Lab Manual 03

DATA STRUCTURE

Submitted by: **Tahira Inam**

Roll No: 105

Instructor: Azka Mir

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Department of Software Engineering

University of Sialkot

Contents

Objectives

a) Understanding the concepts of recursion and its applications.
b) Implement recursion in two contexts: simple function operations and using linked lists.
c) Demonstrate recursive techniques for traversing and processing data.

Exercises

Exercise 3.1: Calculator with factorial, sum, Fibonacci and power functions.

Create a calculator with the following functions:

1. Factorial(): Calculate factorial of 30 and display it.

2. Sum(): Calculate power of a number and display it.

3. FibonacciSeries(): Calculate power of a number and display it.

4. Power(): Calculate power of a number and display it.

Note: A menu should be created and input should be taken by the user.

Exercise 3.2: Manage Playlist of Songs using singly Linked List with reverse and forward display functions.

(a) Implement a singly linked list of Songs Playlist with dynamic memory allocation.

(b) Write a function to recursively traverse the linked list in forward order.

(c) Write another function to recursively traverse the linked list in reverse order.

Source Code and Outputs

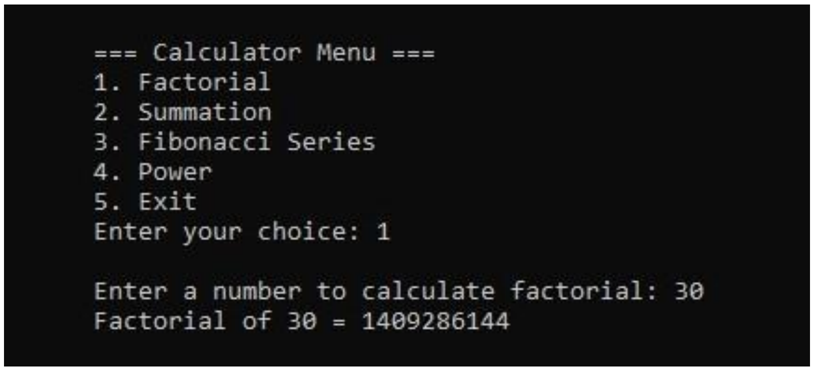
Exercise 3.1 Code

```
#include <iostream>

using namespace std;

class Calculator {

public:

  // Factorial Function

  int factorial(int n) {

    if (n <= 1) {

      return 1;
    } else {
      return n * factorial(n - 1);
    }
  }
  // Summation Function
  int sum(int n) {
    if (n <= 1) {
      return n;
    } else {
      return n + sum(n - 1);
    }
  }
  // Recursive Fibonacci Function
  int fibonacci(int n) {
    if (n <= 1) {
      return n;
    } else {
      return fibonacci(n - 1) + fibonacci(n - 2);
    }
  }
  // Display Fibonacci Series Function
  void fibonacciSeries(int terms) {
    cout << "\n\tFibonacci Series: ";
    for (int i = 0; i < terms; ++i) {
      cout << fibonacci(i) << " ";
    }
```

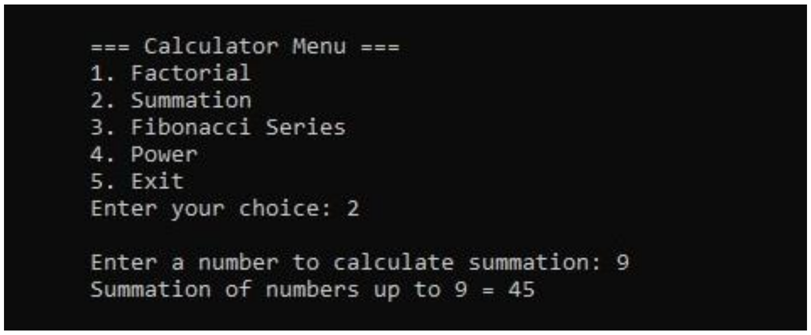
```
        cout << endl;
    }
    // Power Function
    int power(int base, int exp) {
        if (exp == 0) {
            return 1;
        } else {
            return base * power(base, exp - 1);
        }
    }
};
int main() {
    Calculator calc;
    int choice;
    while(true) {
        cout << "\n\n\t=== Calculator Menu ===\n";
        cout << "\t1. Factorial\n";
        cout << "\t2. Summation\n";
        cout << "\t3. Fibonacci Series\n";
        cout << "\t4. Power\n";
        cout << "\t5. Exit\n";
        cout << "\tEnter your choice: ";
        cin >> choice;
        switch (choice) {
        case 1: {
            int num;
    cout << "\n\tEnter a number to calculate factorial: ";
    cin >> num;
    cout << "\tFactorial of " << num << " = " << calc.factorial(num) << endl;
    break;
}
case 2: {
    int num;
    cout << "\n\tEnter a number to calculate summation: ";
    cin >> num;
    cout << "\tSummation of numbers up to " << num << " = " << calc.sum(num) << endl;
    break;
}
case 3: {
    int terms;
    cout << "\n\tEnter the number of terms for the Fibonacci series: ";
    cin >> terms;
    calc.fibonacciSeries(terms);
    break;
}
case 4: {
    int base, exp;
    cout << "\n\tEnter the base number: ";
    cin >> base;
    cout << "\tEnter the exponent: ";
    cin >> exp;
    cout <<"\t"<< base << "^" << exp << " = " << calc.power(base, exp) << endl;
```

```
            break;
        }
        case 5:;
            cout << "\n\tExiting the program...\n";
            return 0;
            break;
        default:
            cout << "\n\tInvalid choice! Please try again.\n";
        }
    }
    return 0;
}
```

