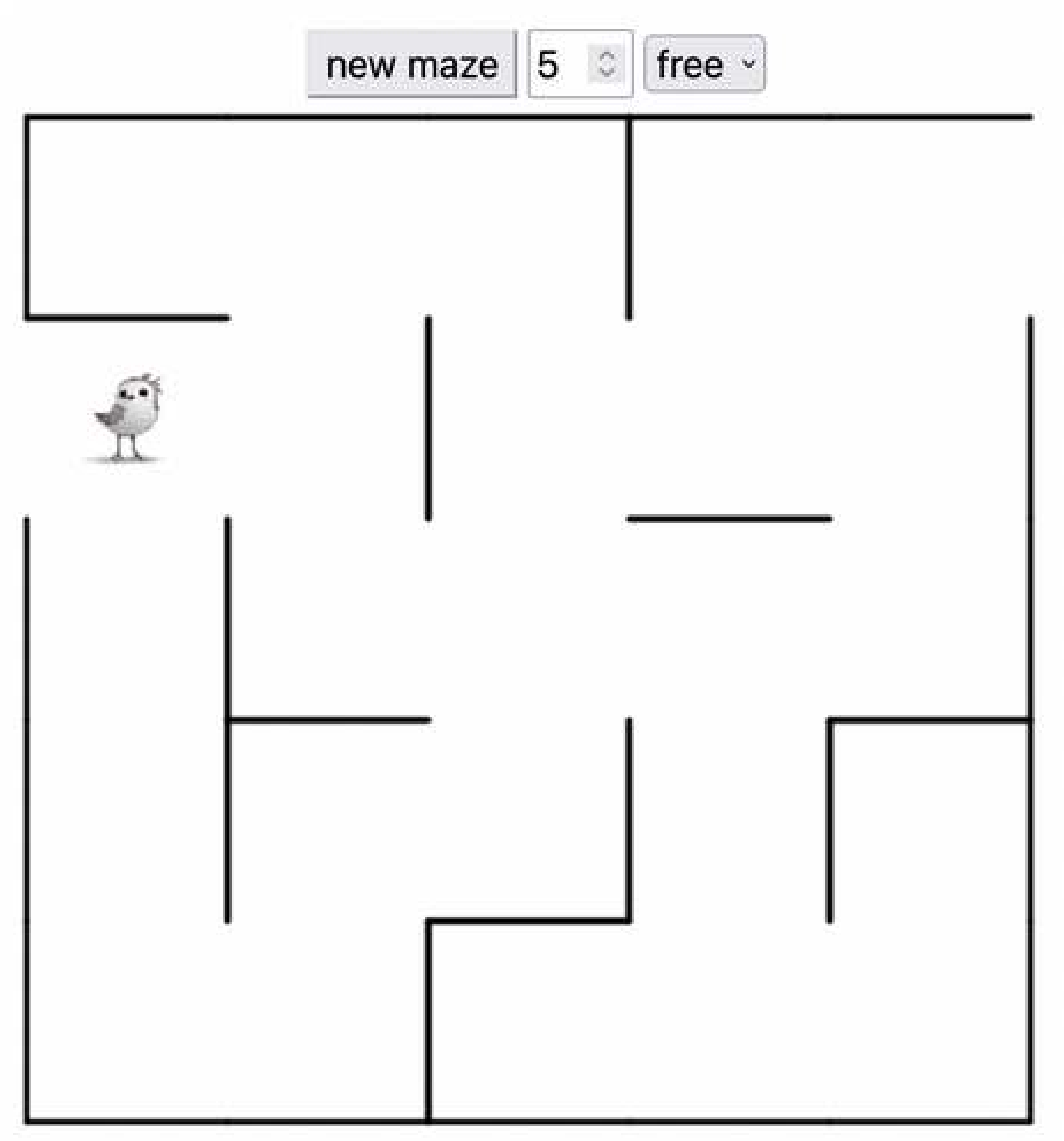
Goals for today:

- 1. Write pseudocode for breadth-first search (BFS) and depth-first-search (DFS) algorithms,
  2. Build a spanning tree using DFS and BFS,
  3. Build a minimum spanning tree (MST) using Prim's algorithm.



1.) relate this maze to graphs?
vertices?
edges?

