DSA PROJECT REPORT

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Data Structures we have used:

1. AVL:

The definition of an AVL tree is a height-balanced binary search tree in which each node has a balance factor that is determined by deducting the height of the node's right subtree from the height of its left subtree.

If each node's balance factor falls between -1 and 1, the tree is said to be balanced; otherwise, the tree needs to be balanced.

AVL rotations:
We perform rotation in AVL tree only in case if Balance Factor is other than **-1, 0, and 1**. There are basically four types of rotations which are as follows:
L L rotation: Inserted node is in the left subtree of left subtree of A
R R rotation: Inserted node is in the right subtree of right subtree of A
L R rotation: Inserted node is in the right subtree of left subtree of A
R L rotation: Inserted node is in the left subtree of right subtree of A
Where node A is the node whose balance Factor is other than -1, 0, 1.
The first two rotations LL and RR are single rotations and the next two rotations LR and RL are double rotations. For a tree to be unbalanced, minimum height must be at least 2

Time complexity:
The best time complexity of AVL is O(log n).

2. BFS:

When a dead end occurs during any iteration, the Breadth First Search (BFS) method employs a queue to keep track of where to retrieve the next vertex to begin a search.

It employs the following rules.

Rule 1 − Visit the adjacent unvisited vertex. Mark it as visited. Display it. Insert it in a queue.

Rule 2 − If no adjacent vertex is found, remove the first vertex from the queue.

Rule 3 − Repeat Rule 1 and Rule 2 until the queue is empty.

Time complexity:
The worst-case time complexity of BFS is O(V+E).

3. DFS:

Depth First Search (DFS) algorithm traverses a graph in a depth ward motion and uses a stack to remember to get the next vertex to start a search, when a dead end occurs in any iteration.

It employs the following rules.

Rule 1 − Visit the adjacent unvisited vertex. Mark it as visited. Display it. Push it in a stack.

Rule 2 − If no adjacent vertex is found, pop up a vertex from the stack. (It will pop up all the vertices from the stack, which do not have adjacent vertices.)

Rule 3 − Repeat Rule 1 and Rule 2 until the stack is empty.

Time complexity:
The worst-case time complexity of DFS is O(V+E).

4. Linear Search:

In this kind of search, each item is sequentially searched through. Each item is examined, and if a match is discovered, that specific item is returned; otherwise, the search is carried out until all the data has been collected.

Time complexity:
The best-case time complexity of Linear Search is O(1) whereas worst-case time complexity is O(n).

5. Binary Search:

Binary search is a fast search algorithm. This search algorithm works on the principle of divide and conquer. For this algorithm to work properly, the data collection should be in the sorted form.

Binary search looks for a particular item by comparing the middle most item of the collection. If a match occurs, then the mid node is returned. If the middle node contains greater value than the required value, then the value is searched in the sub-list to the left of the middle item. Otherwise, the value is searched for in the sub-list to the right of the middle node. This process continues the sub-list as well until all nodes have been searched.

Time complexity:
The time complexity of the binary search algorithm is O(log n). The best-case time complexity would be O(1).

6. Insertion Sort:

Insertion sort is a simple sorting algorithm that works by repeatedly inserting an element from an unsorted portion of the list into its correct position within a sorted portion of the list. It builds the sorted list one element at a time by comparing each new element with the already sorted elements and shifting them to the right to make room for the new element.

Time complexity:
The best-case time complexity of insertion sort algorithm is O(n).

7. Selection Sort:

Selection sort is an effective and efficient sort algorithm based on comparison operations.

It adds one element in each iteration.

You need to select the smallest element in the list and move it to the beginning of the array by swapping it with the front element. The process will continue till the whole list is sorted.

Time complexity:
The time complexity of selection sort is $O(n^2)$.

8. Bubble Sort:

Bubble sort is a simple sorting algorithm that repeatedly steps through the list, compares adjacent elements, and swaps them if they are in the wrong order. It gets its name because smaller elements "bubble" to the top of the list with each iteration. The algorithm continues this process until the entire list is sorted.

Time complexity:
The time complexity of bubble sort is $O(n^2)$.

9. HashTable:

Hash Table is a data structure which stores data in an associative manner. In a hash table, data is stored in an array format, where each data value has its own unique index value. Access of data becomes very fast if we know the index of the desired data.

Thus, it becomes a data structure in which insertion and search operations are very fast irrespective of the size of the data. Hash Table uses an array as a storage medium and uses hash technique to generate an index where an element is to be inserted or is to be located from.

Hashing:
Hashing is a technique to convert a range of key values into a range of indexes of an array. We're going to use a modulo operator to get a range of key values. It has the formula k%n, where k is the value to be stored and n is the size of the HashTable.

Basic Operations:
The following are the basic primary operations of a hash table.

Search − Searches an element in a hash table.

Insert − inserts an element in a hash table.

delete − Deletes an element from a hash table.

Time complexity:
The average complexity to search, insert, and delete data in a hash table is O(1).

