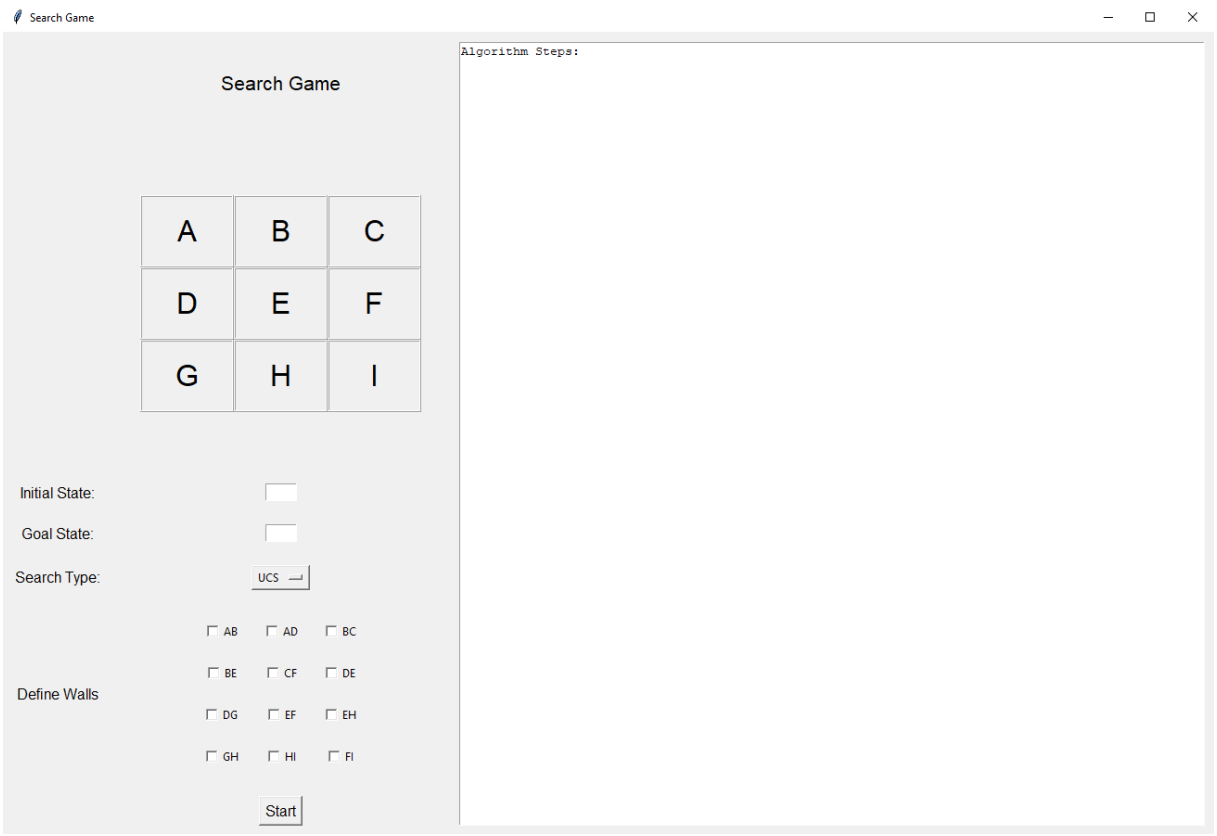
Search Game

Definition

The aim of the game is to detect the walls chosen by the user and go to the target point in the shortest way from the given starting point without touching or passing through them. The user also chooses the starting and destination point and the search algorithm. There are two types of searching algorithms in this game, one is Uniform-Cost Search and the other is A* Search. The game starts when the user clicks the start button after entering the values. At each step, we can see the costs of the paths and the opened node. The results appear on the right side of the screen and the path is indicated in yellow.