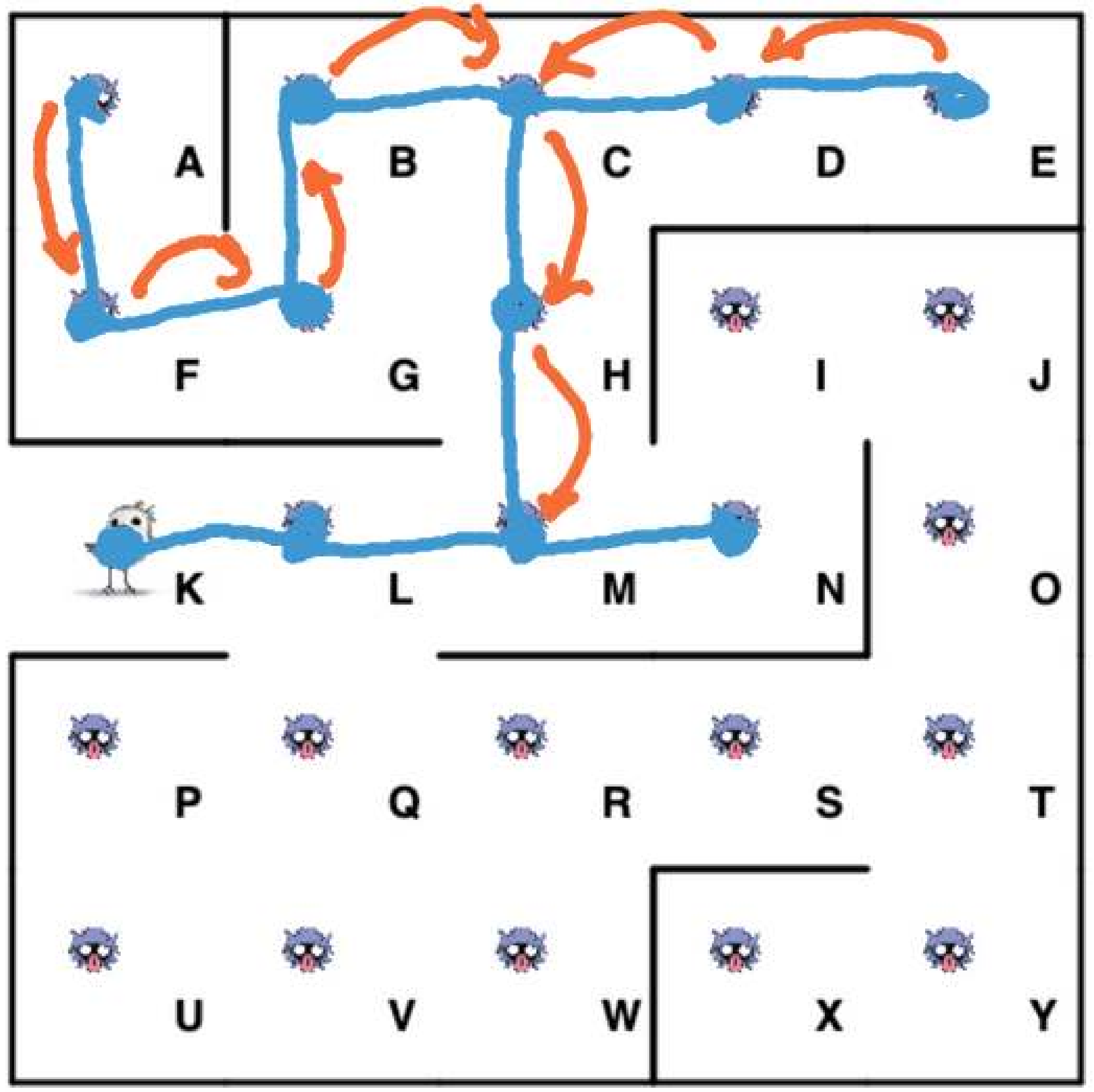
2.) how to find a path through maze?

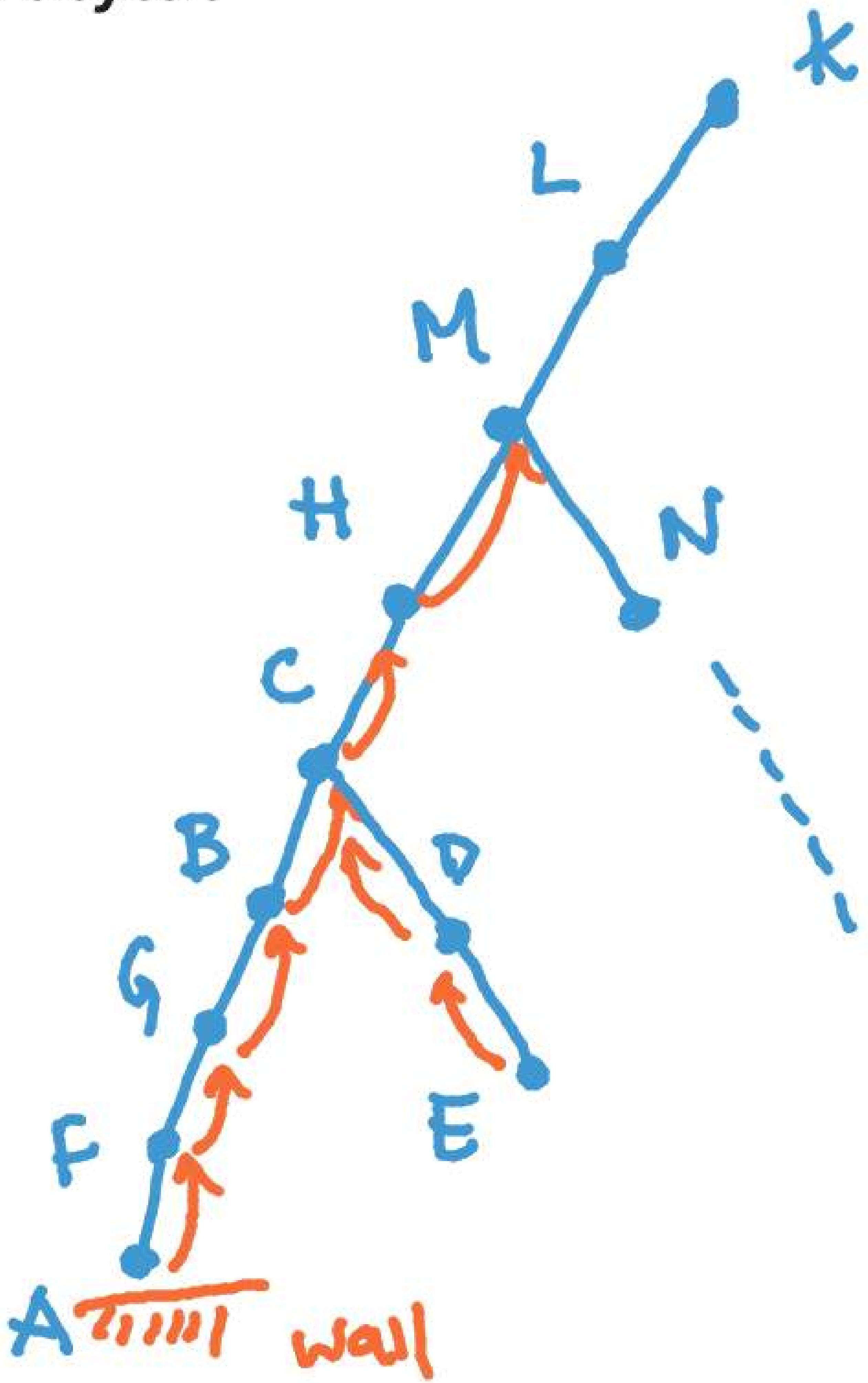
3.) how to find shortest path through maze?

click on "game" in the row for today's class at go/cs200

Depth-First Search ("backtracking").

