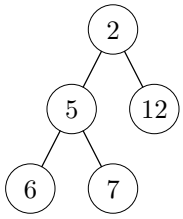
CS 61B
Fall 2026

# Heaps, Graphs

Discussion 08: October 19, 2026

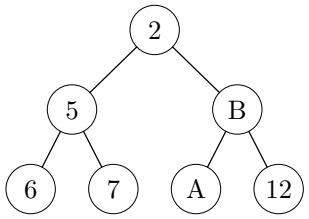
## 1 Heaperations




(a) Draw the heap after inserting 4, 13, and 3 in that order.

(b) Now, draw the heap after 2 calls of `removeMin`.

(c) Suppose we recover the original heap and insert two elements of unknown value, $A$ and $B$, **in that order.**




For each of the following conditional statements, write whether they are **always** true, **sometimes** true, or **never** true, and briefly explain why.

$A < B$

$B > 5$

$A \geq 12$

(d) Fill in the following blanks related to min-heaps. Let $N$ be the number of elements in the min-heap. For the entirety of this question, assume the elements in the min-heap are distinct.

`removeMin` has a best-case runtime of _____ and a worst-case runtime of _____

`insert` has a best-case runtime of _____ and a worst-case runtime of _____

A _____ or _____ traversal on a min-heap may output the elements in sorted order. *(Assume there are at least 3 elements in the min-heap)*

The fourth smallest element in a min-heap with 1000 distinct elements can appear in _____ different places in the heap.

Given a min-heap with $2^{N-1}$ **distinct** elements, for an element

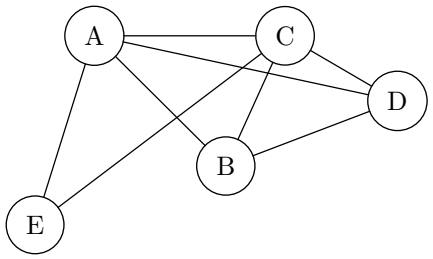
- to be on the second level it must be less than _____ element(s) and greater than _____ element(s).
- to be on the bottommost level it must be less than _____ element(s) and greater than _____ element(s).

*Hint: A complete binary tree (with a full last-level) has* $2^N - 1$ *elements, with* $N$ *being the number of levels.*

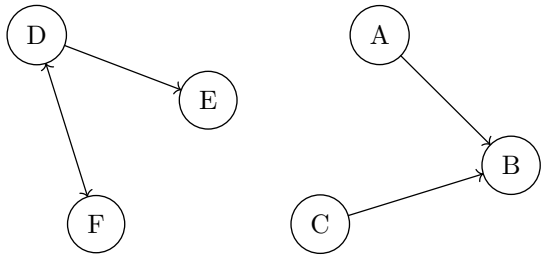
# 2 Write Your Representative

For each scenario below, justify whether an **adjacency list** or **adjacency matrix** would make more sense to represent the graph. Then, draw your chosen representation for the sample graph provided.

(a) A transit agency wants to use a graph to represent connections between bus stops in a **densely connected** bus system. The agency wants to be able to check if two stations are linked **as quickly as possible**.

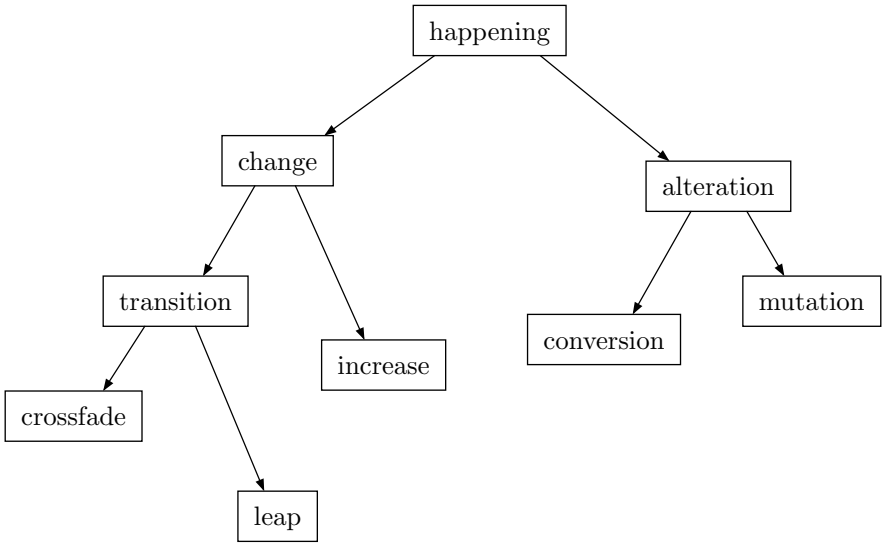



(b) A social media platform wants to represent which users are following other users using a directed graph. The graph is relatively **sparse**, and the platform values **memory efficiency** over all, because the site has a lot of users.



# 3 K Equals Zero

Consider the simplified hyponym graph below.




(a) Write the order in which hyponyms would be returned if we run **DFS preorder** on **change**. Break ties alphabetically.

(b) Write the order in which hyponyms would be returned if we run **DFS postorder** on **change**. Break ties alphabetically.

(c) Write the order in which hyponyms would be returned if we run **BFS** on **happening**. Break ties alphabetically.

(d) As you may know, in Project 4, our hyponym graph is guaranteed to be directed and acyclic. If we changed all edges in the above graph to be undirected instead, would any of your answers change? Why?

# 4 Graph Conceptuals

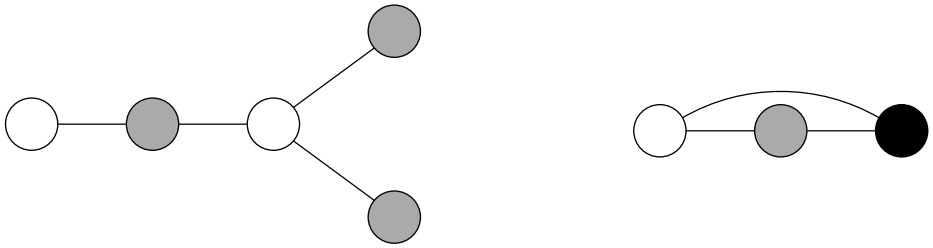
(a) Answer the following questions as either **True** or **False** and provide a brief explanation:

1. If a graph with $n$ vertices has $n-1$ edges, and the graph is connected, it **must** be a tree.

2. Every edge is looked at exactly twice in each full run of DFS on a connected, undirected graph.

3. In BFS, let $d(v)$ be the minimum number of edges between a vertex $v$ and the start vertex. For any two vertices $u$, $v$ in the fringe (recall that the fringe in BFS is a queue), $|d(u) - d(v)|$ is **always less than** 2.

(b) An undirected graph is said to be bipartite if each of its vertices can be painted with one of the two colors, such that every edge connects two vertices of different colors. For example below, the graph on the left is bipartite, whereas on the graph on the right is not.



Provide an algorithm which determines whether or not a graph is bipartite. What is the runtime of your algorithm?

*Hint: Can you modify an algorithm we already know?*