MANIPAL INSTITUTE OF TECHNOLOGY
Manipal – 576 104

DEPARTMENT OF INFORMATION & COMMUNICATION TECHNOLOGY

CERTIFICATE

This is to certify that Ms./Mr. …………………...…………………………………… Reg. No. …..…………………… Section: …. Roll No: ………… has satisfactorily completed the lab exercises prescribed for Algorithms And Operating Systems Lab [ICT-5141] of First Year M. Tech. Degree at MIT, Manipal, in the academic year 2023-2024.

Date: ……....................................

Signature	Signature
Faculty in Charge	Head of the Department

CONTENTS

Course Objectives

- To demonstrate algorithmic complexity using asymptotic notations.
- Implement a solution to a given problem using Trees and graph algorithms.
- Solve a given problem using an appropriate algorithm design technique
- Apply the knowledge of Scheduling in disk and process management.
- Build a new product by the knowledge gained during the different phase of Algorithms and Operating system Concepts

Course Outcomes

- Implement an algorithm to find path between any two vertices in the given graph
- Apply the knowledge of shortest path algorithms for real world problems.
- Implement Greedy, Divide and Conquer, Dynamic Programming, Back tracking and Branch and Bound techniques to solve different problems.
- Apply the knowledge of Scheduling in disk and process management.
- Build a new product by the knowledge gained during the different phase of Algorithms and Operating system Concepts.

Evaluation Plan

Split up of 60 marks for Regular Lab Evaluation
Regular evaluations will be carried out in each weeks, which will have the following split up: Record/Document submission: 10 Marks (Execution/Completion of Task)+(Viva/Quiz): 4 Marks+4Marks Test 1: 10Marks Test 2: 10Marks Project Synopsys:15Marks Project Evaluation: 7 Marks
End Semester Lab Evaluation: 40 marks
End SEM EXAM: 20 Marks

Project Report+ Final Demo: 20 Marks
Total = 40 Marks

INSTRUCTIONS TO THE STUDENTS

Pre- Lab Session Instructions

1. Students should carry the lab manual and the required stationery to every lab session
2. Be in time and follow the institution dress code
3. Must sign in the log register provided
4. Make sure to occupy the allotted seat and answer the attendance
5. Adhere to the rules and maintain the decorum

In- Lab Session Instructions

- Follow the instructions on the allotted exercises
- Show the program and results to the instructors on completion of experiments
- On receiving approval from the instructor, copy the program and results in the lab manual
- Prescribed textbooks and class notes can be kept ready for reference if required.

General Instructions for the exercises in Lab

- Implement the given exercise individually and not in a group.
- The programs should meet the following criteria:
    - Programs should be interactive with appropriate prompt messages, error messages if any, and descriptive messages for outputs.
    - Programs should perform input validation (data type, range error, etc.) and give appropriate error messages and suggest corrective actions.

    - Comments should be used to give the statement of the problem and every function should indicate the purpose of the function, inputs and outputs.
    - Statements within the program should be properly indented.
    - Use meaningful names for variables and functions.
    - Make use of constants and type definitions wherever needed.

- Plagiarism (copying from others) is strictly prohibited and would invite severe penalty in evaluation.
- The exercises for each week are divided under three sets:
    - Solved exercise
    - Lab exercises : to be completed during lab hours
    - Additional Exercises - to be completed outside the lab or in the lab to enhance the skill
- If a student misses a lab class then he/she must ensure that the experiment is completed during the repetition class in case of genuine reason (medical certificate approved by HOD) with the permission of the faculty concerned
- Questions for lab tests and examination are not necessarily limited to the questions in the manual, but may involve some variations and / or combinations of the questions.
- A sample note preparation is given as a model for observation.

THE STUDENTS SHOULD NOT

Bring mobile phones or any other electronic gadgets to the lab.

Go out of the lab without permission.

LAB NO: 1 **Date:**

SEARCHING AND SORTING

Objectives:

1. Understand Algorithm and Algorithm Design Techniques
2. Apply the technique to searching and sorting using step count method
3. Analyze the complexity for different input sizes

1. Algorithm and Algorithm Analysis

Algorithm

Algorithm is a sequence of unambiguous instructions for solving a problem i.e for obtaining required output for any legitimate input in a finite amount of time.

It is procedural solution to problem

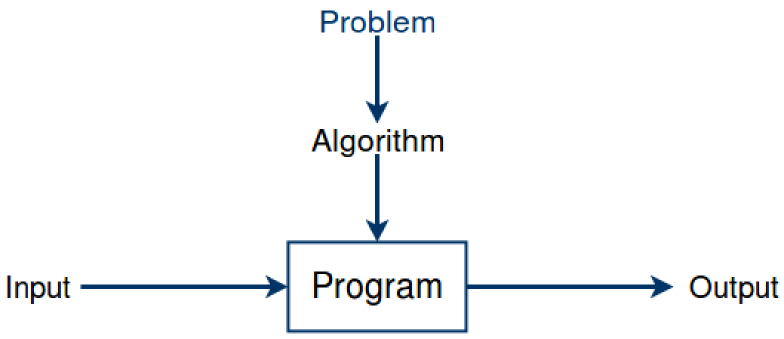


Figure 1: Notion of an Algorithm

2. Algorithm Analysis

Algorithm design technique is a general approach to solving problems algorithmically that is applicable to variety of problems from different areas of computing