Video: https://www.youtube.com/watch?v=jjC2IWRDey4



Requirement 1:

We defined the rooms and their connections using a dictionary.

```python
room_dict = {
    'A': (1, 1), 'B': (1, 2), 'C': (1, 3),
    'D': (2, 1), 'E': (2, 2), 'F': (2, 3),
    'G': (3, 1), 'H': (3, 2), 'I': (3, 3)
}
```

```python
connections = {
    'A': ['B', 'D'],
    'B': ['A', 'C', 'E'],
    'C': ['B', 'F'],
    'D': ['A', 'E', 'G'],
    'E': ['B', 'D', 'F', 'H'],
    'F': ['C', 'E', 'I'],
    'G': ['D', 'H'],
    'H': ['E', 'G', 'I'],
    'I': ['F', 'H']
}
```

Requirement 2:

We received the source and goal room from the user.

```python
def start_game():
    initial_state = initial_state_entry.get().upper()
    goal_state = goal_state_entry.get().upper()
    search_type = search_type_var.get().upper()

    if initial_state not in room_dict:
        messagebox.showerror("Error", "Invalid initial state. Please enter a valid letter (A-I).")
    elif goal_state not in room_dict:
        messagebox.showerror("Error", "Invalid goal state. Please enter a valid letter (A-I).")
    else:
        if search_type == 'UCS':
            uniform_cost_search(initial_state, goal_state, room_dict, search_type)
        elif search_type == 'A*':
            a_star_search(initial_state, goal_state, room_dict, search_type)
        else:
            messagebox.showerror("Error", "Invalid search type. Please enter 'UCS' or 'A*'.")
```

Requirement 3:

In this part of the code, we created separate check buttons for all wall possibilities, that is, twelve. Whichever walls the user clicks on, it calls the define_walls function and deletes those nodes from possible connections.

```
v1 = tk.IntVar()
wall1_check = tk.Checkbutton(walls_frame, text="AB", variable=v1, command=lambda: define_walls(v1))
wall1_check.grid(row=0, column=0, padx=10, pady=10)
```

```
def define_walls(var):
    walls_dict = {
        'AB': v1, 'AD': v2, 'BC': v3,
        'BE': v4, 'CF': v5, 'DE': v6,
        'DG': v7, 'EF': v8, 'EH': v9,
        'GH': v10, 'HI': v11, 'FI': v12
    }

    walls = [key for key, value in walls_dict.items() if value.get() == 1]

    for wall in walls:
        room1, room2 = wall[0], wall[1]
        if room1 in connections and room2 in connections[room1]:
            connections[room1].remove(room2)
            connections[room2].remove(room1)

    return connections
```

Requirement 4:

We wrote such an algorithm to establish the connection between direction and cost.

```
if room_dict[current[-1]][0] == room_dict[i][0]:
    new_cost += 2
elif room_dict[current[-1]][1] == room_dict[i][1]:
    new_cost += 1
```

Requirement 5:

We used OptionMenu widget for search type selection.

```
search_type_label = tk.Label(root, text="Search Type:", font=('Arial', 12))
search_type_label.grid(row=5, column=0, padx=10, pady=10)

search_type_var = tk.StringVar(root)
search_type_var.set("UCS")

search_type_dropdown = tk.OptionMenu(root, search_type_var, "UCS", "A*")
search_type_dropdown.grid(row=5, column=1, padx=10, pady=10)
```

```
search_type = search_type_var.get().upper()
```

```
if search_type == 'UCS':
    uniform_cost_search(initial_state, goal_state, room_dict, search_type)
elif search_type == 'A*':
    a_star_search(initial_state, goal_state, room_dict, search_type)
```

A*:

