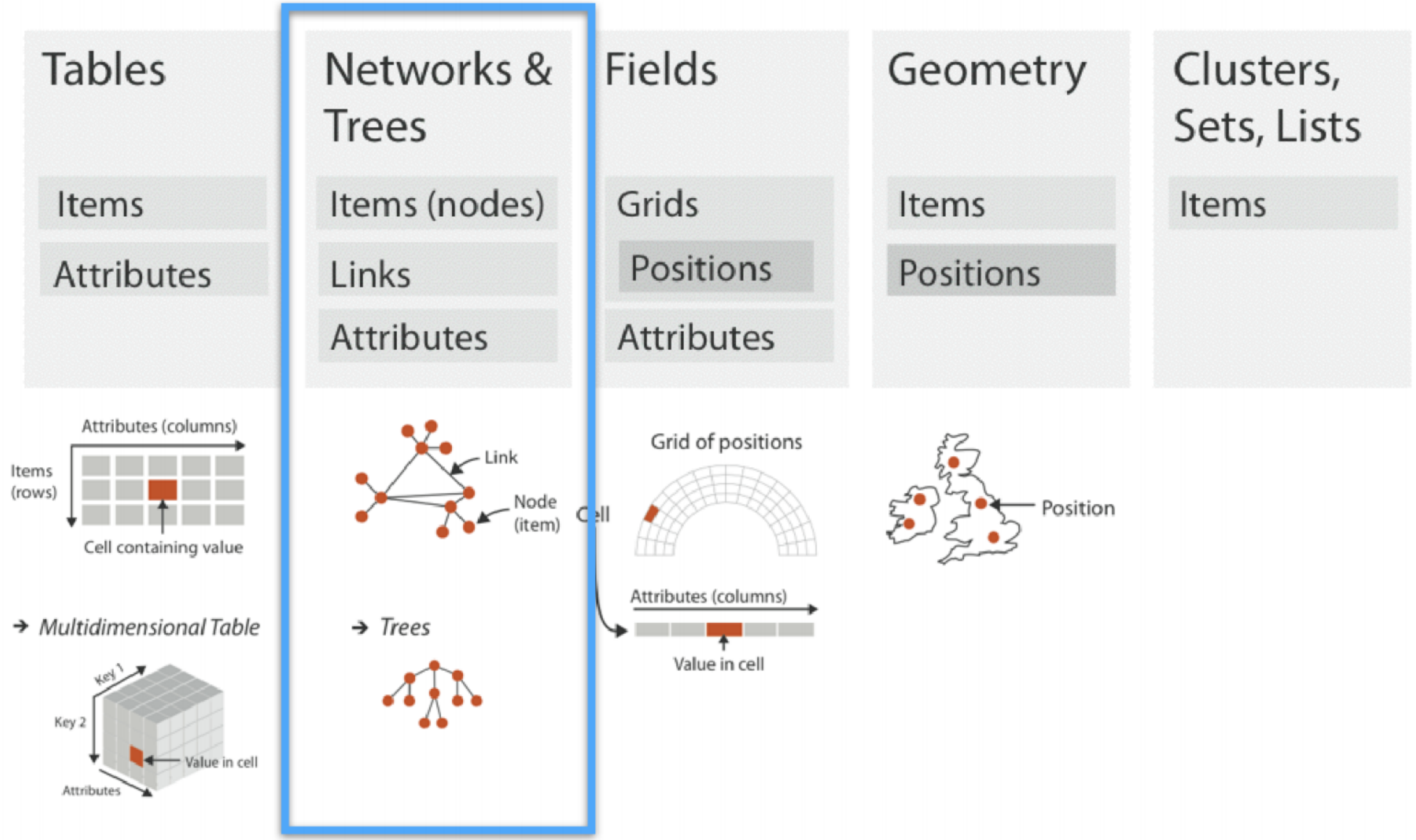
Relational Data

Hierarchies

CSC444

Why hierarchies?



Tables

Items

Attributes

Networks & Trees

Items (nodes)

Links

Attributes

Fields

Grids

Positions

Attributes

Geometry

Items

Positions

Clusters, Sets, Lists

Items

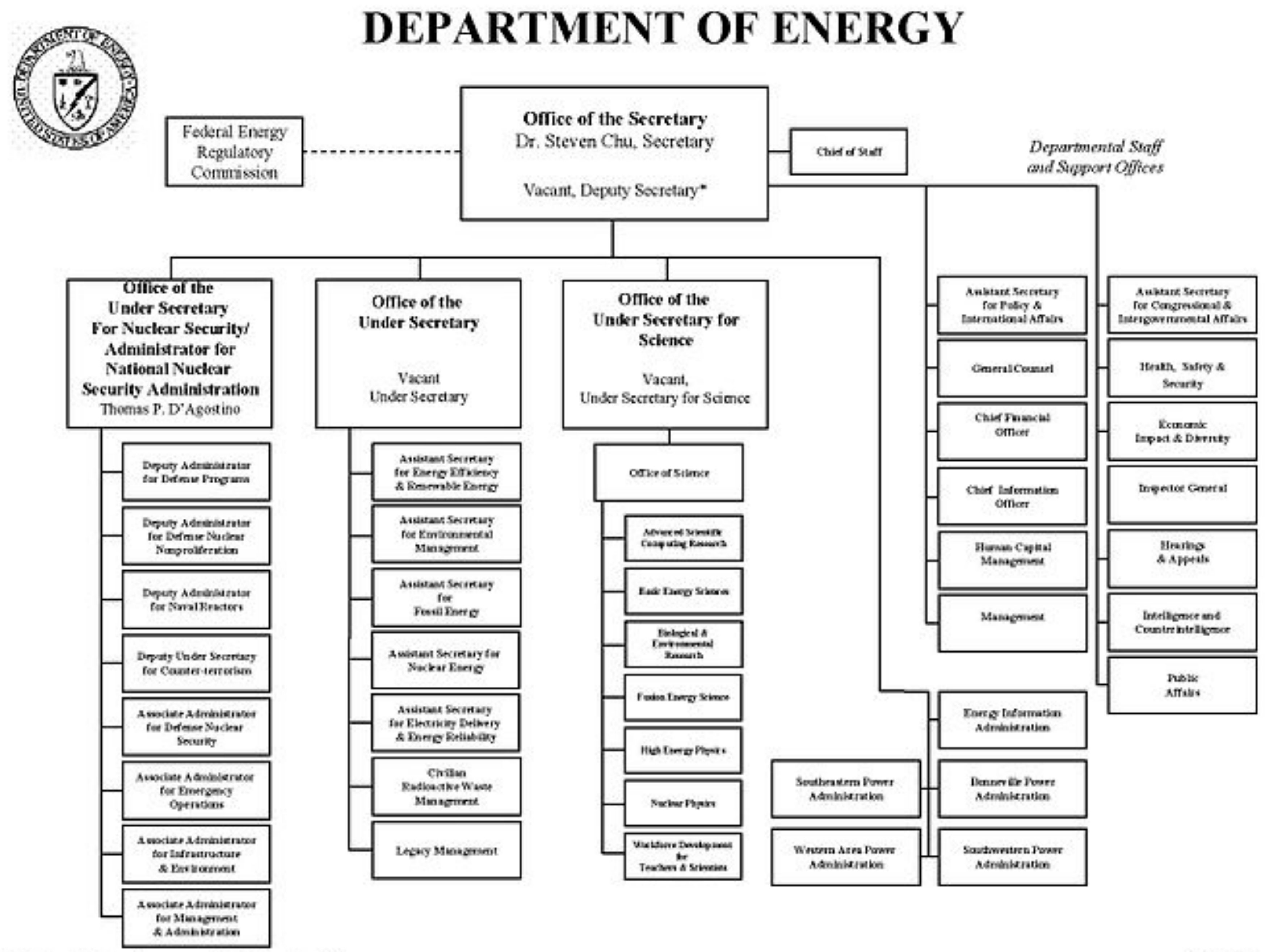
http://www.sci.utah.edu/~miriah/cs6630/lectures/L13-trees-graphs.pdf

Scatterplots; dot plots; line charts, etc.

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

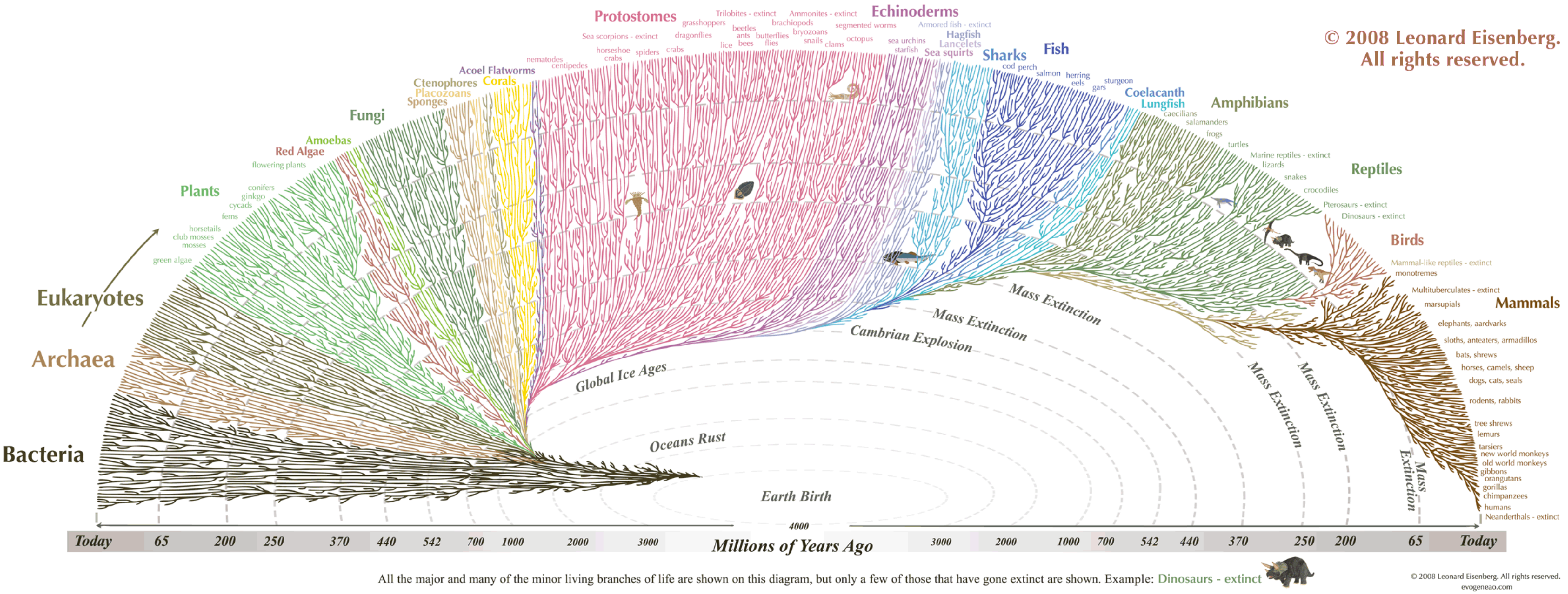
In “relational data”, it’s the **relationship between points** that matters

- The reports-to relationship in an organization


DEPARTMENT OF ENERGY
Office of the Secretary
Dr. Steven Chu, Secretary
Vacant, Deputy Secretary*
Federal Energy Regulatory Commission
Chief of Staff
Departmental Staff and Support Offices
Office of the Under Secretary For Nuclear Security/ Administrator for National Nuclear Security Administration
Thomas P. D'Agostino
Office of the Under Secretary
Vacant Under Secretary
Office of the Under Secretary for Science
Vacant, Under Secretary for Science
Deputy Administrator for Defense Programs
Deputy Administrator for Defense Nuclear Nonproliferation
Deputy Administrator for Naval Reactors
Deputy Under Secretary for Counter-terrorism
Associate Administrator for Defense Nuclear Security
Associate Administrator for Emergency Operations
Associate Administrator for Infrastructure & Environment
Associate Administrator for Management & Administration
Assistant Secretary for Energy Efficiency & Renewable Energy
Assistant Secretary for Environmental Management
Assistant Secretary for Fossil Energy
Assistant Secretary for Nuclear Energy
Assistant Secretary for Electricity Delivery & Energy Reliability
Civilian Radioactive Waste Management
Legacy Management
Office of Science
Advanced Scientific Computing Research
Basic Energy Sciences
Biological & Environmental Research
Fusion Energy Science
High Energy Physics
Nuclear Physics
Workforce Development for Teachers & Scientists
Southeastern Power Administration
Western Area Power Administration
Energy Information Administration
Bonneville Power Administration
Southwestern Power Administration
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

* The Deputy Secretary also serves as the Chief Operating Officer

21 Jan 09



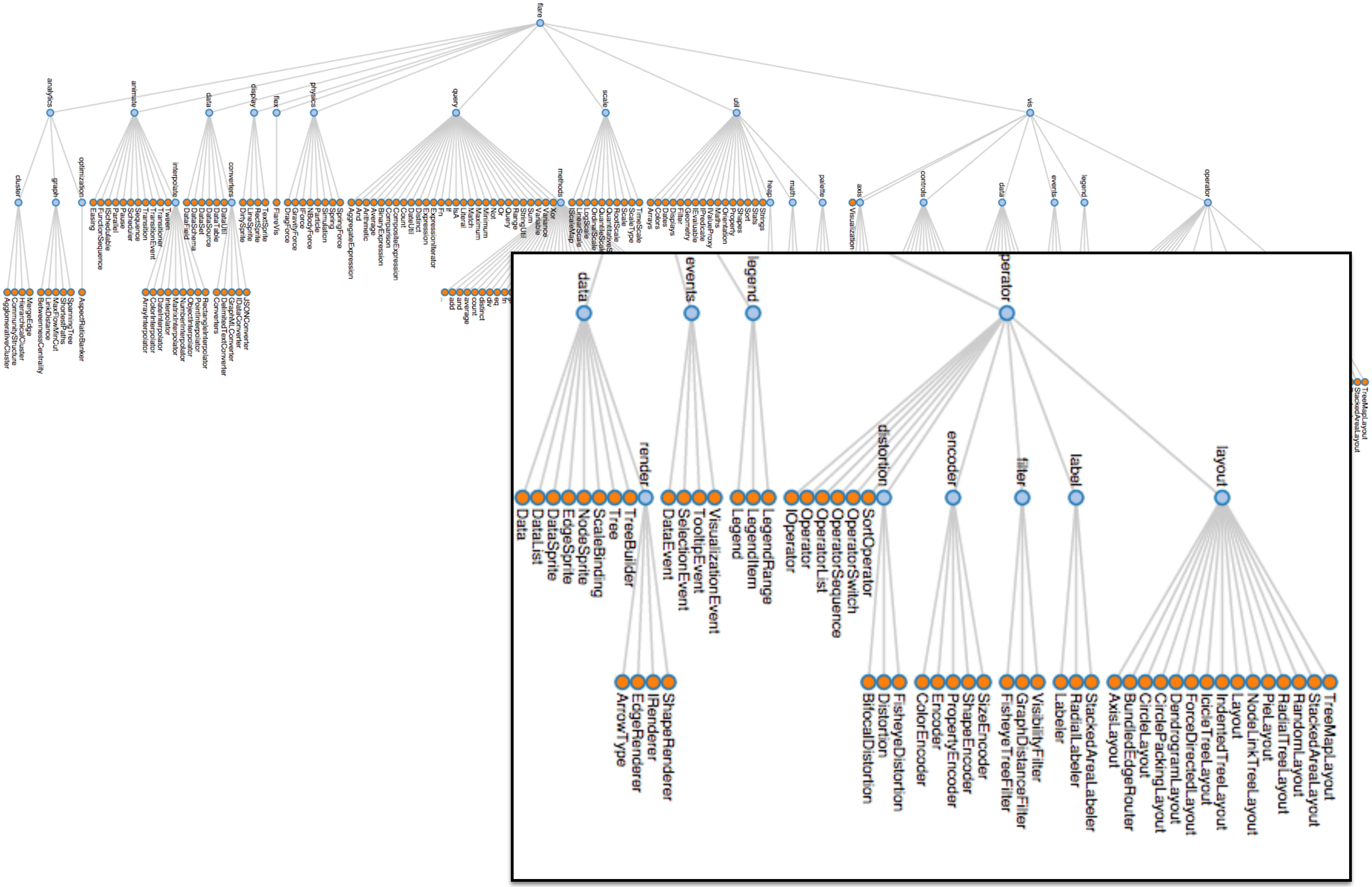
All the major and many of the minor living branches of life are shown on this diagram, but only a few of those that have gone extinct are shown. Example: Dinosaurs - extinct

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

What do we want our drawings to show?

