# CSCI 241

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## Trees: Definition and Terminology

# Goals

Know the definition of a tree.

Know the following basic tree terminology:

root, child, parent, leaf, height, depth, subtree, descendant, ancestor

# Trees in nature

# Trees in computer science

# Linked List Node

```
public class ListNode {
   int value;
   ListNode next;
}
```

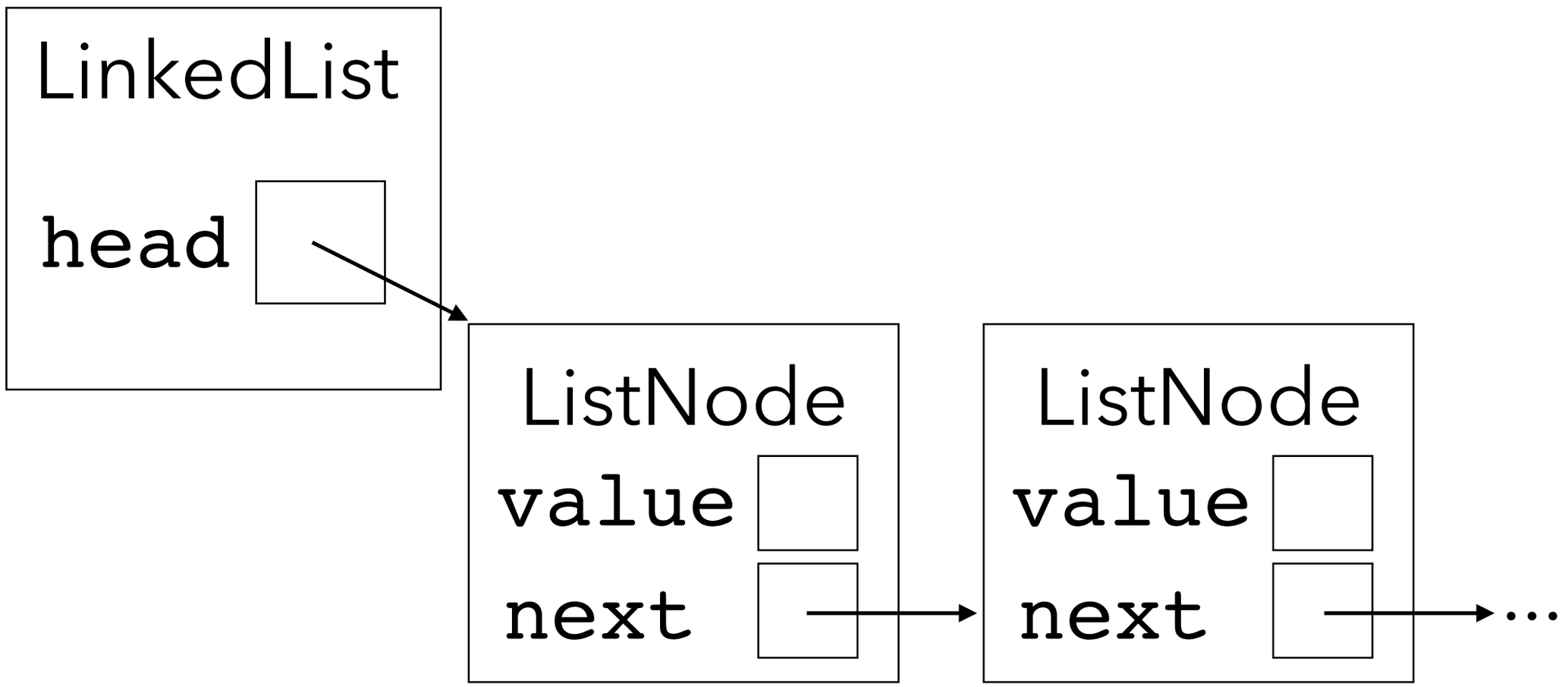
# Tree Node

```
public class TreeNode {
   int value;
   TreeNode next1;
   TreeNode next2;
}
```

A tree is like a linked list, except each node can have more than one successor (`next`).

