Activity No. 9.1	
Tree ADT	
Course Code: CPE010	**Program:** Computer Engineering
Course Title: Data Structures and Algorithms	**Date Performed:** 11/13/24
Section: CPE21S4	**Date Submitted:**
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A. Output(s) and Observation(s)

Task 1: Create code in C++ that will create a tree as shown in the figure above. Use linked lists as the internal representation of this tree. Indicate your code screenshot and comments in table 9-1.

SOURCE CODE:

```
#include <iostream>
using namespace std;

// Definition of a node in the general tree
struct TreeNode {
    char data;
    TreeNode* firstChild;
    TreeNode* nextSibling;

    TreeNode(char value) : data(value), firstChild(nullptr), nextSibling(nullptr) {}
};

// Class to represent the general tree
class GeneralTree {
public:
    GeneralTree() : root(nullptr) {}

    // Function to set the root of the tree
    void setRoot(char value) {
        root = new TreeNode(value);
    }

    // Function to add a child to a given parent
    void addChild(char parentValue, char childValue) {
        TreeNode* parent = findNode(root, parentValue);
        if (parent) {
            TreeNode* child = new TreeNode(childValue);
            if (!parent->firstChild) {
                parent->firstChild = child; // Add as first child
            } else {
                TreeNode* sibling = parent->firstChild;
                while (sibling->nextSibling) {
```

```
                sibling = sibling->nextSibling; // Traverse to the last sibling
            }
            sibling->nextSibling = child; // Add as next sibling
        }
    } else {
        cout << "Parent not found!" << endl;
    }
}

// Function to perform pre-order traversal
void preOrder() {
    preOrderRec(root);
    cout << endl;
}

private:
    TreeNode* root;

    // Helper function to find a node with a specific value
    TreeNode* findNode(TreeNode* node, char value) {
        if (!node) return nullptr;
        if (node->data == value) return node;

        TreeNode* foundNode = findNode(node->firstChild, value);
        return foundNode ? foundNode : findNode(node->nextSibling, value);
    }

    // Helper function for pre-order traversal
    void preOrderRec(TreeNode* node) {
        if (node) {
            cout << node->data << " ";
            preOrderRec(node->firstChild);
            preOrderRec(node->nextSibling);
        }
    }
};

// Main function to demonstrate the general tree
int main() {
    GeneralTree tree;
    tree.setRoot('A'); // Setting 'A' as the root

    // Adding children
    char children[][2] = {
        {'A', 'B'}, {'A', 'C'}, {'A', 'D'},
        {'A', 'E'}, {'A', 'F'}, {'A', 'G'},
        {'D', 'H'}, {'E', 'I'}, {'E', 'J'},
        {'F', 'K'}, {'F', 'L'}, {'F', 'M'},
        {'G', 'N'}, {'J', 'P'}, {'J', 'Q'}
    };
```

```
    for (const auto& pair : children) {
        tree.addChild(pair[0], pair[1]);
    }

    // Pre-order traversal of the tree
    cout << "Pre-order Traversal: ";
    tree.preOrder();
    return 0;
}
```

Table 9-1. General Tree

Task 2: Complete the following table:

NODE	HEIGHT	DEPTH
A	4	0
B	3	1
C	2	1
D	2	2
E	1	2
F	1	2
G	1	2
H	1	3
I	0	3
J	0	3
K	0	3
L	0	3
M	0	3
N	0	3
P	0	4
Q	0	4

Table 9-2. Completed Table

Task 3: After implementing the code for above, answer the following:

3.1 Given the tree diagram, find the result of the pre-order, post-order and in-order traversal strategies by hand. Include this as table 9-3 in section 6.