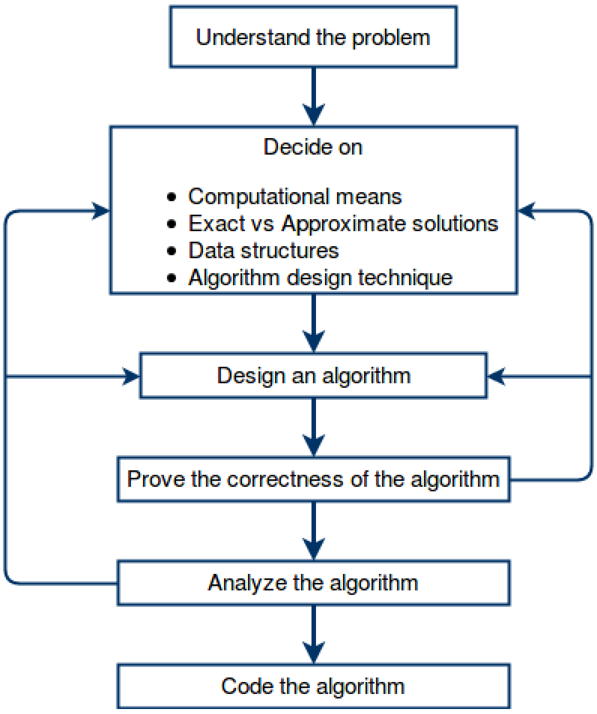


Figure 2: Algorithmic Problem Solving

3. Performance of a Program

Performance analysis of an algorithm depends upon two factors i.e. amount of memory used and amount of compute time consumed on any CPU. Formally they are notified as complexities in terms of:

- Space Complexity
- Time Complexity

Space Complexity of an algorithm is the amount of memory it needs to run to completion i.e. from start of execution to its termination. Space needed by any program is the sum of following components:

Fixed Component: This is independent of the characteristics of the inputs and outputs. This part includes: Instruction Space, Space of simple variables, fixed size component variables, and constants variables.

Variable Component: This consist of the space needed by component variables whose size is dependent on the particular problems instances(Inputs/Outputs) being solved, the space needed by referenced variables and the recursion stack space is one of the most prominent components. Also this included the data structure components like Linked list, heap, trees, graphs etc.

Therefore the total space requirement of any algorithm 'A' can be provided as

Space(A) = Fixed Components(A) + Variable Components(A)

Time complexity: Time Complexity of an algorithm(basically when converted to program) is the amount of computer time it needs to run to completion. The time taken by a program is the sum of the compile time and the run/execution time . The compile time is independent of the instance(problem specific) characteristics. following factors effect the time complexity:

- Characteristics of compiler used to compile the program.
- Computer Machine on which the program is executed and physically clocked
- Multiuser execution system
- Number of program steps.

The number of steps is the most prominent instance characteristics. The number of steps any program statement is assigned depends on the kind of statement like comments count as zero steps, an assignment statement which does not involve any calls to other algorithm is counted as one step, for iterative statements the steps count is considered only for the control part of the statement etc.

Therefore to calculate total number of program steps we use following procedure. For this we build a table in which we list the total number of steps contributed by each statement. This is arrived at by first determining the number of steps per execution of the statement and the frequency of each statement executed. This procedure is explained using Solved Exercise 1.

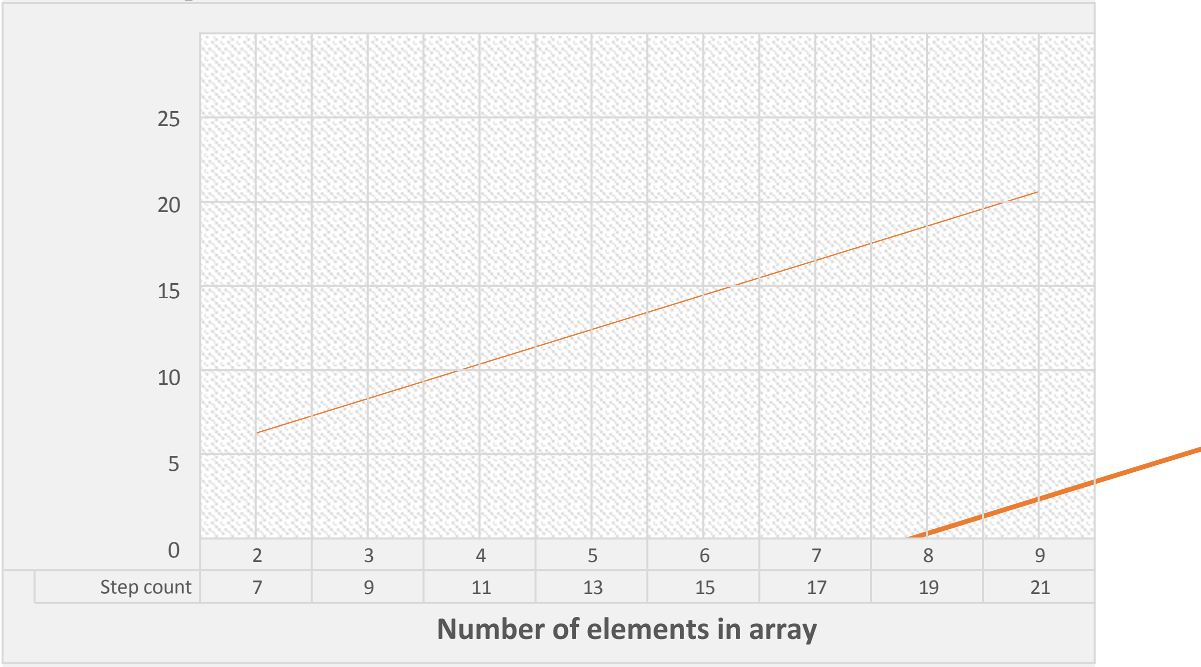
Solved Exercises:

1. **To print step count of sum function (to add elements of an array) and plot number of elements and step counts**