Main idea: Keep traversing edges until you "hit a wall," then go back to parent.
→ maintain a tree: **connected** and **acyclic**





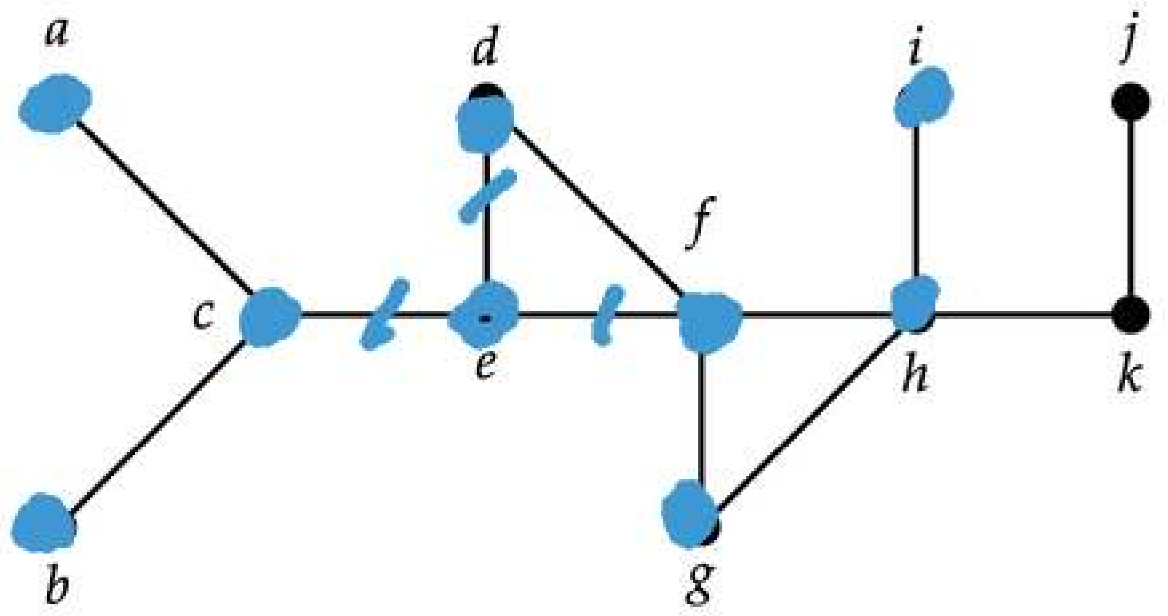
Depth-First Search in pseudocode.

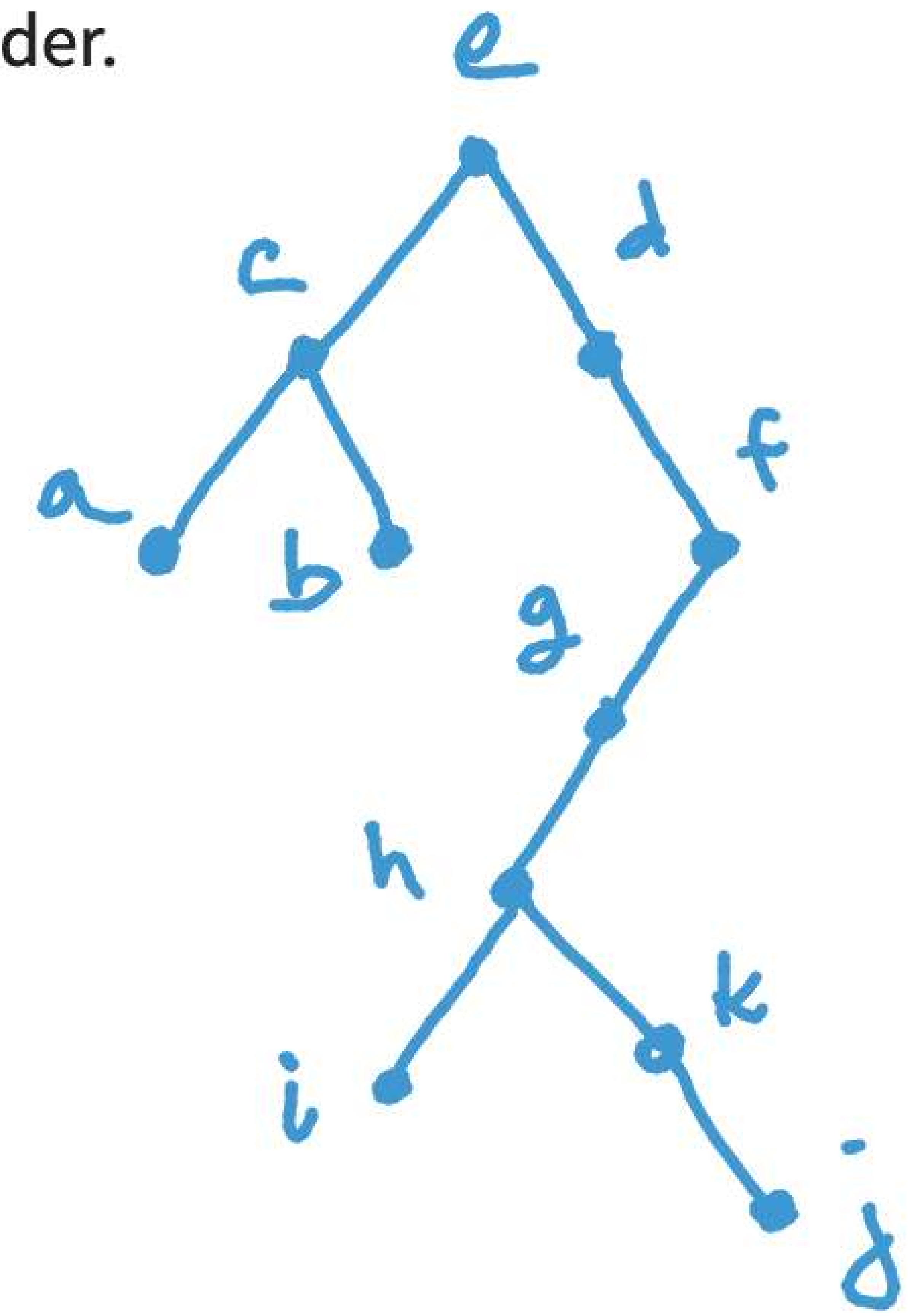
```
depthFirstSearch($G$)

    input: connected graph $G = (V_G, E_G)$
    output: spanning tree $T$
    $u \leftarrow$ arbitrary vertex in $V_G$        ← root
    $T \leftarrow (\{u\}, \emptyset)$
    visit($u, G, T$)
```

```
visit($u, G, T$)

    input: starting vertex $u$, connected graph $G = (V_G, E_G)$,
           current spanning tree $T = (V_T, E_T)$
    output: updated spanning tree $T = (V_T, E_T)$
    for $v \in$ neighbors($u, G$)        ← list of adjacent vertices
        if $v \in V_T$                    avoid cycle! [
            continue
        $E_T \leftarrow$ append($\{u, v\}$)
        $V_T \leftarrow$ append($v$)
        visit($v, G, T$)
```