Pre-order	A B C D H E I J P Q F K L M G N
Post-order	B C H D I P Q J E K L M F N G A
In-order	A B C D E F G H I J K L M N P Q

Table 9-3. Traversal Strategies

Create a function for pre-order, post-order and in-order traversal. Make sure that each function displays an output into the console. Once you have the output, create and fill table 9-4 in section 6 so that it contains the screenshot of the function, screenshot of the output and your observations. Your observations consist of a comparison between output in #1 and the output of your functions in #2.

```
#include <iostream>
using namespace std;

// Definition of a node in the general tree
struct TreeNode {
    char data;
    TreeNode* firstChild;
    TreeNode* nextSibling;

    TreeNode(char value) : data(value), firstChild(nullptr), nextSibling(nullptr) {}
};

// Class to represent the general tree
class GeneralTree {
public:
    GeneralTree() : root(nullptr) {}

    // Function to set the root of the tree
    void setRoot(char value) {
        root = new TreeNode(value);
    }

    // Function to add a child to a given parent
    void addChild(char parentValue, char childValue) {
        TreeNode* parent = findNode(root, parentValue);
        if (parent) {
            TreeNode* child = new TreeNode(childValue);
            if (!parent->firstChild) {
                parent->firstChild = child; // Add as first child
            } else {
                TreeNode* sibling = parent->firstChild;
                while (sibling->nextSibling) {
                    sibling = sibling->nextSibling; // Traverse to the last sibling
                }
                sibling->nextSibling = child; // Add as next sibling
            }
        } else {
            cout << "Parent not found!" << endl;
```

```
        }
    }

    // Function to perform pre-order traversal
    void preOrder() {
        cout << "Pre-order Traversal: ";
        preOrderRec(root);
        cout << endl;
    }

    // Function to perform post-order traversal
    void postOrder() {
        cout << "Post-order Traversal: ";
        postOrderRec(root);
        cout << endl;
    }

    // Function to perform in-order traversal
    void inOrder() {
        cout << "In-order Traversal: ";
        inOrderRec(root);
        cout << endl;
    }

private:
    TreeNode* root;

    // Helper function to find a node with a specific value
    TreeNode* findNode(TreeNode* node, char value) {
        if (!node) return nullptr;
        if (node->data == value) return node;

        TreeNode* foundNode = findNode(node->firstChild, value);
        return foundNode ? foundNode : findNode(node->nextSibling, value);
    }

    // Helper function for pre-order traversal
    void preOrderRec(TreeNode* node) {
        if (node) {
            cout << node->data << " "; // Visit the current node
            preOrderRec(node->firstChild); // Visit first child
            preOrderRec(node->nextSibling); // Visit next sibling
        }
    }

    // Helper function for post-order traversal
    void postOrderRec(TreeNode* node) {
        if (node) {
            postOrderRec(node->firstChild); // Visit first child
            postOrderRec(node->nextSibling); // Visit next sibling
            cout << node->data << " "; // Visit the current node
```

```
        }
    }

    // Helper function for in-order traversal
    void inOrderRec(TreeNode* node) {
        if (node) {
            inOrderRec(node->firstChild); // Visit first child
            cout << node->data << " ";     // Visit current node
            inOrderRec(node->nextSibling);  // Visit next sibling
        }
    }
};

// Main function to demonstrate the general tree
int main() {
    GeneralTree tree;
    tree.setRoot('A'); // Setting 'A' as the root

    // Adding children
    char children[][2] = {
        {'A', 'B'}, {'A', 'C'}, {'A', 'D'},
        {'A', 'E'}, {'A', 'F'}, {'A', 'G'},
        {'D', 'H'}, {'E', 'I'}, {'E', 'J'},
        {'F', 'K'}, {'F', 'L'}, {'F', 'M'},
        {'G', 'N'}, {'J', 'P'}, {'J', 'Q'}
    };

    for (const auto& pair : children) {
        tree.addChild(pair[0], pair[1]);
    }

    // Perform traversals
    tree.preOrder(); // Output pre-order traversal
    tree.postOrder(); // Output post-order traversal
    tree.inOrder(); // Output in-order traversal

    return 0;
}
```