10. Prim’s Algorithm:
Prim's algorithm is a greedy algorithm used to find the minimum spanning tree (MST) of a weighted undirected graph. The MST is a subset of the graph's edges that connects all vertices with the minimum total edge weight. Prim's algorithm starts with an arbitrary vertex and grows the MST by iteratively adding the edge with the minimum weight that connects a vertex in the MST to a vertex outside the MST. The algorithm ensures that the MST grows incrementally, adding the edge with the minimum weight at each step. It efficiently selects the next smallest edge to include in the MST. The process continues until all vertices are visited, and the MST is complete. And it will give minimum cost.

Time complexity:
The time complexity of Prim's algorithm is O(V2).

11. **Dijkstra Algorithm**:
Dijkstra's Algorithm basically starts at the node that you choose (the source node) and it analyzes the graph to find the shortest path between that node and all the other nodes in the graph.

The algorithm keeps track of the currently known shortest distance from each node to the source node and it updates these values if it finds a shorter path.

Once the algorithm has found the shortest path between the source node and another node, that node is marked as "visited" and added to the path.

The process continues until all the nodes in the graph have been added to the path. This way, we have a path that connects the source node to all other nodes following the shortest path possible to reach each node.

Time complexity:
The time complexity of Dijkstra algorithm is O(V2).

Data Set we have used:

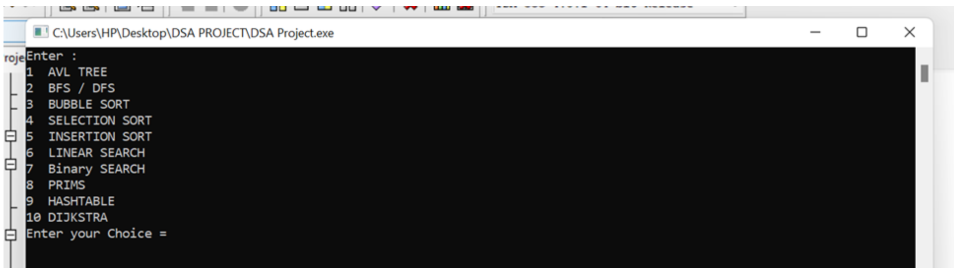
We have used a .csv file. A CSV is a comma-separated values file, which allows data to be saved in a tabular format. CSVs look like a garden-variety spreadsheet but with a .csv extension.

CSV files can be used with most any spreadsheet program, such as Microsoft Excel or Google Spreadsheets. They differ from other spreadsheet file types because you can only have a single sheet in a file, they cannot save cell, column, or row. Also, you cannot save formulas in this format. Our dataset contains **6 columns** and almost **7000 rows.**

The file we have used contains data of Employees' age, gender, education, job title, experience and salary. We have performed different functions of data structures based on salary of Employees.

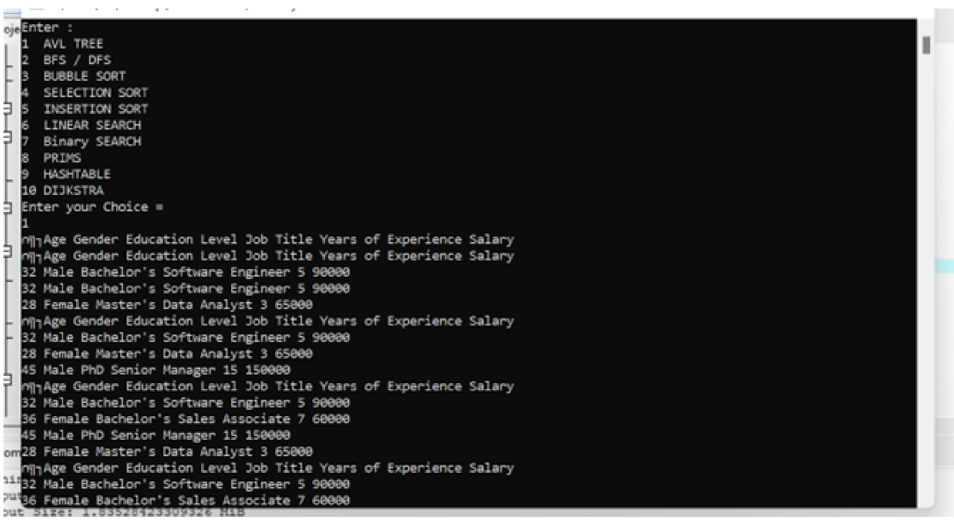
Outputs:

Main menu:

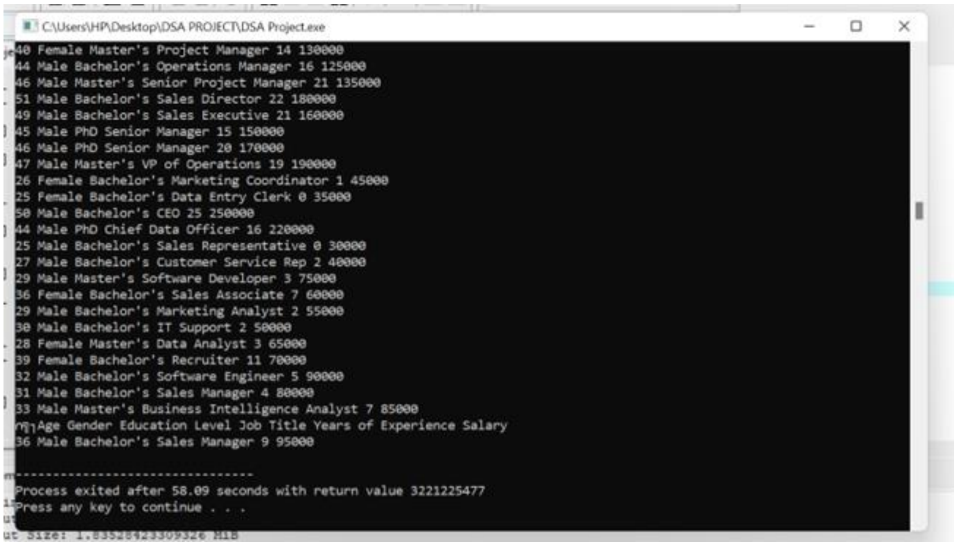


```
C:\Users\HP\Desktop\DSA PROJECT\DSA Project.exe
Enter :
1  AVL TREE
2  BFS / DFS
3  BUBBLE SORT
4  SELECTION SORT
5  INSERTION SORT
6  LINEAR SEARCH
7  Binary SEARCH
8  PRIMS
9  HASHTABLE
10 DIJKSTRA
Enter your Choice =
```

AVL Tree:



```
Enter :
1  AVL TREE
2  BFS / DFS
3  BUBBLE SORT
4  SELECTION SORT
5  INSERTION SORT
6  LINEAR SEARCH
7  Binary SEARCH
8  PRIMS
9  HASHTABLE
10 DIJKSTRA
Enter your Choice =
1
∩╗┐Age Gender Education Level Job Title Years of Experience Salary
∩╗┐Age Gender Education Level Job Title Years of Experience Salary
32 Male Bachelor's Software Engineer 5 90000
32 Male Bachelor's Software Engineer 5 90000
28 Female Master's Data Analyst 3 65000
∩╗┐Age Gender Education Level Job Title Years of Experience Salary
32 Male Bachelor's Software Engineer 5 90000
28 Female Master's Data Analyst 3 65000
45 Male PhD Senior Manager 15 150000
∩╗┐Age Gender Education Level Job Title Years of Experience Salary
32 Male Bachelor's Software Engineer 5 90000
36 Female Bachelor's Sales Associate 7 60000
45 Male PhD Senior Manager 15 150000
28 Female Master's Data Analyst 3 65000
∩╗┐Age Gender Education Level Job Title Years of Experience Salary
32 Male Bachelor's Software Engineer 5 90000
36 Female Bachelor's Sales Associate 7 60000
```



```
40 Female Master's Project Manager 14 130000
44 Male Bachelor's Operations Manager 16 125000
46 Male Master's Senior Project Manager 21 135000
51 Male Bachelor's Sales Director 22 180000
49 Male Bachelor's Sales Executive 21 160000
45 Male PhD Senior Manager 15 150000
46 Male PhD Senior Manager 20 170000
47 Male Master's VP of Operations 19 190000
26 Female Bachelor's Marketing Coordinator 1 45000
25 Female Bachelor's Data Entry Clerk 0 35000
50 Male Bachelor's CEO 25 250000
44 Male PhD Chief Data Officer 16 220000
25 Male Bachelor's Sales Representative 0 30000
27 Male Bachelor's Customer Service Rep 2 40000
29 Male Master's Software Developer 3 75000
36 Female Bachelor's Sales Associate 7 60000
29 Male Bachelor's Marketing Analyst 2 55000
30 Male Bachelor's IT Support 2 50000
28 Female Master's Data Analyst 3 65000
39 Female Bachelor's Recruiter 11 70000
32 Male Bachelor's Software Engineer 5 90000
31 Male Bachelor's Sales Manager 4 80000
33 Male Master's Business Intelligence Analyst 7 85000
Age Gender Education Level Job Title Years of Experience Salary
36 Male Bachelor's Sales Manager 9 95000

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Process exited after 58.09 seconds with return value 3221225477
Press any key to continue . . .
```
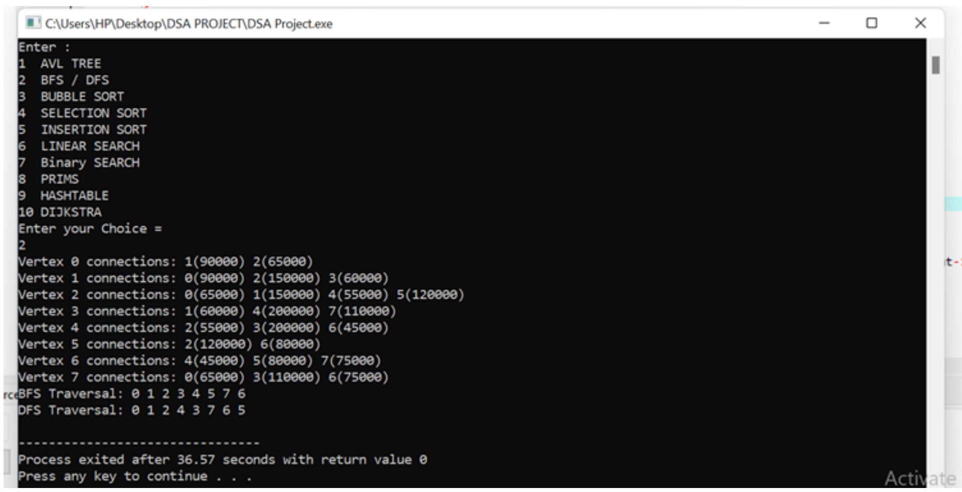