Exercise 1: Build spanning tree of this graph using DFS.

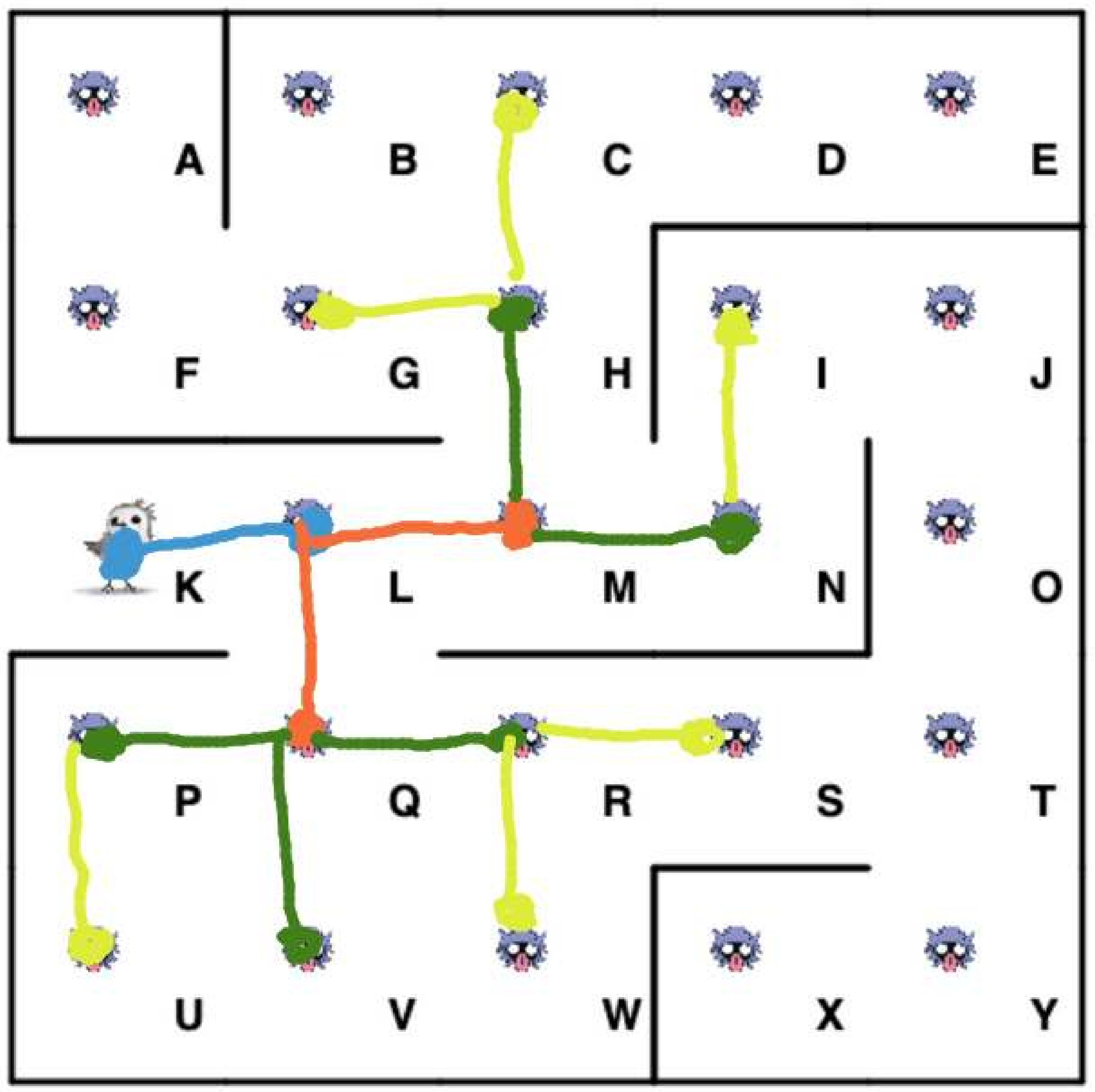
- Start at vertex *e*.
- Visit neighboring vertices in *alphabetical* order.
- List order of vertices visited.