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

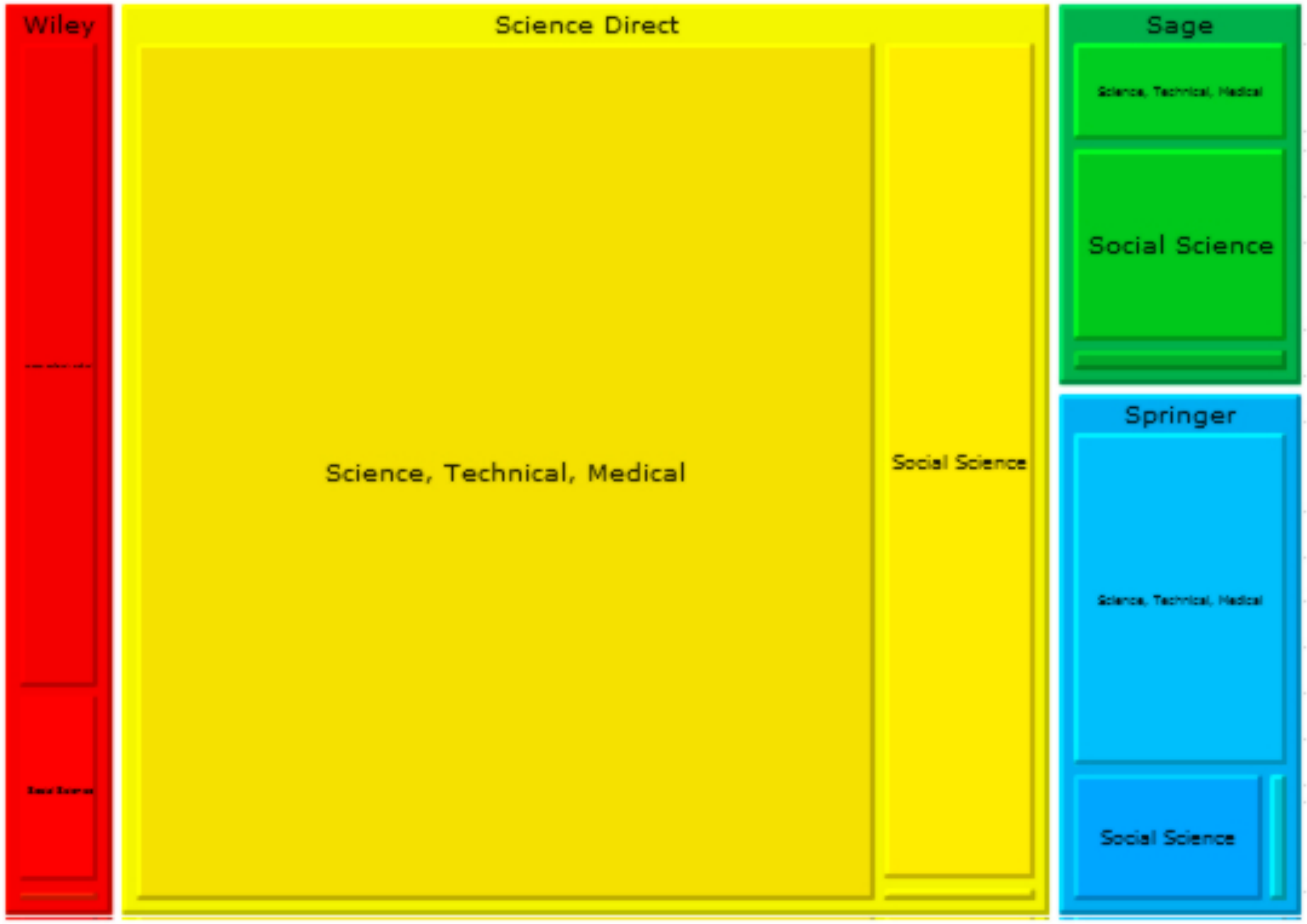
Many different ways to visualize trees



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

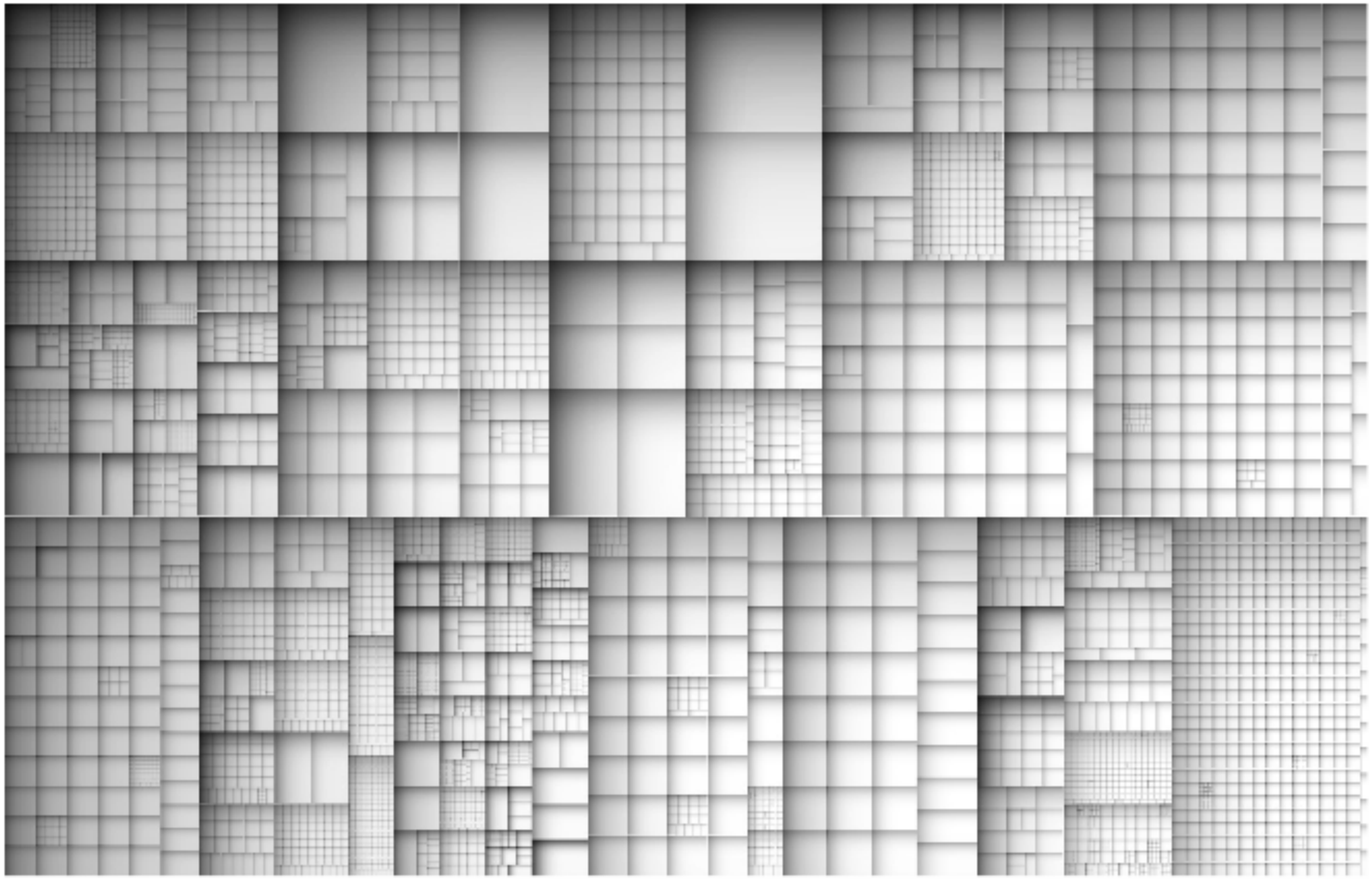
Treemaps

- 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

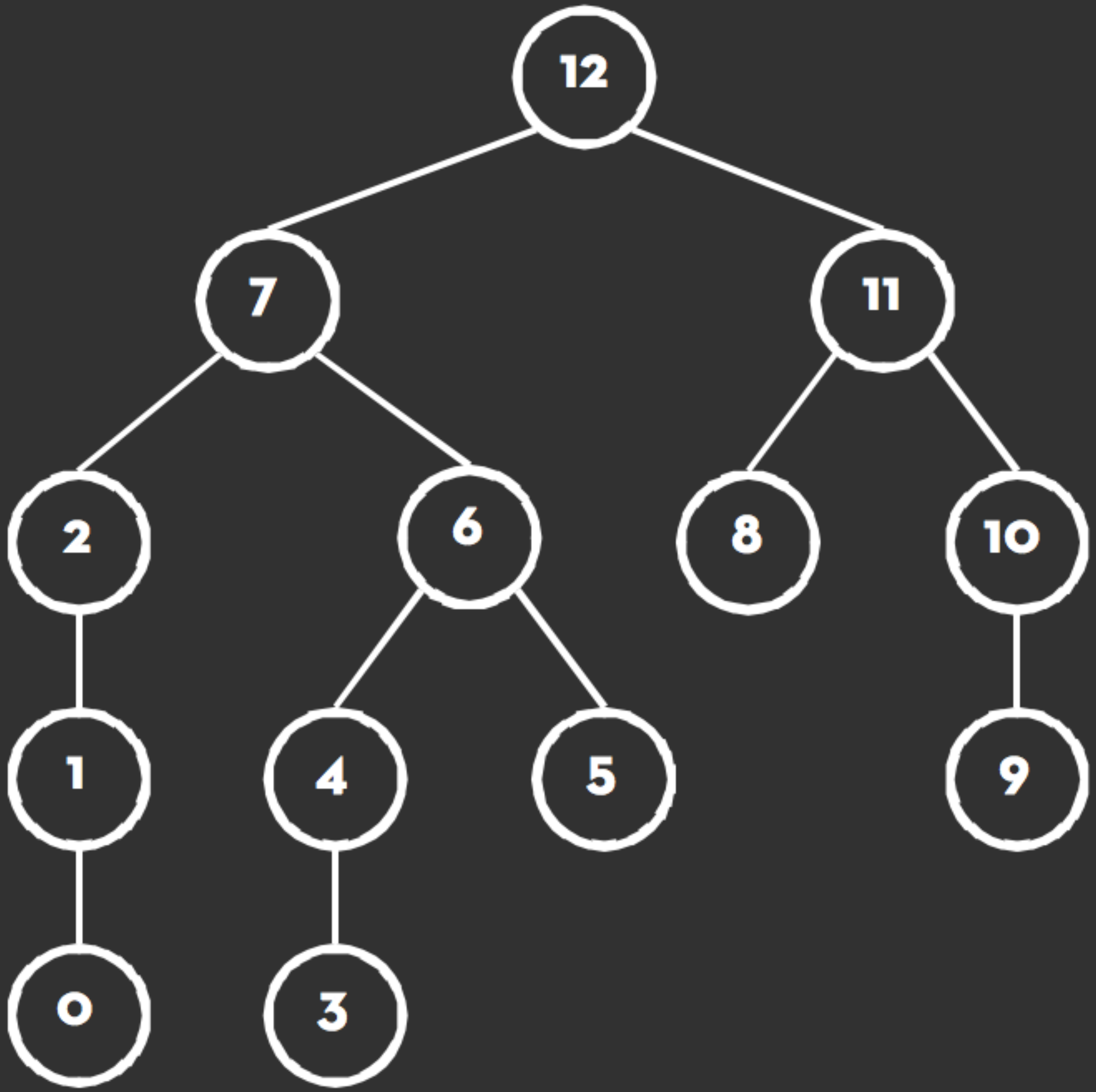


Reingold-Tilford tree drawing

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

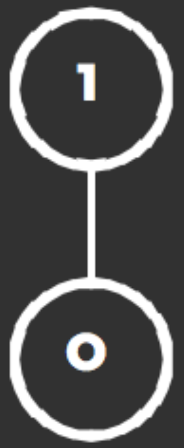
http://hci.stanford.edu/courses/cs448b/f11/lectures/CS448B-20111110-GraphsAndTrees.pdf

Reingold-Tilford Algorithm

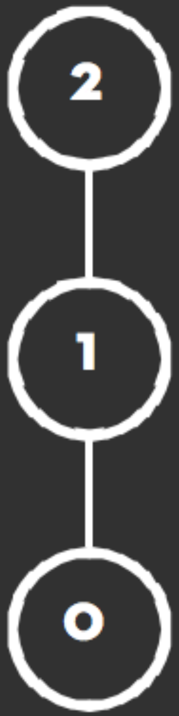


Reingold-Tilford Algorithm

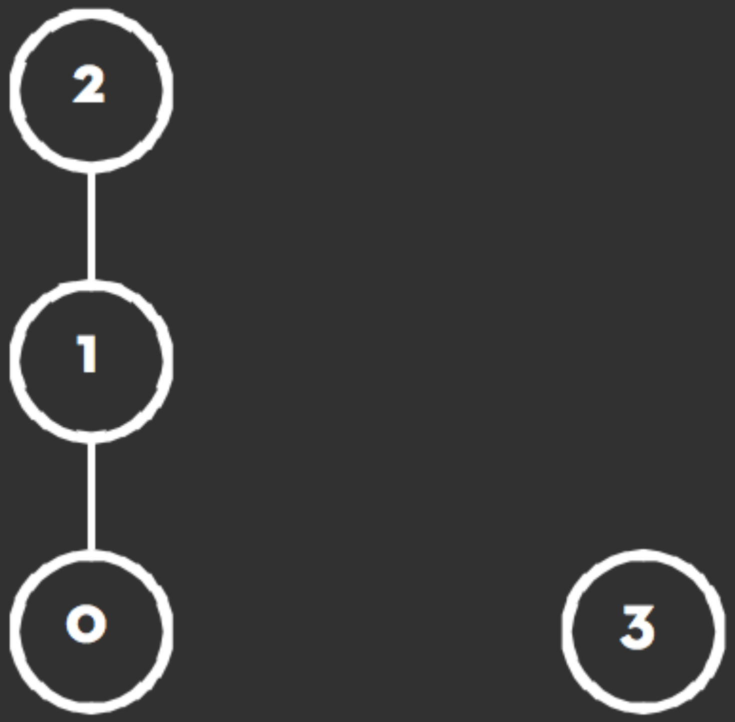
Reingold-Tilford Algorithm



Reingold-Tilford Algorithm



Reingold-Tilford Algorithm



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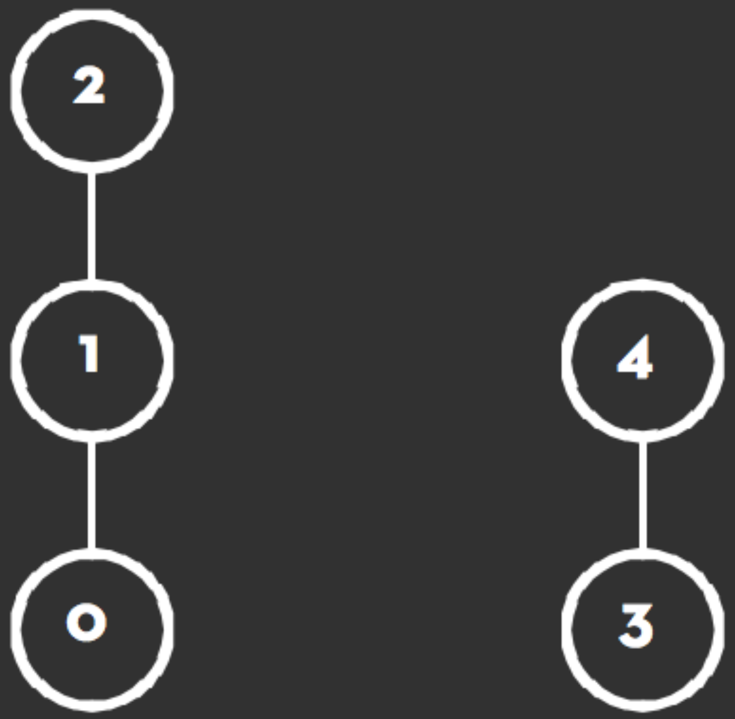
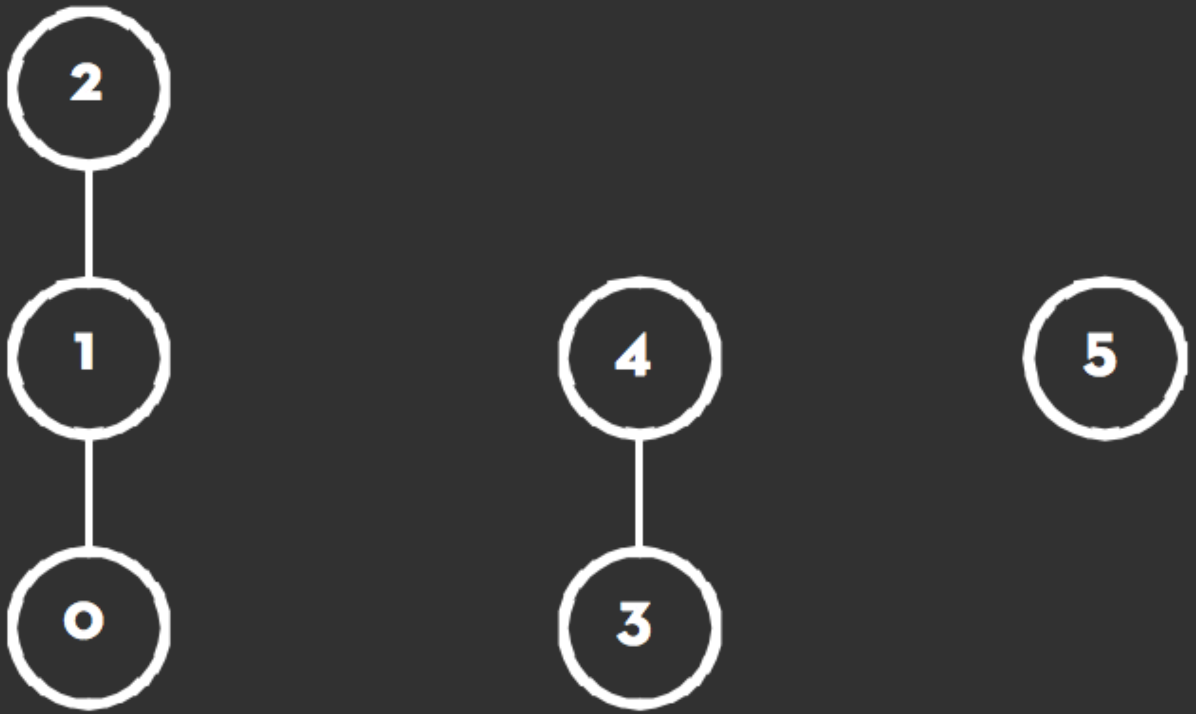