main.cpp

```cpp
#include <iostream>
using namespace std;

// Definition of a node in the general tree
struct TreeNode {
    char data;
    TreeNode* firstChild;
    TreeNode* nextSibling;

    TreeNode(char value) : data(value), firstChild(nullptr), nextSibling(nullptr) {}
};

// Class to represent the general tree
class GeneralTree {
public:
    GeneralTree() : root(nullptr) {}

    // Function to set the root of the tree
    void setRoot(char value) {
        root = new TreeNode(value);
    }

    // Function to add a child to a given parent
    void addChild(char parentValue, char childValue) {
        TreeNode* parent = findNode(root, parentValue);
        if (parent) {
            TreeNode* child = new TreeNode(childValue);
            if (!parent->firstChild) {
                parent->firstChild = child; // Add as first child
            } else {
                TreeNode* sibling = parent->firstChild;
                while (sibling->nextSibling) {
                    sibling = sibling->nextSibling; // Traverse to the last sibling
                }
                sibling->nextSibling = child; // Add as next sibling
            }
        } else {
            cout << "Parent not found!" << endl;
        }
    }

    // Function to perform pre-order traversal
    void preOrder() {
        cout << "Pre-order Traversal: ";
        preOrderRec(root);
        cout << endl;
    }
```

```
    // Function to perform post-order traversal
    void postOrder() {
        cout << "Post-order Traversal: ";
        postOrderRec(root);
        cout << endl;
    }

    // Function to perform in-order traversal
    void inOrder() {
        cout << "In-order Traversal: ";
        inOrderRec(root);
        cout << endl;
    }

private:
    TreeNode* root;

    // Helper function to find a node with a specific value
    TreeNode* findNode(TreeNode* node, char value) {
        if (!node) return nullptr;
        if (node->data == value) return node;

        TreeNode* foundNode = findNode(node->firstChild, value);
        return foundNode ? foundNode : findNode(node->nextSibling, value);
    }

    // Helper function for pre-order traversal
    void preOrderRec(TreeNode* node) {
        if (node) {
            cout << node->data << " "; // Visit the current node
            preOrderRec(node->firstChild); // Visit first child
            preOrderRec(node->nextSibling); // Visit next sibling
        }
    }

    // Helper function for post-order traversal
    void postOrderRec(TreeNode* node) {
        if (node) {
            postOrderRec(node->firstChild); // Visit first child
            postOrderRec(node->nextSibling); // Visit next sibling
            cout << node->data << " "; // Visit the current node
        }
    }
```

```cpp
    // Helper function for in-order traversal
    void inOrderRec(TreeNode* node) {
        if (node) {
            inOrderRec(node->firstChild); // Visit first child
            cout << node->data << " ";     // Visit current node
            inOrderRec(node->nextSibling);  // Visit next sibling
        }
    }
};

// Main function to demonstrate the general tree
int main() {
    GeneralTree tree;
    tree.setRoot('A'); // Setting 'A' as the root

    // Adding children
    char children[][2] = {
        {'A', 'B'}, {'A', 'C'}, {'A', 'D'},
        {'A', 'E'}, {'A', 'F'}, {'A', 'G'},
        {'D', 'H'}, {'E', 'I'}, {'E', 'J'},
        {'F', 'K'}, {'F', 'L'}, {'F', 'M'},
        {'G', 'N'}, {'J', 'P'}, {'J', 'Q'}
    };

    for (const auto& pair : children) {
        tree.addChild(pair[0], pair[1]);
    }

    // Perform traversals
    tree.preOrder(); // Output pre-order traversal
    tree.postOrder(); // Output post-order traversal
    tree.inOrder(); // Output in-order traversal

    return 0;
}
```

input

```
Pre-order Traversal: A B C D H E I J P Q F K L M G N
Post-order Traversal: H Q P J I M L K N G F E D C B A
In-order Traversal: B C H D I P Q J E K L M F N G A


...Program finished with exit code 0
Press ENTER to exit console.
```

