



**Computational Structures in Data Science**

UC Berkeley EECS  
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## Lecture #19: Data Structures: Trees

April 6, 2020 <https://cs88.org>

### Updates

- Updated declaration policies
  - <https://piazza.com/class/hvg0br1u3kx7dg?cid=11615>
  - <https://bit.ly/eecs-piazza> to sign up for “EECS 101”
- If you need help, please reach out.
- Please checkout the midterm survey
  - <https://piazza.com/class/k5ka9pwx0l754?cid=666>
- As a reminder: Private piazza posts are best, since all the staff see them.

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### Computing In The News

How a Real Dog Taught a Robot Dog to Walk

“Instead of coding a mechanical quadruped’s movements line by line, Google researchers fed it videos of real-life pups. Now it can even chase its tail.”

<https://www.wired.com/story/how-a-real-dog-taught-a-robot-dog-to-walk/>



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### Why?

- Trees represent lots of natural structures
  - A boss who has employees report to them
  - Courses which belong to departments, and departments which colleges in a University
  - Anything with a hierarchy, really.
    - » A family tree
    - » Biological taxonomies (Kingdom, Phylum....)
- Trees give us really cool approaches for “divide and conquer”
  - Used in every computer to speed up searching for files
- Another recursive data structure!
  - We can keep practicing recursion and working with classes
- Trees are a simplified form of a graph, a tool which can help us model just about anything.

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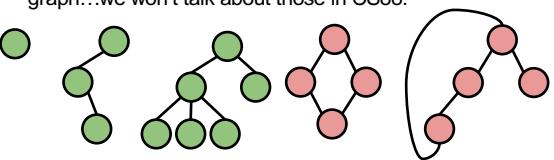
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### What's a tree?

- A set of nodes
- A set of edges or branches
  - Constraint: There is exactly one path between any two nodes

Green structures below are trees. Pink ones are not (right two). A tree with more than one path is a graph...we won't talk about those in CS88.



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### Some Useful Terms

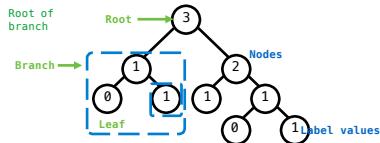
- Entry or Node
  - An item in a tree, it is also a Tree
  - Each one has a value.
- Root
  - The very first item at the top of a tree
- Edges, Branches
  - An implicit connection from one entry to the next

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## Thinking About Trees



**Recursive description (wooden trees):**  
A tree has a **root** and a list of **branches**  
Each branch is a **tree**  
A tree with zero branches is called a **leaf**

**Relative description (family trees):**  
Each location in a tree is called a **node**  
Each node has a **label value**  
One node can be the **parent/child** of another

*People often refer to values by their locations: "each parent is the sum of its children"*

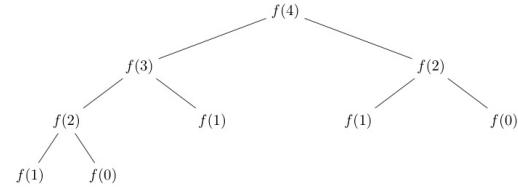
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## Tree Recursion

- $\text{Fib}(4) \rightarrow 9 \text{ Calls}$
- $\text{Fib}(5) \rightarrow 16 \text{ Calls}$
- $\text{Fib}(6) \rightarrow 26 \text{ Calls}$
- $\text{Fib}(7) \rightarrow 43 \text{ Calls}$
- $\text{Fib}(20) \rightarrow$



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