Reingold-Tilford Algorithm



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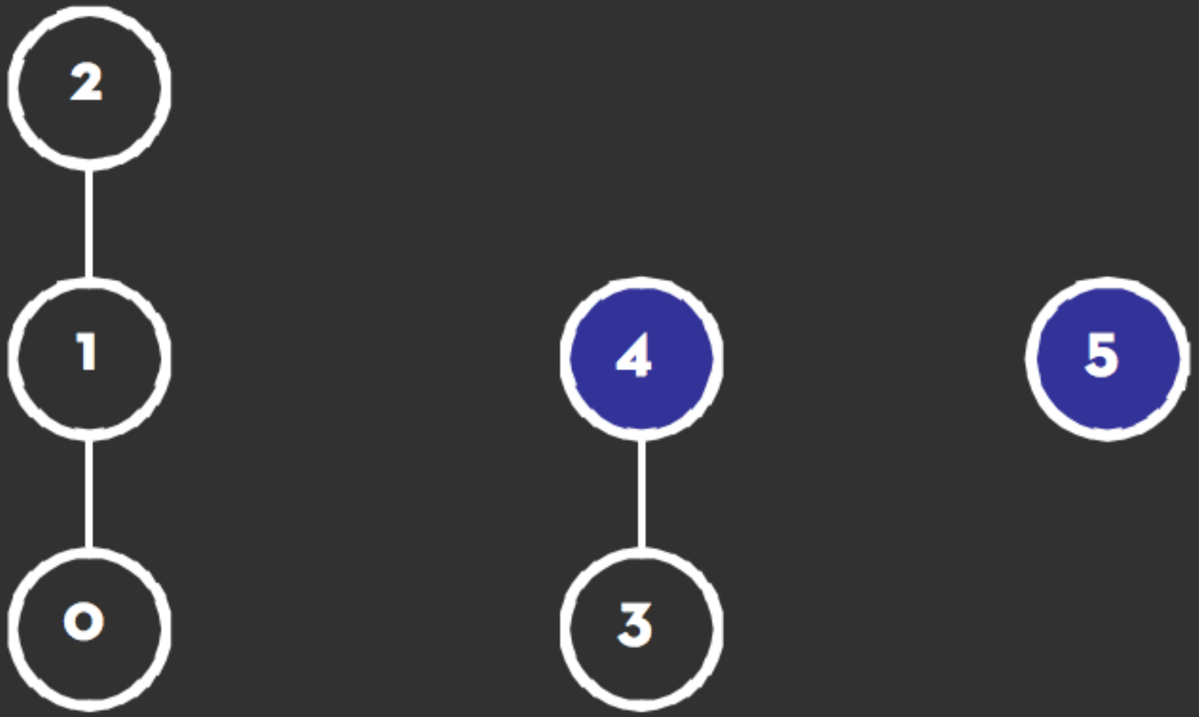
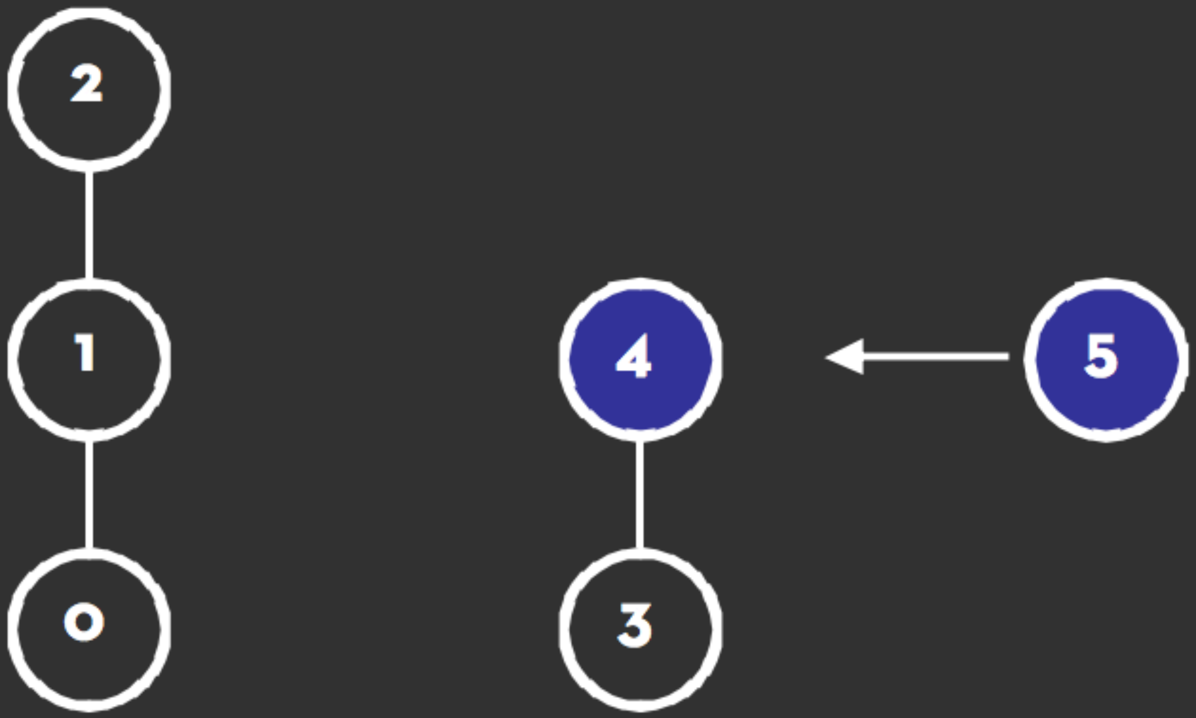


Reingold-Tilford Algorithm



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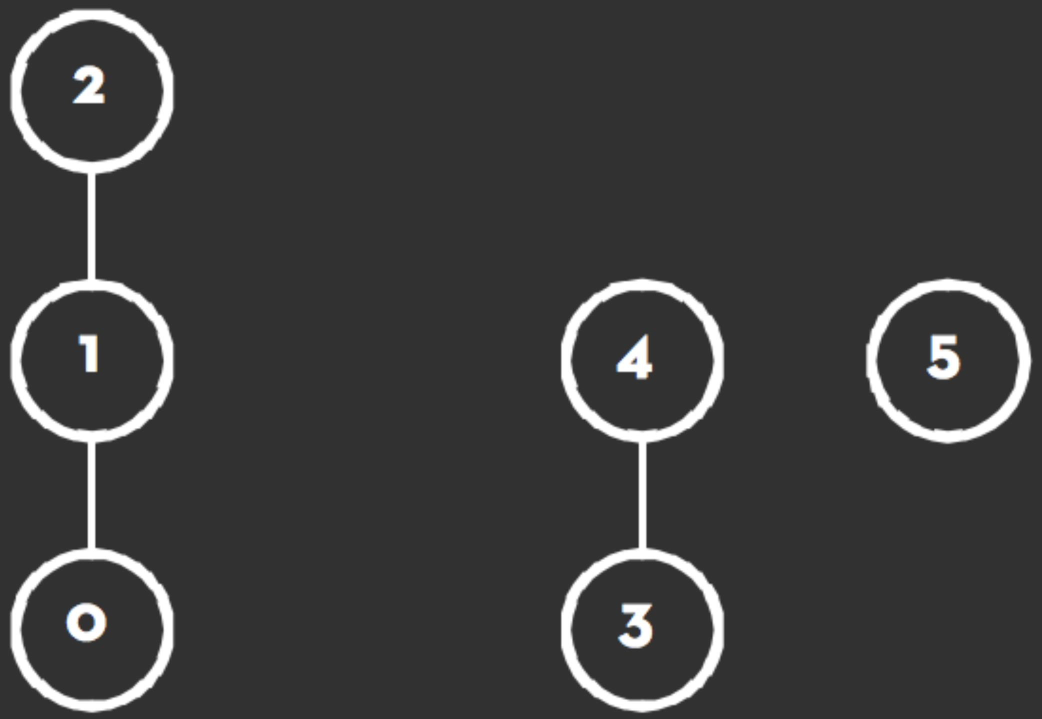

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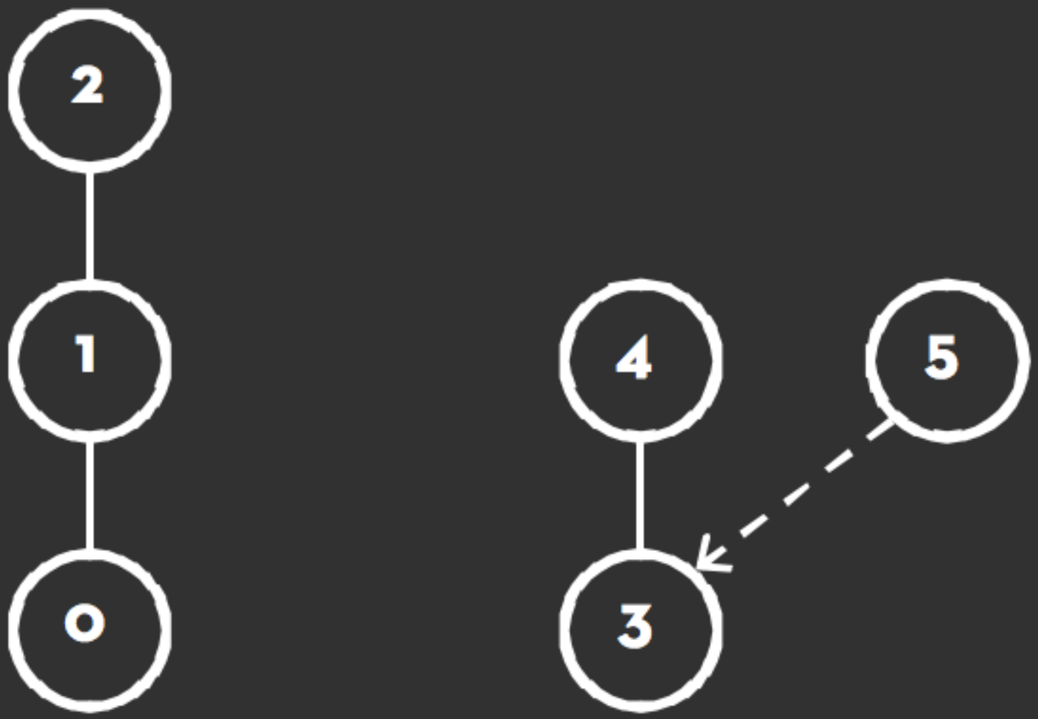

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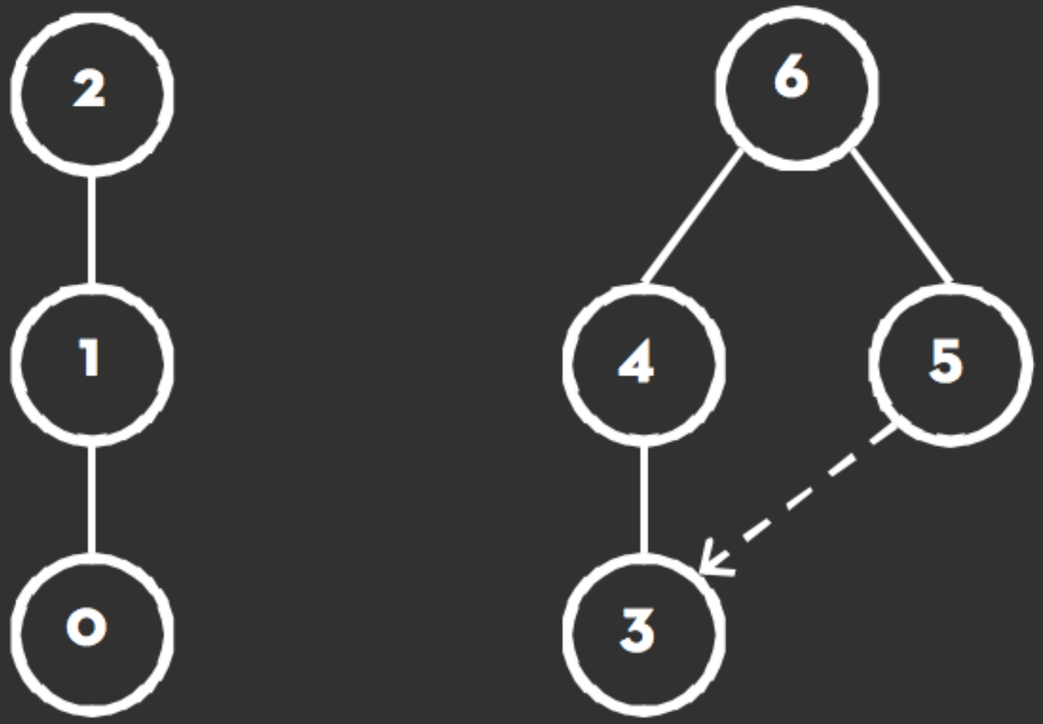

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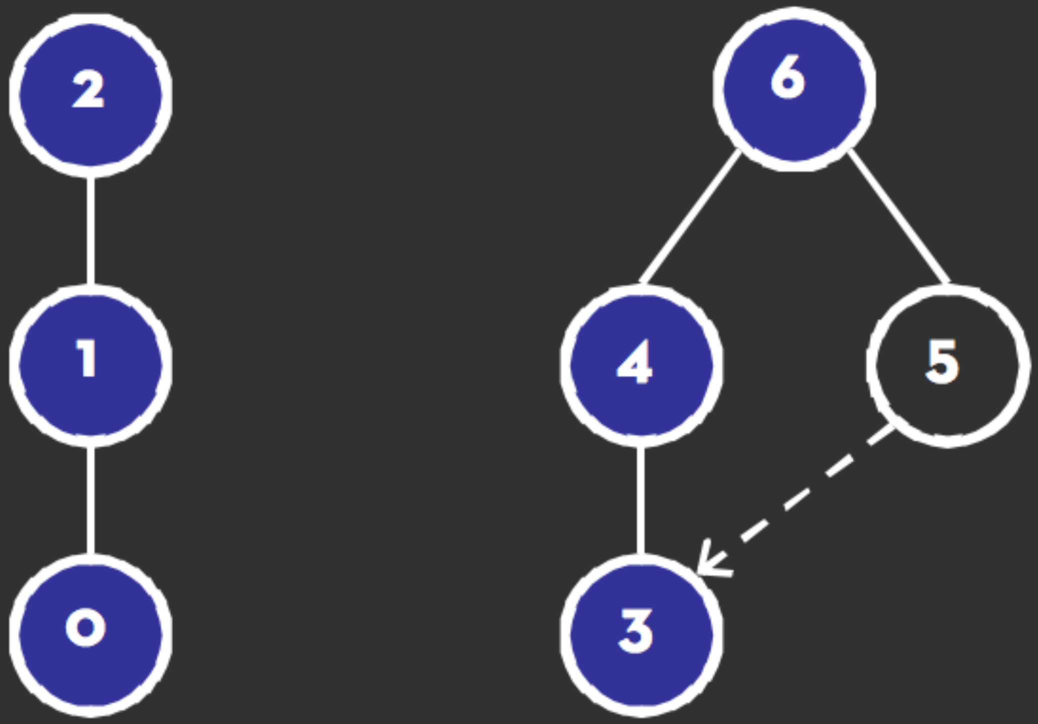
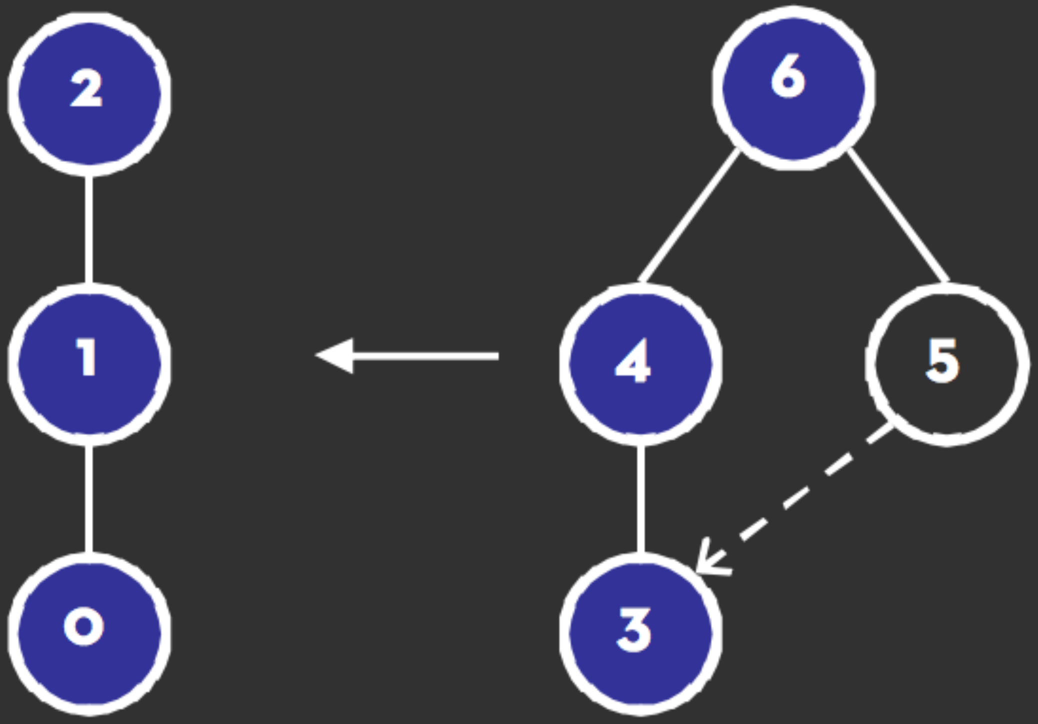
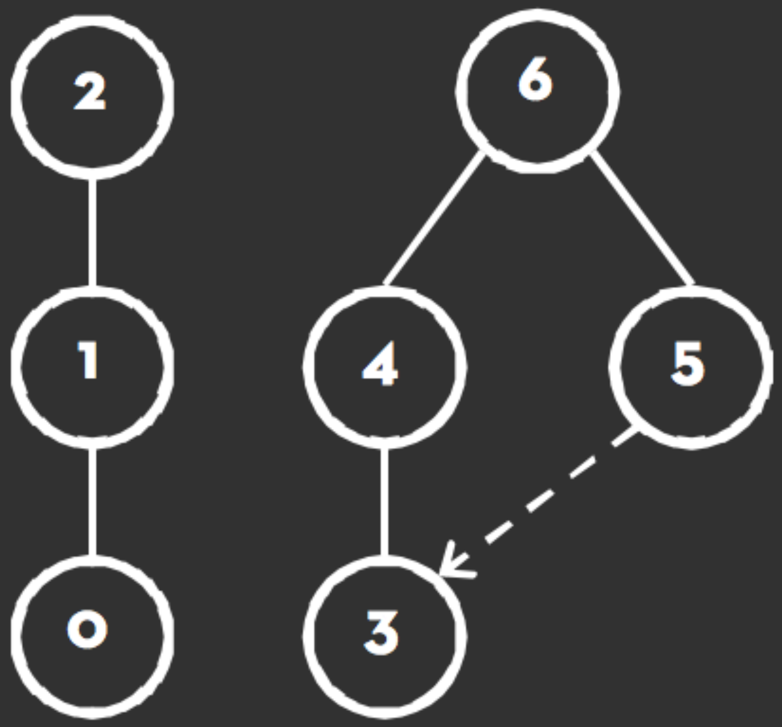