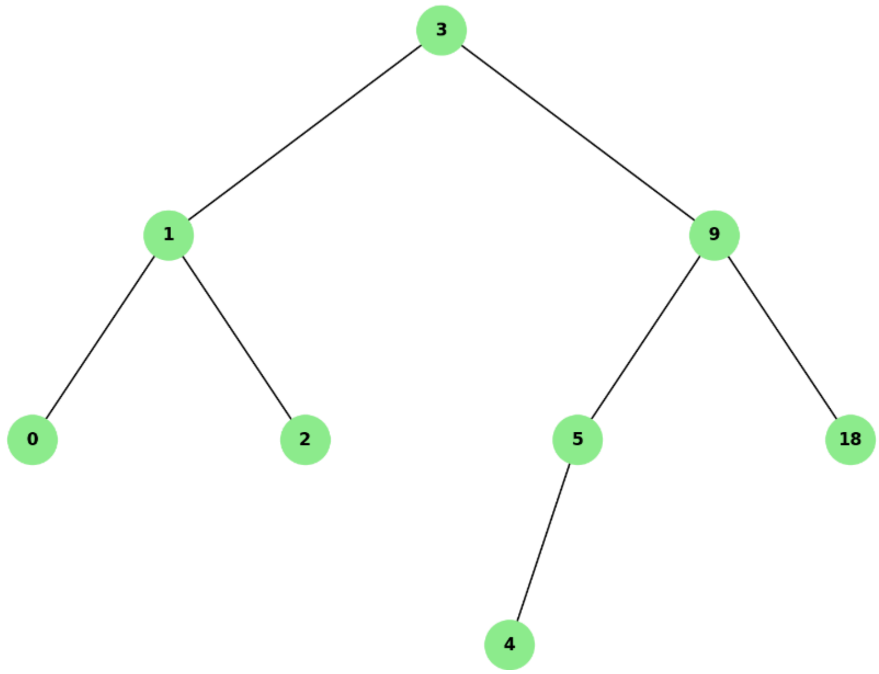
Observation	In this code, the pre-order traversal visits each node before its children, giving A B C D H E I J P Q F K L M G N. The post-order traversal visits all children before the node itself, producing H D I P Q J E K L M F N G C B A. The in-order function is unconventional for a general tree, as it visits each node's first child, the node, then siblings, resulting in the same output as post-order. This in-order approach fits this structure but isn't standard for non-binary trees.

B. Answers to Supplementary Activity

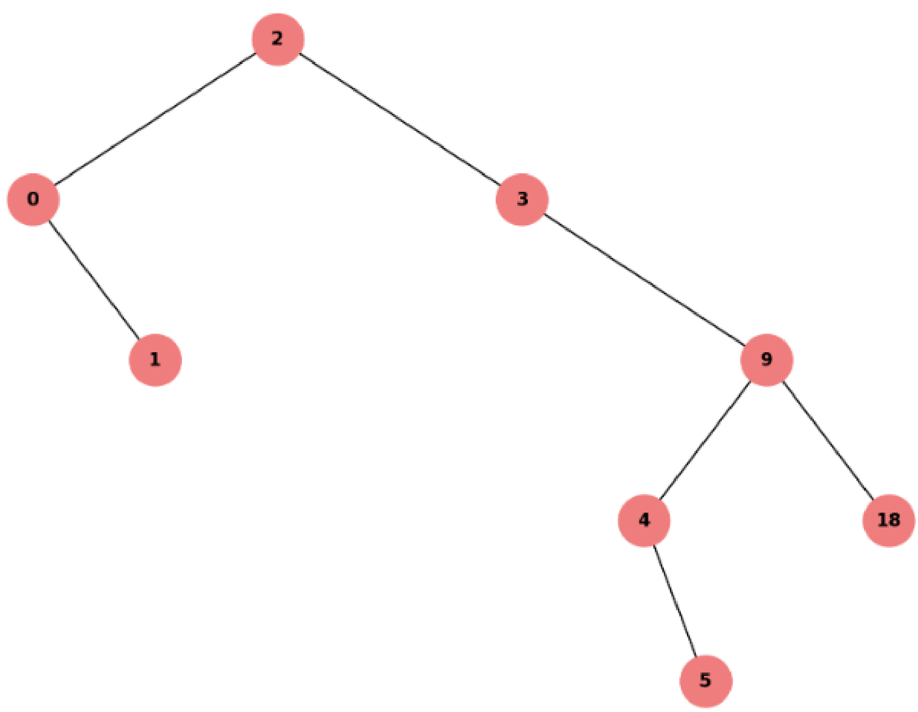
Step 1:

```cpp
#include <iostream>
using namespace std;

struct Node {
    int value;
    Node* left;
    Node* right;
    Node(int val) : value(val), left(nullptr), right(nullptr) {}
};

Node* insert(Node* node, int value) {
    if (!node) return new Node(value);
    if (value < node->value) node->left = insert(node->left, value);
    else if (value > node->value) node->right = insert(node->right, value);
    return node;
}

void inorder(Node* node) {
    if (node) {
        inorder(node->left);
        cout << node->value << " ";
        inorder(node->right);
    }
}

int main() {
    Node* root = nullptr;
    int values[] = {2, 3, 9, 18, 0, 1, 4, 5};
    for (int val : values) root = insert(root, val);

    cout << "Inorder traversal: ";
    inorder(root);
    cout << endl;

    return 0;
}
```