# Linked List Node

```
public class ListNode {
   int value;
   ListNode next;
}
```

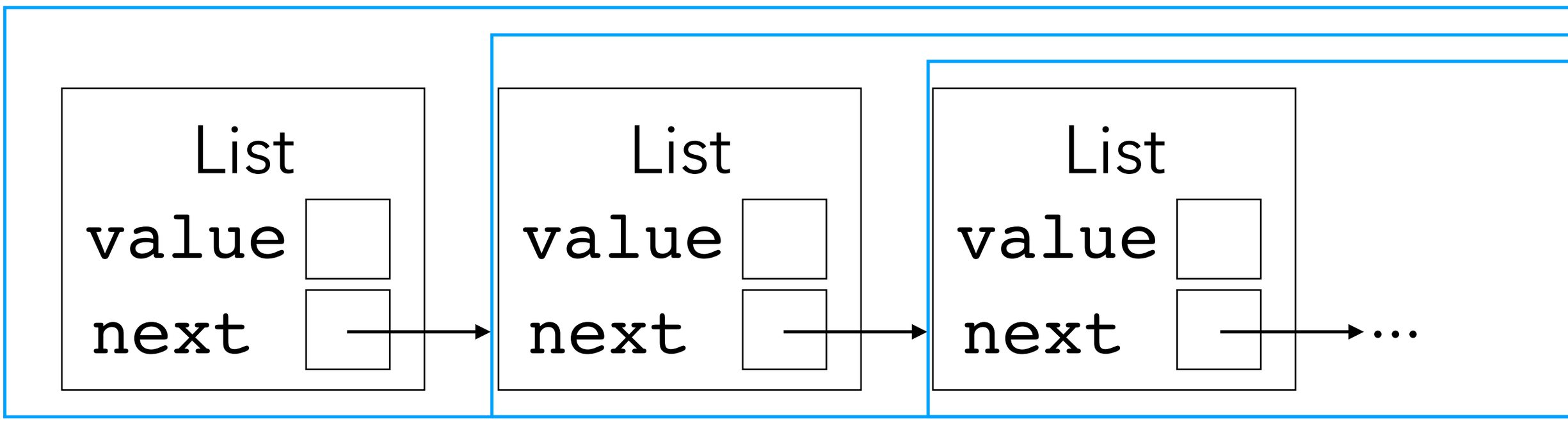


# Linked List

```
public class List {
   int value;
   List next;
}
```

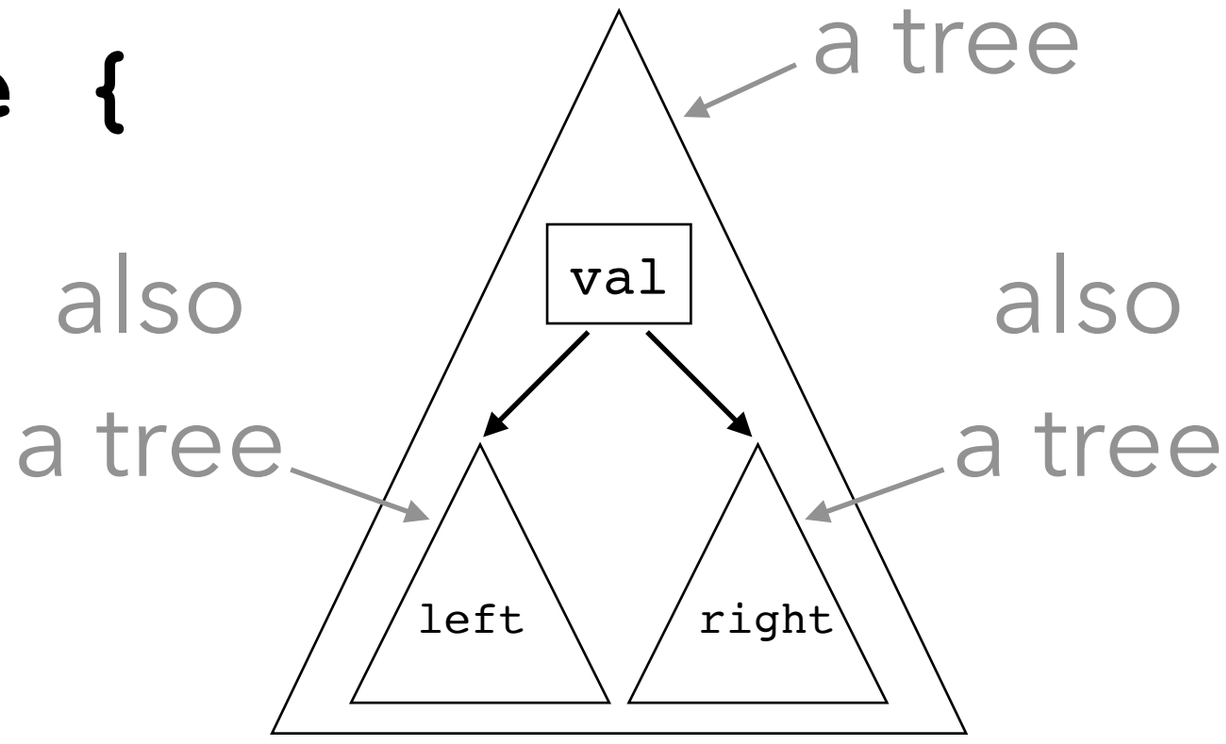
The node ***is*** *the list.*

`next` points to the **tail** of the list (also a list!)



# Binary Tree

```
public class Tree {
   int value;
   Tree left;
   Tree right;
}
```




The node ***is*** *the tree*.