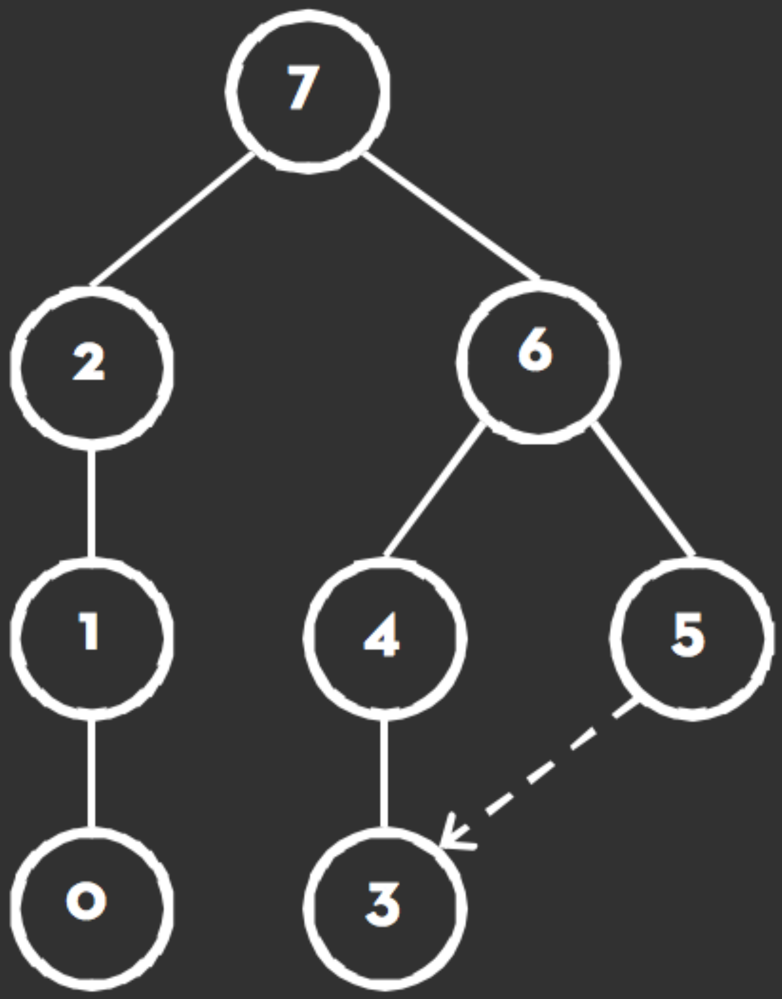
Reingold-Tilford Algorithm



Reingold-Tilford Algorithm



Reingold-Tilford Algorithm



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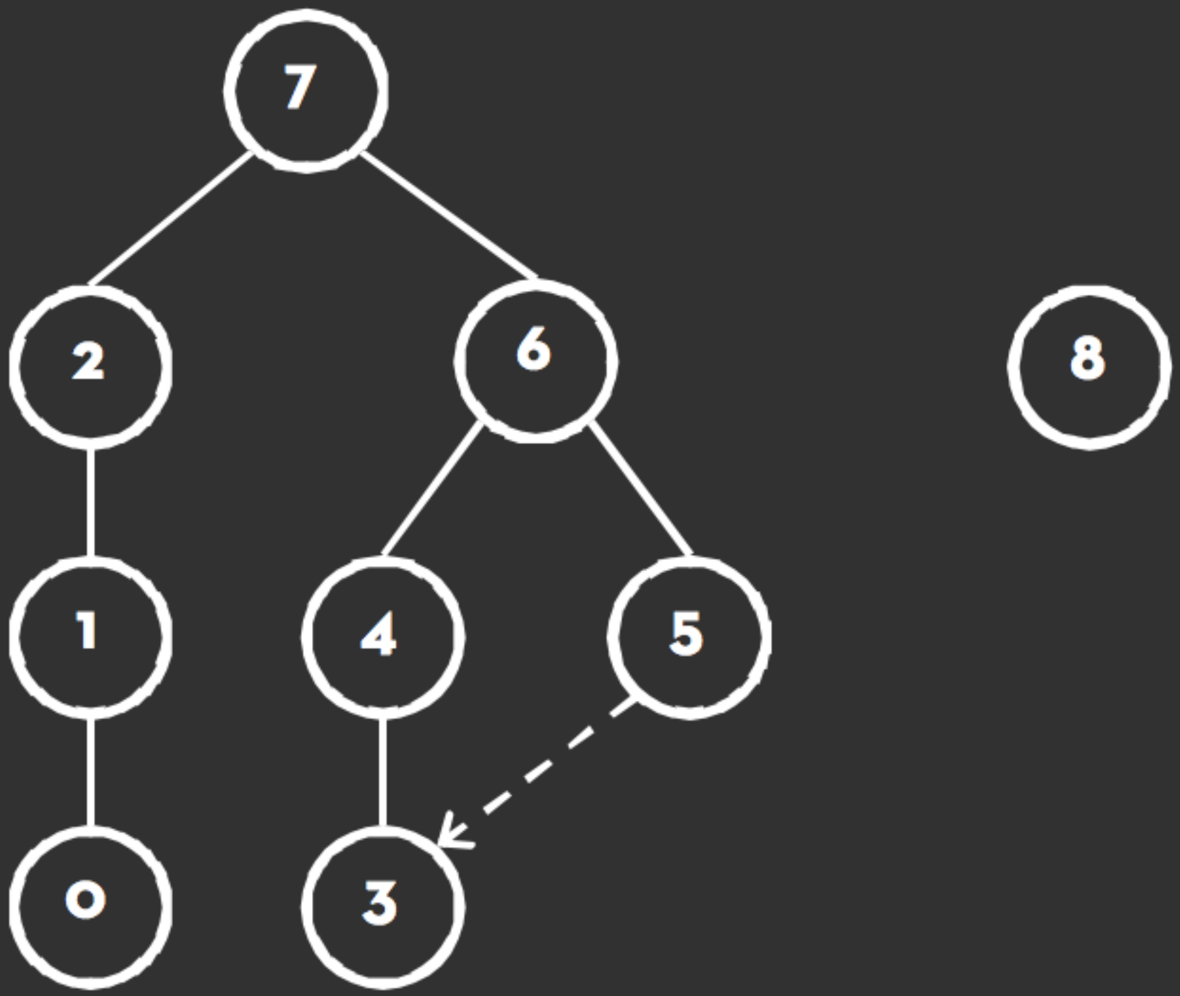

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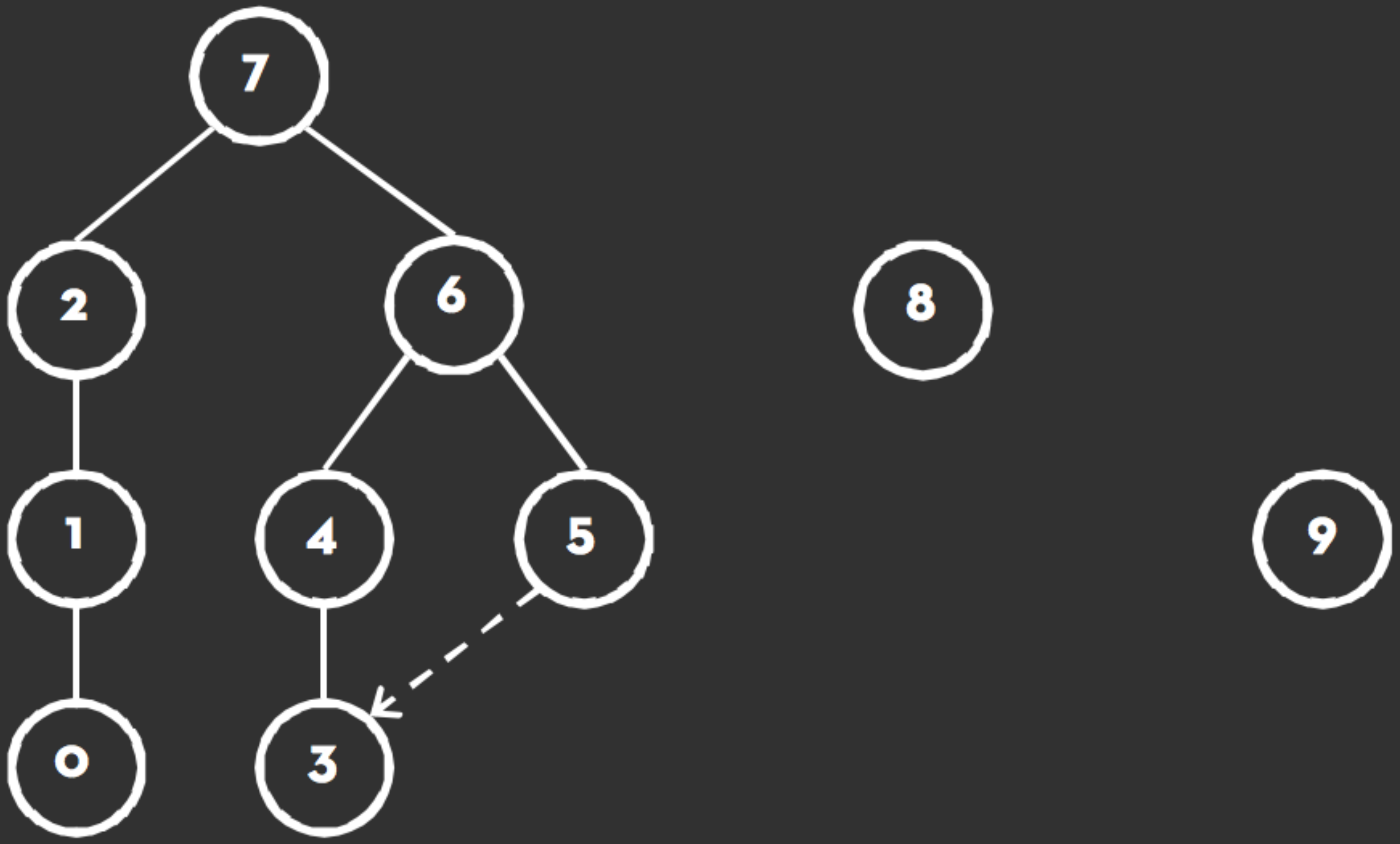

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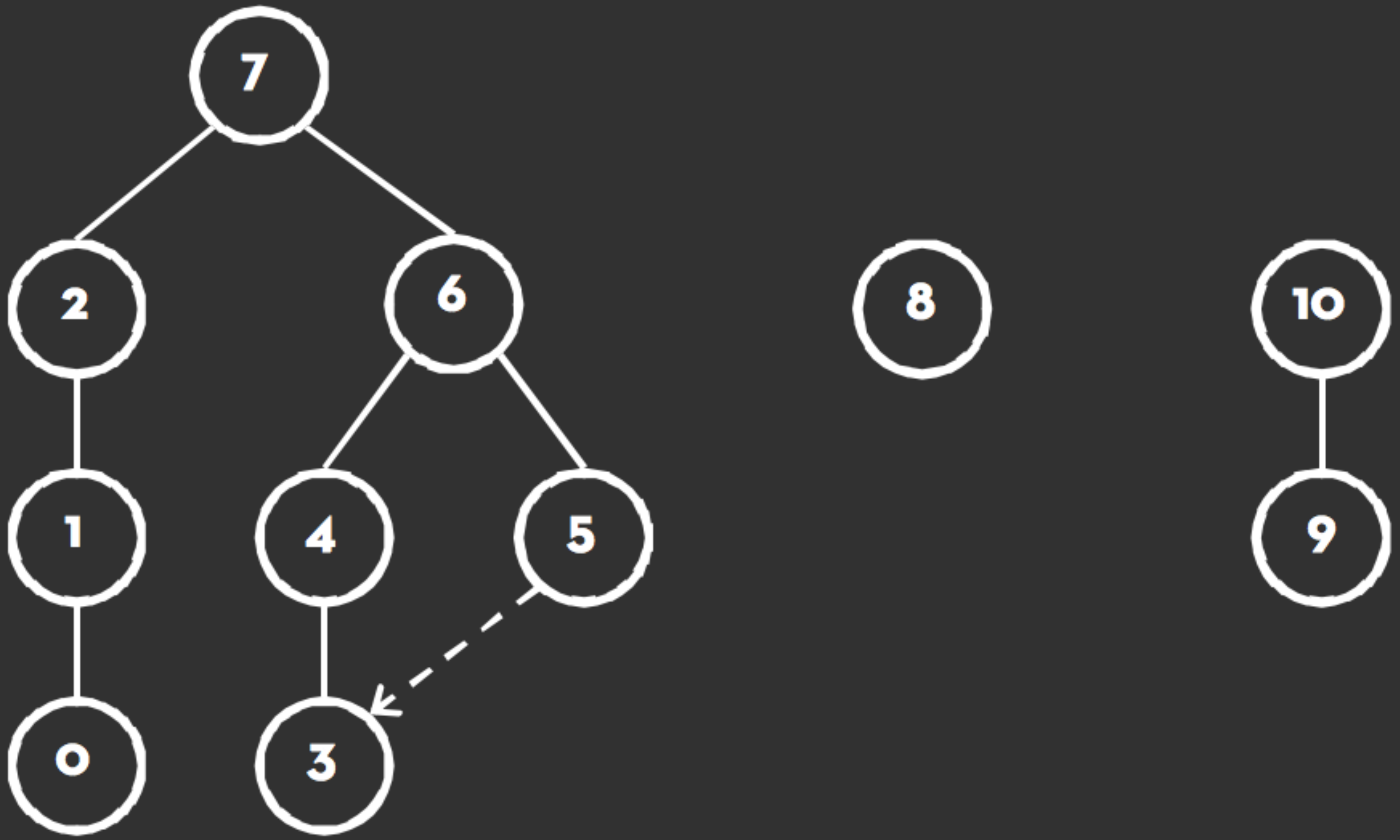

