CODE:

```
def movegen(current, graph):
    return [[n, current, graph[n][1]] for n in graph[current][0]]


def goal_test(current, goal):
    return current in goal


def traversal(closed):
    print("Traversal ", end="")

    for i in range(len(closed)):
        print(closed[i][0], end=" ")
        if i != len(closed) - 1:
            print("-->", end=" ")


def goal_list_function(graph):
    goal_node_heuristic = min(graph.values(), key = lambda x:
x[1])[1]
    goal_nodes = [k for k, v in graph.items() if v[1] ==
goal_node_heuristic]
    return goal_nodes

def dfs(graph):
    open = []
    closed = []

    start_node = input("\n\nEnter the start node: ")
    goal_node = goal_list_function(graph)

    try:
        open.append([start_node,None,graph[start_node][1]])
    except:
        print("\nError! Please enter a start node...")
        exit()

    while open:
        #fetch the min node from the open list
        minimum = min(open, key = lambda x: x[2])

        closed.append(minimum)
```

```
        del open[open.index(minimum)]

        if goal_test(minimum[0], goal_node):
            print("\n\nGoal found\n")
            traversal(closed)
            return
        else:
            child_list = movegen(minimum[0], graph)
            for child in child_list:
                if any(child[0] == o[0] for o in open) or
any(child[0] == c[0] for c in closed):
                    continue
                open.insert(0, child)


def input_graph():
    graph = {}
    n = int(input("Enter the number of nodes: "))

    for i in range(n):
        pair = input("Enter a node and it's heuristic value
seperated by spaces: ").split()
        neighbours = input(f"Enter the neighbours of {pair[0]}
seperated by spaces: ").split()
        graph[pair[0]] = [neighbours,int(pair[1])]

    return graph


if __name__ == "__main__":
    graph = input_graph()
    dfs(graph)
    print()
```

OUTPUT:

1. Goal node is the start node

```
Enter the number of nodes: 13
Enter a node and it's heuristic value seperated by spaces: S -1
Enter the neighbours of S seperated by spaces: A B C
Enter a node and it's heuristic value seperated by spaces: A 2
Enter the neighbours of A seperated by spaces: D E
Enter a node and it's heuristic value seperated by spaces: B 6
Enter the neighbours of B seperated by spaces: F G
Enter a node and it's heuristic value seperated by spaces: C 5
Enter the neighbours of C seperated by spaces: H
Enter a node and it's heuristic value seperated by spaces: D 10
Enter the neighbours of D seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: E 8
Enter the neighbours of E seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: F 10
Enter the neighbours of F seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: G 14
Enter the neighbours of G seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: H 7
Enter the neighbours of H seperated by spaces: I
Enter a node and it's heuristic value seperated by spaces: I 5
Enter the neighbours of I seperated by spaces: K L M
Enter a node and it's heuristic value seperated by spaces: K 1
Enter the neighbours of K seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: L 0
Enter the neighbours of L seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: M 2
Enter the neighbours of M seperated by spaces:


Enter the start node: S


Goal found

Traversal S
```