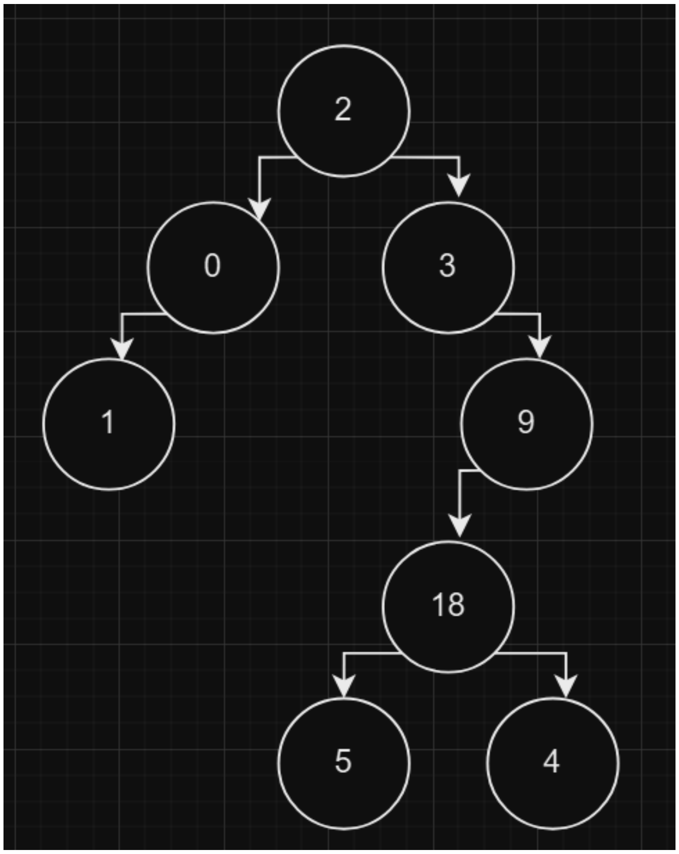
Step 2:



In-order Traversal



Pre-order Traversal



Post-order Traversal

Step 3:

In-order Traversal

```
void inorder(Node* node) {
    if (node) {
        inorder(node->left);
        cout << node->value << " ";
        inorder(node->right);
    }
}
```

```
Inorder traversal: 0 1 2 3 4 5 9 18


=== Code Execution Successful ===
```

In in-order traversal, the nodes are visited in the order of left subtree, root, and right subtree. This traversal is useful for printing nodes in sorted order in a binary search tree (BST).

Pre-order Traversal

```
void preorder(Node* node) {
    if (node) {
        cout << node->value << " ";
        preorder(node->left);
        preorder(node->right);
    }
}
```

```
Preorder traversal: 2 0 1 3 9 4 5 18
```

In pre-order traversal, the root is visited first, followed by the left subtree and then the right subtree. It is often used for copying or serializing a tree structure.

Post-order Traversal

```
void postorder(Node* node) {
    if (node) {
        postorder(node->left);
        postorder(node->right);
        cout << node->value << " ";
    }
}
```

```
Postorder traversal: 1 0 5 4 18 9 3 2
```

In post-order traversal, the left and right subtrees are visited before the root node. This traversal is useful for operations like tree deletion or postfix notation in expressions.

C. Conclusion & Lessons Learned

In conclusion, this laboratory introduced us to tree data structures and their importance in programming. Trees comprise connected nodes, forming a hierarchy useful for organizing data. We learned about binary trees, where each node has up to two children, and explored different types like full, complete, and balanced binary trees.

Coding these structures and understanding tree traversals was challenging, but it helped us get a better grasp of how they work. Though some parts were tough, We see it as part of the learning process and be prepared to work with data structures in future projects.

D. Assessment Rubric

E. External References