1. Design and implement C/C++ Program to find Minimum Cost Spanning

Tree of a given connected undirected graph using Kruskal's algorithm.

Program Code

```
#include<stdio.h>
#define INF 999
#define MAX 100
int p[MAX], c[MAX][MAX], t[MAX][2];
int find(int v)
{
 while (p[v])
 v = p[v];
 return v;
}
void union1(int i, int j)
{
 p[j] = i;
}
void kruskal(int n)
{
 int i, j, k, u, v, min, res1, res2, sum = 0;
 for (k = 1; k < n; k++)
 {
 min = INF;
 for (i = 1; i < n - 1; i++)
 {
```

```
for (j = 1; j <= n; j++)

{

if (i == j) continue;

if (c[i][j] < min)

{

u = find(i);

v = find(j);

if (u != v)

{

res1 = i;

res2 = j;

min = c[i][j];

}

}

}

}

union1(res1, find(res2));

t[k][1] = res1;

t[k][2] = res2;

sum = sum + min;

}

printf("\nCost of spanning tree is=%d", sum);

printf("\nEdges of spanning tree are:\n");

for (i = 1; i < n; i++)

printf("%d -> %d\n", t[i][1], t[i][2]);
```

```
}
int main()
{
 int i, j, n;
 printf("\nEnter the n value:");
 scanf("%d", & n);
 for (i = 1; i <= n; i++)
 p[i] = 0;
 printf("\nEnter the graph data:\n");
 for (i = 1; i <= n; i++)
 for (j = 1; j <= n; j++)
 scanf("%d", & c[i][j]);
 kruskal(n);
 return 0;
}
```

Output

```
Enter the n value:5
Enter the graph data:
1 3 4 6 2
1 7 6 9 3
5 2 8 99 45
1 44 66 33 6
12 4 3 2 0
Cost of spanning tree is=11
Edges of spanning tree are:
```

2 -> 1

1 -> 5

3 -> 2

1 -> 4

2. Design and implement C/C++ Program to find Minimum Cost Spanning

Tree of a given connected undirected graph using Prim's algorithm.

Program Code

```
#include<stdio.h>
#include<conio.h>
#define INF 999
int prim(int c[10][10],int n,int s)
{
 int v[10],i,j,sum=0,ver[10],d[10],min,u;
 for(i=1; i<=n; i++)
 {
 ver[i]=s;
 d[i]=c[s][i];
 v[i]=0;
 }
 v[s]=1;
 for(i=1; i<=n-1; i++)
 {
 min=INF;
 for(j=1; j<=n; j++)
 if(v[j]==0 && d[j]<min)
 {
 min=d[j];
 u=j;
 }
```

```
 v[u]=1;
 sum=sum+d[u];
 printf("\n%d -> %d sum=%d",ver[u],u,sum);
 for(j=1; j<=n; j++)
 if(v[j]==0 && c[u][j]<d[j])
 {
 d[j]=c[u][j];
 ver[j]=u;
 }
 }
 return sum;
}
void main()
{
 int c[10][10],i,j,res,s,n;
 printf("\nEnter n value:");
 scanf("%d",&n);
 printf("\nEnter the graph data:\n");
 for(i=1; i<=n; i++)
 for(j=1; j<=n; j++)
 scanf("%d",&c[i][j]);
 printf("\nEnter the souce node:");
 scanf("%d",&s);
 res=prim(c,n,s);
 printf("\nCost=%d",res);
```

```
getch();
}
```

Output

Enter n value:4

Enter the graph data:

4 5 2 1

7 5 9 2

1 7 6 9

0 2 8 5

Enter the souce node:4

4 -> 1 sum=0

4 -> 2 sum=2

1 -> 3 sum=4

Cost=4

3a. Design and implement C/C++ Program to solve All-Pairs Shortest Paths problem using Floyd's algorithm.

Program Code

```
#include<stdio.h>

#include<conio.h>

#define INF 999

int min(int a,int b)

{

return(a<b)?a:b;

}

void floyd(int p[][10],int n)

{

int i,j,k;

for(k=1; k<=n; k++)

for(i=1; i<=n; i++)

for(j=1; j<=n; j++)

p[i][j]=min(p[i][j],p[i][k]+p[k][j]);

}

void main()

{

int a[10][10],n,i,j;

printf("\nEnter the n value:");

scanf("%d",&n);

printf("\nEnter the graph data:\n");

for(i=1; i<=n; i++)

for(j=1; j<=n; j++)
```

```
scanf("%d",&a[i][j]);

floyd(a,n);

printf("\nShortest path matrix\n");

for(i=1; i<=n; i++)

{

for(j=1; j<=n; j++)

printf("%d ",a[i][j]);

printf("\n");

}

getch();

}
```

Output

Enter the n value:4

Enter the graph data:

0 999 3 999

2 0 999 999

999 7 0 1

6 999 999 0

Shortest path matrix

0 10 3 4

2 0 5 6

7 7 0 1

6 16 9 0

3b. Design and implement C/C++ Program to find the transitive closure using Warshal's algorithm.