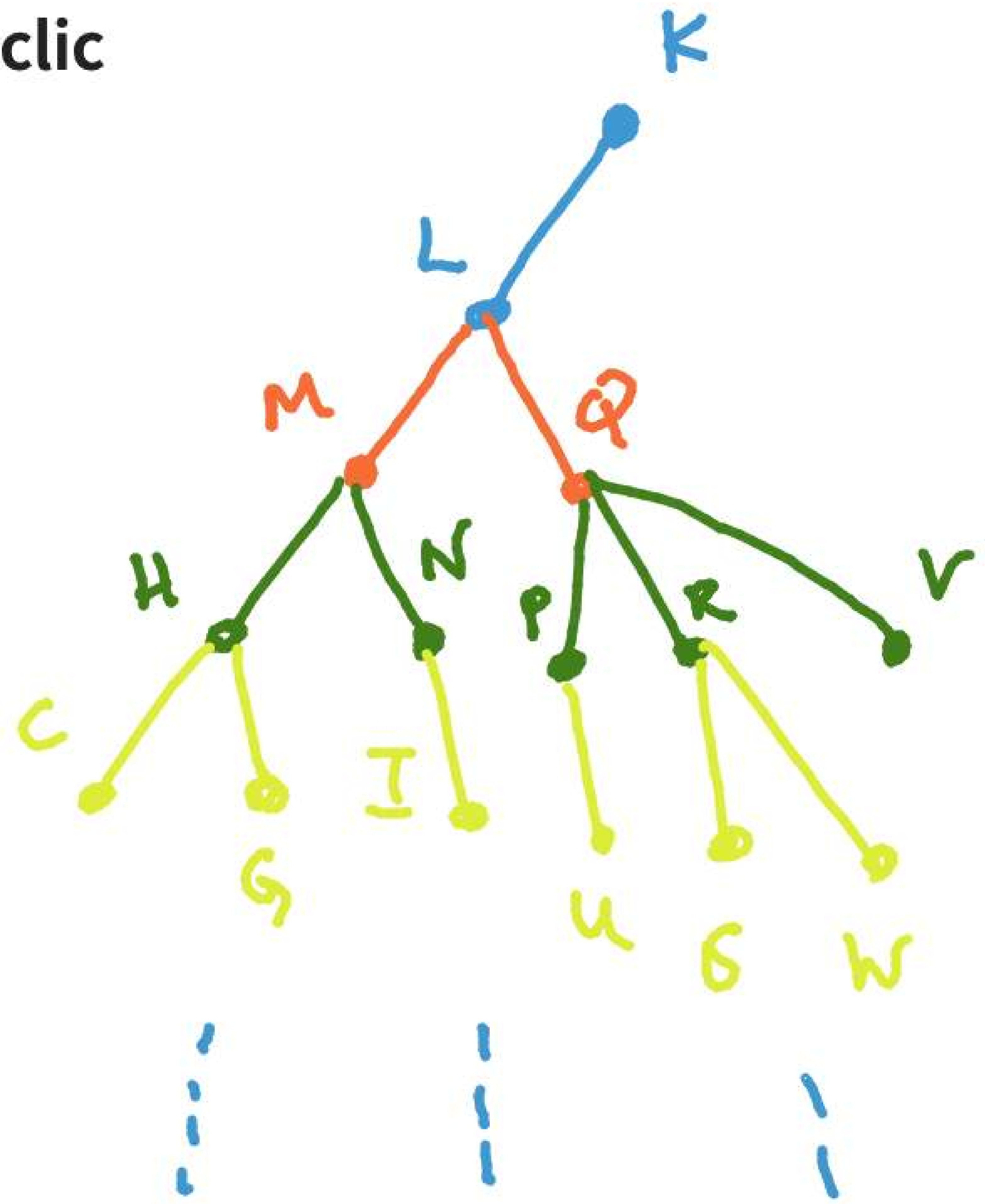




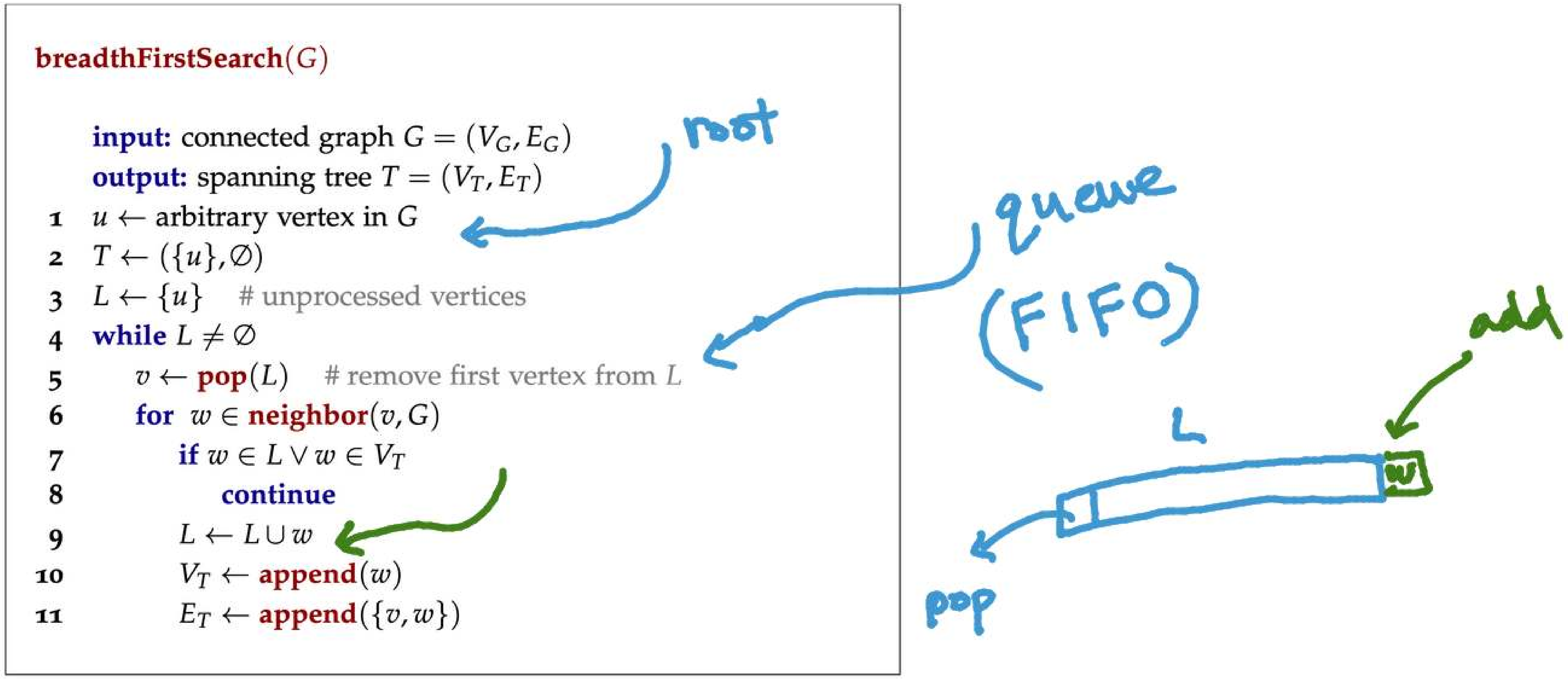
Breadth-First Search ("flooding").