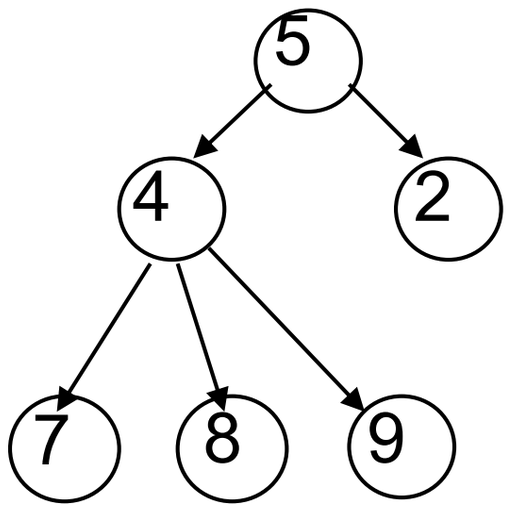
left points to the **left child** of the tree (also a tree!)

right points to the **right child** of the tree (also a tree!)

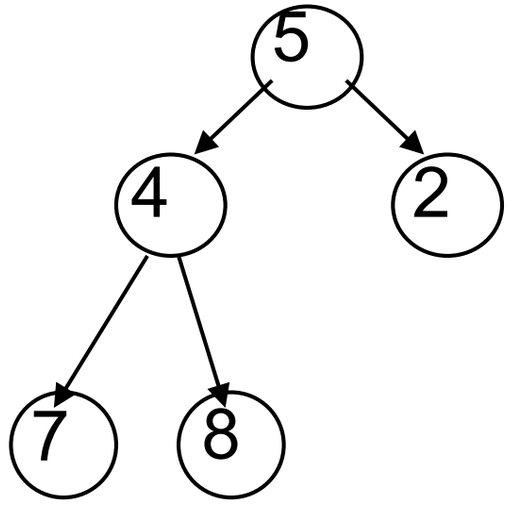
# Tree - Definition

Tree: like a linked list, but:

- Each node may have zero or more *successors* (children)
- Each node has exactly one *predecessor* (parent) except the root, which has none
- All nodes are reachable from *root*