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

int sum(int arr[], int n)
{
    int i,s=0;
    count++;
    for (i = 0; i < n; i++)
    {
        count++;
        count++;
        s=s+arr[i];

    }
    count++;
    count++;
    return s;
}

int main(void)
{
    int arr[25], n, x;
    count=0;
    cout<<"enter no. of elements";
    cin>>n;
    cout<<"enter "<< n <<" elements";
    for(int i=0;i<n;i++)
    cin>>arr[i];
    int result = sum(arr, n);
    cout<<"Sum of elements "<<result;
    cout<<endl;
    cout<<"Number of steps for sum function "<<count;
   return 0;
}
```

```
enter no. of elements 5
enter 5 elements1 2 3 4 5
Sum of elements 15
```

```
Number of steps for sum function 13

enter no. of elements 8
enter 8 elements 11 12 33 21 43 22 43 67
Sum of elements 252
Number of steps for sum function 19

Number of steps : 2n+3
```



	2	3	4	5	6	7	8	9
Step count	7	9	11	13	15	17	19	21

2. To print the time taken by the sum function

```
#include <iostream>
#include <chrono>
using namespace std;
using namespace std::chrono;
int count;
int sum(int arr[], int n)
{

    int i,s=0;
    count++;
    for (i = 0; i < n; i++)
    {
        count++;
        count++;
        s=s+arr[i];

    }
    count++;
    count++;

    return s;
}

int main(void)
{
    int arr[1000], n, x;
    count=0;
    cout<<"enter no. of elements";
    cin>>n;
    //cout<<"enter "<< n <<" elements";
    for(int i=0;i<n;i++)
    arr[i]=i;
    auto start = high_resolution_clock::now();
    int result = sum(arr, n);
    auto stop = high_resolution_clock::now();
    cout<<"Sum of elements "<<result;
    cout<<endl;
    auto duration = duration_cast<microseconds>(stop - start);
    cout << "time taken to run sum fucntion:  "<<duration.count() << endl;
   cout<<"Number of steps for sum function "<<count << microseconds;
   return 0;
}
```

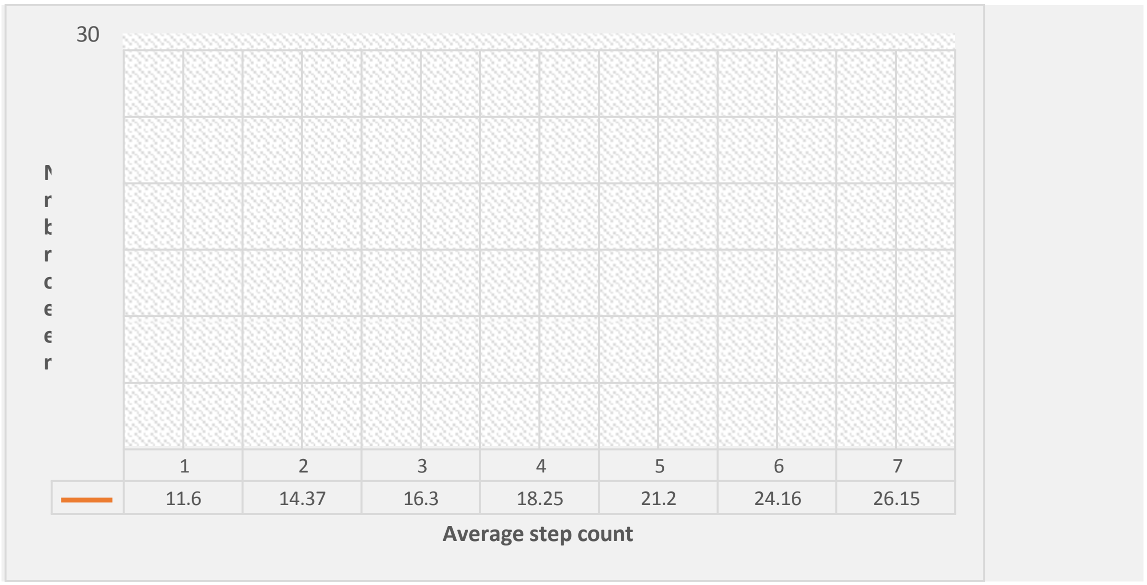
Output

```
enter no. of elements500
Sum of elements 124750
time taken to run sum function:  2 microseconds
Number of steps for sum function 1003
```

3. To print step counts of linear search function and plot average step counts

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

int search(int arr[], int n, int x)
{
    int i;
    count++;
    for (i = 0; i < n; i++)
    {
        count++;
        count++;
        if (arr[i] == x)
          {
          count++;
           return i;
          }
     }
    count++;
    count++;
    return -1;
}

int main(void)
{
    int arr[25], n, x;
    count=0;
    cout<<"enter no. of elements";
    cin>>n;
    cout<<"enter "<< n <<" elements";
    for(int i=0;i<n;i++)
    cin>>arr[i];
    cout<<"enter the element to be searched";
    cin>> x;
    int result = search(arr, n, x);
   (result == -1)? cout<<"Element is not present in array"
                 : cout<<"Element is present at index " <<result;
    cout<<endl;
    cout<<"Number of seteps for search function "<<count;
   return 0;
}
enter no. of elements 6
enter 6 elements 1 3 2 5 4 6
enter the element to be searched 3
Element is present at index 1
Number of steps for search function 6

enter no. of elements 6
enter 6 elements 1 3  2 5 4 6
enter the element to be searched 4
Element is present at index 4
Number of steps for search function 12

enter no. of elements 6
enter 6 elements 1 3 2 5 4 6
enter the element to be searched 10
Element is not present in array
Number of steps for search function 15

enter no. of elements 6
enter 6 elements 1 3 2 5 4 6
enter the element to be searched56
Element is not present in array
Number of steps for search function 15
```