Main idea: Visit neighbors one "level" at a time.
→ maintain a tree: **connected** and **acyclic**





Depth-First Search in pseudocode.

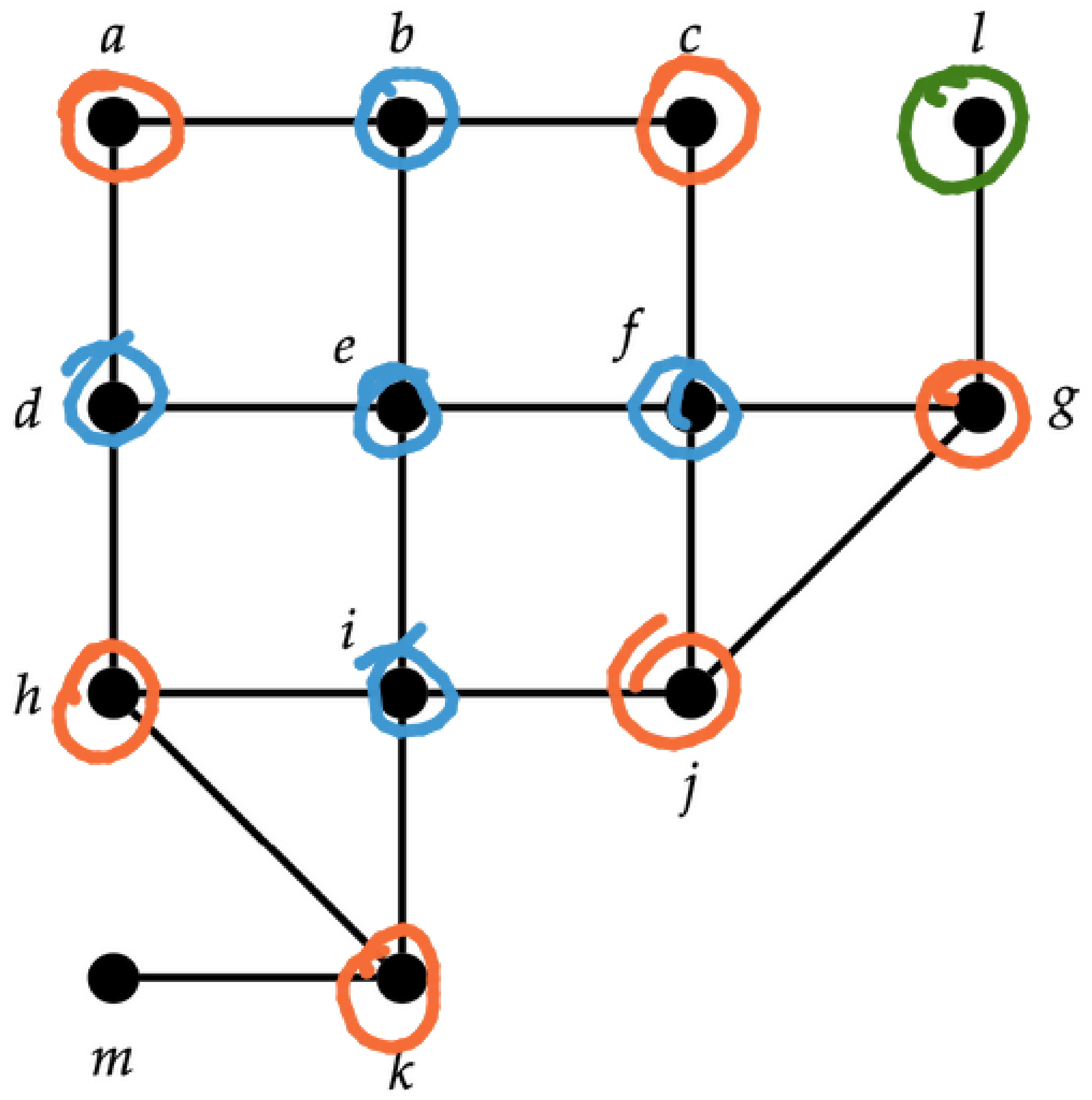


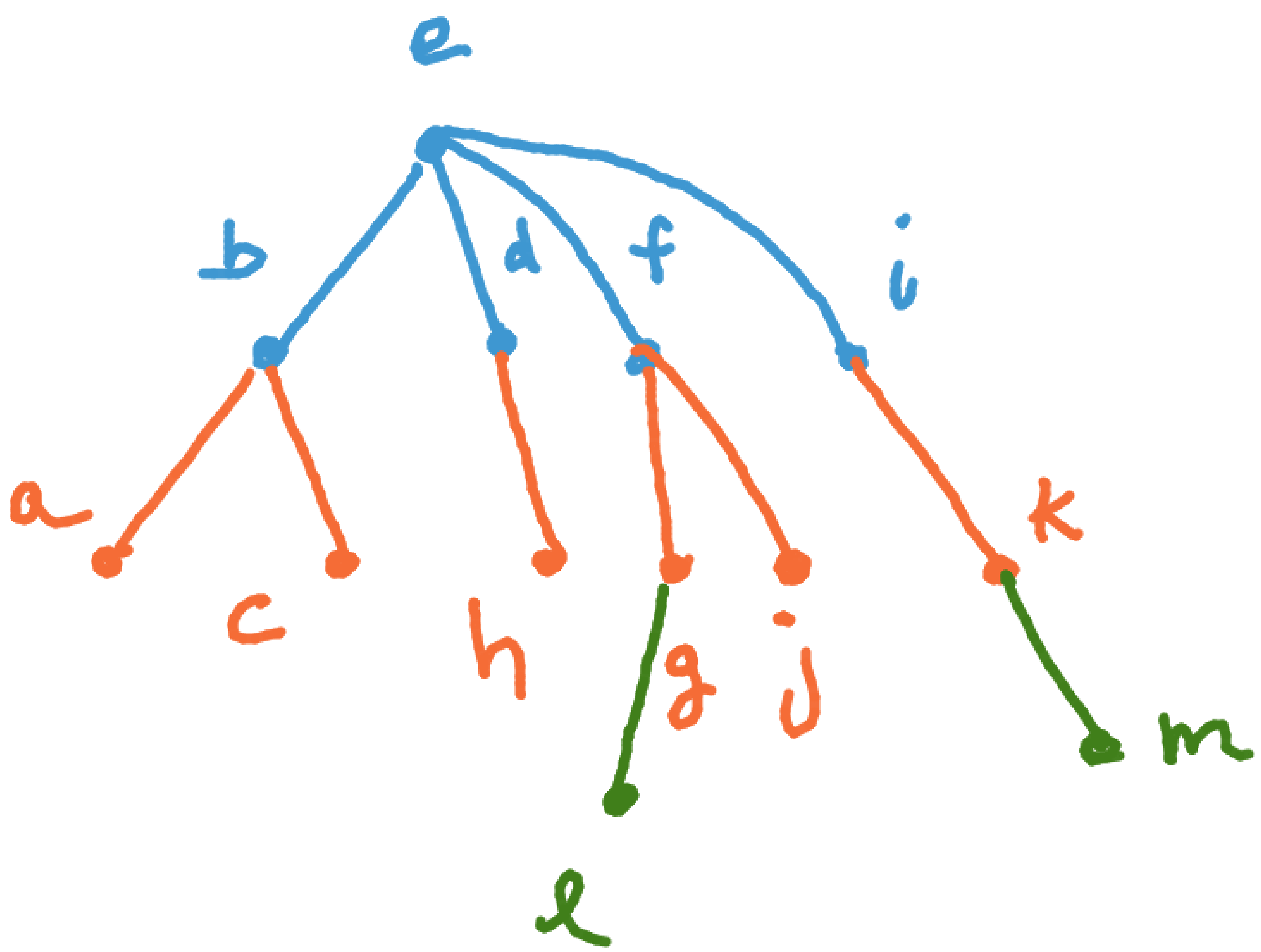
```
breadthFirstSearch($G$)

  input: connected graph $G = (V_G, E_G)$
  output: spanning tree $T = (V_T, E_T)$
  $u \leftarrow$ arbitrary vertex in $G$
  $T \leftarrow (\{u\}, \emptyset)$
  $L \leftarrow \{u\}$    # unprocessed vertices
  while $L \neq \emptyset$
      $v \leftarrow$ pop($L$)    # remove first vertex from $L$
      for $w \in$ neighbor($v, G$)
          if $w \in L \vee w \in V_T$
              continue
          $L \leftarrow L \cup w$
          $V_T \leftarrow$ append($w$)
          $E_T \leftarrow$ append($\{v, w\}$)
```

root
queue
(FIFO)
add
L
w
pop

Exercise 2: Build spanning tree of this graph using BFS.

- Start at vertex *e*.
- Visit neighboring vertices in *alphabetical* order.
- List order of vertices visited.