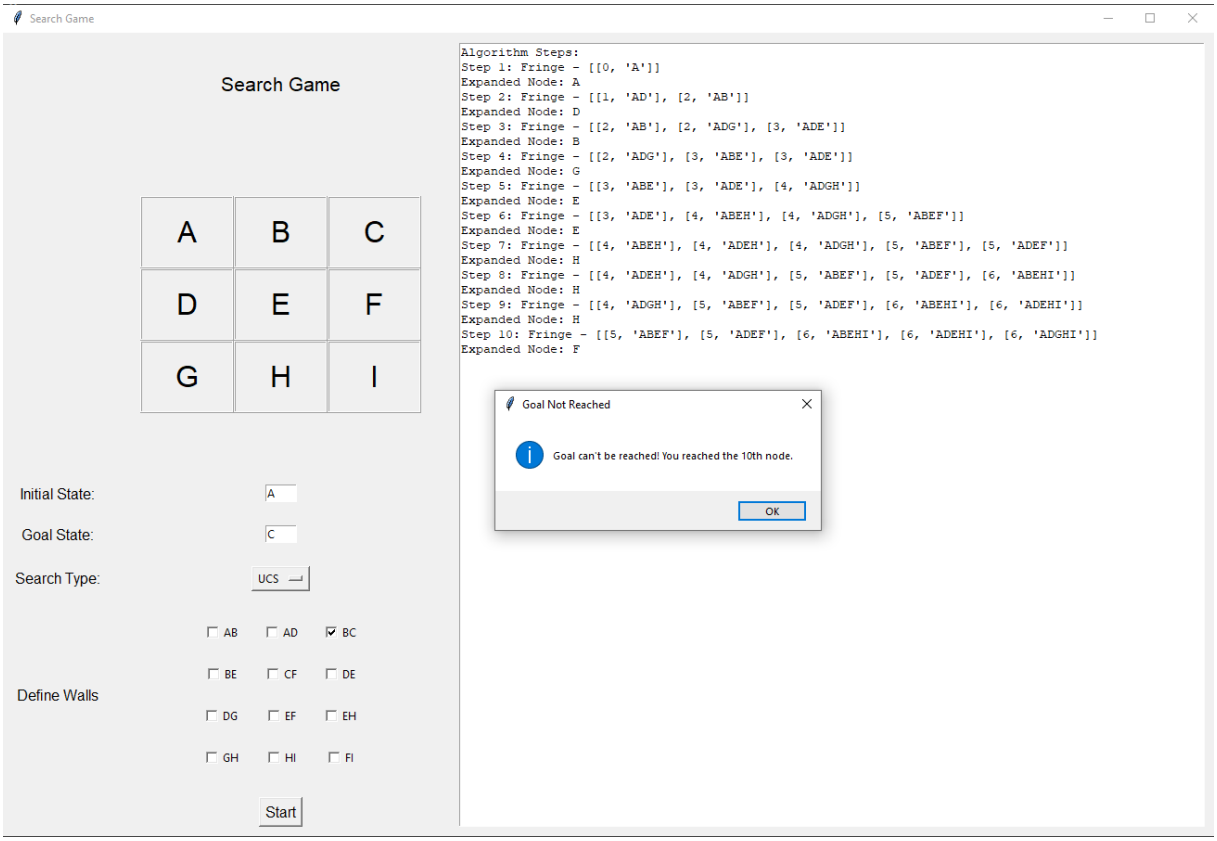
```
if search_type == 'A*':
    if room_dict[current[-1]][0] == room_dict[i][0]:
        new_cost = new_cost + 2 + manhattan_distance(i, goal_state)
    elif room_dict[current[-1]][1] == room_dict[i][1]:
        new_cost = new_cost + 1 + manhattan_distance(i, goal_state)
```

