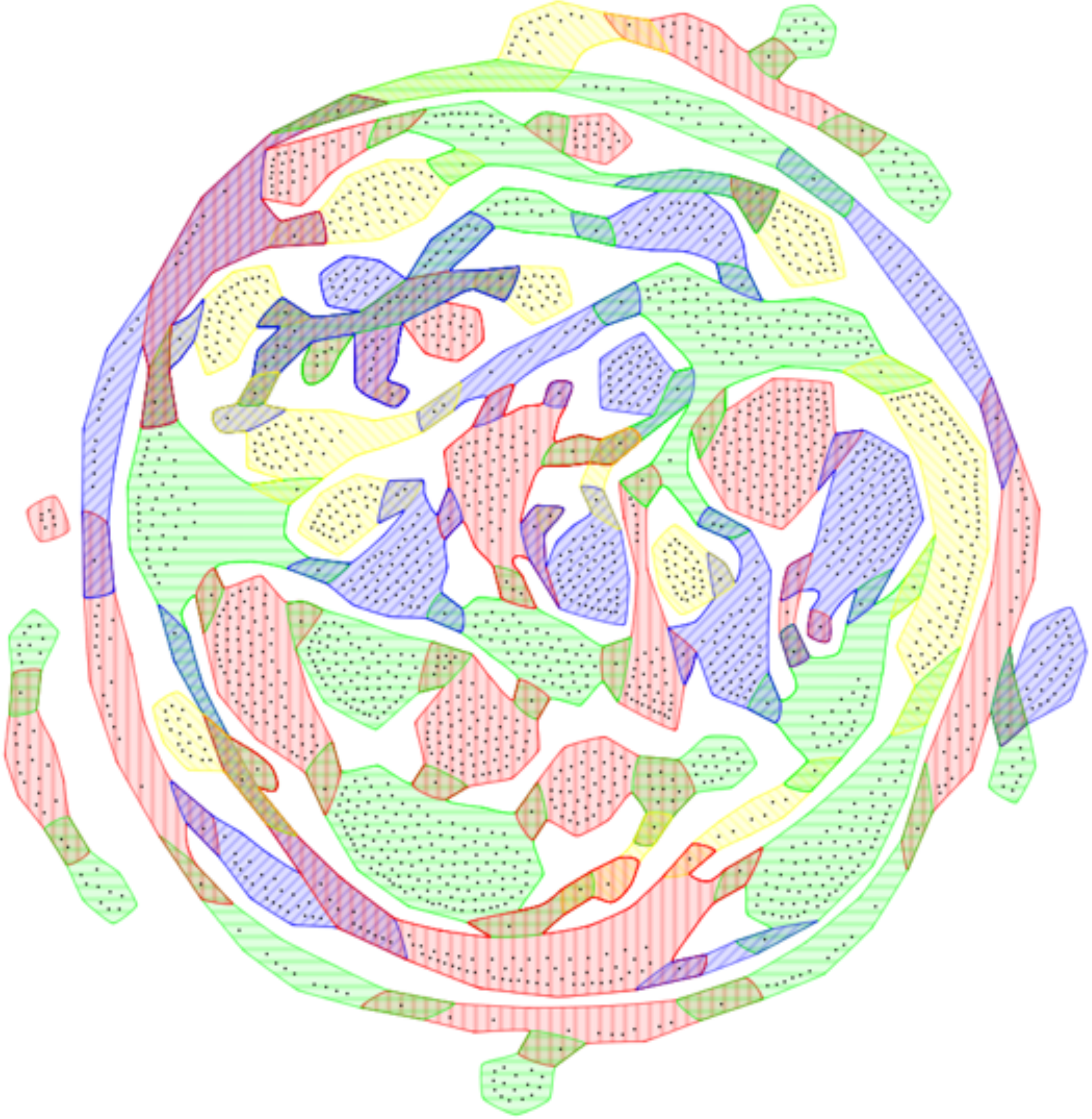
- Represent relationship by containment

- Algorithms are very complicated, tend to produce bad shapes



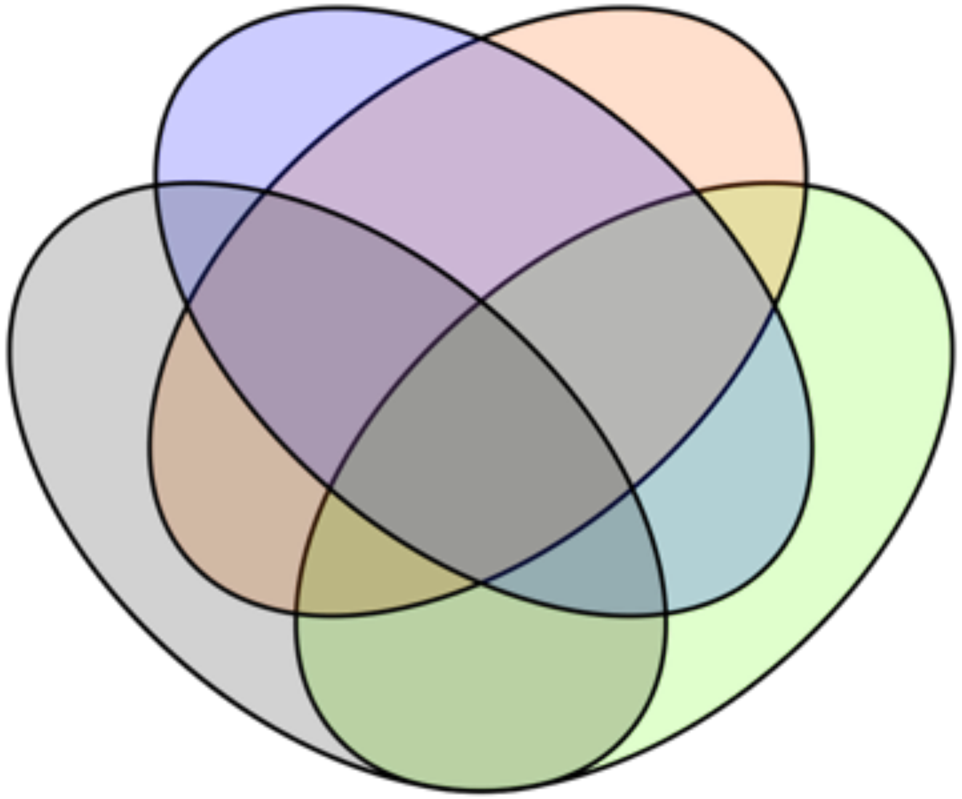
Euler Diagrams

- Doesn’t scale to large diagrams



http://raweb.inria.fr/rapportsactivite/RA2009/gravite/3.png