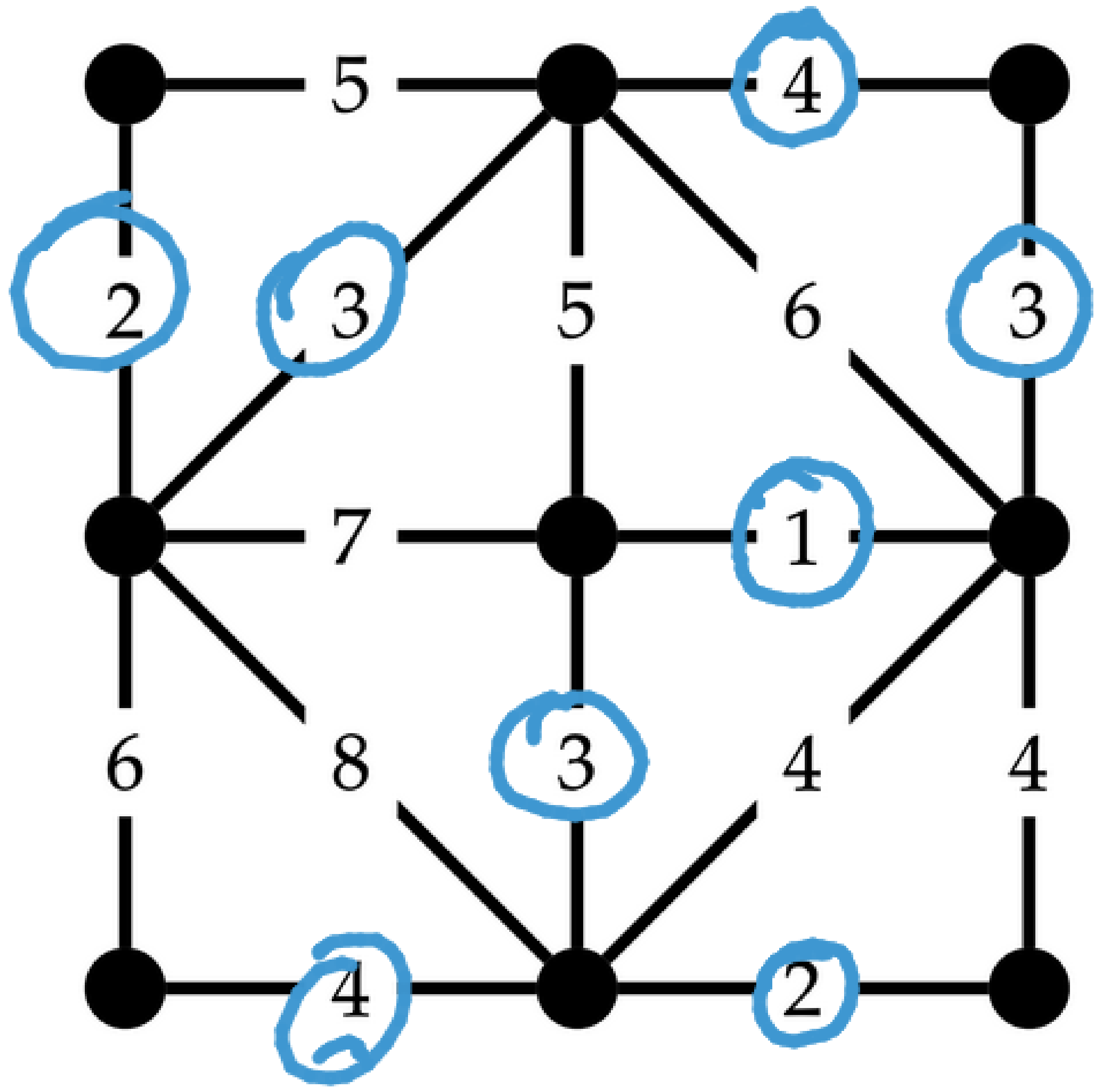


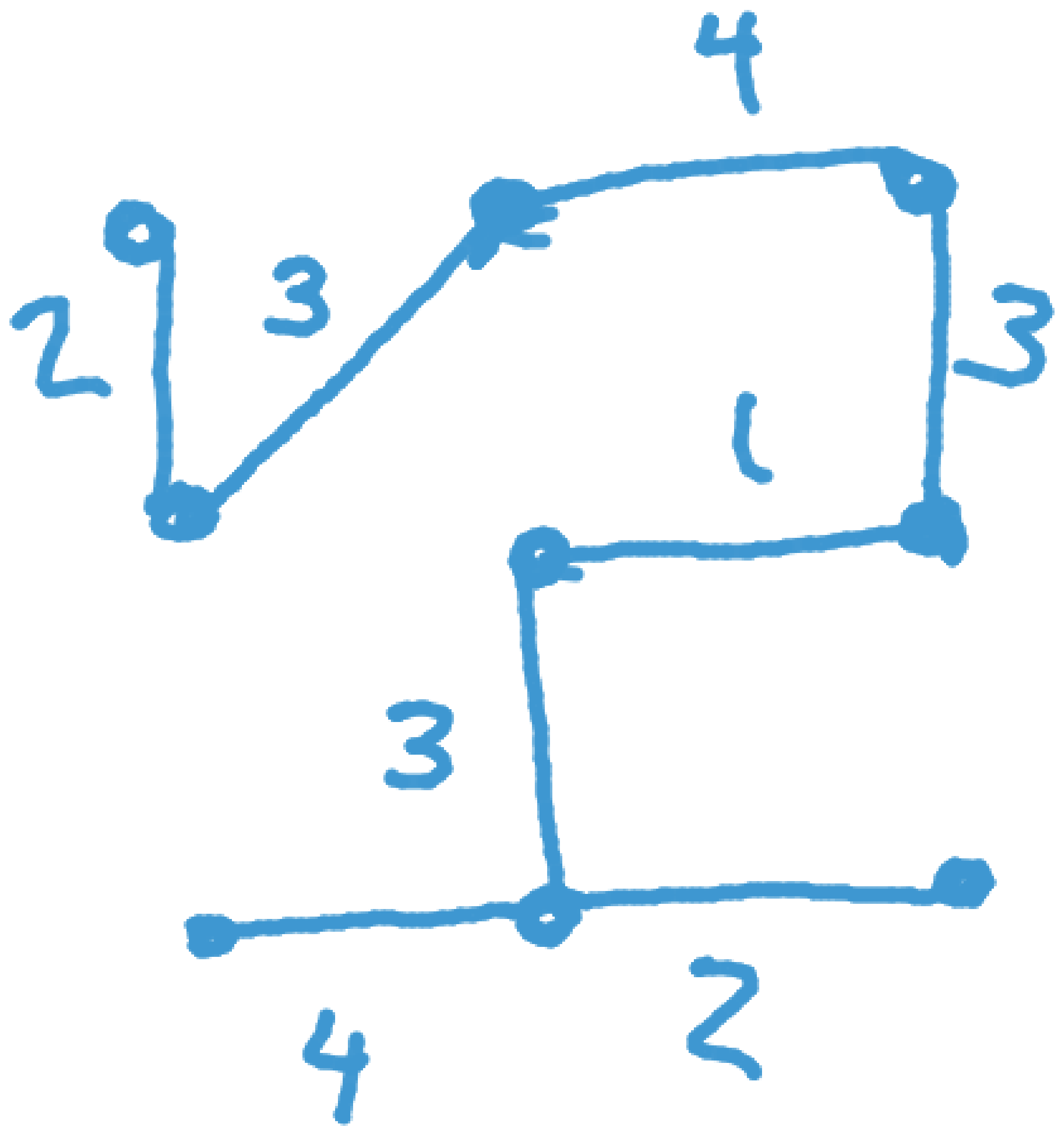


Prim's algorithm for constructing a minimum spanning tree (MST).

Minimum spanning tree: Spanning tree of a graph with minimum sum of edge weights.

Main idea: Add minimum weight edge that is (1) connected to current tree and (2) does not form a cycle.





weight = 22