

CSCI 136:  
Data Structures  
and  
Advanced Programming

Lecture 23

Trees, part 2

Instructor: Dan Barowy

**Williams**

Topics

Tree terminology

Your to-dos

1. Read **before Wed**: Bailey, Ch 14.4.
2. Lab 7 (partner lab), **due Tuesday 11/8 by 10pm**.

Announcements

**CSCI 136 final exam**  
Saturday, December 17 at 1:30pm  
Room TBD

## Tree ADT

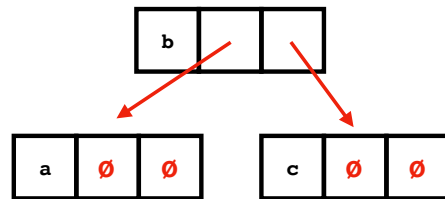
A **tree** is a recursive data structure that stores information hierarchically. A tree is either:

- **empty** (i.e.,  $\emptyset$ ), or
- a **node** containing a **value** and references to one or more **trees**.

The empty tree:

$\emptyset$

A non-empty **binary** tree:

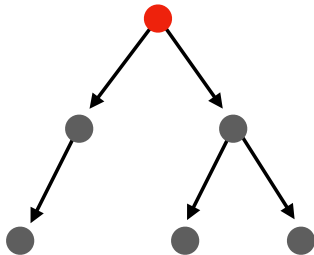


## Binary Tree

Let's implement this together.

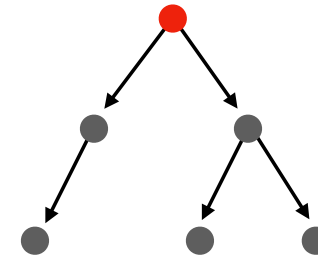
## Terminology

The topmost node is called the **root**.



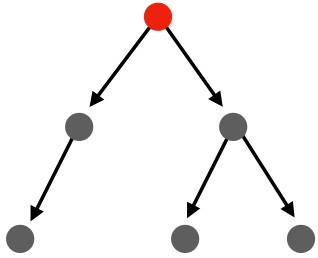
## Properties of trees

**Connected:** every node in a tree is **reachable** by following a single unique **path** starting from the **root** node.



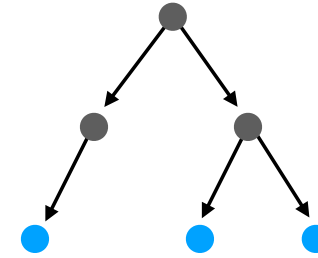
## Properties of trees

# edges: a tree having  $n$  vertices always has  $n-1$  edges.



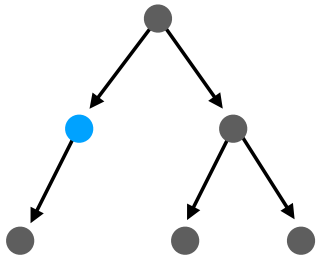
## Terminology

The nodes at the bottom of a tree are called **leaves**.



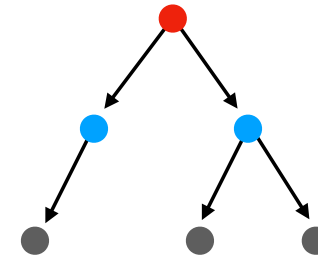
## Terminology

Any node that is not a leaf is an **interior node**.



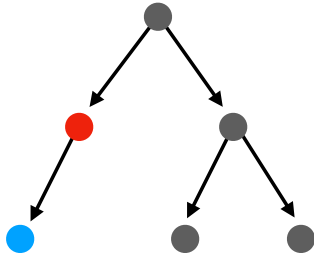
## Terminology

A **node** may have **children**.