Number of steps :
If lement found in the ith position : 2(i)+2
If element not found : 2n+3
Hence total number of intsnces : n+1
Average case complexity = $\frac{\sum_{i=1}^{n}(2i+2)+2n+3}{n+1}$



	1	2	3	4	5	6	7
▬	11.6	14.37	16.3	18.25	21.2	24.16	26.15

Lab Exercises

Write a Program to perform the following and find the time complexity using step count method

1. Binary Search (both iterative and recursive)
2. Bubble Sort
3. Selection Sort
4. Insertion Sort

Additional Exercises

1. Find the substring in a given string without using String handling functions.
2. Implement rank sort algorithm.

LAB NO: 2 **Date:**

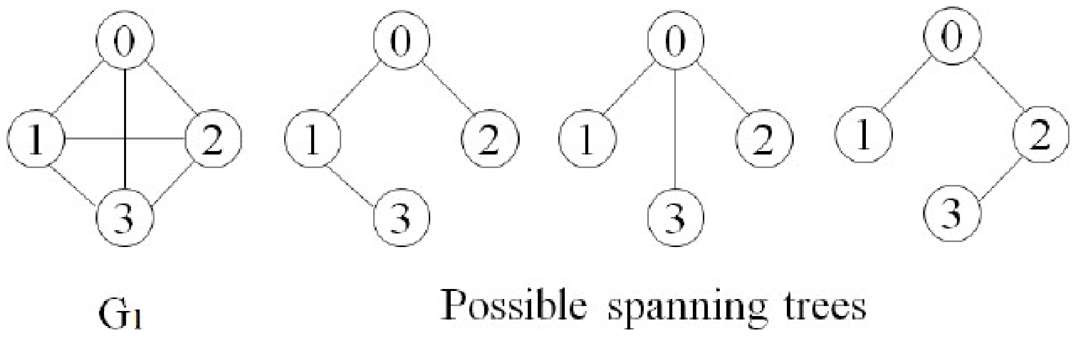
TREES

Objectives:

1. To Understand spanning tree
2. Apply greedy technique to find the minimum cost spanning tree and shortest path from single source
3. Analyze the time complexity for the same

1. **Spanning Tree**

   A spanning tree is a subset of Graph G, which has all the vertices covered with minimum possible number of edges. Hence, a spanning tree does not have cycles and it cannot be disconnected.



Minimum Cost Spanning Tree

In a weighted graph, a minimum spanning tree is a spanning tree that has minimum weight than all other spanning trees of the same graph. Following algorithms are used find the minimum cost spanning tree.

A. Prims's
B. Kruskal;s

Application: For example, if the vertices of the graph represent cities and edge path costs represent driving distances between pairs of cities connected by a direct road, Dijkstra's algorithm can be used to find the shortest route between one city and all other cities. As a result, the shortest path first is widely used in network routing protocols. “Shortest” can be in time, distance, cost, etc. It can be applied to numerous applications like Map navigation, Flight itineraries, Circuit wiring, Network routing.

Greedy criterion:
From the remaining edges, select a least cost edge that doesn't result in a cycle when added to a set of already selected edges.

Solved Exercise
Find the minimum cost spanning tree using Kruskal’s algorithm.

```
#include <bits/stdc++.h>
using namespace std;

#define V 6
#define Infinity 5000
int parent[V];

// Find set of vertex i
int find(int i)
{
        while (parent[i] != i)
                i = parent[i];
        return i;
}

// Does union of i and j. It returns  false if i and j are already in the same set.
void union1(int i, int j)
{
        int  a  =  find(i);
        int  b  =  find(j);
        parent[a] = b; }
```

```
// Finds MST using Kruskal's algorithm
void kruskals(int cost[][V])
{
	int mincost = 0; // Cost of min MST.

	// Initialize sets of disjoint sets.
	for (int i = 0; i < V; i++)
		parent[i] = i;

	// Include minimum weight edges one by one
	int edge_count = 0;
	cout<<"Edges Selected and corresponding cost"<<":"<<"\n";
	while (edge_count < V - 1) {
		int min = Infinity, a = -1, b = -1;
		for (int i = 0; i < V; i++) {
			for (int j = 0; j < V; j++) {
				if (find(i) != find(j) && cost[i][j] < min) {
					min = cost[i][j];
					a = i;
					b = j;
						}
					}
		}
	union1(a, b);
	cout<<"("<<a+1<<','<<b+1<<")"<<"\t\t"<<min<<"\n";
	edge_count++;
		mincost += min;
	}
	cout<<"Minimum cost="<<mincost; }
int main()
     {
		int cost[][V] = {
		   { Infinity, 6,1,5,Infinity,Infinity },
		   { 6,Infinity,5, Infinity, 3, Infinity },
		   { 1,5,Infinity, 5,6,4 },
		   { 5,Infinity, 5,Infinity,Infinity,2 },
		   { Infinity, 3,6,Infinity,Infinity,6 },
		   { Infinity, Infinity, 4,2,6,Infinity },
          };

          // Print the solution
          kruskals(cost);

          return 0;
}
```

```
Output:
Edge :(1,3)Cost:1
Edge :(4,6)Cost:2
Edge :(2,5)Cost:3
Edge :(3,6)Cost:4
Edge :(2,3)Cost:5

Minimum cost= 15
```

Time Complexity

Time complexity is O(V+E). Where V and E represents the number vertices and edges of the given graph respectively.

Lab Exercises

1. Write a program to find the minimum cost spanning tree using Prim's algorithm and also analyze the complexity.
2. Write a program to find the maximum cost spanning tree for the given connected weighed graph.