2. goal node is intermediate node

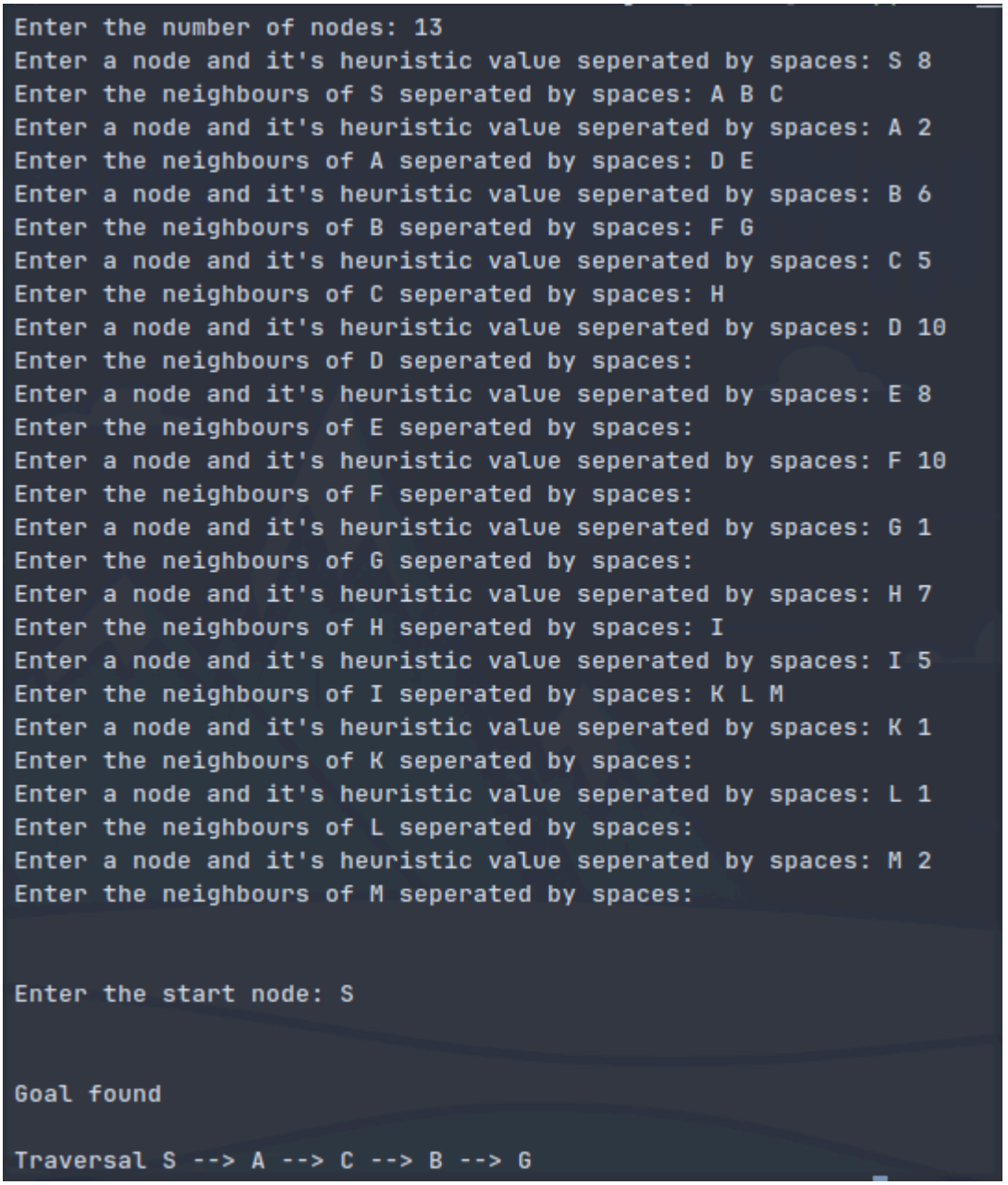
```
Enter the number of nodes: 13
Enter a node and it's heuristic value seperated by spaces: S 8
Enter the neighbours of S seperated by spaces: A B C
Enter a node and it's heuristic value seperated by spaces: A 2
Enter the neighbours of A seperated by spaces: D E
Enter a node and it's heuristic value seperated by spaces: B 6
Enter the neighbours of B seperated by spaces: F G
Enter a node and it's heuristic value seperated by spaces: C 5
Enter the neighbours of C seperated by spaces: H
Enter a node and it's heuristic value seperated by spaces: D 10
Enter the neighbours of D seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: E 8
Enter the neighbours of E seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: F 10
Enter the neighbours of F seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: G 14
Enter the neighbours of G seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: H 7
Enter the neighbours of H seperated by spaces: I
Enter a node and it's heuristic value seperated by spaces: I 5
Enter the neighbours of I seperated by spaces: K L M
Enter a node and it's heuristic value seperated by spaces: K 1
Enter the neighbours of K seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: L 0
Enter the neighbours of L seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: M 2
Enter the neighbours of M seperated by spaces:


Enter the start node: S


Goal found

Traversal S --> A --> C --> B --> H --> I --> L
```

3. Multiple goal nodes



```
Enter the number of nodes: 13
Enter a node and it's heuristic value seperated by spaces: S 8
Enter the neighbours of S seperated by spaces: A B C
Enter a node and it's heuristic value seperated by spaces: A 2
Enter the neighbours of A seperated by spaces: D E
Enter a node and it's heuristic value seperated by spaces: B 6
Enter the neighbours of B seperated by spaces: F G
Enter a node and it's heuristic value seperated by spaces: C 5
Enter the neighbours of C seperated by spaces: H
Enter a node and it's heuristic value seperated by spaces: D 10
Enter the neighbours of D seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: E 8
Enter the neighbours of E seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: F 10
Enter the neighbours of F seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: G 1
Enter the neighbours of G seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: H 7
Enter the neighbours of H seperated by spaces: I
Enter a node and it's heuristic value seperated by spaces: I 5
Enter the neighbours of I seperated by spaces: K L M
Enter a node and it's heuristic value seperated by spaces: K 1
Enter the neighbours of K seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: L 1
Enter the neighbours of L seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: M 2
Enter the neighbours of M seperated by spaces:


Enter the start node: S


Goal found

Traversal S --> A --> C --> B --> G
```

4. Overestimation of heuristic value at node H

```
Enter the number of nodes: 13
Enter a node and it's heuristic value seperated by spaces: S 8
Enter the neighbours of S seperated by spaces: A B C
Enter a node and it's heuristic value seperated by spaces: A 2
Enter the neighbours of A seperated by spaces: D E
Enter a node and it's heuristic value seperated by spaces: B 6
Enter the neighbours of B seperated by spaces: F G
Enter a node and it's heuristic value seperated by spaces: C 5
Enter the neighbours of C seperated by spaces: H
Enter a node and it's heuristic value seperated by spaces: D 10
Enter the neighbours of D seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: E 8
Enter the neighbours of E seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: F 10
Enter the neighbours of F seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: G 14
Enter the neighbours of G seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: H 20
Enter the neighbours of H seperated by spaces: I
Enter a node and it's heuristic value seperated by spaces: I 5
Enter the neighbours of I seperated by spaces: K L M
Enter a node and it's heuristic value seperated by spaces: K 1
Enter the neighbours of K seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: L 0
Enter the neighbours of L seperated by spaces:
Enter a node and it's heuristic value seperated by spaces: M 2
Enter the neighbours of M seperated by spaces:


Enter the start node: S


Goal found

Traversal S --> A --> C --> B --> E --> F --> D --> G --> H --> I --> L
```

5. Underestimation of heuristic value at node B