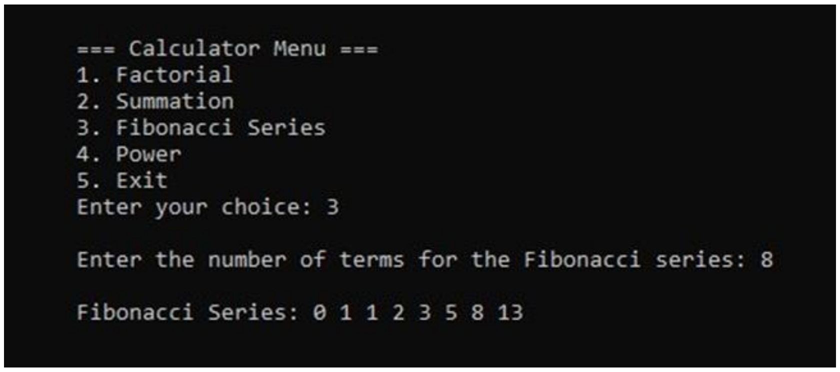
Output:



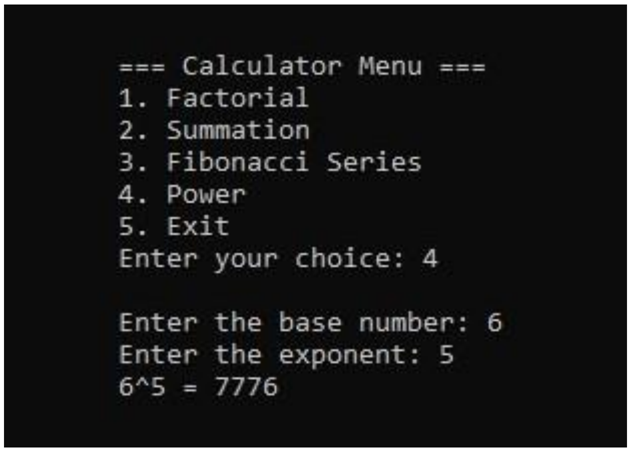
```
=== Calculator Menu ===
1. Factorial
2. Summation
3. Fibonacci Series
4. Power
5. Exit
Enter your choice: 1

Enter a number to calculate factorial: 30
Factorial of 30 = 1409286144
```



```
=== Calculator Menu ===
1. Factorial
2. Summation
3. Fibonacci Series
4. Power
5. Exit
Enter your choice: 2

Enter a number to calculate summation: 9
Summation of numbers up to 9 = 45
```



```
=== Calculator Menu ===
1. Factorial
2. Summation
3. Fibonacci Series
4. Power
5. Exit
Enter your choice: 3

Enter the number of terms for the Fibonacci series: 8

Fibonacci Series: 0 1 1 2 3 5 8 13
```



```
=== Calculator Menu ===
1. Factorial
2. Summation
3. Fibonacci Series
4. Power
5. Exit
Enter your choice: 4

Enter the base number: 6
Enter the exponent: 5
6^5 = 7776
```

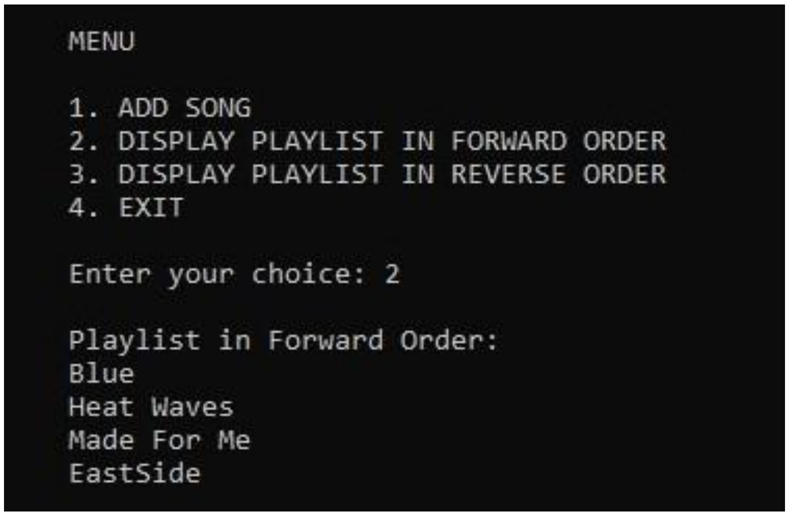
Exercise 3.2 Code

```
#include <iostream>

#include <string>

using namespace std;

struct Node {

  string songName;

  Node* next;

};

class Playlist {

public:

  Node* head;

  Node* tail;
```