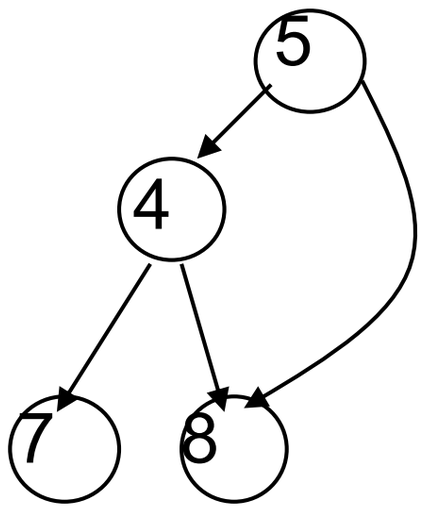

General tree



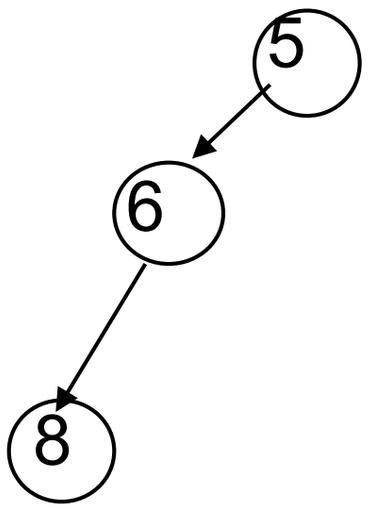

Binary tree

Binary tree: A tree, but:

- Each node can have at most two children (left child, right child)