Additional Exercises

1. Write a program to find the minimum cost spanning tree using Sollin's algorithm and also analyze the complexity.
2. Implement Huffman tree construction algorithm.

LAB NO: 3 **Date:**

GRAPHS

Objectives:

1. Understand the graph representations
2. Understand Breadth First Search (BFS) and Depth-First Search (DFS), graph traversal algorithms.
3. Apply the BFS and DFS to find sequence and analyze the complexities based on the graph representaions

1. Graph Representations

Graph is a data structure that consists of following two components:

1. A finite set of vertices also called as nodes.

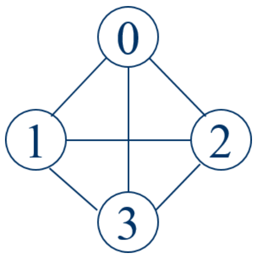
2. A finite set of ordered pair of the form (u, v) called as edge. The pair is ordered because (u, v) is not same as (v, u) in case of a directed graph(di-graph). The pair of the form (u, v) indicates that there is an edge from vertex u to vertex v. The edges may contain weight/value/cost.

Following two are the most commonly used representations of a graph.

1. Adjacency Matrix

2. Adjacency List

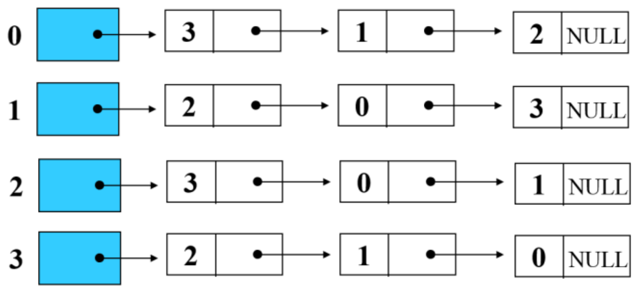
Adjacency Matrix:



Adjacency Matrix is a 2D array of size V x V where V is the number of vertices in a graph. Let the 2D array be adj[][], a slot adj[i][j] = 1 indicates that there is an edge from vertex i to vertex j. Adjacency matrix for undirected graph is always symmetric. Adjacency Matrix is also used to represent weighted graphs. If adj[i][j] = w, then there is an edge from vertex i to vertex j with weight w.

0	1	1	1
1	0	1	1
1	1	0	1
1	1	1	0

Adjacency List:
An array of lists is used. Size of the array is equal to the number of vertices. Let the array be array[]. An entry array[i] represents the list of vertices adjacent to the ***i***th vertex. This representation can also be used to represent a weighted graph. The weights of edges can be represented as lists of pairs. Following is adjacency list representation of the above graph.



2. Breadth First Search

.B x.readth-first search (BFS) is an algorithm for traversing or searching tree or graph data structures. It starts at the tree root (or some arbitrary node of a graph, sometimes referred to as a 'search key') and explores the neighbor nodes first, before moving to the next level neighbors.

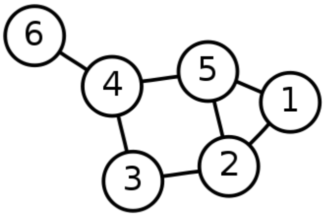
Input: A graph and a starting vertex root of Graph

Output: All vertices reachable from root labeled as explored.

Example:

BFS will visit the sibling vertices before the child vertices using this algorithm:

```
Mark the starting node of the graph as visited and enqueue it into the queue
While the queue is not empty
        Dequeue the next node from the queue to become the current node
        While there is an unvisited child of the current node
           Mark the child as visited and enqueue the child node into the queue
```



The queue operation enqueue adds to the left and dequeue removes from the right.

Action	Current Node	Queue	Unvisited Nodes	Visited Nodes
Start with node 1		1	2, 3, 4, 5, 6	1
Dequeue node 1	1		2, 3, 4, 5, 6	1
Node 1 has unvisited children nodes 2 and 5	1		2, 3, 4, 5, 6	1
Mark 2 as visited and enqueue into queue	1	2	3, 4, 5, 6	1, 2
Mark 5 as visited and enqueue into queue	1	5, 2	3, 4, 6	1, 2, 5
Node 1 has no more unvisited children, dequeue a new current node 2	2	5	3, 4, 6	1, 2, 5
Mark 3 as visited and enqueue into queue	2	3, 5	4, 6	1, 2, 5, 3
Node 2 has no more unvisited children, dequeue a new current node 5	5	3	4, 6	1, 2, 5, 3
Mark 4 as visited and enqueue into queue	5	4, 3	6	1, 2, 5, 3, 4
Node 5 has no more unvisited children, dequeue a new current node 3	3	4	6	1, 2, 5, 3, 4
Node 3 has no more unvisited children, dequeue a new current node 4	4		6	1, 2, 5, 3, 4
Mark 6 as visited and enqueue into queue	4	6		1, 2, 5, 3, 4, 6

2. Depth-First Search :

Considering a given node as the parent and connected nodes as children, DFS will visit the child vertices before visiting siblings using this algorithm.

```
Mark the starting node of the graph as visited and push it onto the stack
While the stack is not empty
Peek at top node on the stack (look at the top element on the stack, but do not remove it)
If there is an unvisited child of that node
        Mark the child as visited and push the child node onto the stack
Else
        Pop the top node off the stack
```