Program Code

```
#include<stdio.h>

void warsh(int p[][10],int n)

{

int i,j,k;

for(k=1; k<=n; k++)

for(i=1; i<=n; i++)

for(j=1; j<=n; j++)

p[i][j]=p[i][j] || p[i][k] && p[k][j];

}

int main()

{

int a[10][10],n,i,j;

printf("\nEnter the n value:");

scanf("%d",&n);

printf("\nEnter the graph data:\n");

for(i=1; i<=n; i++)

for(j=1; j<=n; j++)

scanf("%d",&a[i][j]);

warsh(a,n);

printf("\nResultant path matrix\n");

for(i=1; i<=n; i++)

{

for(j=1; j<=n; j++)
```

```
printf("%d ",a[i][j]);

printf("\n");

}

return 0;

}
```

Output

Enter the n value:4

Enter the graph data:

0 1 0 0

0 0 0 1

0 0 0 0

1 0 1 0

Resultant path matrix

1 1 1 1

1 1 1 1

0 0 0 0

1 1 1 1

4. Design and implement C/C++ Program to find shortest paths from a given vertex in a weighted connected graph to other vertices using Dijkstra's algorithm.

Program Code

```
#include<stdio.h>

#define INF 999

void dijkstra(int c[10][10],int n,int s,int d[10])

{

int v[10],min,u,i,j;

for(i=1; i<=n; i++)

{

d[i]=c[s][i];

v[i]=0;

}

v[s]=1;

for(i=1; i<=n; i++)

{

min=INF;

for(j=1; j<=n; j++)

if(v[j]==0 && d[j]<min)

{

min=d[j];

u=j;

}

v[u]=1;
```

```
for(j=1; j<=n; j++)

if(v[j]==0 && (d[u]+c[u][j])<d[j])

d[j]=d[u]+c[u][j];

}

}

int main()

{

int c[10][10],d[10],i,j,s,sum,n;

printf("\nEnter n value:");

scanf("%d",&n);

printf("\nEnter the graph data:\n");

for(i=1; i<=n; i++)

for(j=1; j<=n; j++)

scanf("%d",&c[i][j]);

printf("\nEnter the souce node:");

scanf("%d",&s);

dijkstra(c,n,s,d);

for(i=1; i<=n; i++)

printf("\nShortest distance from %d to %d is %d",s,i,d[i]);

return 0;

}
```

Output

Enter n value:4

Enter the graph data:

444 767 987 12

999 87 56 45

1 0 999 678

444 678 235 0

Enter the souce node:1

Shortest distance from 1 to 1 is 444

Shortest distance from 1 to 2 is 247

Shortest distance from 1 to 3 is 247

Shortest distance from 1 to 4 is 12

5. Design and implement C/C++ Program to obtain the Topological ordering of vertices in a given digraph.

Program Code

```
#include<stdio.h>

#include<conio.h>

int temp[10],k=0;

void sort(int a[][10],int id[],int n)

{

int i,j;

for(i=1; i<=n; i++)

{

if(id[i]==0)

{

id[i]=-1;

temp[++k]=i;

for(j=1; j<=n; j++)

{

if(a[i][j]==1 && id[j]!=-1)

id[j]--;

}

i=0;

}

}

}

void main()

{
```

```
int a[10][10],id[10],n,i,j;

printf("\nEnter the n value:");

scanf("%d",&n);

for(i=1; i<=n; i++)

id[i]=0;

printf("\nEnter the graph data:\n");

for(i=1; i<=n; i++)

for(j=1; j<=n; j++)

{

scanf("%d",&a[i][j]);

if(a[i][j]==1)

id[j]++;

}

sort(a,id,n);

if(k!=n)

printf("\nTopological ordering not possible");

else

{

printf("\nTopological ordering is:");

for(i=1; i<=k; i++)

printf("%d ",temp[i]);

}

getch();

}
```

Output 1

Enter the n value:6

Enter the graph data:

0 0 1 1 0 0

0 0 0 1 1 0

0 0 0 1 0 1

0 0 0 0 0 1

0 0 0 0 0 1

0 0 0 0 0 0

Topological ordering is: 1 2 3 4 5 6

Output 2

Enter the n value:4

Enter the graph data:

1 4 3 2

5 4 2 1

5 3 4 2

4 1 2 3

Topological ordering not possible

6. Design and implement C/C++ Program to solve 0/1 Knapsack problem using Dynamic Programming method.

Program Code

```
#include<stdio.h>

int w[10],p[10],n;

int max(int a,int b)

{

return a>b?a:b;

}

int knap(int i,int m)

{

if(i==n) return w[i]>m?0:p[i];

if(w[i]>m) return knap(i+1,m);

return max(knap(i+1,m),knap(i+1,m-w[i])+p[i]);

}

int main()

{

int m,i,max_profit;

printf("\nEnter the no. of objects:");

scanf("%d",&n);

printf("\nEnter the knapsack capacity:");

scanf("%d",&m);

printf("\nEnter profit followed by weight:\n");

for(i=1; i<=n; i++)

scanf("%d %d",&p[i],&w[i]);

max_profit=knap(1,m);
```

```
printf("\nMax profit=%d",max_profit);

return 0;

}
```

Output

```
Enter the no. of objects:4

Enter the knapsack capacity:5

Enter profit followed by weight:

12 3

43 5

45 2

55 3

Max profit=100
```

7. Design and implement C/C++ Program to solve discrete Knapsack and continuous Knapsack problems using greedy approximation method.