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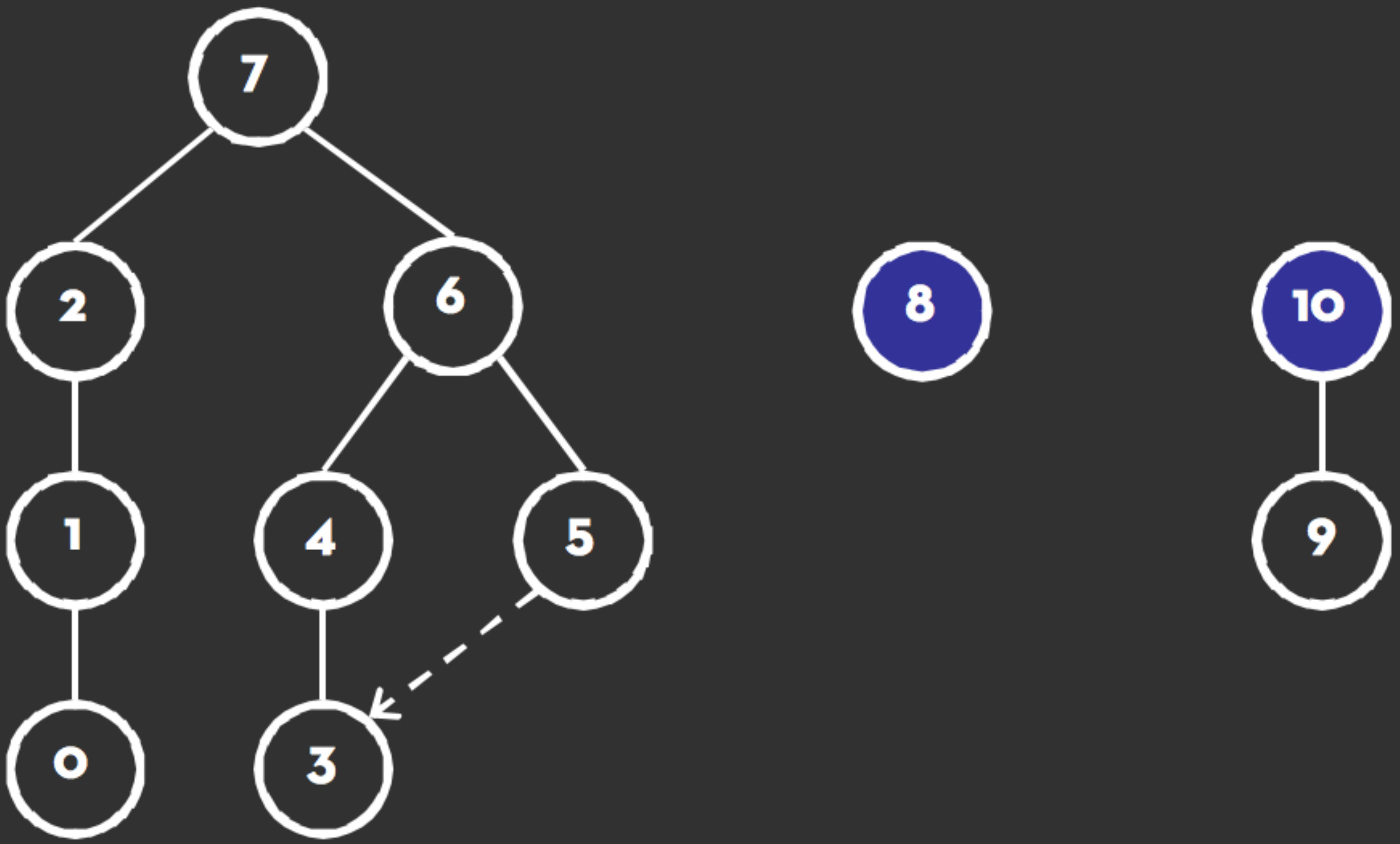

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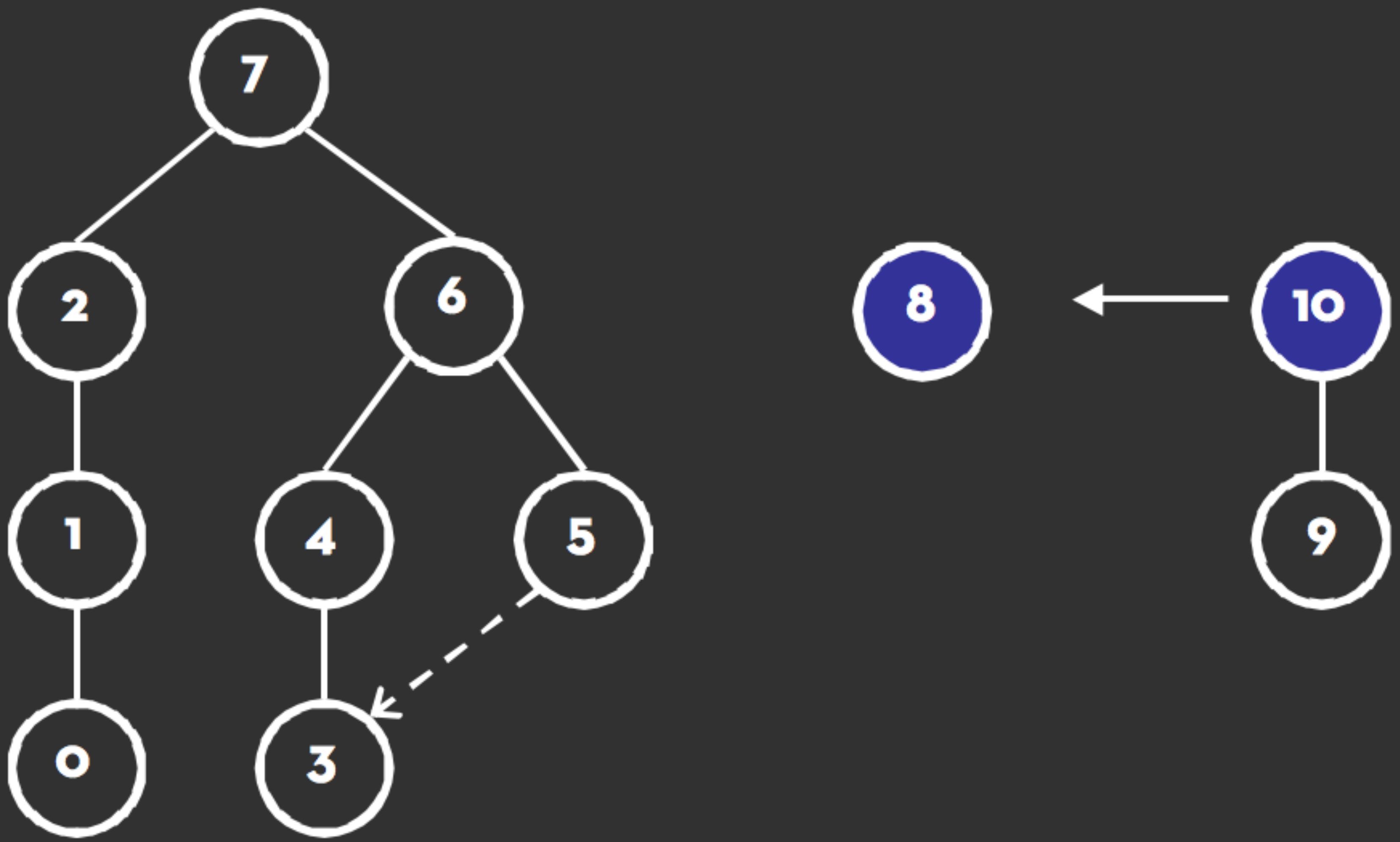

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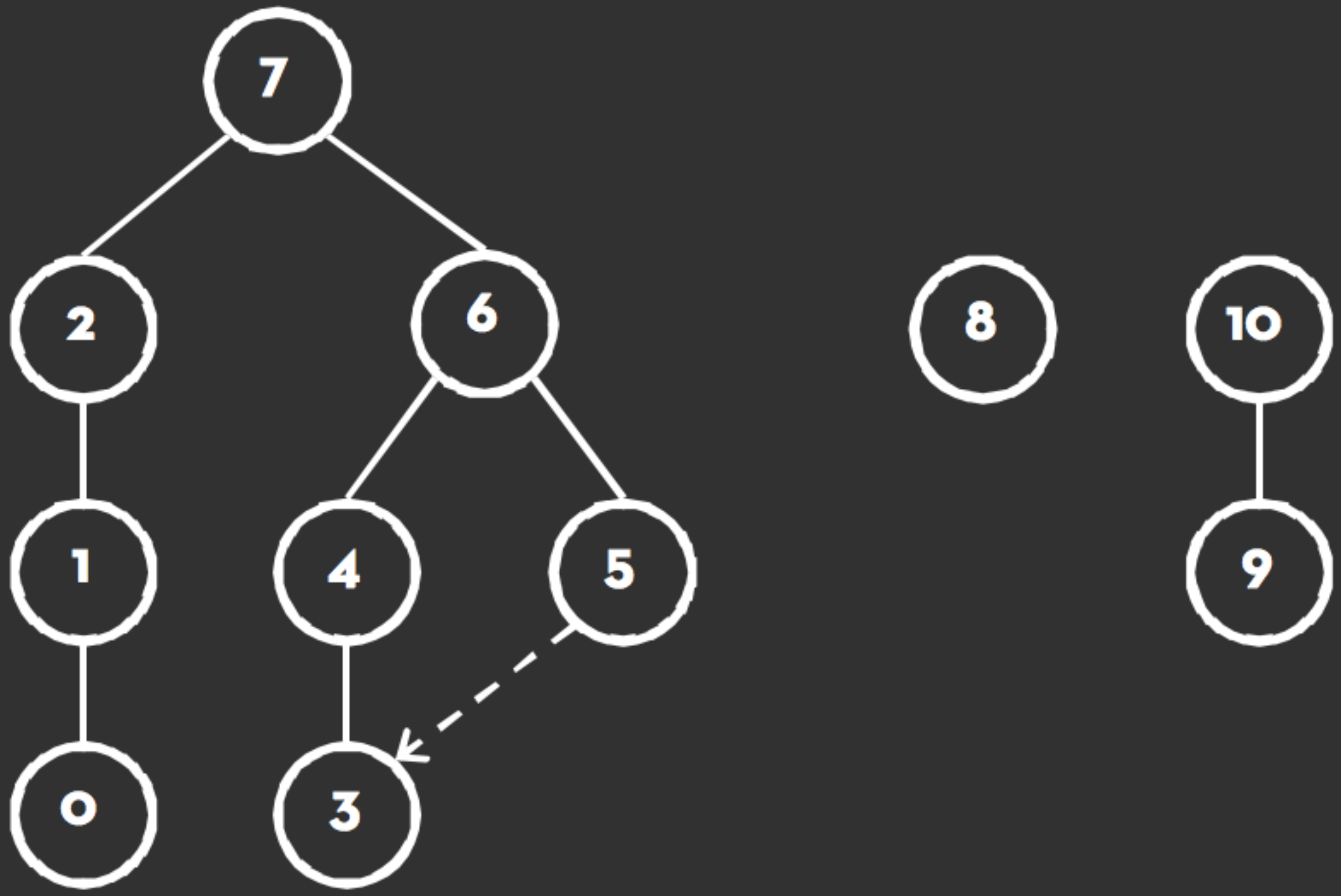

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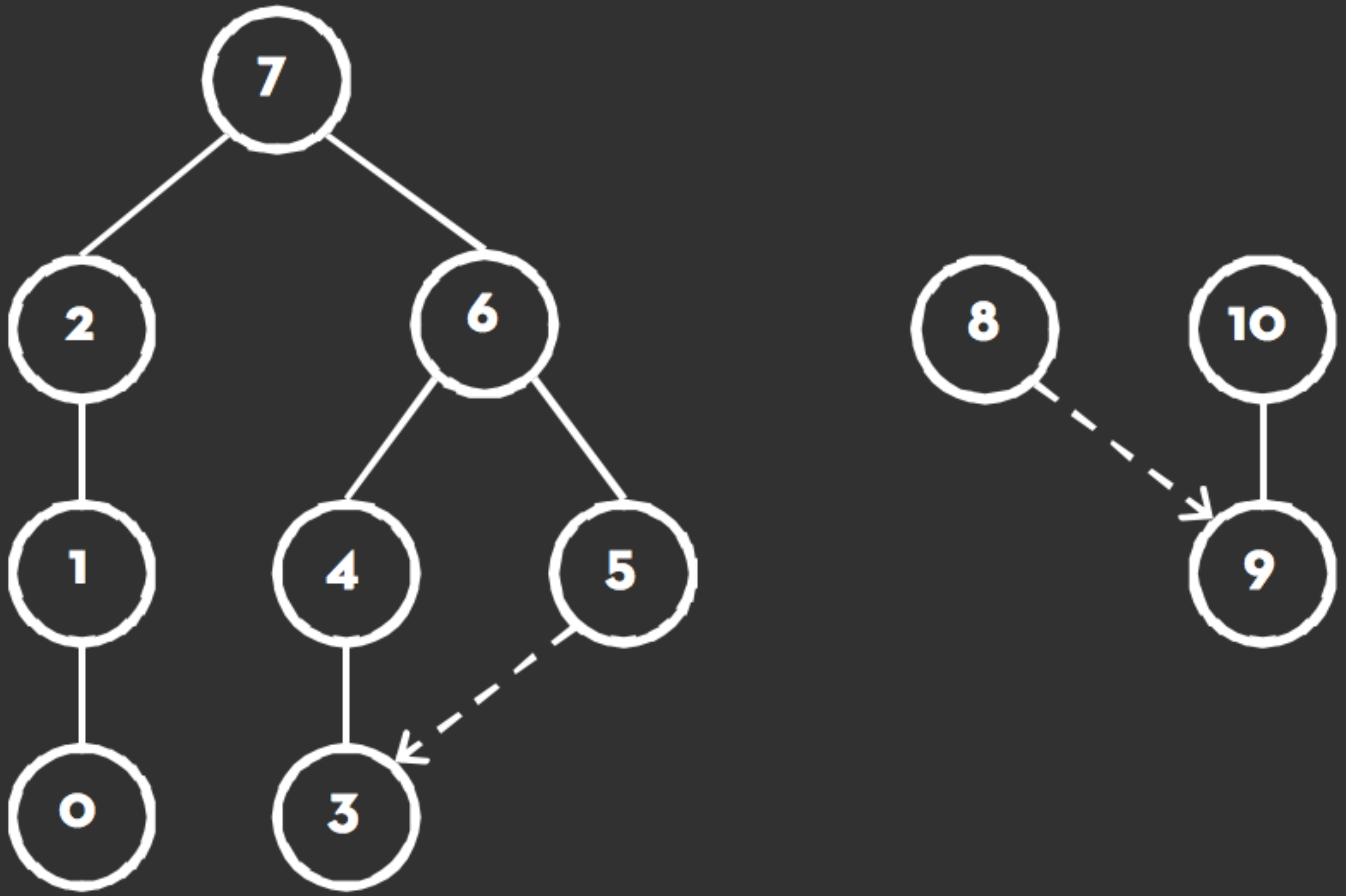

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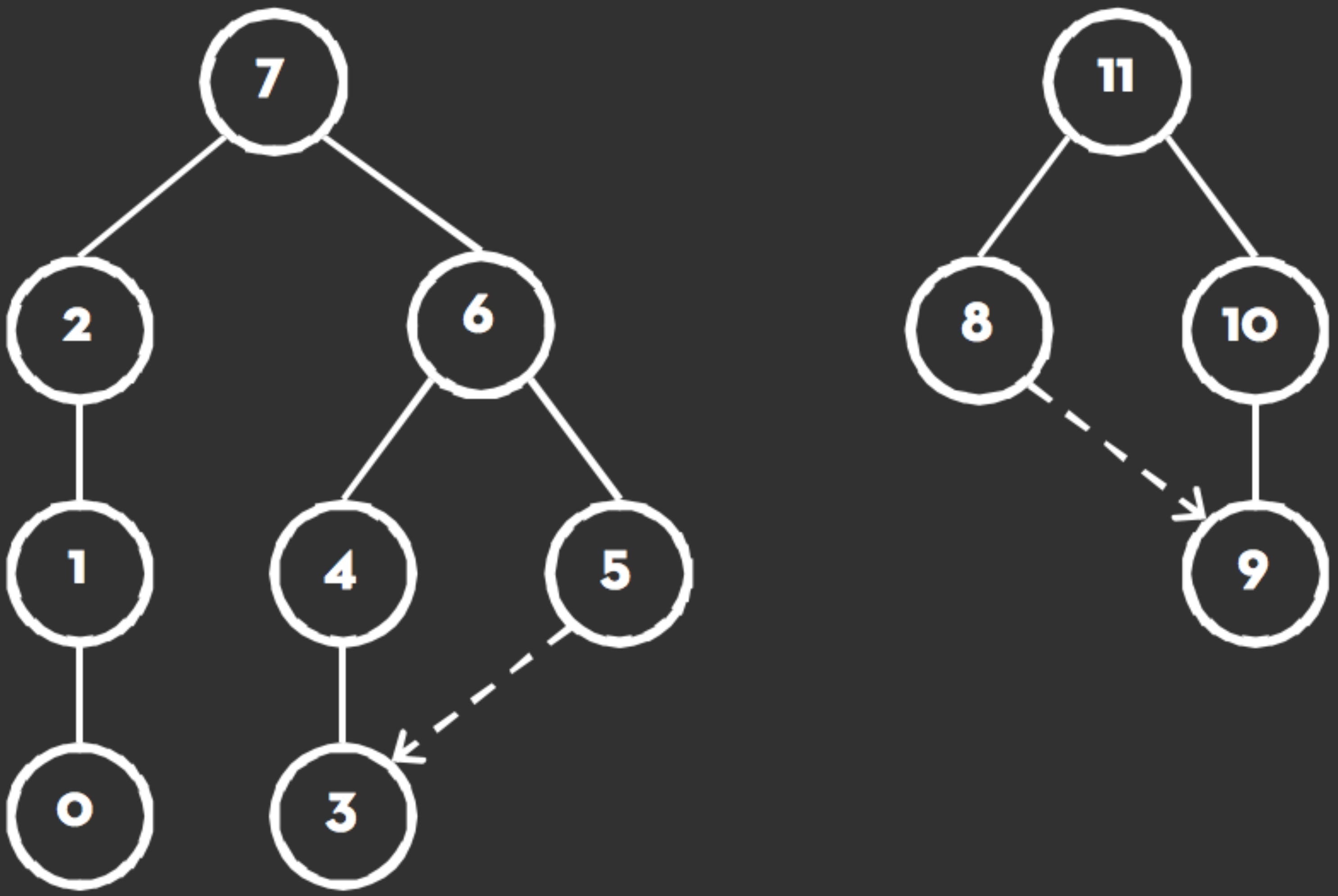