Action	Stack	Unvisited Nodes	Visited Nodes
Start with node 1	1	2, 3, 4, 5, 6	1
Peek at the stack Node 1 has unvisited child nodes 2 and 5	1	2, 3, 4, 5, 6	1
Mark node 2 visited	1, 2	3, 4, 5, 6	1, 2
Peek at the stack Node 2 has unvisited child nodes 3 and 5	1, 2	3, 4, 5, 6	1, 2
Mark node 3 visited	1, 2, 3	4, 5, 6	1, 2, 3
Peek at the stack Node 3 has unvisited child node 4	1, 2, 3	4, 5, 6	1, 2, 3
Mark node 4 visited	1, 2, 3, 4	5, 6	1, 2, 3, 4
Peek at the stack Node 4 has unvisited child node 5	1, 2, 3, 4	5, 6	1, 2, 3, 4
Mark node 5 visited	1, 2, 3, 4, 5	6	1, 2, 3, 4, 5
Peek at the stack Node 5 has no unvisited children	1, 2, 3, 4, 5	6	1, 2, 3, 4, 5
Pop node 5 off stack	1, 2, 3, 4	6	1, 2, 3, 4, 5
Peek at the stack Node 4 has unvisited child node 6	1, 2, 3, 4	6	1, 2, 3, 4, 5
Mark node 6 visited	1, 2, 3, 4, 6		1, 2, 3, 4, 5, 6

Solved Exercise: Representing graph using adjacency matrix and printing indegree of vertices

```
#include  <iostream>
using namespace std;
int count;
int indegree(int arr[][10], int p, int n)
{
   int c1=0;

   for (int i = 1; i <= n; i++)
   {
      if(arr[i][p]==1)
      c1++;
   }

   return c1;
}

int main(void)
{
   int A[10][10], n, m,x;
   count=0;
   cout<<"enter no. of vertices";
   cin>>n;
   cout<<"enter number of edges";
   cin>>m;
   for(int i=1;i<=n;i++)
   for(int j=1;j<=n;j++)
   A[i][j]=0;
   int p,q;

   for(int i=1;i<=m;i++)
   {
     cout<<"enter Source";
     cin>> p;
     cout<<"enter destination ";
     cin>>q;
     A[p][q]=1;
   }

   for(p=1;p<=n;p++)
   {
   int result = indegree(A,p,n);
   cout<<endl;
   cout<<"Indegree of "<< p <<" is:" << result;
    }
   return 0;
}
```

```
Output
enter no. of vertices4
enter number of edges5
enter Source 1
enter destination  3 enter Source1  enter destination 4 enter Source3  enter destination 4 enter
Source4  enter destination 2 enter Source2  enter destination 1

Indegree of 1 is:1
Indegree of 2 is:1
Indegree of 3 is:1
Indegree of 4 is:2
```

Lab Exercises

Write Programs to perform the following and find the time complexity using step count method:

1. Depth First Search (DFS)
2. Breadth First Search (BFS)
3. To find mother vertex in a graph
4. To find transpose of a given graph
5. Finding a path and Cycle in the graph
6. Check whether the given graph is connected or not.

Additional Exercises

Write a Program to input a graph from the user (nodes should be given numbers 1, 2,.. upto n) and perform the following:

1. Display the nodes with even number using BFS.
2. Display the nodes with odd number using DFS

LAB NO: 4 **Date:**

GREEDY TECHNIQUE

Objectives:

1. Understand optimization problem and Greedy Technique
2. Apply the technique to container loading, find the topological sequence etc..
3. Analyze the time complexity

1. **Optimization Problem**
   In an Optimization problem, we are given a set of constraints and an optimization function. Solutions that satisfy the constraints are called feasible solutions. A feasible solution for which the optimization function has the best possible value is called an optimal solution.

2. **Greedy Technique**
   A greedy technique, as the name suggests, always makes the choice that seems to be the best at that moment. In greedy algorithm approach, decisions are made from the given solution domain. A decision made in one stage is not changed in later state, so each decision should assure feasibility.

   The criterion used to make the greedy decision at each stage is called the greedy criterion.

   Some of the applications of this technique are finding the topological sequence, container loading problem etc.,

Solved Exercise:

Machine Scheduling Problem

Given n tasks and an infinite supply of machines on which these tasks can be performed. Each task has start time S_i and finish time F_i, $S_i < F_i$. $[S_i , F_i]$ is the processing interval for task i. Two tasks i & j overlap iff their processing intervals overlap at a point other than start or finish time. Schedule the tasks using minimum number of machines.

Greedy Criterion:

If an old machine becomes available by the start time of the task to be assigned, assign the task to this machine; if not, assign it to a new machine.

```
#include <iostream>
using namespace std;
#include <bits/stdc++.h>
using namespace std;

class Task
{         public: int start, finish;   };

bool Comparetasks(Task t1, Task t2)
{
          return (t1.start < t2.start);  }

void printtasks(Task arr[], int n)
{
          sort(arr, arr+n, Comparetasks);
           int i = 0;
          bool selected[n];
          for(i=0;i<n;i++)
                    selected[i]=false;
          int k=0,j;
          for(i=0;i<n;i++)
          {
              if(selected[i])
                  continue;
                cout<<"========================================";
              cout <<"\n"<<" Task Allocation : For Machine "<<k+1<<"\n";
             cout << "(" <<arr[i].start<< ", " <<arr[i].finish<<")"<<"\n";

             for (j = i+1; j < n; j++)
                {
                   if(selected[j])
                      continue;
                    if (arr[i].finish<= arr[j].start)
                  {
                              i = j;
                        selected[j]=1;
                        cout << "(" <<arr[j].start<<","<<arr[j].finish<<")"<<"\n";
                  }
                        }
         //k++;
         i=++k;
         cout<<"=========================================="; }
   cout<<"\n"<<"Total Machines Used "<<k;  }

int main()
{
        Task arr[10];
        int n;
        cout<<"Enter the number of Total Number Tasks";
        cin>>n;
        cout<<"Enter Start and Finish time of each machine";
        for(int i=0;i<n;i++)
        cin>>arr[i].start>>arr[i].finish;
        printtasks(arr, n);
        return 0;
}
```

Output

```
Enter the number of Total Number Tasks7
Enter Start and Finish time of each machine
9 11
7  10
6  8
4  7
3  7
2 5
1 2
==========================================
 Task Allocation : For Machine 1
(1, 2)
```

```
(2,5)
(6,8)
(9,11)
=============================================
 Task Allocation : For Machine 2
(3, 7)
(7,10)
=============================================
 Task Allocation : For Machine 3
(4, 7)
=============================================
Total Machines Used 3
```

Time Complexity :
Time taken is O(n log n) if the tasks are not in sorted order.