BFS&DFS:



```
Enter :
1  AVL TREE
2  BFS / DFS
3  BUBBLE SORT
4  SELECTION SORT
5  INSERTION SORT
6  LINEAR SEARCH
7  Binary SEARCH
8  PRIMS
9  HASHTABLE
10 DIJKSTRA
Enter your Choice =
2
Vertex 0 connections: 1(90000) 2(65000)
Vertex 1 connections: 0(90000) 2(150000) 3(60000)
Vertex 2 connections: 0(65000) 1(150000) 4(55000) 5(120000)
Vertex 3 connections: 1(60000) 4(200000) 7(110000)
Vertex 4 connections: 2(55000) 3(200000) 6(45000)
Vertex 5 connections: 2(120000) 6(80000)
Vertex 6 connections: 4(45000) 5(80000) 7(75000)
Vertex 7 connections: 0(65000) 3(110000) 6(75000)
BFS Traversal: 0 1 2 3 4 5 7 6
DFS Traversal: 0 1 2 4 3 7 6 5

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Process exited after 36.57 seconds with return value 0
Press any key to continue . . .
```
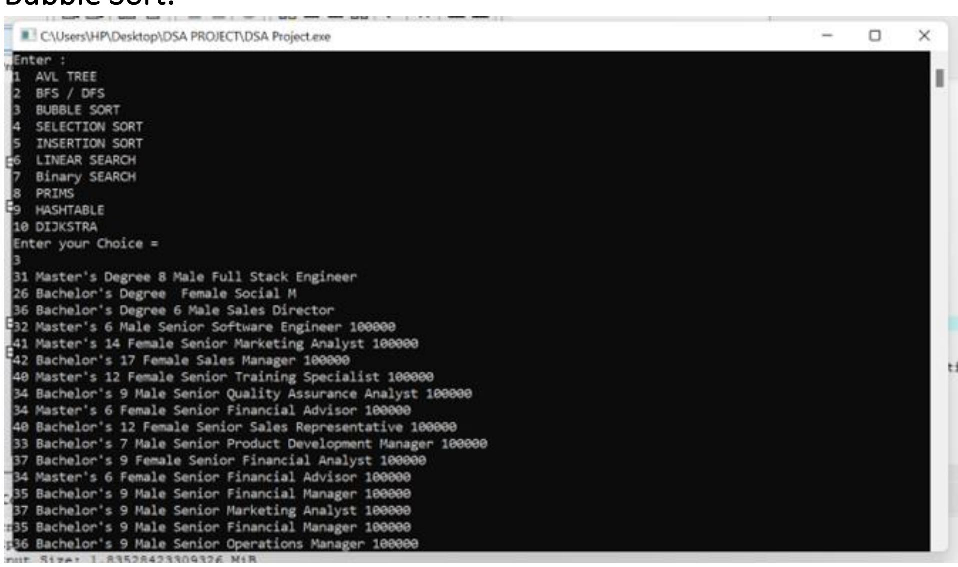

Bubble Sort:



```
Enter :
1  AVL TREE
2  BFS / DFS
3  BUBBLE SORT
4  SELECTION SORT
5  INSERTION SORT
6  LINEAR SEARCH
7  Binary SEARCH
8  PRIMS
9  HASHTABLE
10 DIJKSTRA
Enter your Choice =
3
31 Master's Degree 8 Male Full Stack Engineer
26 Bachelor's Degree  Female Social M
36 Bachelor's Degree 6 Male Sales Director
32 Master's 6 Male Senior Software Engineer 100000
41 Master's 14 Female Senior Marketing Analyst 100000
42 Bachelor's 17 Female Sales Manager 100000
40 Master's 12 Female Senior Training Specialist 100000
34 Bachelor's 9 Male Senior Quality Assurance Analyst 100000
34 Master's 6 Female Senior Financial Advisor 100000
40 Bachelor's 12 Female Senior Sales Representative 100000
33 Bachelor's 7 Male Senior Product Development Manager 100000
37 Bachelor's 9 Female Senior Financial Analyst 100000
34 Master's 6 Female Senior Financial Advisor 100000
35 Bachelor's 9 Male Senior Financial Manager 100000
37 Bachelor's 9 Male Senior Marketing Analyst 100000
35 Bachelor's 9 Male Senior Financial Manager 100000
36 Bachelor's 9 Male Senior Operations Manager 100000
```