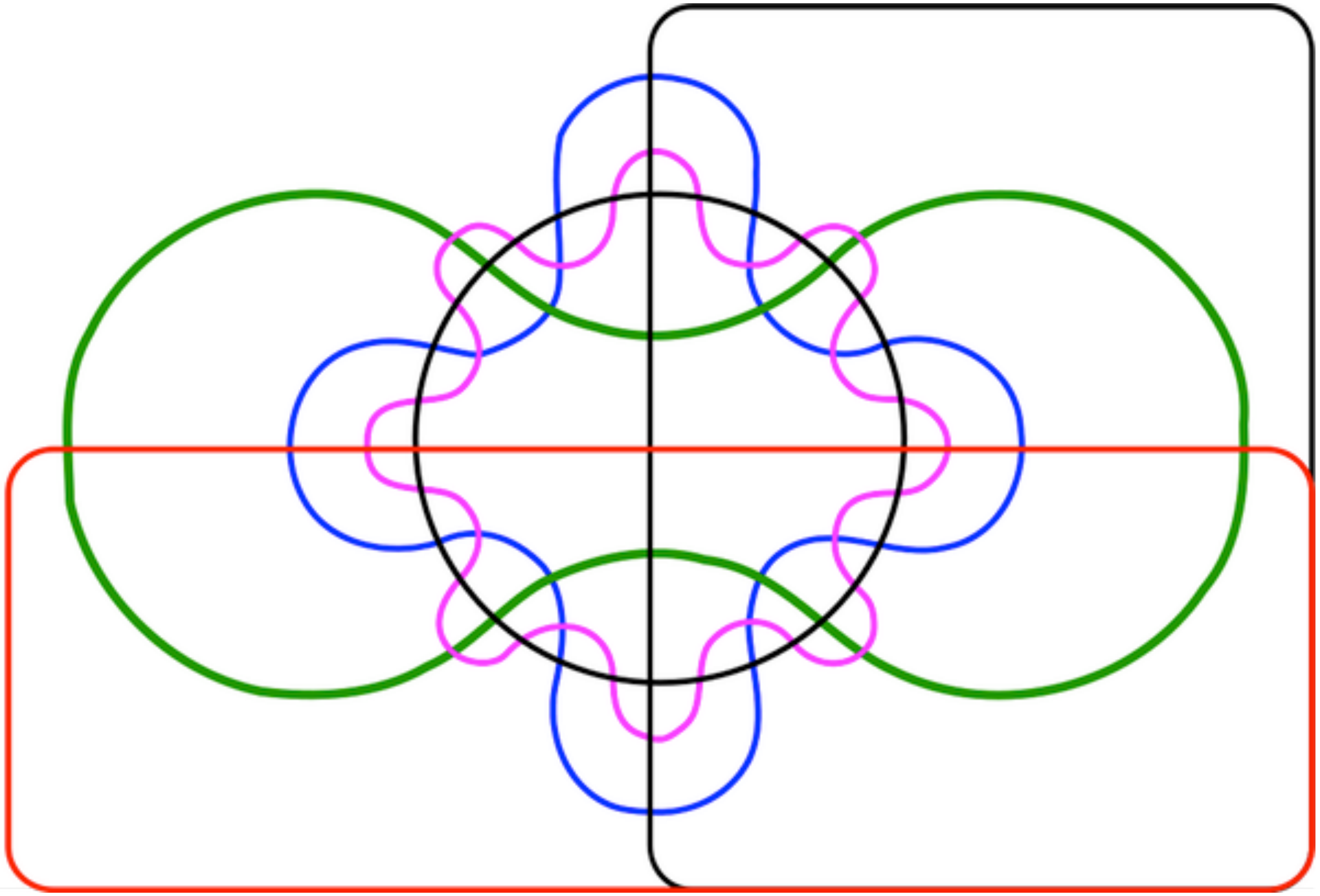
Euler Diagrams



16 regions

- Doesn't scale to "large" diagrams

64 regions



Recap

	Not a Hierarchy	Hierarchy
Not a Tree	NEXT CLASS	Sugiyama’s algorithm Euler Diagrams
A Tree	NEXT CLASS	Reingold-Tilford Treemaps