Lab Exercises

Write a Program to perform the following and find the time complexity using step count method:

1. Container Loading Problem
2. 0/1 Knapsack Problem
3. Topological Sorting

Additional Exercises

1. To Check whether a given graph is bipartite or not.
2. To find the minimal cover of a Bipartite graph
3. Implement 0/1 Knapsack problem using profit by density method.

LAB NO:5 **Date:**

DIVIDE AND CONQUER

Objectives:

1. Understand the divide and conquer algorithm design technique
2. Apply this technique to sort the elements of the list
3. Analyze the complexity

1. Basic Concepts :

Divide & conquer is a general algorithm design strategy with a general plan as follows:

- DIVIDE: A problem's instance is divided into several smaller instances of the same problem, ideally of about the same size.
- RECUR: Solve the sub-problem recursively.
- CONQUER: If necessary, the solutions obtained for the smaller instances are combined to get a solution to the original instance.

1. General divide & conquer recurrence:

An instance of size “n” can be divided into “b” instances of size n/b, with “a" of them needing to be solved. [$a \geq 1$; $b \geq 1$]

Assume size n is a power of b. The recurrence for the running time T(n) is as follows:

$T(n) = aT(n/b) + f(n)$

Where f (n) is a function that accounts for the time spent on dividing the problem into smaller ones and on combining their solutions

Therefore, the order of growth of T(n) depends on the values of the constants a & b and the order of growth of the function f (n).

Solved Exercise

Search an element using in a sorted array using binary search, divide and conquer technique.

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

int binSearch(int arr[], int l, int r, int x)
{
        while (l <= r) {
                int m = l + (r - l) / 2;

                if (arr[m] == x) //Mid element
                        return m;  // Element Present
                if (arr[m] < x)  // Search Right half
                        l = m + 1;
                else //Search Left half
                        r = m - 1;
        }
        return -1; // not found
}

int main(void)
{
   int n,ele,arr[20];
        cout<< "Enter the total number of elements";
        cin>>n;
        cout<<"Enter the elements in ascending order";
        for(int i=0;i<n;i++)
          cin>>arr[i];
        cout<<"Enter the element to search";
        cin>>ele;
        int result = binSearch(arr, 0, n - 1, ele);
            if(result == -1){
              cout << "Element is not present in array";
            exit(0);}

                        cout << "Element is present at index " << result+1;
        return 0;
}
```

Output

```
Enter the total number of elements8
Enter the elements 1 6 7 9 10 12 16 18
Enter the element to search 16
Element is present at index 7
```

Complexity Analysis
Recurrence Relation: $T(n) = T(n/2) + c$
Hence the complexity is (Log n).

Auxiliary Space: O(1) in case of iterative implementation.

Lab Exercises

1. Write a program to sort the elements of an array using the following and analyze the complexity.

1. Quick Sort
2. Merge Sort

2. Write a program find the maximum and minimum of an array using divide and conquer technique.

Additional Exercises

1. Given set of strings, find the longest common prefix using Divide and Conquer given set of strings**.**

2. Write a program to compute a^b using divide and conquer technique and analyze the complexity.

LAB NO: 6 **Date:**

DYNAMIC PROGRAMMING

Objective:

1. Understand the Dynamic Programming algorithm design method
2. Apply the same to find the optimal packing of Knapsack, find the optimal order of multiplication etc.
3. Analyze the time complexity

1. Dynamic Programming

Dynamic programming (usually referred to as DP) is a very powerful technique to solve a particular class of problems. A DP is an algorithmic technique which is usually based on a recurrent formula and one (or some) starting states. A sub-solution of the problem is constructed from previously found ones. DP solutions have a polynomial complexity. It demands very elegant formulation of the approach and simple thinking and the coding part is very easy. The idea is very simple, if you have solved a problem with the given input, then save the result for future reference, so as to avoid solving the same problem again. Shortly '*Remember your Past'*. If the given problem can be broken up in to smaller sub-problems and these smaller subproblems are in turn divided in to still-smaller ones, and in this process, if you observe some over-lappping subproblems, then it's a big hint for DP. Also, the optimal solutions to the subproblems contribute to the optimal solution of the given problem.

It uses bottom-up approach i.e. analyze the problem and see the order in which the sub-problems are solved and start solving from the trivial subproblem, up towards the given problem. In this process, it is guaranteed that the subproblems are solved before solving the problem. This is referred to as Dynamic Programming.

Solved Exercise

Generation of Fibonacci Series using Dynamic Programming

Lab

```
#include<stdio.h>
#include <bits/stdc++.h>
using namespace std;
void fib_series(int n)
{
int fib[n+2], i;
fib[0] = 0;  // 1st number of the series
fib[1] = 1;  /// 2nd  number of the series
cout<<"Fibonacci Series of length "<<n<<"\n";
cout<<fib[0]<< " " <<fib[1]<<" ";
for (i = 2; i < n; i++)
   {
            fib[i] = fib[i-1] + fib[i-2];
            cout<<fib[i]<< " "; }
   }

int main () {
cout<<"Enter the Value n (Length of the Series) ";
int n;
cin>>n;
fib_series(n);
return 0;  }
```

Output