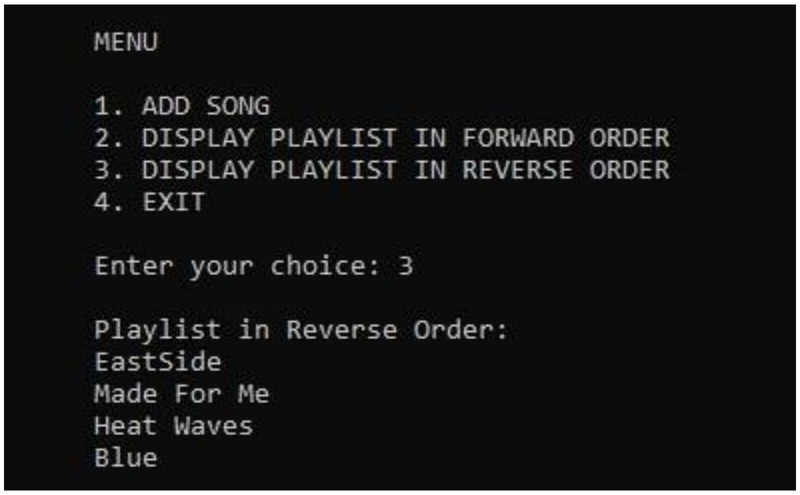
```
Playlist() {
    head = NULL;
    tail = NULL;
}
// Function to add a song to the playlist
void insert() {
    Node* temp = new Node;
    cout << "\n\tEnter Song Name: ";
    cin.ignore();
    getline(cin, temp->songName);
    temp->next = NULL;
    if (head == NULL) {
        head = temp;
        tail = temp;
    } else {
        tail->next = temp;
        tail = temp;
    }
    cout << "\n\tSong added successfully!" << endl;
}
// Recursive function to traverse the playlist in forward order
void traverseForward(Node* node) {
    if (node == NULL) {
        return;
    }
    cout << "\t" << node->songName << endl;
```

```
        traverseForward(node->next);
    }
    // Recursive function to traverse the playlist in reverse order
    void traverseReverse(Node* node) {
        if (node == NULL) {
            return;
        }
        traverseReverse(node->next);
        cout << "\t" << node->songName << endl;
    }
    // Function to print the playlist in forward order using recursion
    void displayForward() {
        cout << "\n\tPlaylist in Forward Order:" << endl;
        traverseForward(head);
    }
    // Function to print the playlist in reverse order using recursion
    void displayReverse() {
        cout << "\n\tPlaylist in Reverse Order:" << endl;
        traverseReverse(head);
    }
};
// MAIN FUNCTION
int main() {
    Playlist p;
    while (true) {
        cout << "\n\tMENU\n";
        cout << "\n\t1. ADD SONG";
        cout << "\n\t2. DISPLAY PLAYLIST IN FORWARD ORDER";
        cout << "\n\t3. DISPLAY PLAYLIST IN REVERSE ORDER";
        cout << "\n\t4. EXIT\n";
        int choice;
        cout << "\n\tEnter your choice: ";
        cin >> choice;
        switch (choice) {
          case 1:
            p.insert();
            break;
          case 2:
            p.displayForward();
            break;
          case 3:
            p.displayReverse();
            break;
          case 4:
            return 0;
          default:
            cout << "\n\tINVALID CHOICE! Please try again." << endl;
        }
    }
    return 0;
}
```

Output:



```
MENU

1. ADD SONG
2. DISPLAY PLAYLIST IN FORWARD ORDER
3. DISPLAY PLAYLIST IN REVERSE ORDER
4. EXIT

Enter your choice: 2

Playlist in Forward Order:
Blue
Heat Waves
Made For Me
EastSide
```



```
MENU

1. ADD SONG
2. DISPLAY PLAYLIST IN FORWARD ORDER
3. DISPLAY PLAYLIST IN REVERSE ORDER
4. EXIT

Enter your choice: 3

Playlist in Reverse Order:
EastSide
Made For Me
Heat Waves
Blue
```