Program Code

```
#include <stdio.h>

#define MAX 50

int p[MAX], w[MAX], x[MAX];

double maxprofit;

int n, m, i;

void greedyKnapsack(int n, int w[], int p[], int m)

{

double ratio[MAX];

// Calculate the ratio of profit to weight for each item

for (i = 0; i < n; i++)

{

ratio[i] = (double)p[i] / w[i];

}

// Sort items based on the ratio in non-increasing order

for (i = 0; i < n - 1; i++)

{

for (int j = i + 1; j < n; j++)

{

if (ratio[i] < ratio[j])

{

double temp = ratio[i];

ratio[i] = ratio[j];

ratio[j] = temp;
```

```
int temp2 = w[i];
w[i] = w[j];
w[j] = temp2;
temp2 = p[i];
p[i] = p[j];
p[j] = temp2;
}
}
}
int currentWeight = 0;
maxprofit = 0.0;
// Fill the knapsack with items
for (i = 0; i < n; i++)
{
if (currentWeight + w[i] <= m)
{
x[i] = 1; // Item i is selected
currentWeight += w[i];
maxprofit += p[i];
}
else
{
// Fractional part of item i is selected
x[i] = (m - currentWeight) / (double)w[i];
maxprofit += x[i] * p[i];
```

```
break;
}
}
printf("Optimal solution for greedy method: %.1f\n", maxprofit);
printf("Solution vector for greedy method: ");
for (i = 0; i < n; i++)
printf("%d\t", x[i]);
}
int main()
{
printf("Enter the number of objects: ");
scanf("%d", &n);
printf("Enter the objects' weights: ");
for (i = 0; i < n; i++)
scanf("%d", &w[i]);
printf("Enter the objects' profits: ");
for (i = 0; i < n; i++)
scanf("%d", &p[i]);
printf("Enter the maximum capacity: ");
scanf("%d", &m);
greedyKnapsack(n, w, p, m);
return 0;
}
```

Output

Enter the number of objects: 4

Enter the objects' weights: 56 78 98 78

Enter the objects' profits: 23 45 76 78

Enter the maximum capacity: 100

Optimal solution for greedy method: 78.0

Solution vector for greedy method: 1 0 0 0

8. Design and implement C/C++ Program to find a subset of a given set S = {s1, s2,…..,sn} of n positive integers whose sum is equal to a given positive integer d.

Program Code

```
#include<stdio.h>

#define MAX 10

int s[MAX],x[MAX],d;

void sumofsub(int p,int k,int r)

{

int i;

x[k]=1;

if((p+s[k])==d)

{

for(i=1; i<=k; i++)

if(x[i]==1)

printf("%d ",s[i]);

printf("\n");

}

else if(p+s[k]+s[k+1]<=d)

sumofsub(p+s[k],k+1,r

-s[k]);

if((p+r

-s[k]>=d) && (p+s[k+1]<=d))

{

x[k]=0;

sumofsub(p,k+1,r
```

```
-s[k]);
}
}
int main()
{
int i,n,sum=0;
printf("\nEnter the n value:");
scanf("%d",&n);
printf("\nEnter the set in increasing order:");
for(i=1; i<=n; i++)
scanf("%d",&s[i]);
printf("\nEnter the max subset value:");
scanf("%d",&d);
for(i=1; i<=n; i++)
sum=sum+s[i];
if(sum<d || s[1]>d)
printf("\nNo subset possible");
else
sumofsub(0,1,sum);
return 0;
}
```

Output

Enter the n value:9

Enter the set in increasing order:1 2 3 4 5 6 7 8 9

Enter the max subset value:9

1 2 6

1 3 5

1 8

2 3 4

2 7

3 6

4 5

9. Design and implement C/C++ Program to sort a given set of n integer elements using Selection Sort method and compute its time complexity. Run the program for varied values of n> 5000 and record the time taken to sort. Plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.

Step 1: Implement the Selection Sort Algorithm

The Selection Sort algorithm works by repeatedly finding the minimum element from

the unsorted part and putting it at the beginning.

Program Code

```
#include <stdio.h>

#include <stdlib.h>

#include <time.h>

// Function to perform selection sort on an array

void selectionSort(int arr[], int n)

{

int i, j, min_idx;

for (i = 0; i < n-1; i++)

{

min_idx = i; // Assume the current element is the minimum

for (j = i+1; j < n; j++)

{

if (arr[j] < arr[min_idx])

{

min_idx = j; // Update min_idx if a smaller element is found

}

}
```

```
// Swap the found minimum element with the current element
int temp = arr[min_idx];
arr[min_idx] = arr[i];
arr[i] = temp;
}
}
// Function to generate an array of random numbers
void generateRandomNumbers(int arr[], int n)
{
for (int i = 0; i < n; i++)
{
arr[i] = rand() % 10000; // Generate random numbers between 0 and 9999
}
}
int main()
{
int n;
printf("Enter number of elements: ");
scanf("%d", &n); // Read the number of elements from the user
if (n <= 5000)
{
printf("Please enter a value greater than 5000\n");
return 1; // Exit if the number of elements is not greater than 5000
}
// Allocate memory for the array
```

```
int *arr = (int *)malloc(n * sizeof(int));
if (arr == NULL)
{
printf("Memory allocation failed\n");
return 1; // Exit if memory allocation fails
}
// Generate random numbers and store them in the array
generateRandomNumbers(arr, n);
// Measure the time taken to sort the array
clock_t start = clock();
selectionSort(arr, n);
clock_t end = clock();
// Calculate and print the time taken to sort the array
double time_taken = ((double)(end - start)) / CLOCKS_PER_SEC;
printf("Time taken to sort %d elements: %f seconds\n", n, time_taken);
// Free the allocated memory
free(arr);
return 0;
}
```

Step 2: Measure Time Taken

The above program generates n random numbers, sorts them using the Selection Sort algorithm, and measures the time taken for the sorting process. Step 3: Run the Program for Various Values of n

To collect data, run the program with different values of n greater than 5000, such as 6000, 7000, 8000, etc., and record the time taken for each.