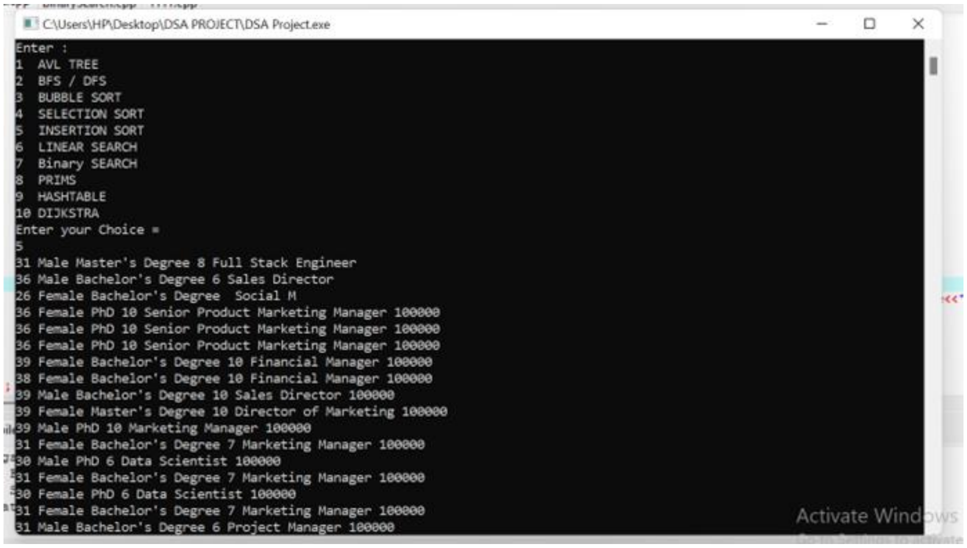
```
C:\Users\HP\Desktop\DSA PROJECT\DSA Project.exe
36 PhD 9 Female Marketing Manager 95000
36 PhD 9 Female Marketing Manager 95000
36 PhD 9 Female Marketing Manager 95000
28 High School 7 Male Back end Developer 95845
28 High School 7 Male Back end Developer 95845
33 Bachelor's Degree 7 Male Operations Manager 96000
33 Bachelor's Degree 7 Male Operations Manager 96000
33 Bachelor's Degree 7 Male Operations Manager 96000
33 Bachelor's Degree 7 Male Operations Manager 96000
33 Bachelor's Degree 7 Male Operations Manager 96000
33 Bachelor's Degree 7 Male Operations Manager 96000
33 Bachelor's Degree 7 Male Operations Manager 96000
29 PhD 5 Female Full Stack Engineer 98568
29 PhD 5 Female Full Stack Engineer 98568
34 Bachelor's Degree 9 Female Human Resources Manager 99000
34 Bachelor's Degree 9 Female Human Resources Manager 99000
34 Bachelor's Degree 9 Female Human Resources Manager 99000
34 Bachelor's Degree 9 Female Human Resources Manager 99000
34 Bachelor's Degree 9 Female Human Resources Manager 99000
34 Bachelor's Degree 9 Female Human Resources Manager 99000
34 Bachelor's Degree 9 Female Human Resources Manager 99000
34 Bachelor's Degree 9 Female Human Resources Manager 99000
30 Master's Degree 6 Male Front end Developer 99363
28 Master's Degree 5 Female Senior Software Engineer 99747
28 Master's Degree 5 Female Senior Software Engineer 99747
Age Education Level Years of Experience Gender Job Title Salary

--------------------------------
Process exited after 28.54 seconds with return value 0
Press any key to continue . . .
```

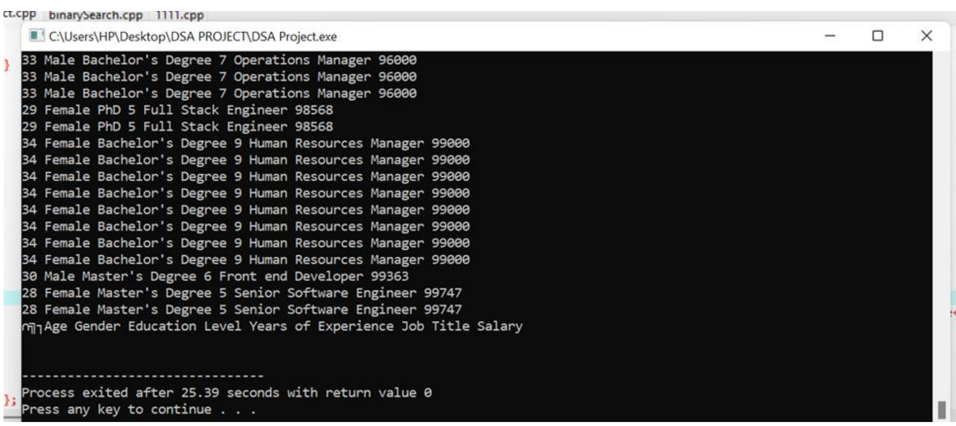
Selection Sort:

```
C:\Users\HP\Desktop\DSA PROJECT\DSA Project.exe
Enter :
1  AVL TREE
2  BFS / DFS
3  BUBBLE SORT
4  SELECTION SORT
5  INSERTION SORT
6  LINEAR SEARCH
7  Binary SEARCH
8  PRIMS
9  HASHTABLE
10 DIJKSTRA
Enter your Choice =
4
After Selection Sort :
Age Gender Education Level Years of Experience Job Title
32 Male Bachelor's 5 Software Engineer
28 Female Master's 3 Data Analyst
45 Male PhD 15 Senior Manager 100000
36 Female Bachelor's 7 Sales Associate 100000
52 Male Master's 20 Director 100000
29 Male Bachelor's 2 Marketing Analyst 100000
42 Female Master's 12 Product Manager 100000
31 Male Bachelor's 4 Sales Manager 100000
26 Female Bachelor's 1 Marketing Coordinator 100000
38 Male PhD 10 Senior Scientist 100000
29 Male Master's 3 Software Developer 100000
48 Female Bachelor's 18 HR Manager 100000
35 Male Bachelor's 6 Financial Analyst 100000
40 Female Master's 14 Project Manager 100000
27 Male Bachelor's 2 Customer Service Rep 100000
```