Not a tree




List-like tree

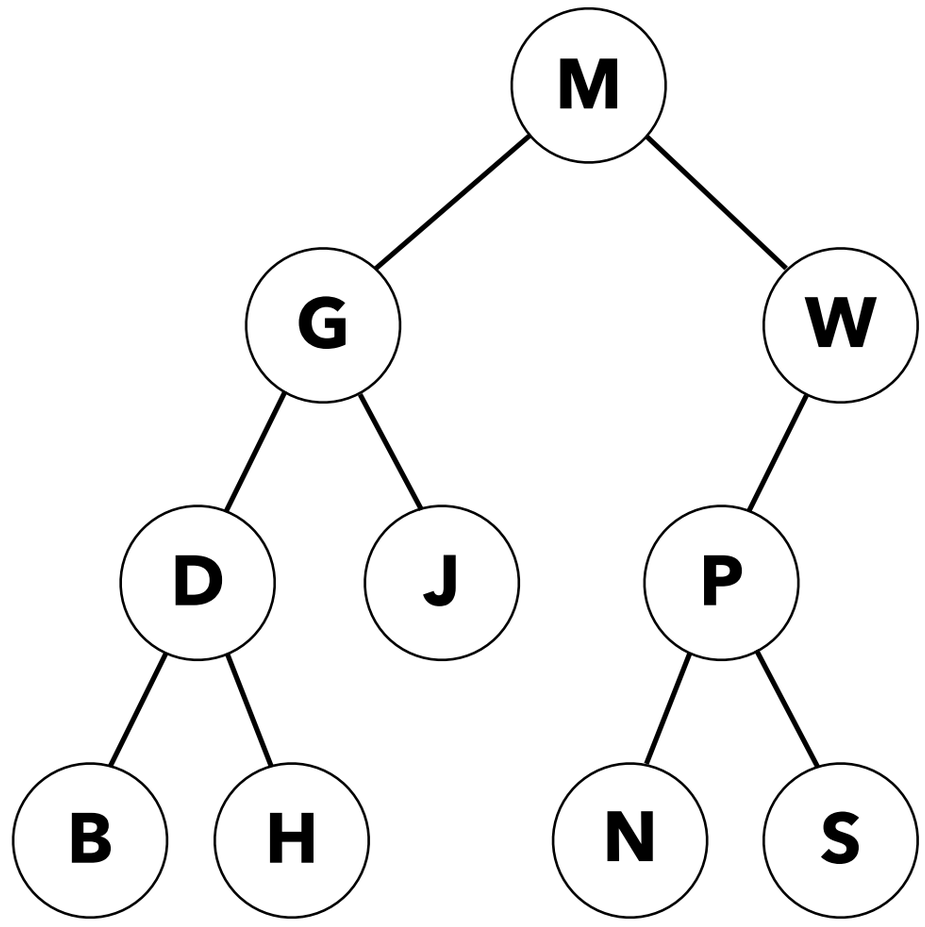
# Tree Terminology

**M** is the root of this tree

**N** is the left child of **P**

**S** is the right child of **P**

**P** is the parent of **N**



# Ancestor, Descendant

**M** is the root of this tree

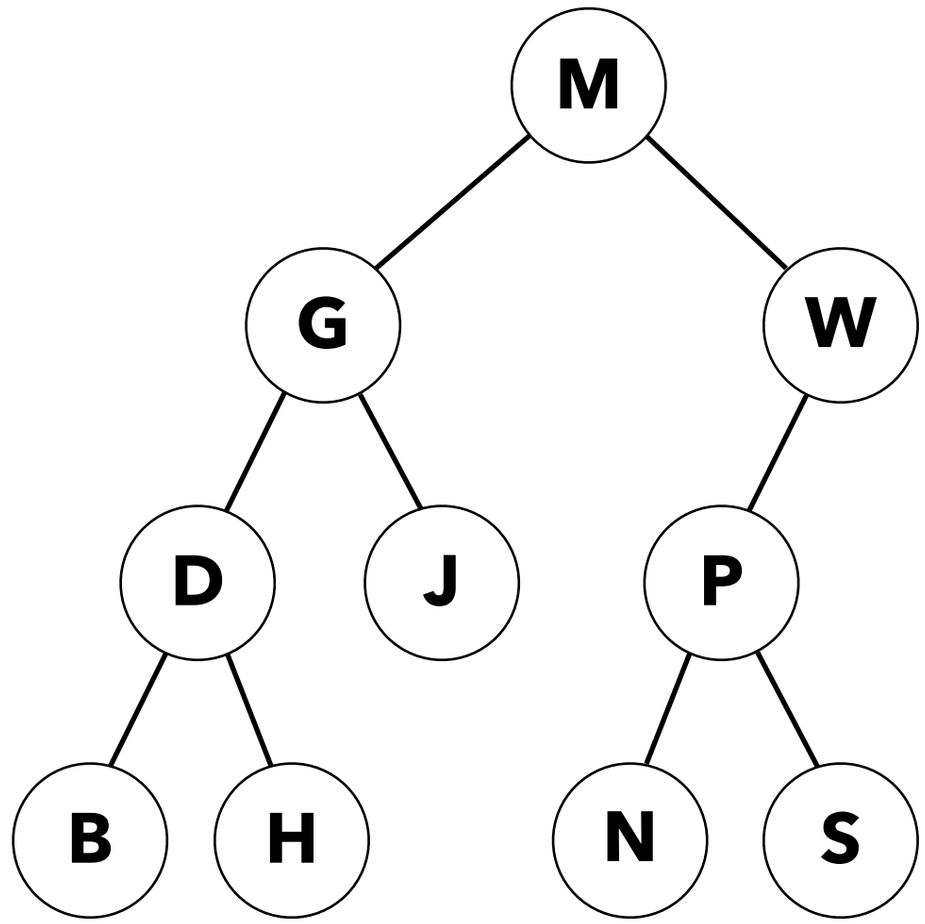
**N** is the left child of **P**

**S** is the right child of **P**

**P** is the parent of **N**

**M** and **G** are ancestors of **D**

**P**, **N**, **S** are descendants of **W**




A node's ancestors are the nodes on the path to the root

A node's descendants include its children, its children's children, and so on.