Output

Enter number of elements: 6000

Time taken to sort 6000 elements: 0.031000 seconds

Enter number of elements: 7000

Time taken to sort 7000 elements: 0.034000 seconds

Enter number of elements: 8000

Time taken to sort 8000 elements: 0.047000 seconds

Enter number of elements: 9000

Time taken to sort 9000 elements: 0.052000 seconds

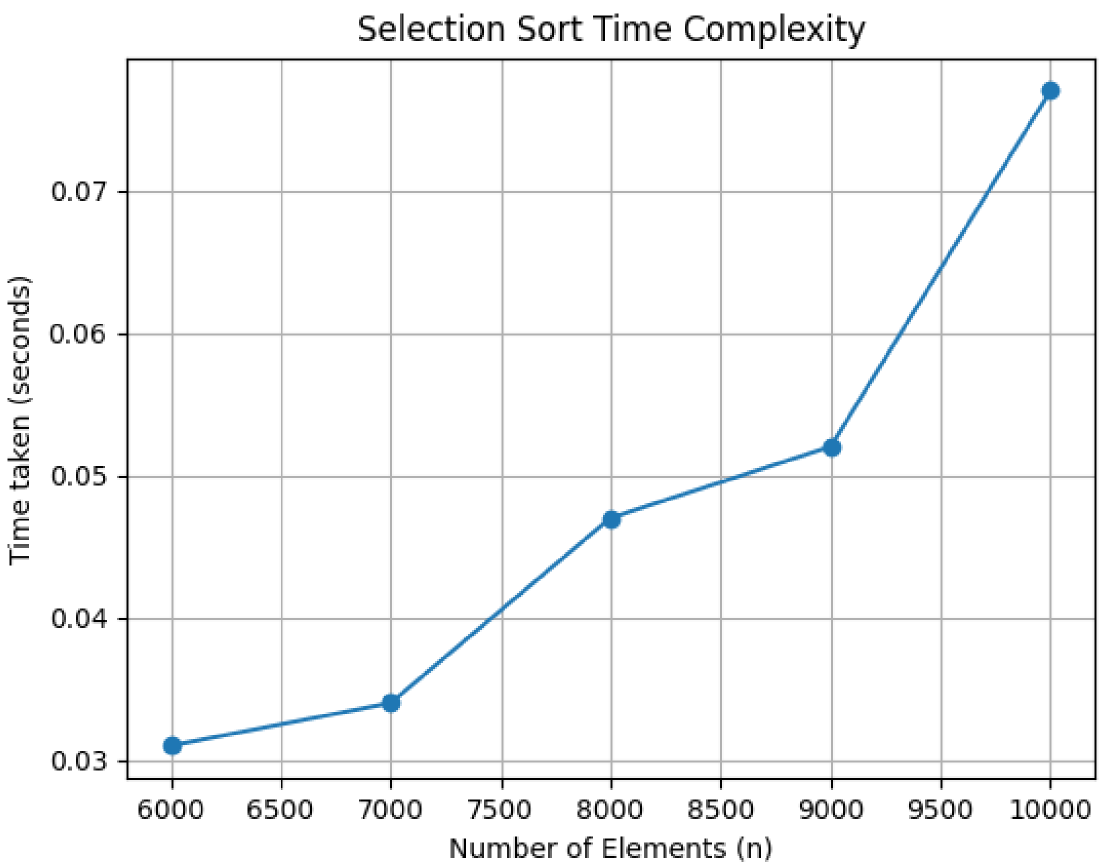
Enter number of elements: 10000

Time taken to sort 10000 elements: 0.077000 seconds

Step 4: Plot the Results

You can use a graphing tool like Python with matplotlib to plot the results.

```
import matplotlib.pyplot as plt

# data collected

n_values = [6000, 7000, 8000, 9000, 10000]

time_taken = [0.031000, 0.034000, 0.047000, 0.052000, 0.077000] # replace with actual
 times recorded

plt.plot(n_values, time_taken, marker='o')

plt.title('Selection Sort Time Complexity')

plt.xlabel('Number of Elements (n)')

plt.ylabel('Time taken (seconds)')

plt.grid(True)

plt.show()
```


Selection Sort Time Complexity
Time taken (seconds)
0.03
0.04
0.05
0.06
0.07
6000
6500
7000
7500
8000
8500
9000
9500
10000
Number of Elements (n)

9. Design and implement C/C++ Program to sort a given set of n integer elements using Selection Sort method and compute its time complexity. Run the program for varied values of n> 5000 and record the time taken to sort. Plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.

Step 1: Implement the Selection Sort Algorithm

The Selection Sort algorithm works by repeatedly finding the minimum element

from the unsorted part and putting it at the beginning.

Program Code

```
#include <stdio.h>

#include <stdlib.h>

#include <time.h>

// Function to perform selection sort on an array

void selectionSort(int arr[], int n)

{

int i, j, min_idx;

for (i = 0; i < n-1; i++)

{

min_idx = i; // Assume the current element is the minimum

for (j = i+1; j < n; j++)

{

if (arr[j] < arr[min_idx])

{

min_idx = j; // Update min_idx if a smaller element is found

}

}
```

```
// Swap the found minimum element with the current element
int temp = arr[min_idx];
arr[min_idx] = arr[i];
arr[i] = temp;
}
}
// Function to generate an array of random numbers
void generateRandomNumbers(int arr[], int n)
{
for (int i = 0; i < n; i++)
{
arr[i] = rand() % 10000; // Generate random numbers between 0 and 9999
}
}
int main()
{
int n;
printf("Enter number of elements: ");
scanf("%d", &n); // Read the number of elements from the user
if (n <= 5000)
{
printf("Please enter a value greater than 5000\n");
return 1; // Exit if the number of elements is not greater than 5000
}
// Allocate memory for the array
```

```
int *arr = (int *)malloc(n * sizeof(int));

if (arr == NULL)

{

printf("Memory allocation failed\n");

return 1; // Exit if memory allocation fails

}

// Generate random numbers and store them in the array

generateRandomNumbers(arr, n);

// Measure the time taken to sort the array

clock_t start = clock();

selectionSort(arr, n);

clock_t end = clock();

// Calculate and print the time taken to sort the array

double time_taken = ((double)(end - start)) / CLOCKS_PER_SEC;

printf("Time taken to sort %d elements: %f seconds\n", n, time_taken);

// Free the allocated memory

free(arr);

return 0;

}
```