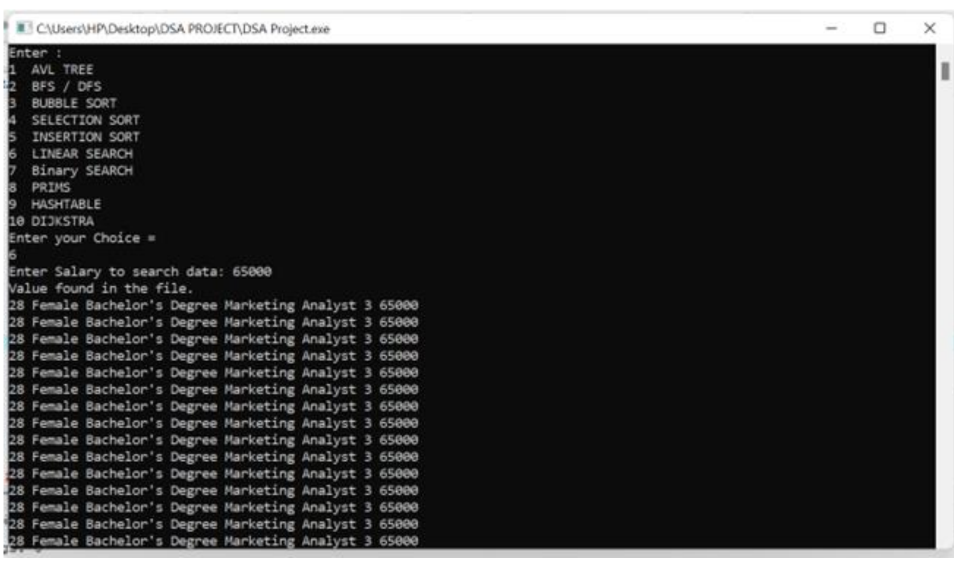
```
C:\Users\HP\Desktop\DSA PROJECT\DSA Project.exe
28 Male PhD 4 Marketing Manager 95845
51 Female Master's Degree 19 Content Marketing Manager 95845
37 Male Bachelor's Degree 7 Sales Director 96000
49 Female PhD 20 Senior Product Marketing Manager 96000
32 Male High School 3 Junior Sales Representative 96000
30 Female Bachelor's Degree 5 Sales Manager 96000
46 Male Master's Degree 16 Director of Marketing 96000
26 Female High School 1 Sales Associate 96000
42 Male Bachelor's Degree 13 Financial Manager 96000
36 Female PhD 9 Marketing Manager 98568
24 Male Bachelor's Degree 1 Sales Executive 98568
43 Female Master's Degree 14 Sales Manager 99000
27 Male High School 2 Digital Marketing Manager 99000
33 Female Bachelor's Degree 7 Content Marketing Manager 99000
28 Male PhD 4 Sales Representative 99000
51 Female Master's Degree 19 Senior Product Marketing Manager 99000
37 Male Bachelor's Degree 6 Junior Sales Representative 99000
49 Female PhD 20 Director of Marketing 99000
32 Male High School 3 Sales Associate 99000
30 Female Bachelor's Degree 4 Financial Manager 99363
46 Male Master's Degree 14 Marketing Manager 99747
26 Female High School 1 Sales Executive 99747
 Female High School 1 Sales Executive Salary


--------------------------------
Process exited after 24.49 seconds with return value 0
Press any key to continue . . .
```

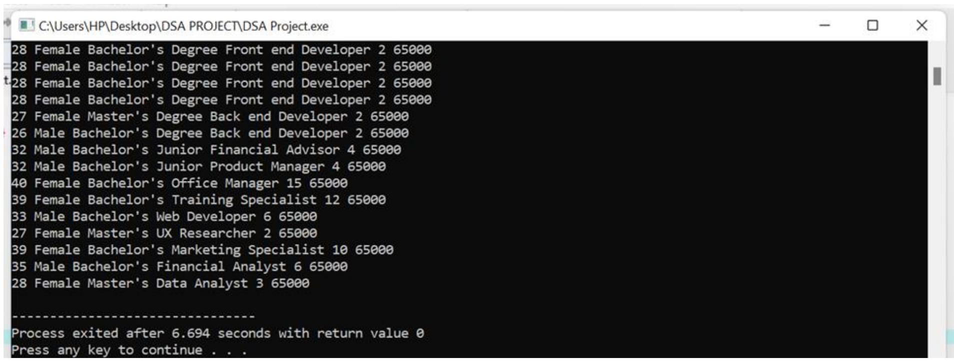
Insertion Sort:





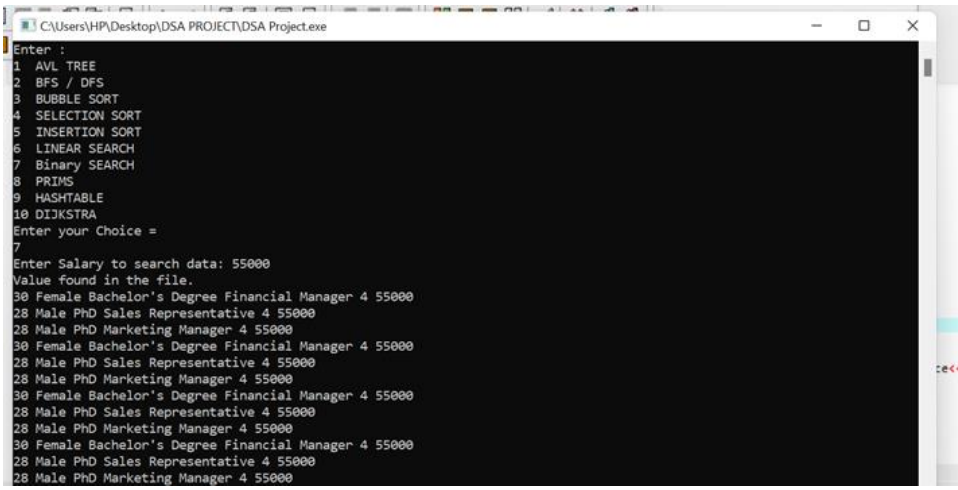
Linear Search:



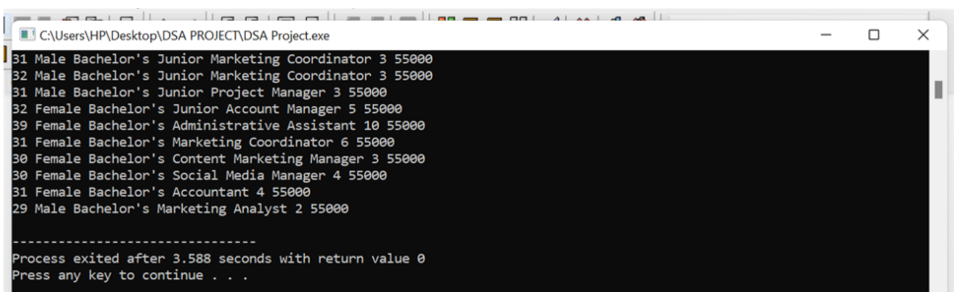


```
C:\Users\HP\Desktop\DSA PROJECT\DSA Project.exe
28 Female Bachelor's Degree Front end Developer 2 65000
28 Female Bachelor's Degree Front end Developer 2 65000
28 Female Bachelor's Degree Front end Developer 2 65000
28 Female Bachelor's Degree Front end Developer 2 65000
27 Female Master's Degree Back end Developer 2 65000
26 Male Bachelor's Degree Back end Developer 2 65000
32 Male Bachelor's Junior Financial Advisor 4 65000
32 Male Bachelor's Junior Product Manager 4 65000
40 Female Bachelor's Office Manager 15 65000
39 Female Bachelor's Training Specialist 12 65000
33 Male Bachelor's Web Developer 6 65000
27 Female Master's UX Researcher 2 65000
39 Female Bachelor's Marketing Specialist 10 65000
35 Male Bachelor's Financial Analyst 6 65000
28 Female Master's Data Analyst 3 65000

--------------------------------
Process exited after 6.694 seconds with return value 0
Press any key to continue . . .
```

Binary Search:



```
C:\Users\HP\Desktop\DSA PROJECT\DSA Project.exe
Enter :
1  AVL TREE
2  BFS / DFS
3  BUBBLE SORT
4  SELECTION SORT
5  INSERTION SORT
6  LINEAR SEARCH
7  Binary SEARCH
8  PRIMS
9  HASHTABLE
10 DIJKSTRA
Enter your Choice =
7
Enter Salary to search data: 55000
Value found in the file.
30 Female Bachelor's Degree Financial Manager 4 55000
28 Male PhD Sales Representative 4 55000
28 Male PhD Marketing Manager 4 55000
30 Female Bachelor's Degree Financial Manager 4 55000
28 Male PhD Sales Representative 4 55000
28 Male PhD Marketing Manager 4 55000
30 Female Bachelor's Degree Financial Manager 4 55000
28 Male PhD Sales Representative 4 55000
28 Male PhD Marketing Manager 4 55000
30 Female Bachelor's Degree Financial Manager 4 55000
28 Male PhD Sales Representative 4 55000
28 Male PhD Marketing Manager 4 55000
```



```
C:\Users\HP\Desktop\DSA PROJECT\DSA Project.exe
31 Male Bachelor's Junior Marketing Coordinator 3 55000
32 Male Bachelor's Junior Marketing Coordinator 3 55000
31 Male Bachelor's Junior Project Manager 3 55000
32 Female Bachelor's Junior Account Manager 5 55000
39 Female Bachelor's Administrative Assistant 10 55000
31 Female Bachelor's Marketing Coordinator 6 55000
30 Female Bachelor's Content Marketing Manager 3 55000
30 Female Bachelor's Social Media Manager 4 55000
31 Female Bachelor's Accountant 4 55000
29 Male Bachelor's Marketing Analyst 2 55000

--------------------------------
Process exited after 3.588 seconds with return value 0
Press any key to continue . . .
```