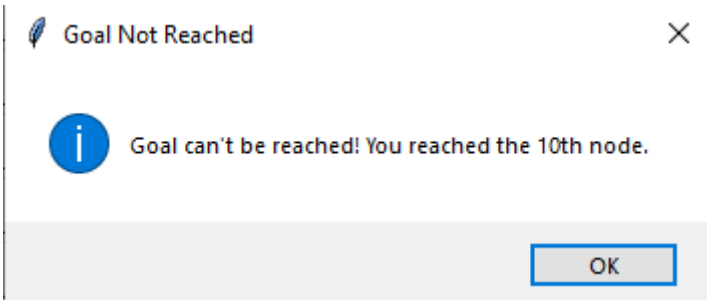
UCS:

```
if search_type == 'UCS':
    if room_dict[current[-1]][0] == room_dict[i][0]:
        new_cost += 2
    elif room_dict[current[-1]][1] == room_dict[i][1]:
        new_cost += 1
```

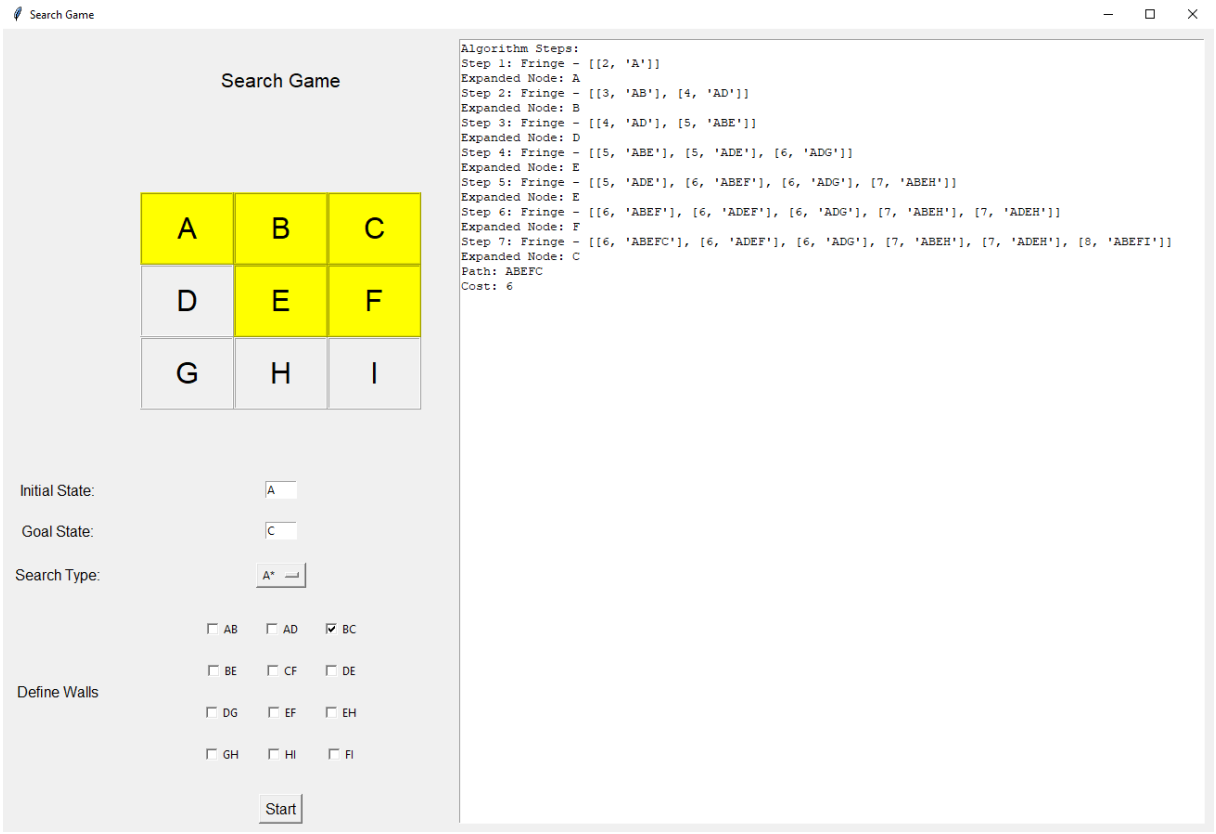
Requirement 6:

If the algorithm cannot reach the target in 10 nodes, it gives such an error message. But it still shows the stages and opened nodes.