Step 2: Measure Time Taken

The above program generates n random numbers, sorts them using the Selection Sort algorithm, and measures the time taken for the sorting process. Step 3: Run the Program for Various Values of n

To collect data, run the program with different values of n greater than 5000, such as 6000, 7000, 8000, etc., and record the time taken for each.

Output

Enter number of elements: 6000

Time taken to sort 6000 elements: 0.031000 seconds

Enter number of elements: 7000

Time taken to sort 7000 elements: 0.034000 seconds

Enter number of elements: 8000

Time taken to sort 8000 elements: 0.047000 seconds

Enter number of elements: 9000

Time taken to sort 9000 elements: 0.052000 seconds

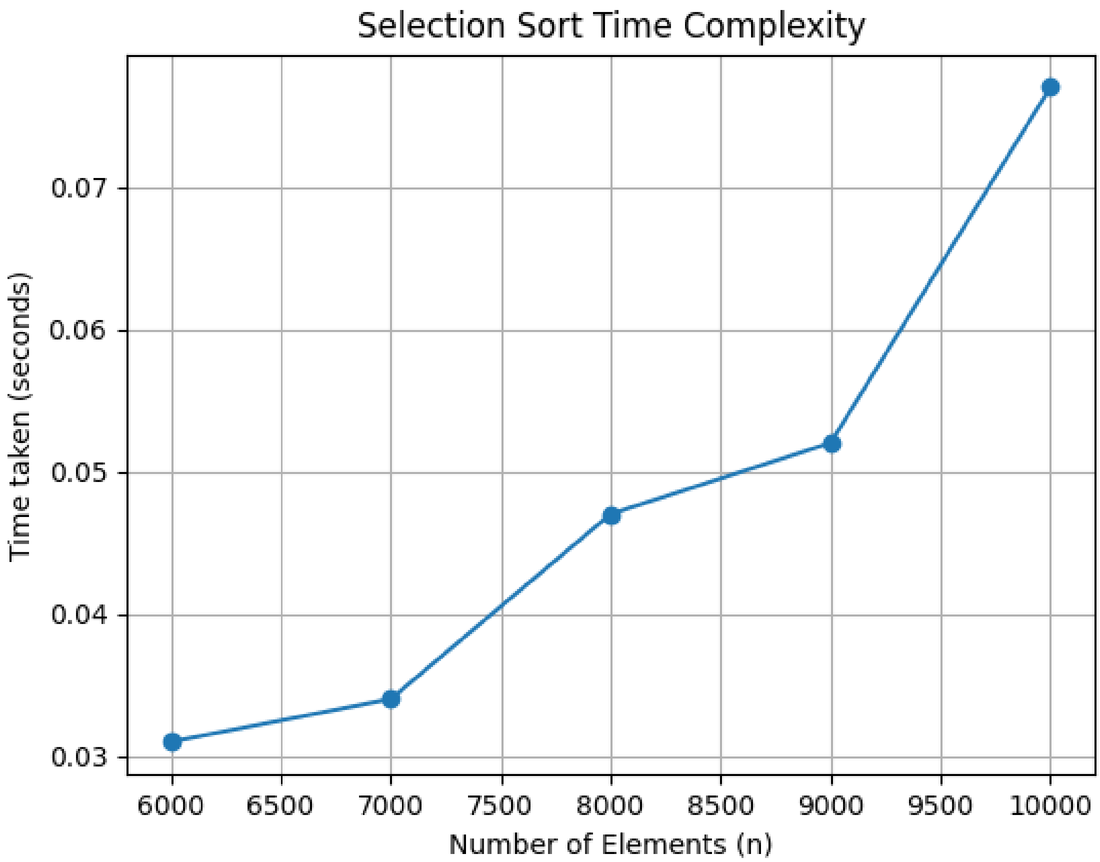
Enter number of elements: 10000

Time taken to sort 10000 elements: 0.077000 seconds

Step 4: Plot the Results

You can use a graphing tool like Python with matplotlib to plot the results.

```
import matplotlib.pyplot as plt

# data collected

n_values = [6000, 7000, 8000, 9000, 10000]

time_taken = [0.031000, 0.034000, 0.047000, 0.052000, 0.077000] # replace with actual
times    recorded

plt.plot(n_values, time_taken, marker='o')

plt.title('Selection Sort Time Complexity')

plt.xlabel('Number of Elements (n)')

plt.ylabel('Time taken (seconds)')

plt.grid(True)

plt.show()
```


Selection Sort Time Complexity
Time taken (seconds)
0.03
0.04
0.05
0.06
0.07
6000
6500
7000
7500
8000
8500
9000
9500
10000
Number of Elements (n)

10. Design and implement C/C++ Program to sort a given set of n integer elements using Quick Sort method and compute its time complexity. Run the program for varied values of n> 5000 and record the time taken to sort. Plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.

Step 1: Implement the Quick Sort Algorithm

Quick Sort is a divide-and-conquer algorithm that works by selecting a 'pivot' element and partitioning the array into elements less than and greater than the pivot.