# Subtree

**M** is the root of this tree

**N** is the left child of **P**

**S** is the right child of **P**

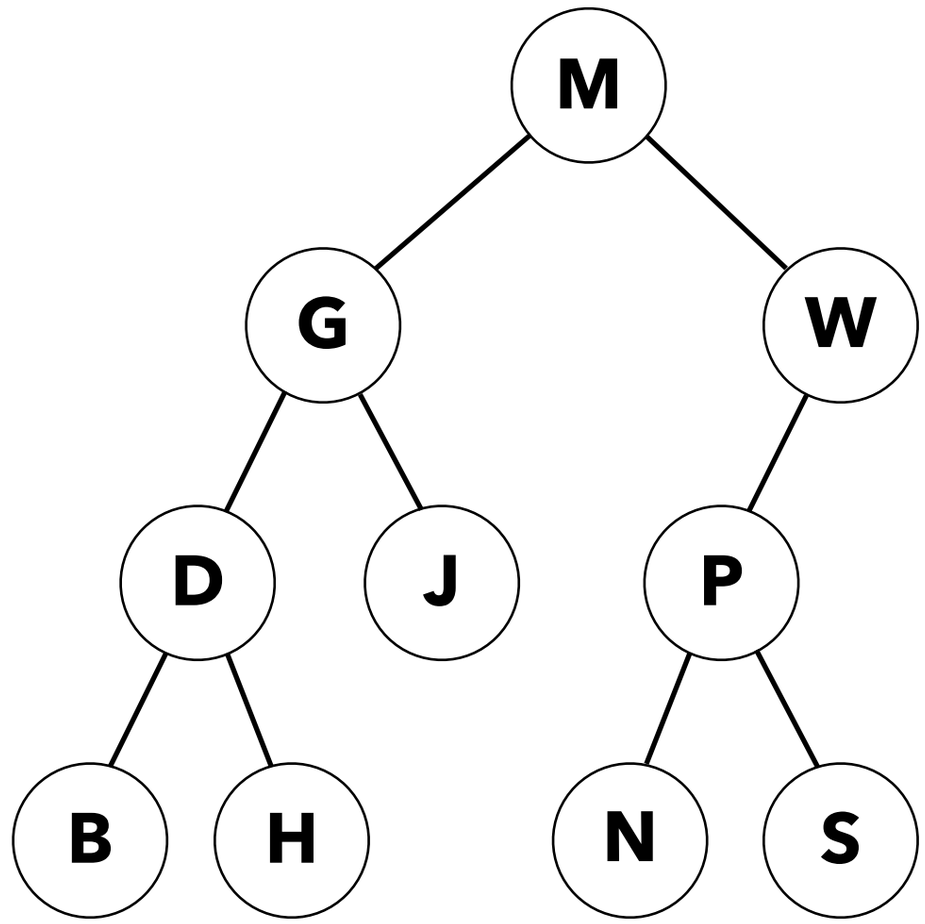
**P** is the parent of **N**

**M** and **G** are ancestors of **D**

**P**, **N**, **S** are descendants of **W**

The subtree rooted at **G** contains **G**, **D**, **J**, **B**, and **H**.

**G** is the root of the left subtree of **M**




A subtree is a subset of a tree containing a node and its descendants.