This is the output when the goal is reached. Also, if it reaches the destination, the shortest path is indicated in yellow.



Algorithm Execution

Uniform-Cost Search:

Initial State: A

Goal State: H

Walls: AD – CF – DG – EF

STEP 1:

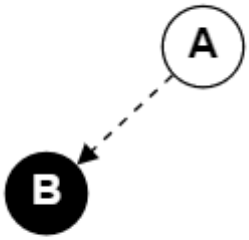
Fringe: A(0)

Expanded Node: A

STEP 2:

Fringe: AB(2)

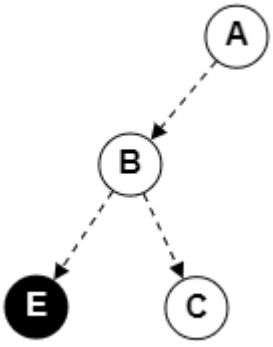
Expanded Node: B



STEP 3:

Fringe: ABE(3), ABC(4)

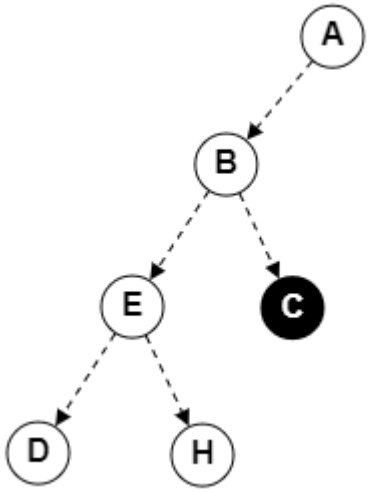
Expanded Node: E



STEP 4:

Fringe: ABC(4), ABEH(4), ABED(5)

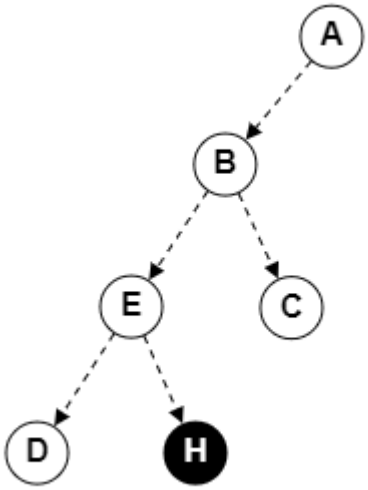
Expanded Node: C



STEP 5:

Fringe: ABEH(4), ABED(5)

Expanded Node: H



PATH = ABEH

COST = 4

A* Search:

Initial State: I

Goal State: D

Walls: AB – CF – FI – EH

STEP 1:

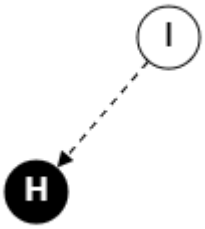
Fringe: I(3)

Expanded Node: I

STEP 2:

Fringe: IH(4)

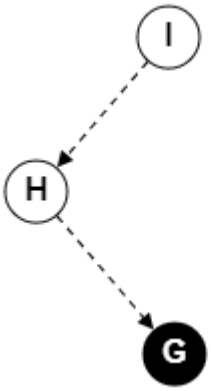
Expanded Node: H



STEP 3:

Fringe: IHG(5)

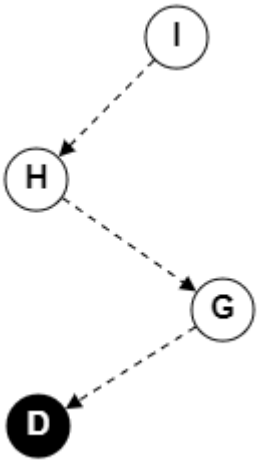
Expanded Node: G



STEP 4:

Fringe: IHGD(5)

Expanded Node: D



PATH = IHGD

COST = 5