Program Code

```
#include <stdio.h>

#include <stdlib.h>

#include <time.h>

// Function to swap two elements

void swap(int* a, int* b)

{

int t = *a;

*a = *b;

*b = t;

}

// Partition function for Quick Sort

int partition(int arr[], int low, int high)

{

int pivot = arr[high]; // Pivot element

int i = (low - 1); // Index of smaller element

for (int j = low; j <= high - 1; j++)

{
```

```
if (arr[j] < pivot)
{
i++; // Increment index of smaller element
swap(&arr[i], &arr[j]);
}
}
swap(&arr[i + 1], &arr[high]);
return (i + 1);
}
// Quick Sort function
void quickSort(int arr[], int low, int high)
{
if (low < high)
{
int pi = partition(arr, low, high);
// Recursively sort elements before and after partition
quickSort(arr, low, pi - 1);
quickSort(arr, pi + 1, high);
}
}
// Function to generate random numbers
void generateRandomNumbers(int arr[], int n)
{
for (int i = 0; i < n; i++)
{
```

```
arr[i] = rand() % 100000; // Generate random numbers between 0 and 99999
}
}
int main()
{
int n;
printf("Enter number of elements: ");
scanf("%d", &n); // Read the number of elements from the user
if (n <= 5000)
{
printf("Please enter a value greater than 5000\n");
return 1; // Exit if the number of elements is not greater than 5000
}
// Allocate memory for the array
int *arr = (int *)malloc(n * sizeof(int));
if (arr == NULL)
{
printf("Memory allocation failed\n");
return 1; // Exit if memory allocation fails
}
// Generate random numbers and store them in the array
generateRandomNumbers(arr, n);
// Measure the time taken to sort the array
clock_t start = clock();
quickSort(arr, 0, n - 1);
```

```
clock_t end = clock();
// Calculate and print the time taken to sort the array
double time_taken = ((double)(end - start)) / CLOCKS_PER_SEC;
printf("Time taken to sort %d elements: %f seconds\n", n, time_taken);
// Free the allocated memory
free(arr);
return 0;
}
```

Step 2: Measure Time Taken This program generates n random numbers, sorts them using the Quick Sort algorithm, and measures the time taken for the sorting process.

Step 3: Run the Program for Various Values of n To collect data, run the program with different values of n greater than 5000, such as 6000, 7000, 8000, etc., and record the time taken for each if you didn't get time then increase the value of n for example 20000, 40000, 60000 etc….