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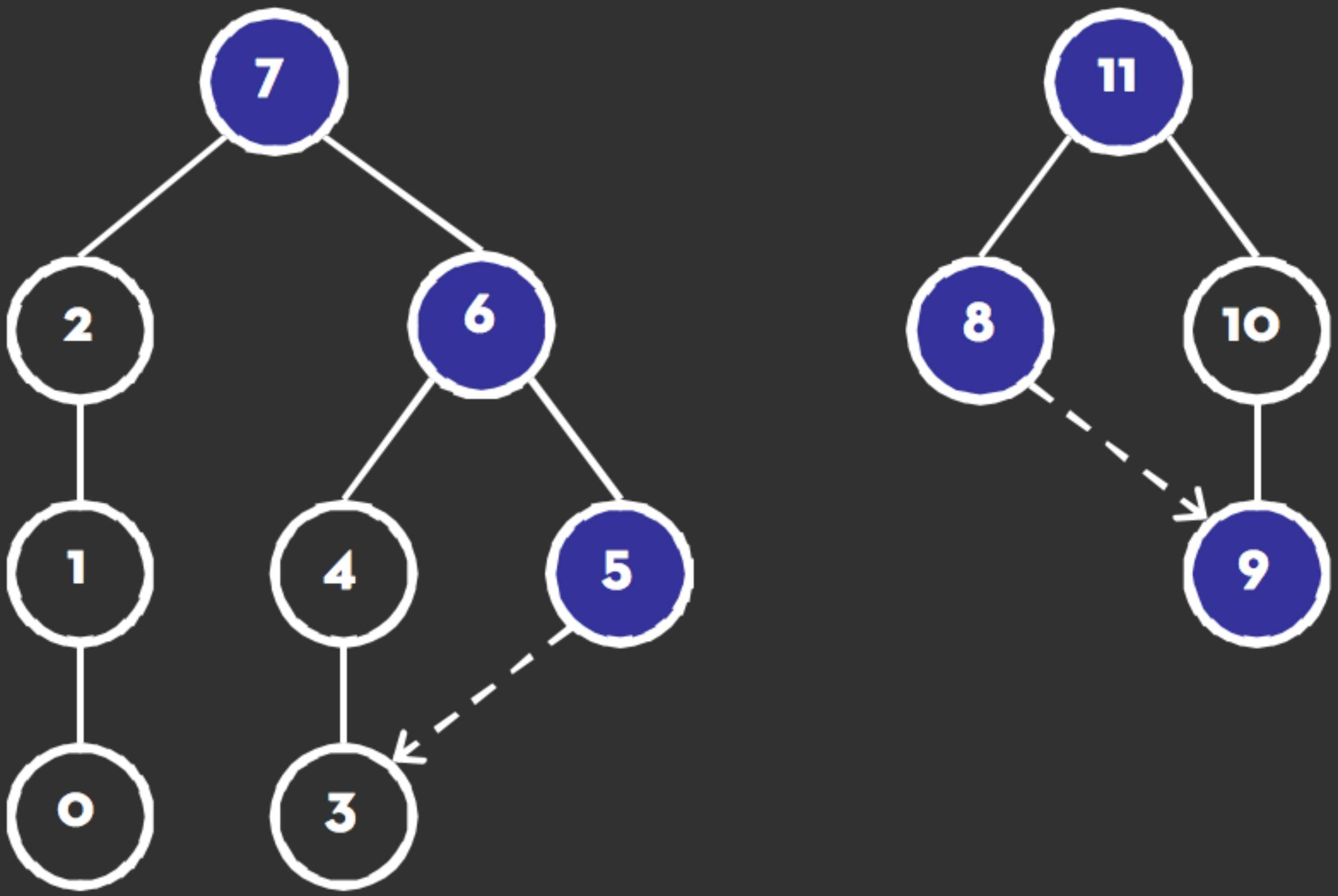

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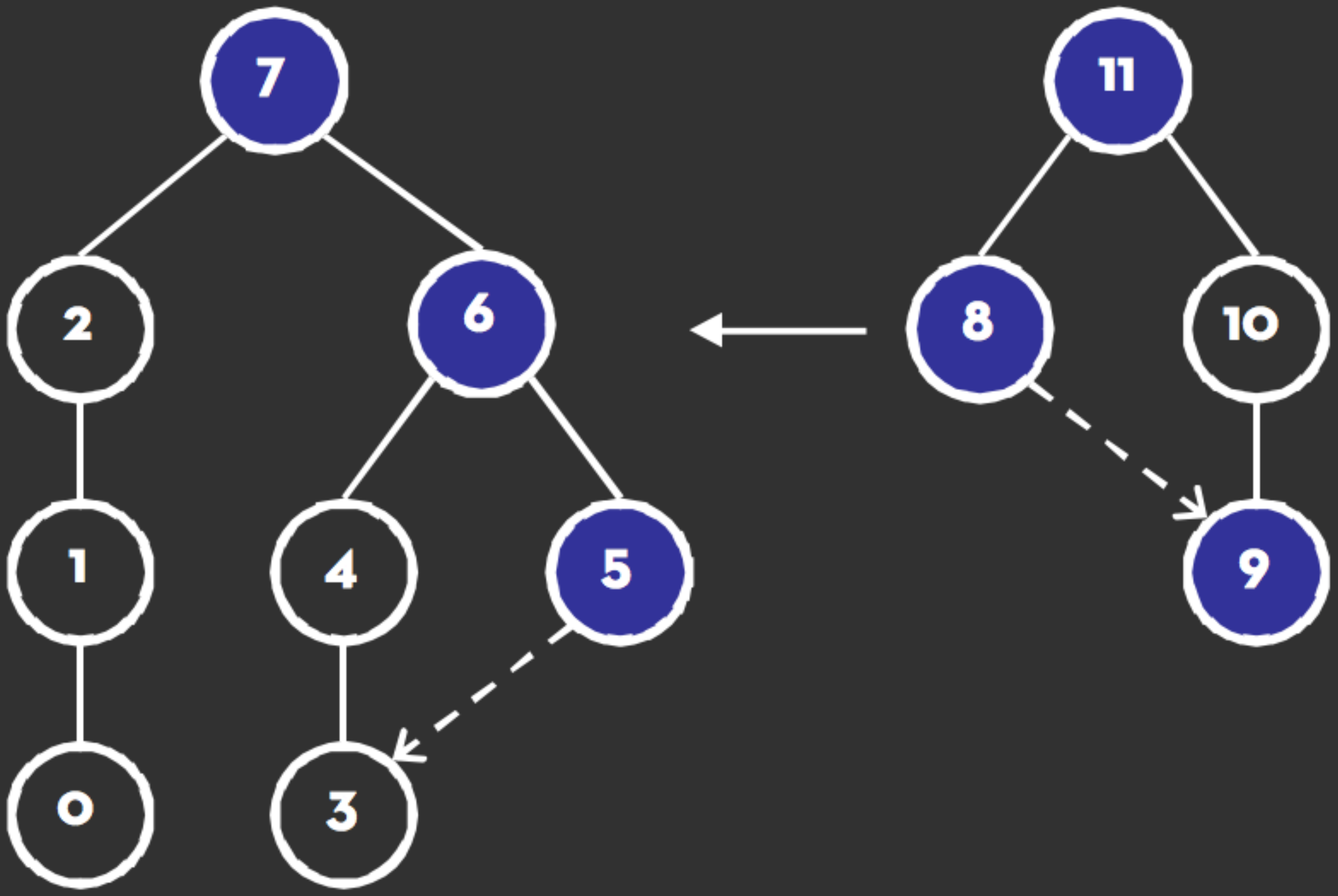

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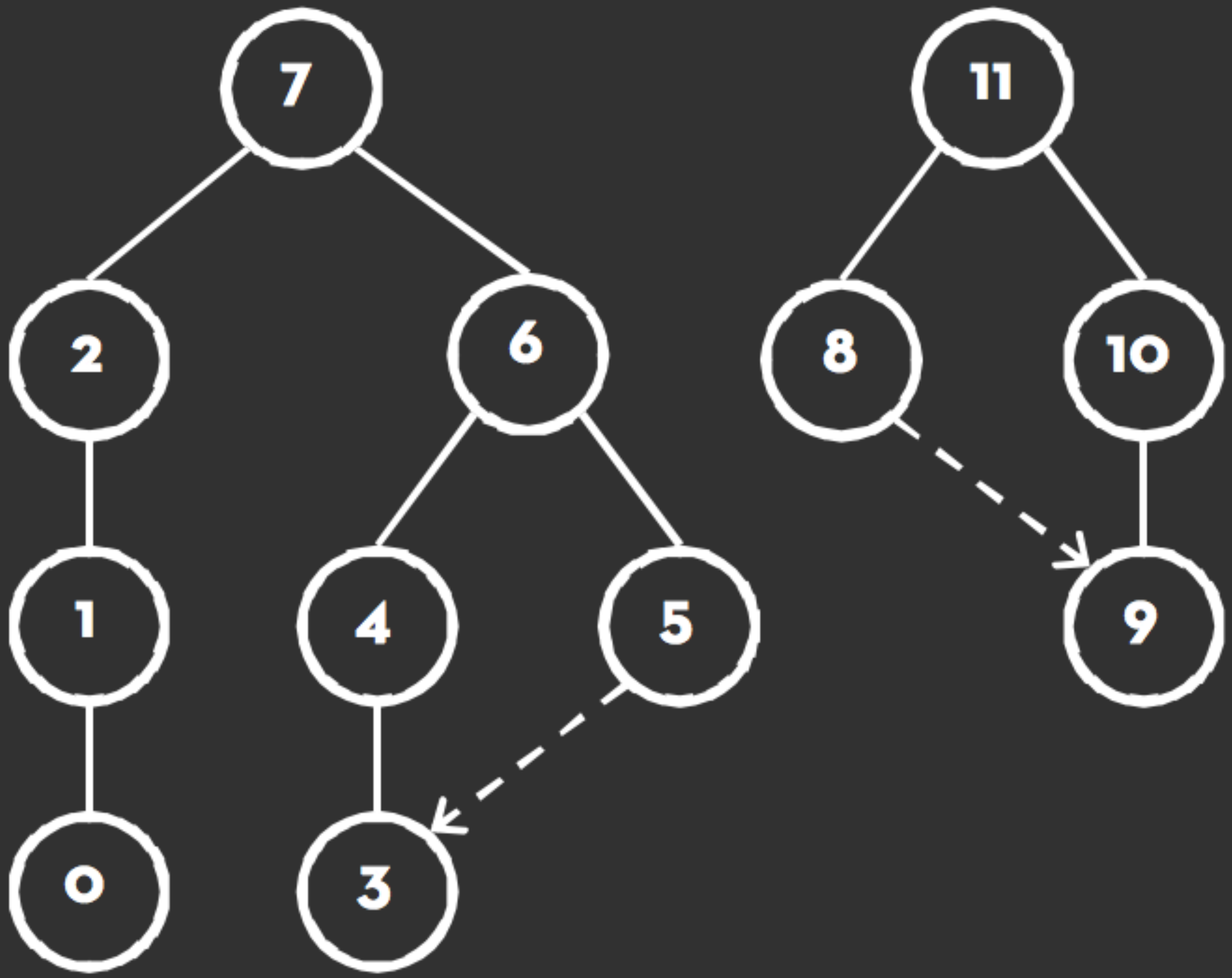

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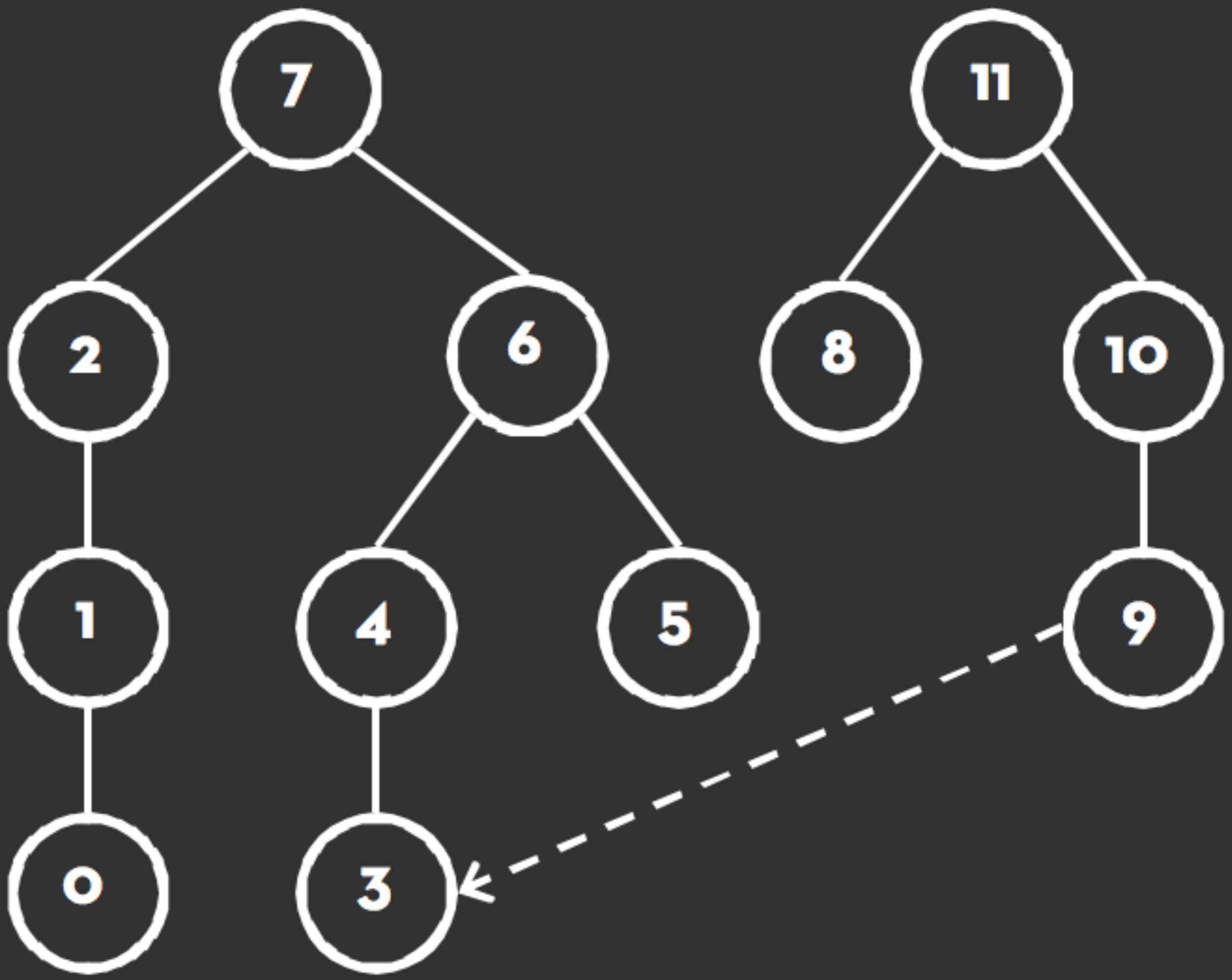

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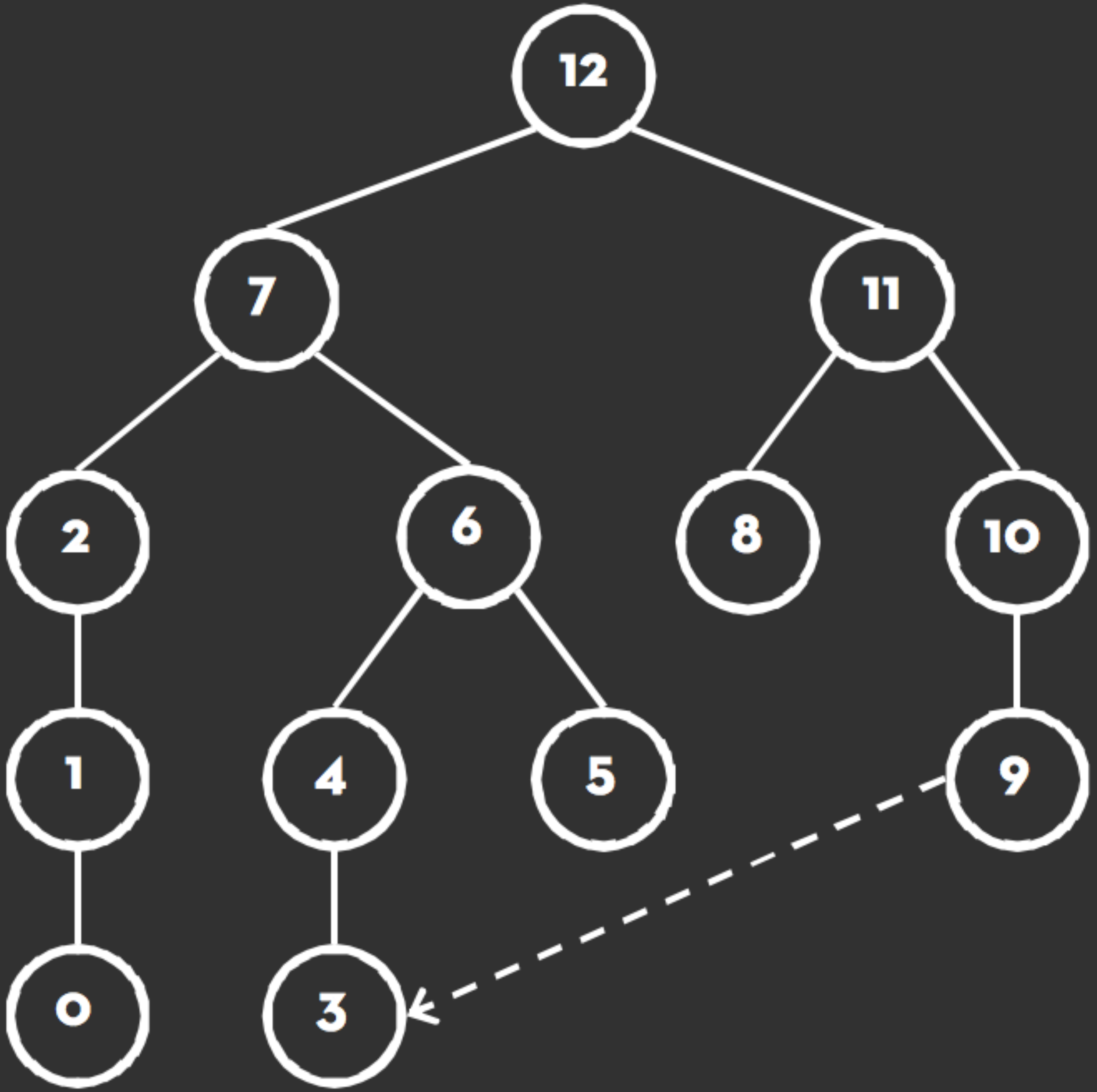