# Leaf

**M** is the root of this tree

**N** is the left child of **P**

**S** is the right child of **P**

**P** is the parent of **N**

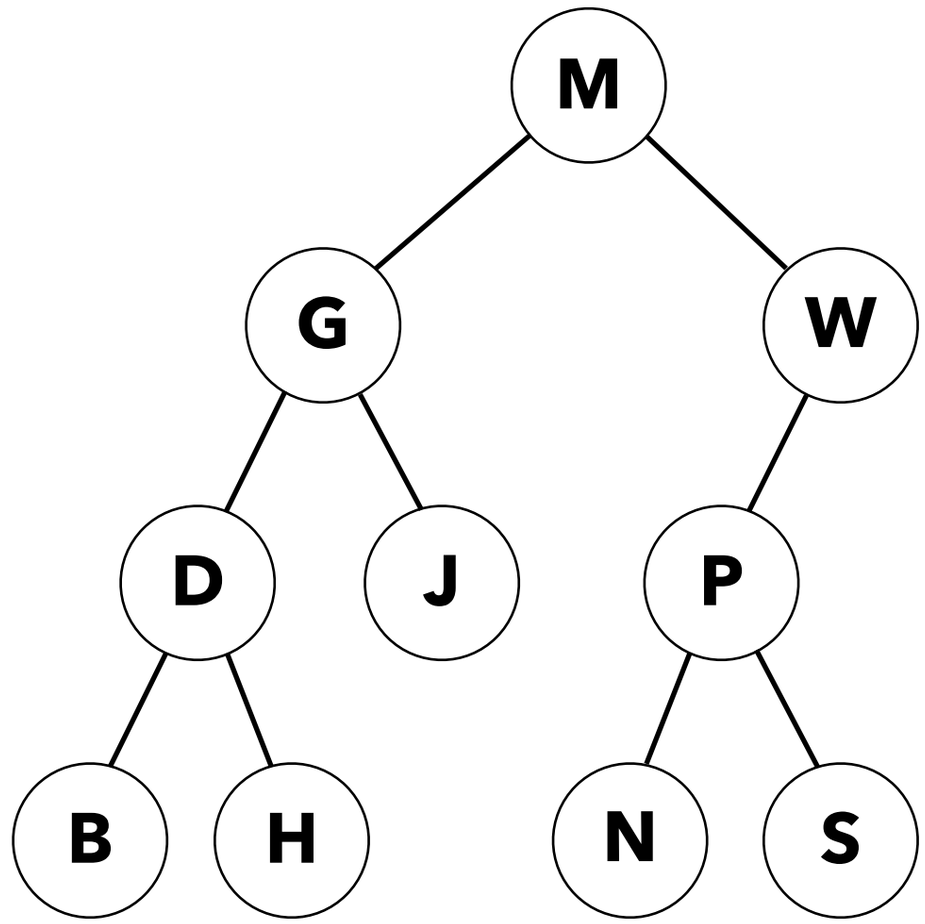
**M** and **G** are ancestors of **D**

**P**, **N**, **S** are descendants of **W**

The subtree rooted at **G** contains **G**, **D**, **J**, **B**, and **H**.

**G** is the root of the left subtree of **M**

**B**, **H**, **J**, **N**, **S** are leaves




A leaf is a node with no children.

# Height (of a tree)

**M** is the root of this tree

**N** is the left child of **P**

**S** is the right child of **P**

**P** is the parent of **N**

**M** and **G** are ancestors of **D**

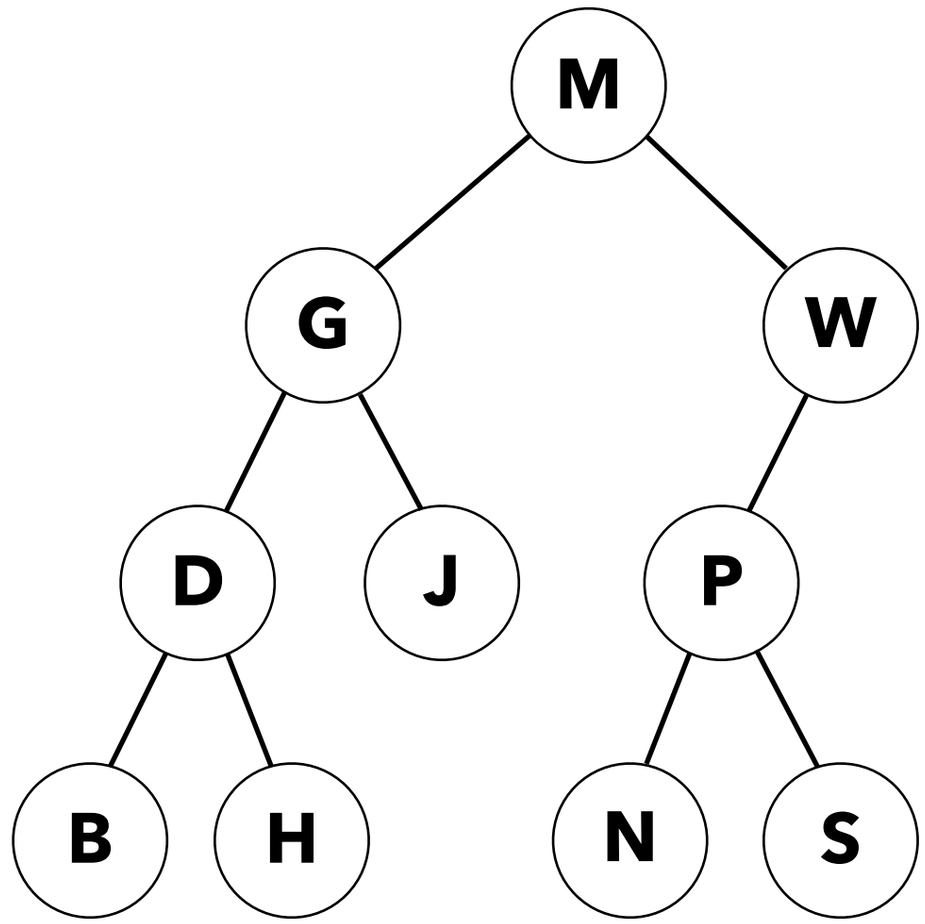
**P**, **N**, **S** are descendants of **W**

The subtree rooted at **G** contains **G**, **D**, **J**, **B**, and **H**.