0utput

Enter number of elements: 10000

Time taken to sort 10000 elements: 0.0000 seconds

Enter number of elements: 20000

Time taken to sort 20000 elements: 0.015000 seconds

Enter number of elements: 30000

Time taken to sort 30000 elements: 0.011000 seconds

Enter number of elements: 35000

Time taken to sort 35000 elements: 0.003000 seconds

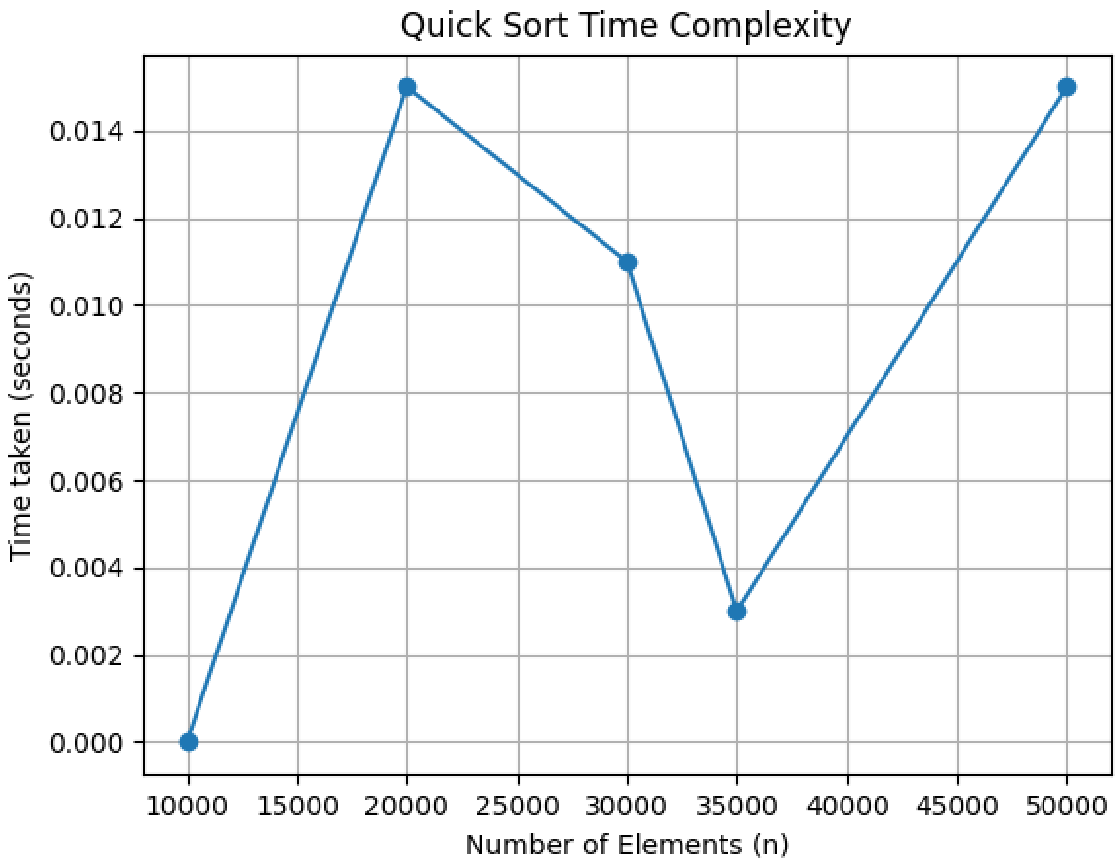
Enter number of elements: 50000

Time taken to sort 50000 elements: 0.015000 seconds

Step 4: Plot the Results

You can use a graphing tool like Python with matplotlib to plot the results.

```
import matplotlib.pyplot as plt

#data collected

n_values = [10000, 20000, 30000, 35000, 50000]

time_taken = [0.0000, 0.015000, 0.011000, 0.003000, 0.015000]

plt.plot(n_values, time_taken, marker='o')

plt.title('Quick Sort Time Complexity')

plt.xlabel('Number of Elements (n)')

plt.ylabel('Time taken (seconds)')

plt.grid(True)

plt.show()
```


Quick Sort Time Complexity
Time taken (seconds)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
10000
15000
20000
25000
30000
35000
40000
45000
50000
Number of Elements (n)

11. Design and implement C/C++ Program to sort a given set of n integer elements usingMerge Sort method and compute its time complexity. Run the program for varied values of n> 5000, and record the time taken to sort. Plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.

Step 1: Implement the Merge Sort Algorithm Merge Sort is a divide-and-conquer algorithm that splits the array into values, sorts each half, and then merges the sorted values.

Program Code

```
#include <stdio.h>

#include <stdlib.h>

#include <time.h>

// Function to merge two sorted arrays

void merge(int arr[], int left, int mid, int right)

{

int i, j, k;

int n1 = mid - left + 1;

int n2 = right - mid;

int *L = (int *)malloc(n1 * sizeof(int));

int *R = (int *)malloc(n2 * sizeof(int));

for (i = 0; i < n1; i++)

L[i] = arr[left + i];

for (j = 0; j < n2; j++)

R[j] = arr[mid + 1 + j];

i = 0;

j = 0;

k = left;
```

```
while (i < n1 && j < n2)

{

if (L[i] <= R[j])

{

arr[k] = L[i];

i++;

}

else

{

arr[k] = R[j];

j++;

}

k++;

}

while (i < n1)

{

arr[k] = L[i];

i++;

k++;

}

while (j < n2)

{

arr[k] = R[j];

j++;

k++;
```

```
}
free(L);
free(R);
}
// Function to implement Merge Sort
void mergeSort(int arr[], int left, int right)
{
if (left < right)
{
int mid = left + (right - left) / 2;
mergeSort(arr, left, mid);
mergeSort(arr, mid + 1, right);
merge(arr, left, mid, right);
}
}
// Function to generate random integers
void generateRandomArray(int arr[], int n)
{
for (int i = 0; i < n; i++)
arr[i] = rand() % 100000; // Generate random integers between 0 and 99999
}
int main()
{
int n;
printf("Enter the number of elements: ");
```

```
scanf("%d", &n);
if (n <= 5000)
{
printf("Please enter a value greater than 5000\n");
return 1; // Exit if the number of elements is not greater than 5000
}
int *arr = (int *)malloc(n * sizeof(int));
if (arr == NULL)
{
printf("Memory allocation failed\n");
return 1; // Exit if memory allocation fails
}
generateRandomArray(arr, n);
// Repeat the sorting process multiple times to increase duration for timing
clock_t start = clock();
for (int i = 0; i < 1000; i++)
{
mergeSort(arr, 0, n - 1);
}
clock_t end = clock();
// Calculate the time taken for one iteration
double time_taken = ((double)(end - start)) / CLOCKS_PER_SEC / 1000.0;
printf("Time taken to sort %d elements: %f seconds\n", n, time_taken);
free(arr);
return 0;
```

}

Step 2: Measure Time Taken This program generates n random numbers, sorts them using the Merge Sort algorithm, and measures the time taken for the sorting process.

Step 3: Run the Program for Various Values of n To collect data, run the program with different values of n greater than 5000, such as 6000, 7000, 8000, etc., and record the time taken for each. Output