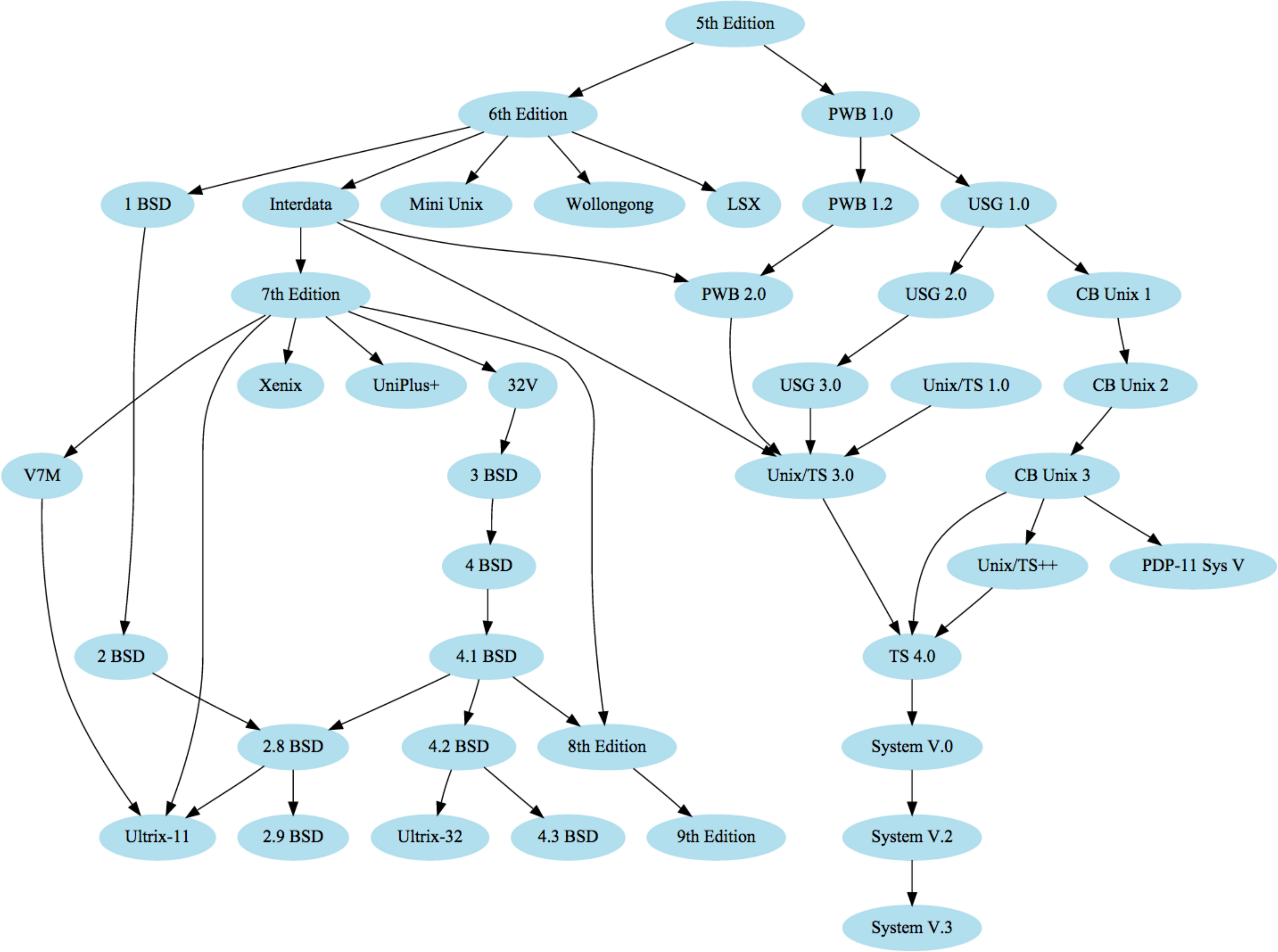
Reingold-Tilford Algorithm

- 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

Not all Hierarchies are Trees

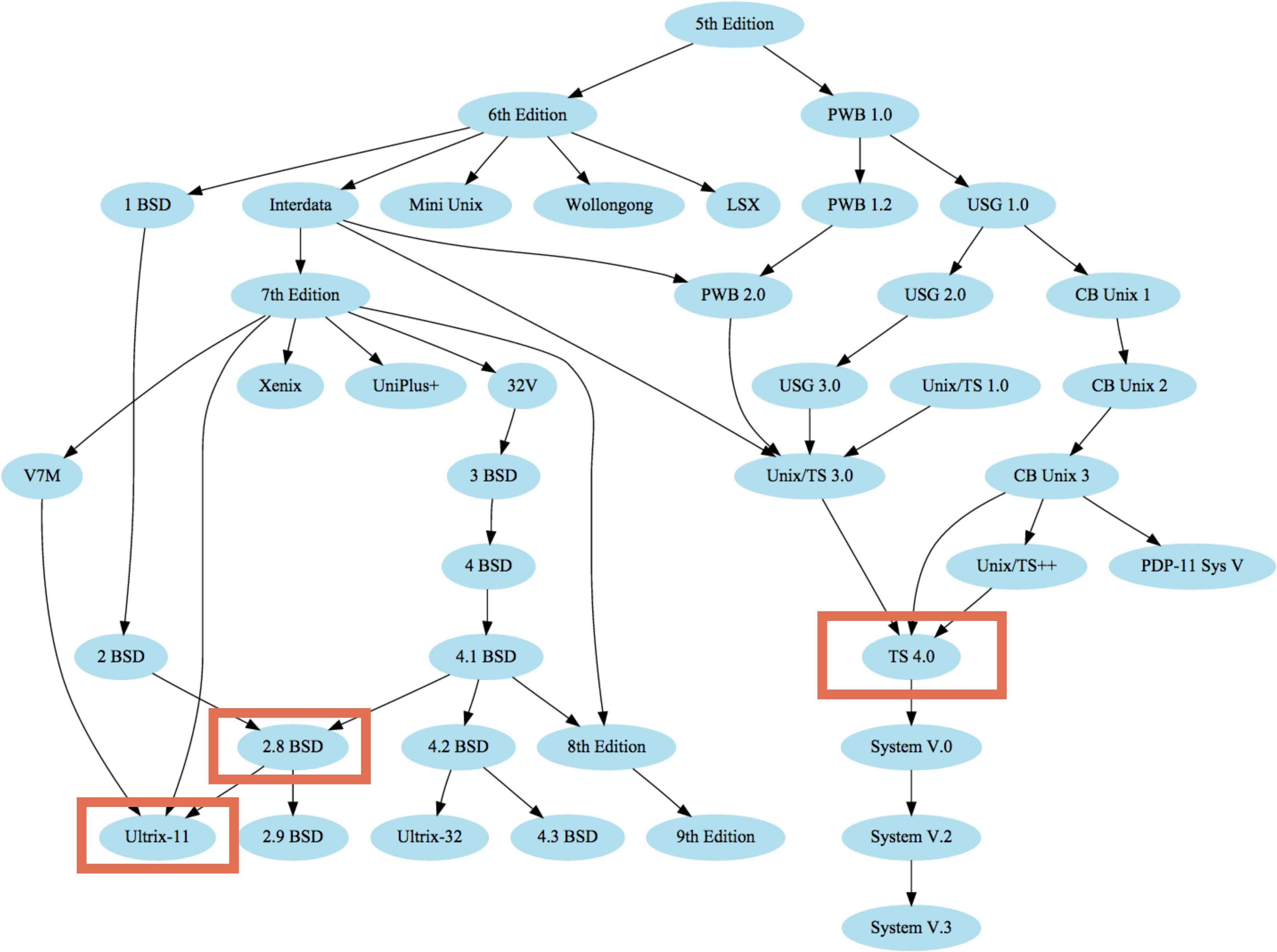
Given what we know about tree drawing, how do we draw a DAG?

The evolution of UNIX



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

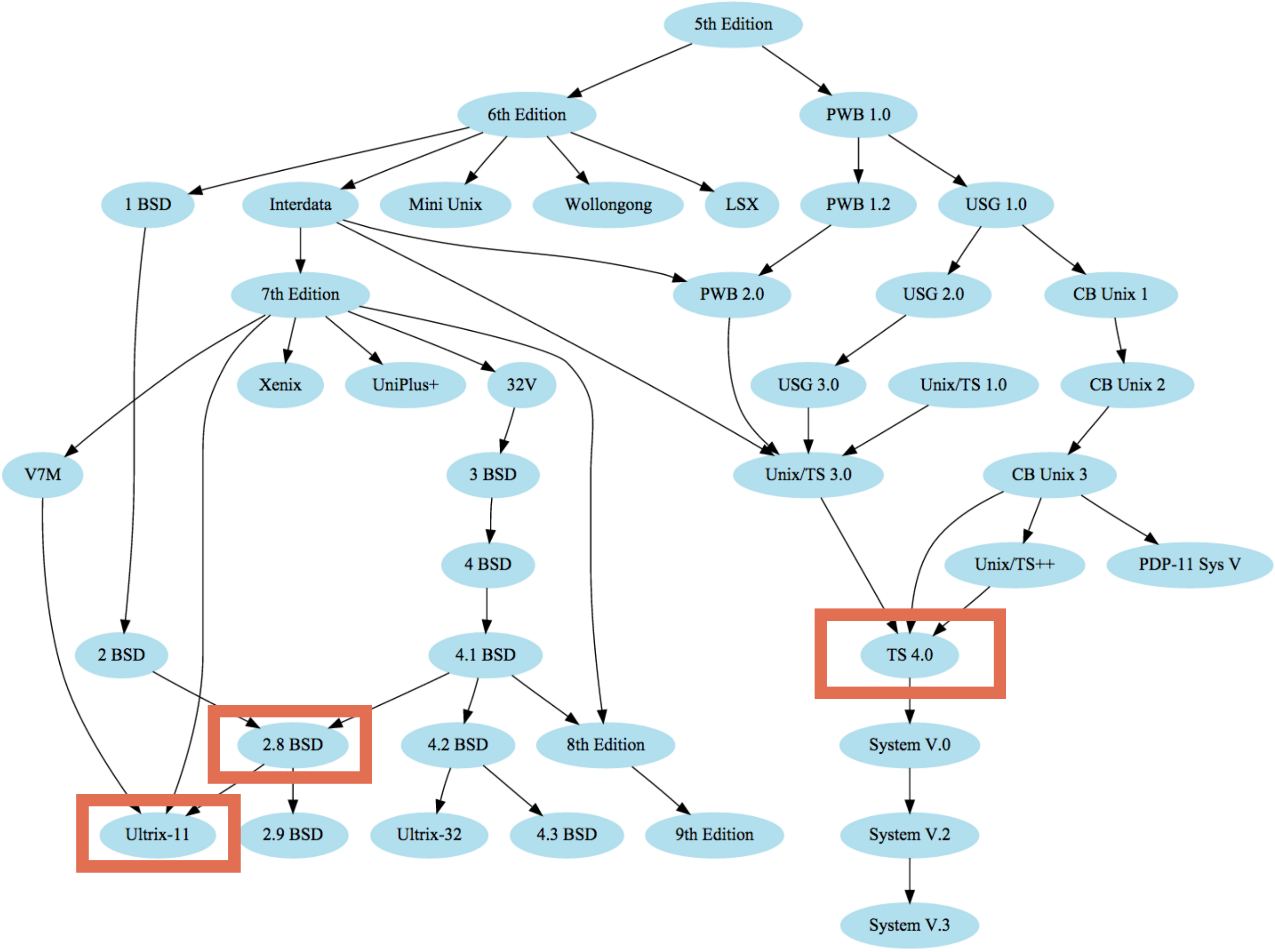
The evolution of UNIX



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

Directed, Acyclic Graphs

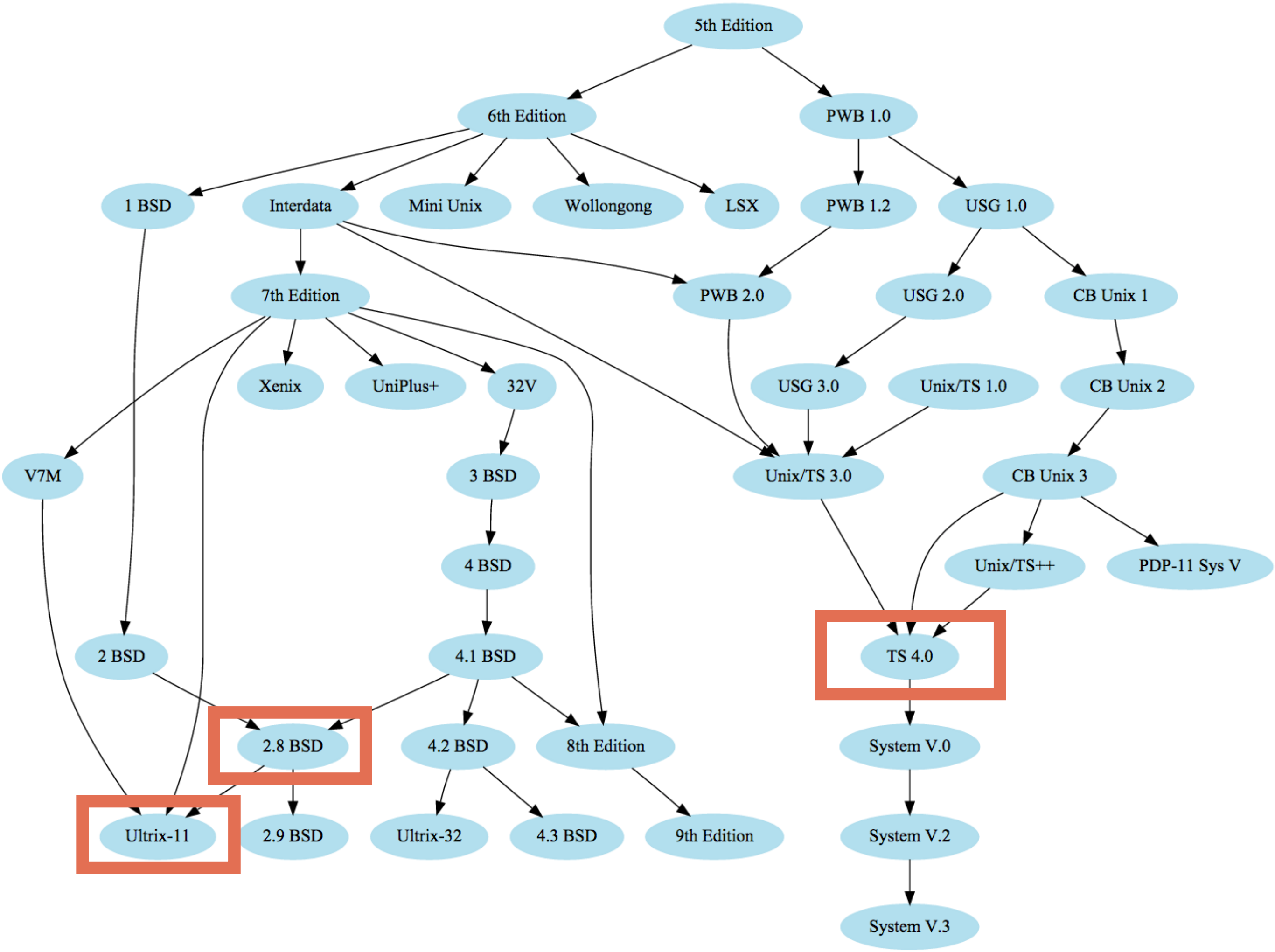
- Like a hierarchy, but "direct ancestor" is not unique



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
- This is known as a “Sugiyama layout” for its inventor
- Gansner et al., *A Technique for Drawing Directed Graphs.* http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=221135