**G** is the root of the left subtree of **M**

**B**, **H**, **J**, **N**, **S** are leaves

The subtree rooted at **W** has height 2




The height of a tree is the length of the path from the root to the deepest leaf.

# Depth (of a node)

**M** is the root of this tree

**N** is the left child of **P**

**S** is the right child of **P**

**P** is the parent of **N**

**M** and **G** are ancestors of **D**

**P**, **N**, **S** are descendants of **W**

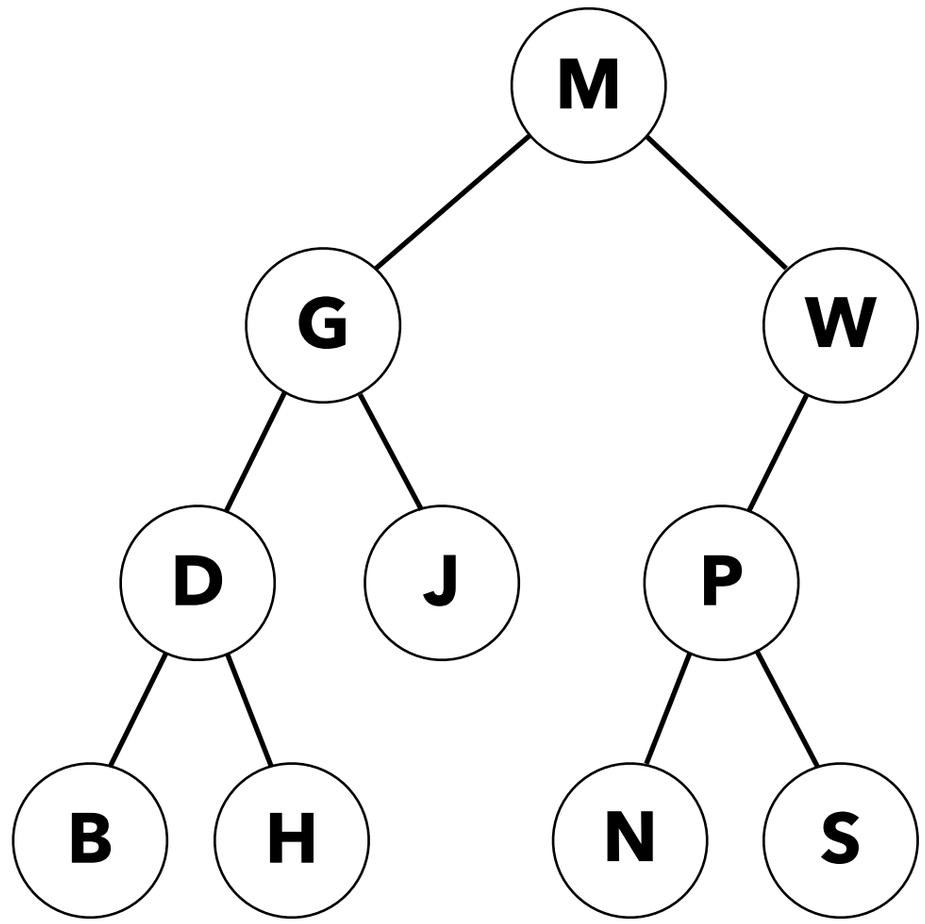
The subtree rooted at **G** contains **G**, **D**, **J**, **B**, and **H**.

**G** is the root of the left subtree of **M**

**B**, **H**, **J**, **N**, **S** are leaves

The subtree rooted at **W** has height 2

**J** is at depth 2




The depth of a node is the length of the path from the root to that node.