Enter number of elements: 6000

Time taken to sort 6000 elements: 0.000709 seconds

Enter number of elements: 7000

Time taken to sort 7000 elements: 0.000752 seconds

Enter number of elements: 8000

Time taken to sort 8000 elements: 0.000916 seconds

Enter number of elements: 9000

Time taken to sort 9000 elements: 0.001493 seconds

Enter number of elements: 10000

Time taken to sort 10000 elements: 0.001589 seconds

Enter number of elements: 11000

Time taken to sort 11000 elements: 0.002562 seconds

Enter number of elements: 12000

Time taken to sort 12000 elements: 0.001944 seconds

Enter number of elements: 13000

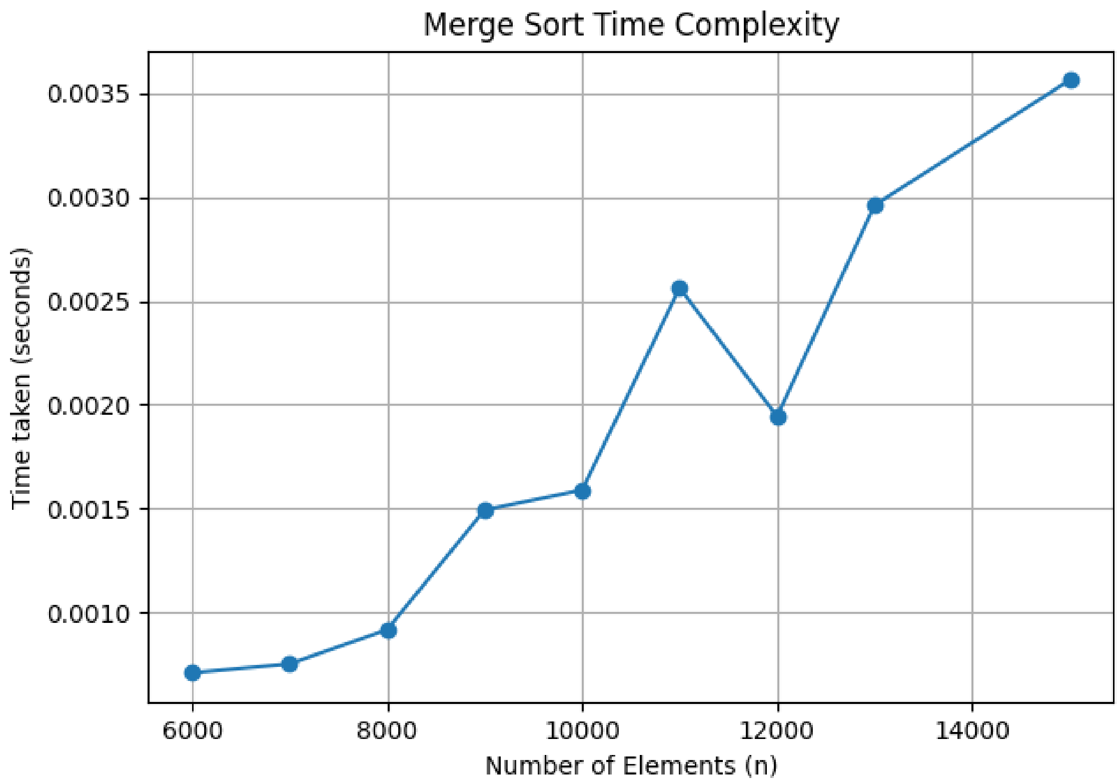
Time taken to sort 13000 elements: 0.002961 seconds

Enter number of elements: 15000

Time taken to sort 15000 elements: 0.003563 seconds

Step 4: Plot the Results You can use a graphing tool like Python with matplotlib to plot the results.

```
import matplotlib.pyplot as plt

# data collected n_values = [6000, 7000, 8000, 9000, 10000, 11000, 12000, 13000, 15000]

time_taken = [0.000709, 0.000752, 0.000916, 0.001493, 0.001589, 0.002562,

0.001944, 0.002961, 0.003563]

plt.plot(n_values, time_taken, marker='o')

plt.title('Merge Sort Time Complexity')

plt.xlabel('Number of Elements (n)')

plt.ylabel('Time taken (seconds)')

plt.grid(True)

plt.show()
```


Merge Sort Time Complexity
Time taken (seconds)
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
6000
8000
10000
12000
14000
Number of Elements (n)

12. Design and implement C/C++ Program for N Queen's problem using Backtracking.

Program Code

```
#include <stdio.h>

#include <stdlib.h>

#include <stdbool.h>

// Function to print the solution

void printSolution(int **board, int N)

{

for (int i = 0; i < N; i++)

{

for (int j = 0; j < N; j++)

{

printf("%s ", board[i][j] ? "Q" : "#");

}

printf("\n");

}

}

// Function to check if a queen can be placed on board[row][col]

bool isSafe(int **board, int N, int row, int col)

{

int i, j;

// Check this row on left side

for (i = 0; i < col; i++)

{

if (board[row][i])
```

```
{
return false;
}
}
// Check upper diagonal on left side
for (i = row, j = col; i >= 0 && j >= 0; i--, j--)
{
if (board[i][j])
{
return false;
}
}
// Check lower diagonal on left side
for (i = row, j = col; j >= 0 && i < N; i++, j--)
{
if (board[i][j])
{
return false;
}
}
return true;
}
// A recursive utility function to solve N Queen problem
bool solveNQUtil(int **board, int N, int col)
{
```

```
// If all queens are placed, then return true

if (col >= N)

{

return true;

}

// Consider this column and try placing this queen in all rows one by one

for (int i = 0; i < N; i++)

{

if (isSafe(board, N, i, col))

{

// Place this queen in board[i][col]

board[i][col] = 1;

// Recur to place rest of the queens

if (solveNQUtil(board, N, col + 1))

{

return true;

}

// If placing queen in board[i][col] doesn't lead to a solution,

// then remove queen from board[i][col]

board[i][col] = 0; // BACKTRACK

}

}

// If the queen cannot be placed in any row in this column col, then return false

return false;

}
```

```
// This function solves the N Queen problem using Backtracking

// It mainly uses solveNQUtil() to solve the problem

// It returns false if queens cannot be placed, otherwise, return true and prints the placement

 of queens

bool solveNQ(int N)

{

int **board = (int **)malloc(N * sizeof(int *));

for (int i = 0; i < N; i++)

{

board[i] = (int *)malloc(N * sizeof(int));

for (int j = 0; j < N; j++)

{

board[i][j] = 0;

}

}

if (!solveNQUtil(board, N, 0))

{

printf("Solution does not exist\n");

for (int i = 0; i < N; i++)

{

free(board[i]);

}

free(board);

return false;

}
```

```
printSolution(board, N);
for (int i = 0; i < N; i++)
{
free(board[i]);
}
free(board);
return true;
}
int main()
{
int N;
printf("Enter the number of queens: ");
scanf("%d", &N);
solveNQ(N);
return 0;
}
```

Output 1:

```
Enter the number of queens: 4
# # Q #
Q # # #
# # # Q
# Q # #
```

Output 2:

```
Enter the number of queens: 3
Solution does not exist
```