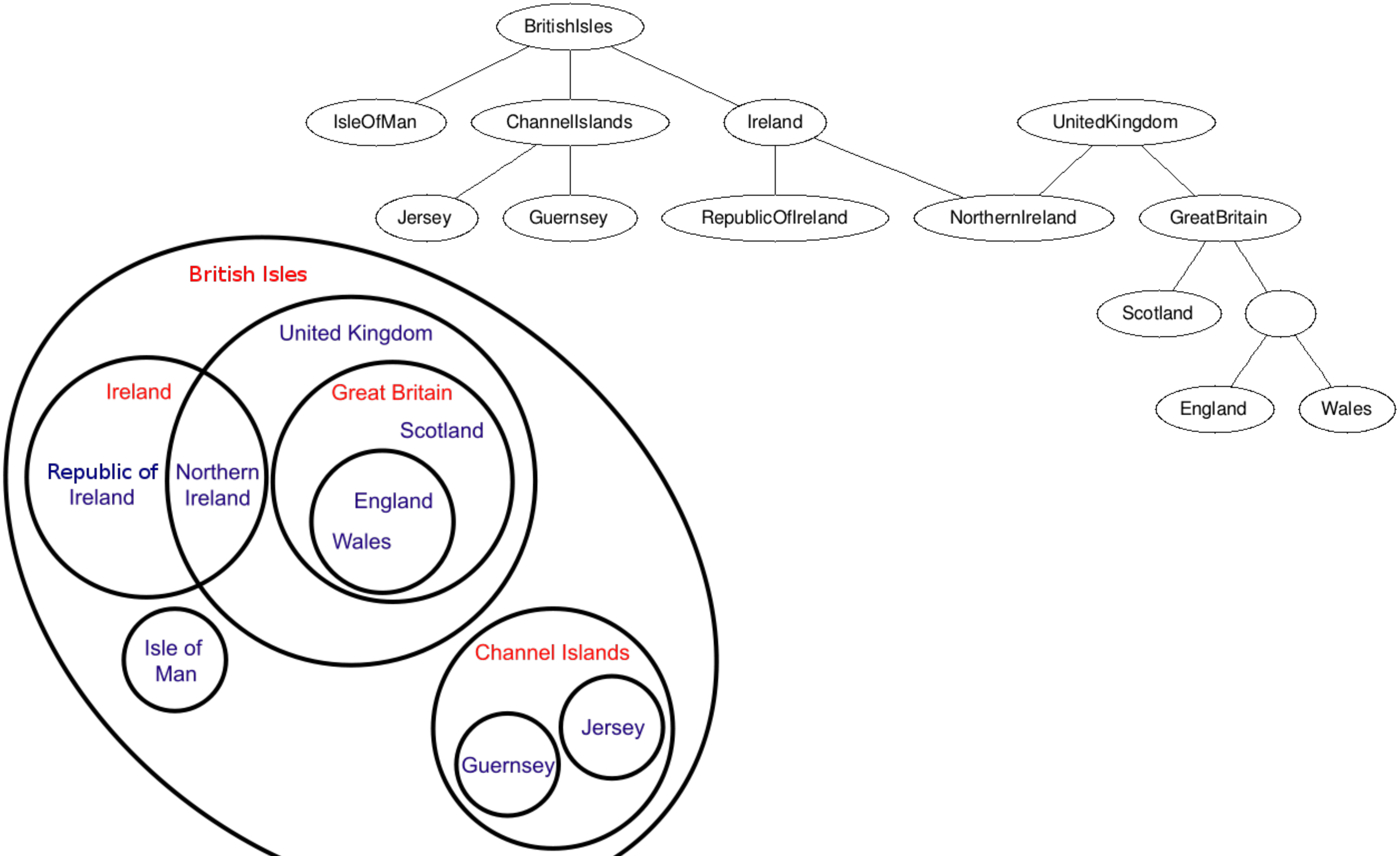
Let’s draw a DAG



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

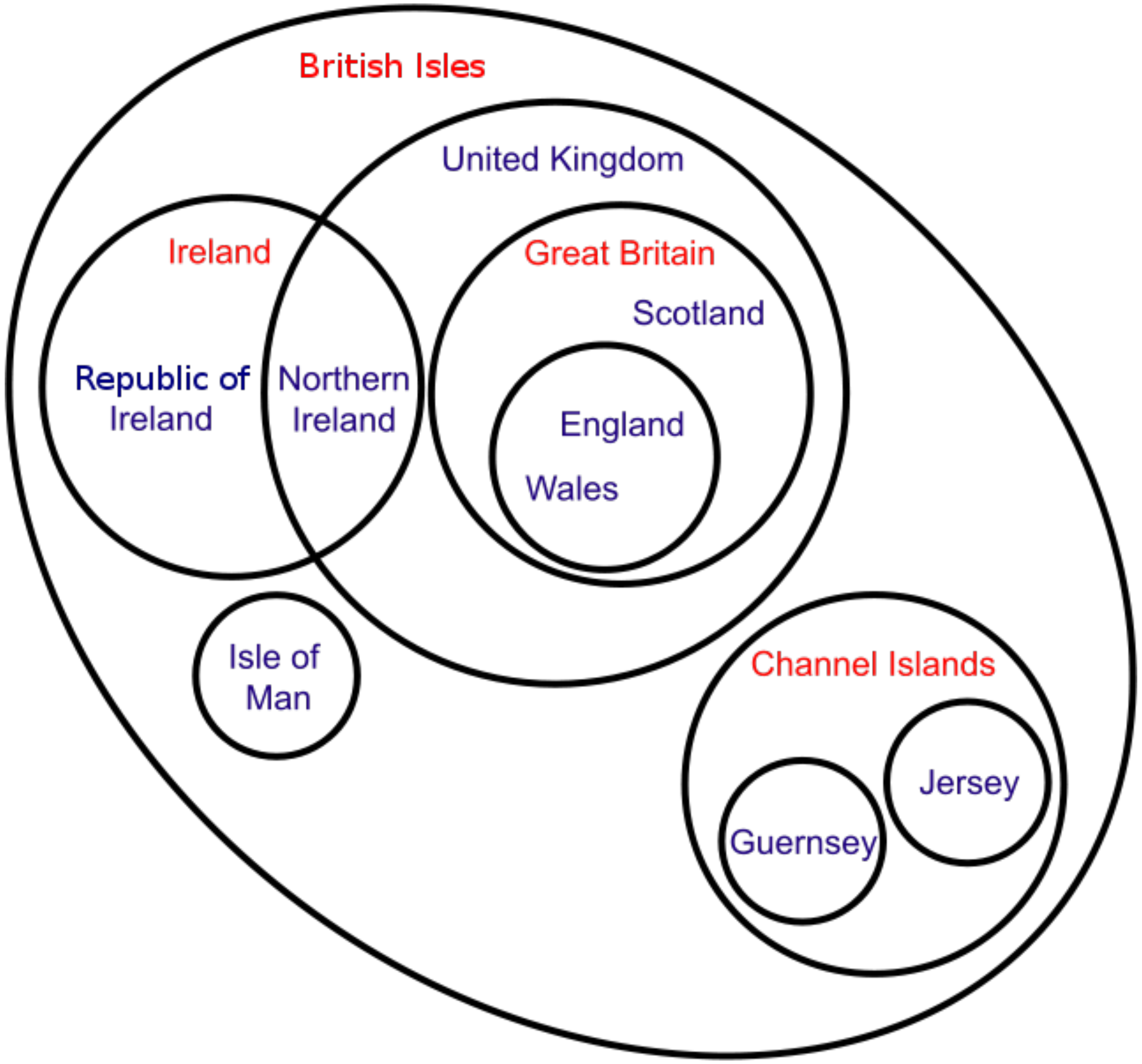
Given what we know about treemaps, can we draw a DAG?

Euler Diagrams (Venn Diagrams)



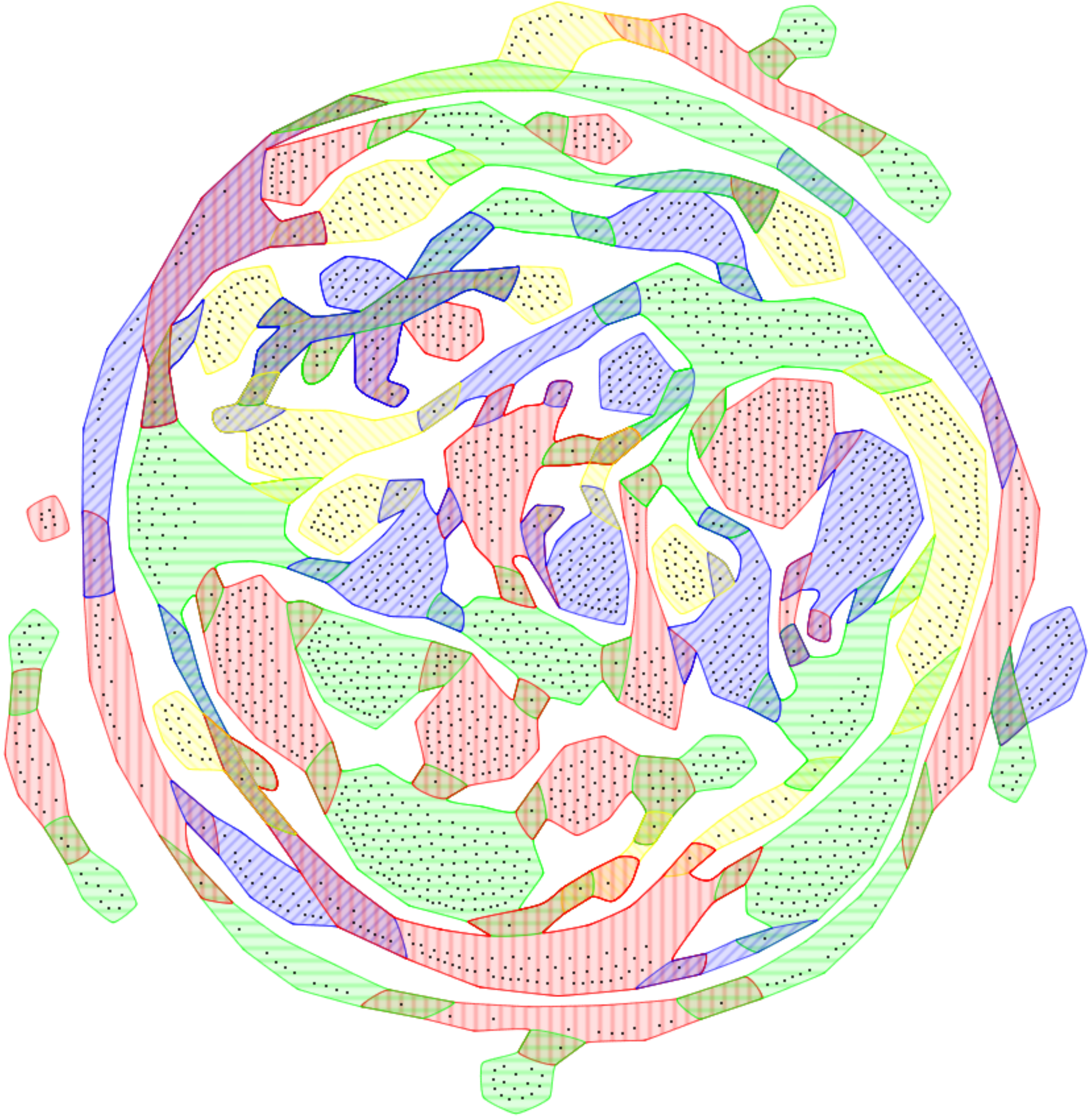
Euler Diagrams

- Represent relationship by containment
- Algorithms are very complicated, tend to produce bad shapes



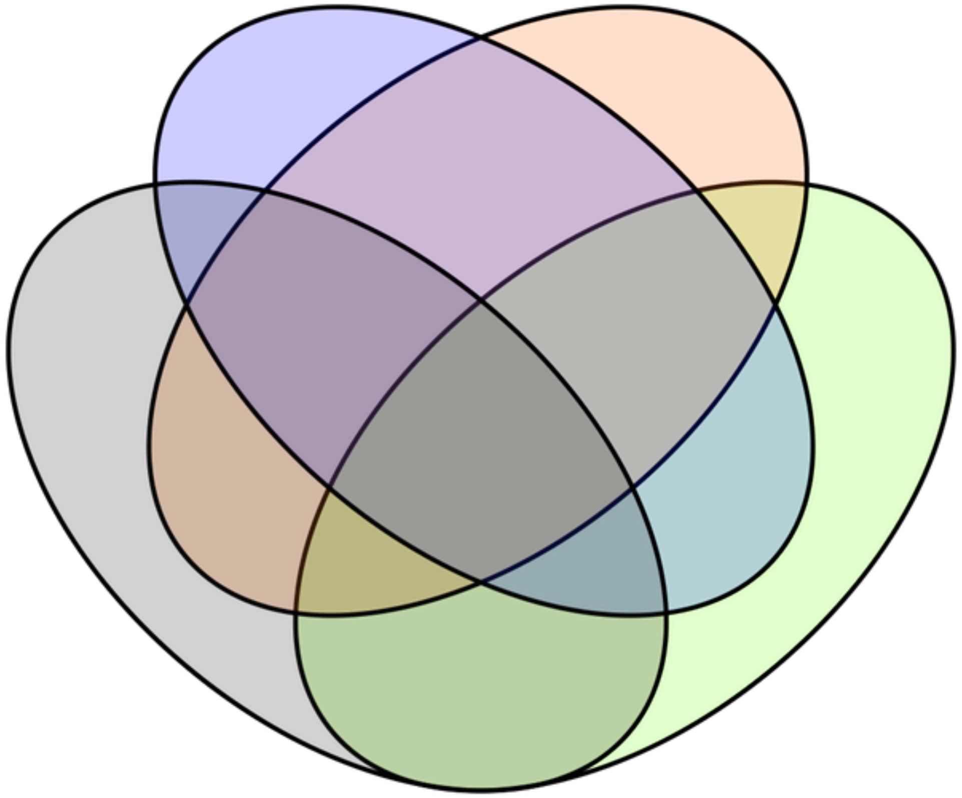
Euler Diagrams

- Doesn’t scale to large diagrams



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

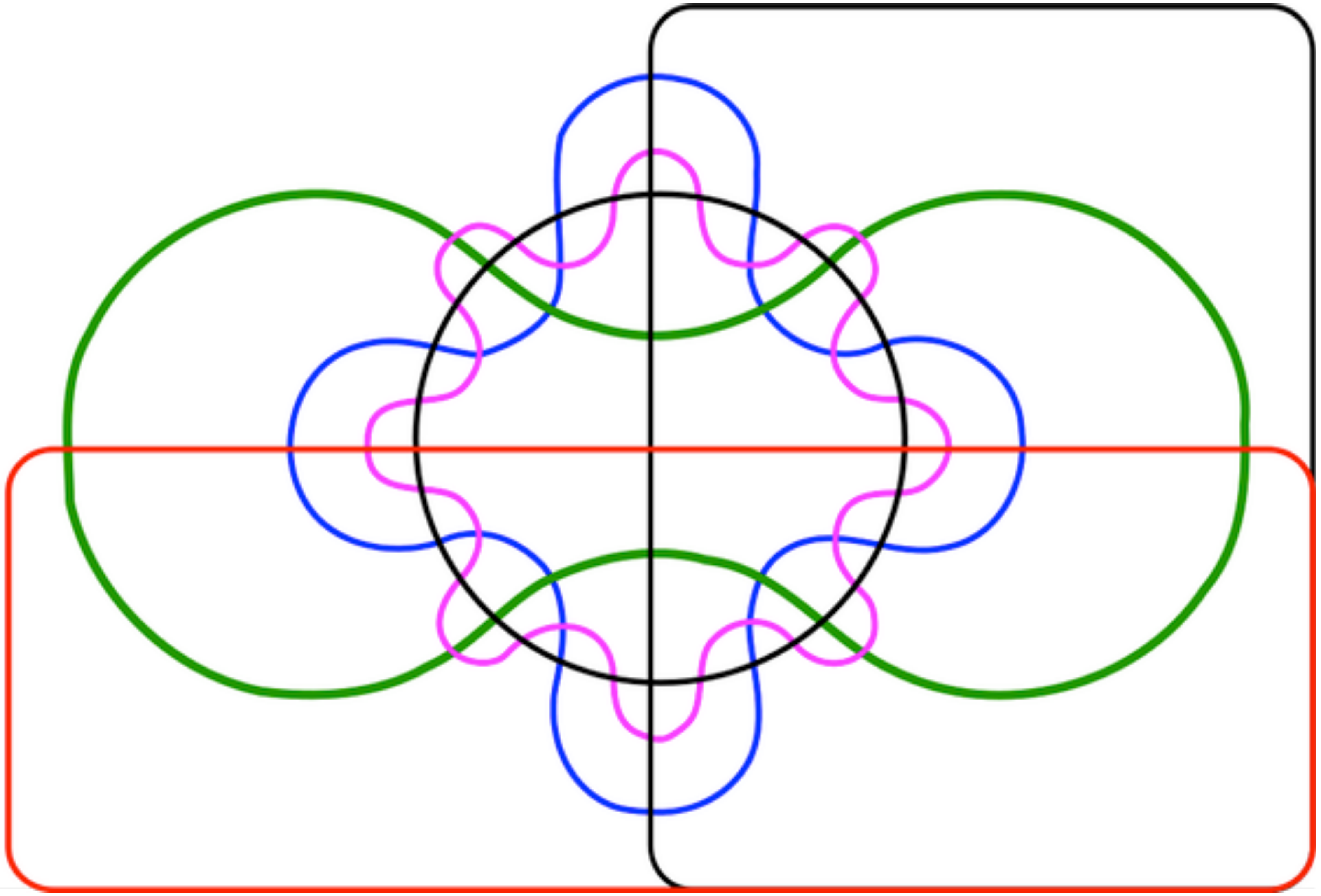
Euler Diagrams



16 regions

- Doesn't scale to “large” diagrams

64 regions



Recap

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