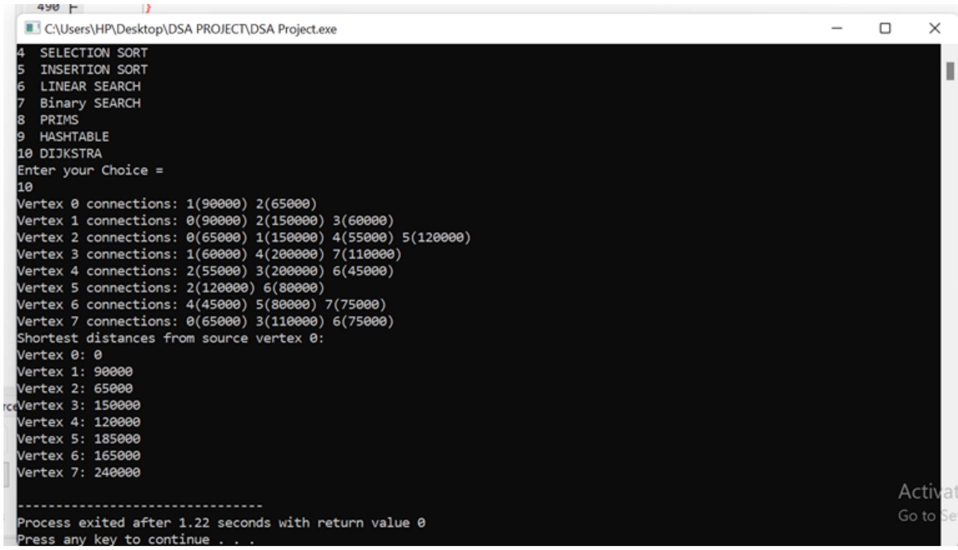
Prims Algorithm:

```
C:\Users\HP\Desktop\DSA PROJECT\DSA Project.exe
Enter :
1  AVL TREE
2  BFS / DFS
3  BUBBLE SORT
4  SELECTION SORT
5  INSERTION SORT
6  LINEAR SEARCH
7  Binary SEARCH
8  PRIMS
9  HASHTABLE
10 DIJKSTRA
Enter your Choice =
8
Edge   Weight
0 - 1    90000
0 - 2    65000
1 - 3    60000
2 - 4    55000
6 - 5    80000
4 - 6    45000
6 - 7    75000
6 - 8    65000

--------------------------------
Process exited after 2.062 seconds with return value 0
Press any key to continue . . .
```

Dijkstra :

```
C:\Users\HP\Desktop\DSA PROJECT\DSA Project.exe
4  SELECTION SORT
5  INSERTION SORT
6  LINEAR SEARCH
7  Binary SEARCH
8  PRIMS
9  HASHTABLE
10 DIJKSTRA
Enter your Choice =
10
Vertex 0 connections: 1(90000) 2(65000)
Vertex 1 connections: 0(90000) 2(150000) 3(60000)
Vertex 2 connections: 0(65000) 1(150000) 4(55000) 5(120000)
Vertex 3 connections: 1(60000) 4(200000) 7(110000)
Vertex 4 connections: 2(55000) 3(200000) 6(45000)
Vertex 5 connections: 2(120000) 6(80000)
Vertex 6 connections: 4(45000) 5(80000) 7(75000)
Vertex 7 connections: 0(65000) 3(110000) 6(75000)
Shortest distances from source vertex 0:
Vertex 0: 0
Vertex 1: 90000
Vertex 2: 65000
Vertex 3: 150000
Vertex 4: 120000
Vertex 5: 185000
Vertex 6: 165000
Vertex 7: 240000

--------------------------------
Process exited after 1.22 seconds with return value 0
Press any key to continue . . .
```

Hash Table:



C:\Users\HP\Desktop\DSA PROJECT\DSA Project.exe

```
4  SELECTION SORT
5  INSERTION SORT
6  LINEAR SEARCH
7  Binary SEARCH
8  PRIMS
9  HASHTABLE
10 DIJKSTRA
Enter your Choice =
10
Vertex 0 connections: 1(90000) 2(65000)
Vertex 1 connections: 0(90000) 2(150000) 3(60000)
Vertex 2 connections: 0(65000) 1(150000) 4(55000) 5(120000)
Vertex 3 connections: 1(60000) 4(200000) 7(110000)
Vertex 4 connections: 2(55000) 3(200000) 6(45000)
Vertex 5 connections: 2(120000) 6(80000)
Vertex 6 connections: 4(45000) 5(80000) 7(75000)
Vertex 7 connections: 0(65000) 3(110000) 6(75000)
Shortest distances from source vertex 0:
Vertex 0: 0
Vertex 1: 90000
Vertex 2: 65000
Vertex 3: 150000
Vertex 4: 120000
Vertex 5: 185000
Vertex 6: 165000
Vertex 7: 240000

--------------------------------
Process exited after 1.22 seconds with return value 0
Press any key to continue . . .
```