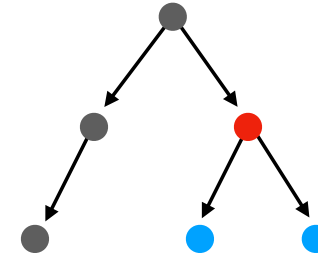
## Terminology

A **node** may have **children**.



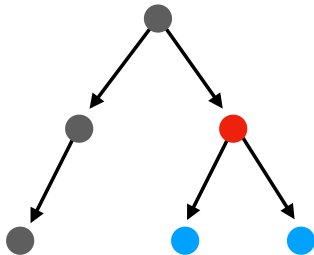
## Terminology

A **node** may have **children**.



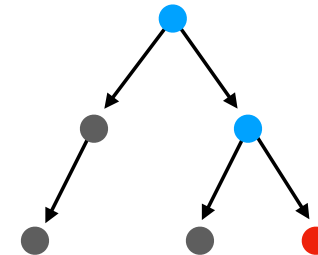
## Terminology

A **node** that has **children** is called the **parent** of those children.



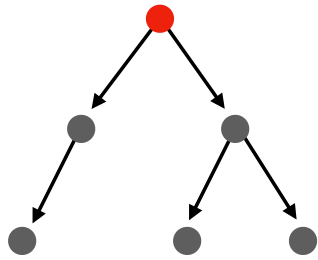
## Terminology

For a **given node**, all of the nodes above it are called **ancestors**.



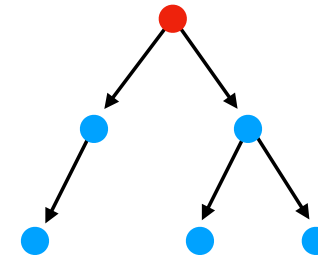
## Properties of trees

**Single ancestor:** every node in a tree has at most one ancestor.



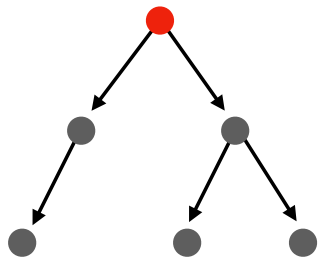
## Terminology

For a **given node**, all of the nodes below it are called **descendants**.



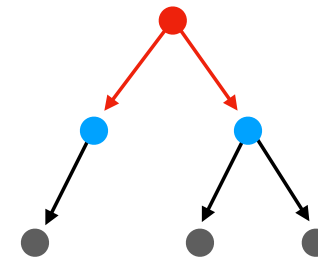
## Properties of trees

**Subtrees:** the descendants of every tree (except the empty tree) are also trees.



## Terminology

The **degree** of a tree is the maximum number of **children** had by any node.

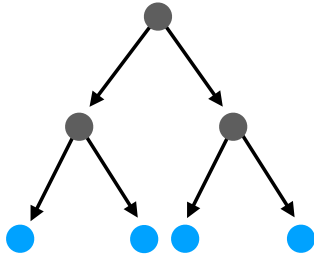


Degree of this tree: 2

Degree 2 trees are common: we call them **binary trees**.

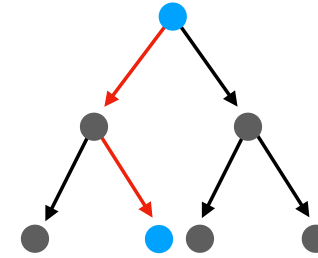
## Terminology

A tree that is missing no leaves is **full**.



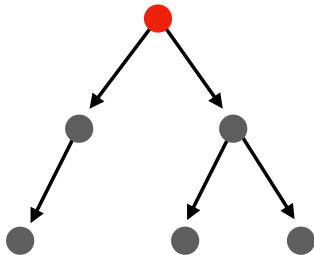
## Terminology

A **path** is a sequence of edges between **two nodes**.



## Properties of trees

**Cycle-free**: no path will ever revisit the same node.



## Recap & Next Class

### Today:

Tree terminology

### Next class:

Tree traversals