LAB 7 Hill Climbing Search

In examining a search tree, hill climbing will move to the first successor node that is "better" than the current node—in other words, the first node that it comes across with a heuristic value lower than that of the current node. Now hill climbing proceeds as with depth-first search, but at each step, the new nodes to be added to the queue are sorted into order of distance from the goal.

1.1 Hill Climbing Algorithm

```
Function hill ()
{
     queue = [];     // initialize an empty queue
     state = root_node;   // initialize the start state
     while (true)
     {
          if is_goal (state)
               then return SUCCESS
          else
          {
               sort (successors (state));
               add_to_front_of_queue (successors (state));
          }
          if queue == []
               then report FAILURE;
          state = queue [0]; // state = first item in queue
          remove_first_item_from (queue);
     }
}
```

1.1.1 Simple Hill Climbing

Simple hill climbing is the simplest way to implement a hill-climbing algorithm. It only evaluates the neighbour node state at a time and selects the first one which optimizes current cost and set it as a current state. It only checks it's one successor state, and if it finds better than the current state, then move else be in the same state.

- **Step 1:** Evaluate the initial state, if it is goal state then return success and Stop.
- **Step 2:** Loop Until a solution is found or there is no new operator left to apply.
- **Step 3:** Select and apply an operator to the current state.
- **Step 4:** Check new state:
    i. If it is goal state, then return success and quit.
    ii. else if it is better than the current state then assign new state as a current state.
    iii. else if not better than the current state, then return to step 2.
- **Step 5:** Exit.

1.1.2 Steepest-Ascent hill climbing

The steepest-Ascent algorithm is a variation of the simple hill-climbing algorithm. This algorithm examines all the neighboring nodes of the current state and selects one neighbor node which is closest to the goal state. This algorithm consumes more time as it searches for multiple neighbors.

- **Step 1:** Evaluate the initial state, if it is goal state then return success and stop, else make the current state as your initial state.
- **Step 2:** Loop until a solution is found or the current state does not change.
  i. Let **S** be a state such that any successor of the current state will be better than it.
  ii. For each operator that applies to the current state;
     - Apply the new operator and generate a new state.
     - Evaluate the new state.
     - If it is goal state, then return it and quit, else compare it to the **S**.
     - If it is better than **S**, then set new state as **S**.
     - If the **S** is better than the current state, then set the current state to **S**.
- **Step 5:** Exit.

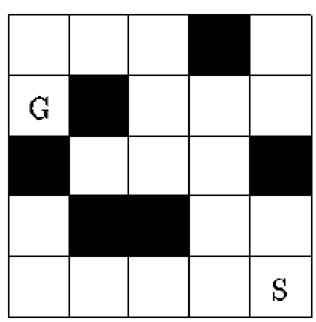
1.1.3 Stochastic hill climbing

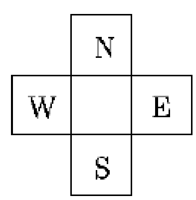
Stochastic hill climbing does not examine for all its neighbors before moving. Rather, this search algorithm selects one neighbor node at random and evaluate it as a current state or examine another state.

1.2 Lab Tasks

Exercise 7.1.

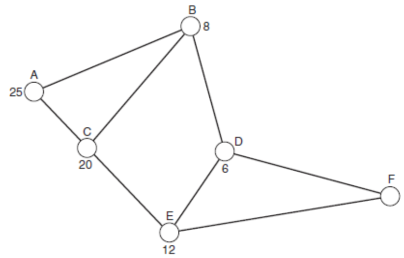
Consider the following maze. The problem is to get from the start node S to the goal node G, by moving horizontally and vertically and avoiding the black obstacles in the above maze. Implement the two variants of hill climbing algorithm discussed above.





Exercise 7.2. ***Travelling Salesman Problem***

Suppose a TCS delivery boy has to deliver parcels from *Head Office (MM Alam Road)* to 7 different locations in Lahore *(Johar Town, Shahdara, DHA Phase 6, Wapda Town, Askari 10, Allama Iqbal Town, Mall Road)* and then return back to the *Head Office.* He wants to find the route with least travelling distance. Can you help him with that using Hill Climbing Algorithm?



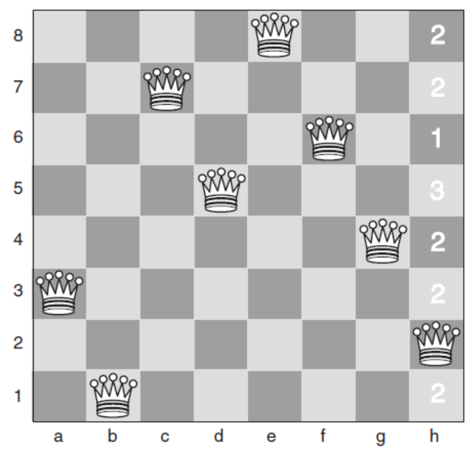
[You can construct distance matrix using google maps OR you can take random values (between 0-50) for distances between any two spots.]

Exercise 7.3.

Consider the function $f(x) = x^2 + 3x + 5$ defined on integer numbers in the interval $[-20,20]$. Use the hill-climbing algorithm to find the function's minimum value on this interval.

Exercise 7.4.

The eight queen puzzle is the problem of placing eight chess queens on an 8×8 chessboard so that no two queens threaten each other. Thus, a solution requires that no two queens share the same row, column, or diagonal.



a. Evaluate the heuristics for this problem.
b. Solve the problem using Hill Climbing Search algorithm