```
Enter the Value n (Length of the Series) 10
Fibonacci Series of length 10
0 1 1 2 3 5 8 13 21 34
```

exercises

1. Write a Program to implement 0/1 Knapsack using dynamic programming technique and analyze the complexity.

2. Write a program to find the optimal order of multiplication in a chain of matrices and analyze the complexity

3. Write a program to find the shortest path between every pair of vertices in a given graph using dynamic programming technique.

Additional exercises

1. Write program to find the binomial coefficient of any numbers *n* and *k* using dynamic programming technique.

2. Given a set of non-negative integers, and a value sum, determine if there is a subset of the given set with sum equal to given sum.

   Sample Input: set[] = {3, 34, 4, 12, 5, 2}, sum = 9

   Sample Output: True //There is a subset (4, 5) with sum 9.

LAB NO:7 **Date:**

BASICS OF UNIX COMMANDS

Objectives:

1. To study about the basics of UNIX
2. To study the Basic UNIX Commands

Basic Concepts:

UNIX:

It is a multi-user operating system. Developed at AT & T Bell Industries, USA in 1969.

Ken Thomson along with Dennis Ritchie developed it from MULTICS (Multiplexed Information and Computing Service) OS.

By1980, UNIX had been completely rewritten using C language.

LINUX:

It is similar to UNIX, which is created by Linus Torualds. All UNIX commands works in Linux. Linux is a open source software. The main feature of Linux is coexisting with other OS such as windows and UNIX.

STRUCTURE OF A LINUXSYSTEM:

It consists of three parts.

a) UNIX kernel
b) Shells
c) Tools and Applications

UNIX KERNEL:

Kernel is the core of the UNIX OS. It controls all tasks, schedule all Processes andcarries out all the functions of OS.

Decides when one programs tops and another starts.

SHELL:

Shell is the command interpreter in the UNIX OS. It accepts command from the userand analyses and interprets them

CONTENT:

Note: Syn->Syntax

a) date

–used to check the date and timeSyn:$date

Format	Purpose	Example	Result
+%m	To display only month	$date+%m	06
+%h	To display month name	$date+%h	June
+%d	To display day of month	$date+%d	O1
+%y	To display last two digits of years	$date+%y	09
+%H	To display hours	$date+%H	10
+%M	To display minutes	$date+%M	45
+%S	To display seconds	$date+%S	55

b) cal

–used to display the calendar Syn:$cal
2 2009

c)echo

–used to print the message on the screen.
Syn:$echo “text”

d) ls

–used to list the files. Your files are kept in a directory.
Syn:$lsls–s
All files (include files with prefix) ls–l
Lodetai (provide file statistics) ls–t Order by creation time
ls– u Sort by access time (or show when last accessed together with –l)ls–s Order by size

Lab exercises

1. To write C Programs using the following system calls of UNIX operating system, opendir, readdir and closedir.
2. To write C Programs using the following system calls of UNIX operating system, fork, getpid, exit.

Additional exercises

1. Write simple shell programs by using conditional, branching and looping statements.

LAB NO:8 **Date:**

CPU SCHEDULING ALGORITHMS

Objectives:

1. To write a C program for implementation of Priority scheduling algorithms.
2. To write a C program for implementation of Round Robin scheduling algorithms.

Basic Concepts:

ALGORITHM:

```
Step 1: Inside the structure declare the variables.
Step 2: Declare the variable i,j as integer,  totwtime and totttime is
equal to zero.Step 3: Get the value of „n" assign p and allocate the
memory.
Step 4: Inside the for loop get the value of burst time
and priority.Step 5: Assign wtime as zero .
Step 6: Check p[i].pri is greater than p[j].pri .
Step 7: Calculate the total of burst time and waiting time and assign as
turnaround time.
Step 8: Stop the program.
```

PROGRAM:

```
#include<stdio.h>
 #include<stdio.h>
#include<stdlib.h>
typedef struct
{
int pno; int pri; int pri; int btime;
int wtime;
}sp;
int main()
{
int i,j,n;
int tbm=0,totwtime=0,totttime=0; sp *p,t;
printf("\n PRIORITY SCHEDULING.\n");
printf("\n enter the no of process. \n");
scanf("%d",&n); p=(sp*)malloc(sizeof(sp));
printf("enter the burst time and priority:\n"); for(i=0;i<n;i++)
{
printf("process%d:",i+1); scanf("%d%d",&p[i].btime,&p[i].pri);
p[i].wtime=0;
}
for(i=0;i<n-1;i++) for(j=i+1;j<n;j++)
{
if(p[i].pri>p[j].pri)
{
t=p[i]; p[i]=p[j]; p[j]=t;
}
}
printf("\n process\tbursttime\twaiting time\tturnaround time\n");
for(i=0;i<n;i++)
{
totwtime+=p[i].wtime=tbm; tbm+=p[i].btime;
printf("\n%d\t\t%d",p[i].pno,p[i].btime);
printf("\t\t%d\t\t%d",p[i].wtime,p[i].wtime+p[i].btime);
}
totttime=tbm+totwtime;
printf("\n total waiting time:%d",totwtime);
printf("\n average waiting time:%f",(float)totwtime/n); printf("\n total
turnaround time:%d",totttime); printf("\n avg turnaround
time:%f",(float)totttime/n);
}
```

Lab exercises

1. To write a C program for implementation of Round Robin scheduling algorithms.
2. To write a C program for implementation of SJF scheduling algorithms.

Additional exercises

1. To write a C program for implementation of SJF scheduling algorithms.

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