AI Assignment-2 Report

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1 Approach

The basic approach we used for the A.I assignment is to use the concept of Heuristic Search Algorithms and apply BFS {Best First Search} and Hill-climbing techniques.

State Space

A state space is the set of all configurations that a given problem and its environment could achieve .

We have been given with the fact that each node has exactly not more than 6 neighbors . The Set Space Set (S) consists of all possible configuration of the boxes in the set of 3 stacks .

Start & Goal node

We have taken the start node , the goal node and the algorithm mode as inputs which are provided in input.txt file and the corresponding output is displayed in CLI .

The heuristic value for each visited node is calculated with reference to the goal node using the heuristic function .

One such example is the following :
Start Node :
E B F
D A
C
Goal Node :
A D B
E F C

2 Pseudo Code

The main pseudo code used in our assignment is as follows :

move_gen function

```
def move_gen(curr_state):
    global closed, open,parent
    state = copy.deepcopy(curr_state)
    neighbors = [ ]
    for i in range(len(state)):
      temp = copy.deepcopy(state)
      if length of temp[i] is greater than 0:
        elem = temp[i].pop()
        for j in range(len(temp)):
          temp1 = copy.deepcopy(temp)
          if j not equal to i:
            temp1[j] = temp1[j] + [elem]
            if(parent.get(stringify(temp1)) is empty):
              neighbors.append(temp1)
    return neighbors
```

goal_state function

```
def goal_state(cur,i):
    global goal
    if(heuristic(cur,i) is equal to heuristic(goal,i)):
       return 1
     return 0
```

3 Heuristic functions

3.1 Heuristic 1

- This function turns the Block problem into a maximization problem for the Best First Search Algorithm .
- A block is in its correct position iff it is present in the correct stack with appropriate height .
- This heuristic function assigns the value :
    1. $+1$ to the blocks of the current stack which are present in their correct position with respect to the goal state's blocks .
    2. -1 to the blocks which are not present in their right position with respect to the goal state .
- The sum of the assigned values to each of the blocks gives us the heuristic value for that state .
- The higher the heuristic value of a given state, the more priority is given to it during the BFS search .

3.2 Heuristic 2

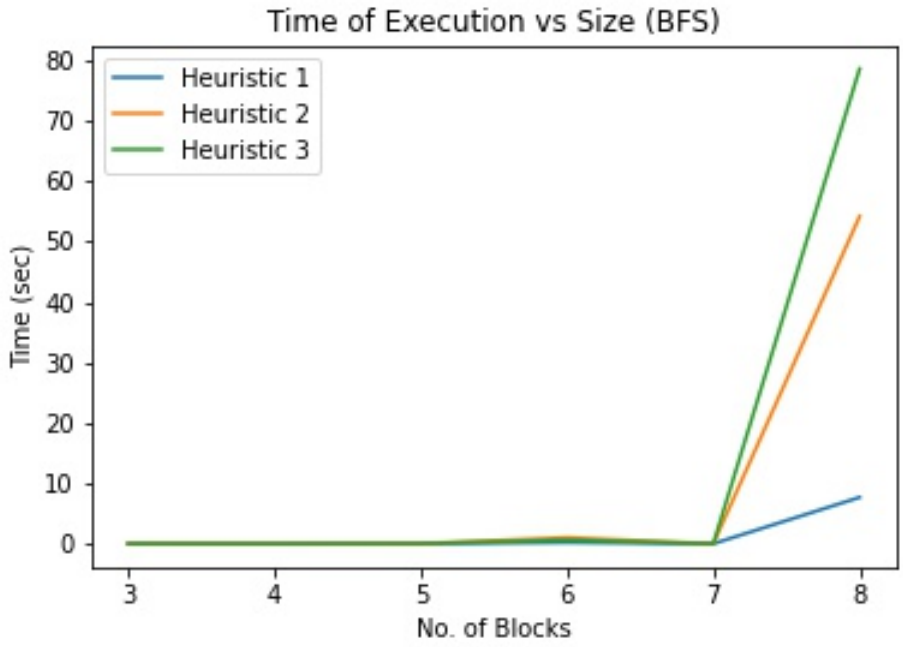
- This function turns the Block problem into a maximization problem for the Best First Search Algorithm .
- A block is in its correct position iff it is present in the correct stack with appropriate height .
- This heuristic function assigns the value :
    1. $+$h to those blocks of the current stack which have the same height as of that to the goal state's blocks , where h is the height of the block.
    2. $-h$ to the blocks which do not have the same height with respect to the goal state's blocks , where h is the height of the block .
- The sum of the assigned values to each of the blocks gives us the heuristic value for that state .
- The higher the heuristic value of a given state, the more priority is given to it during the BFS search .

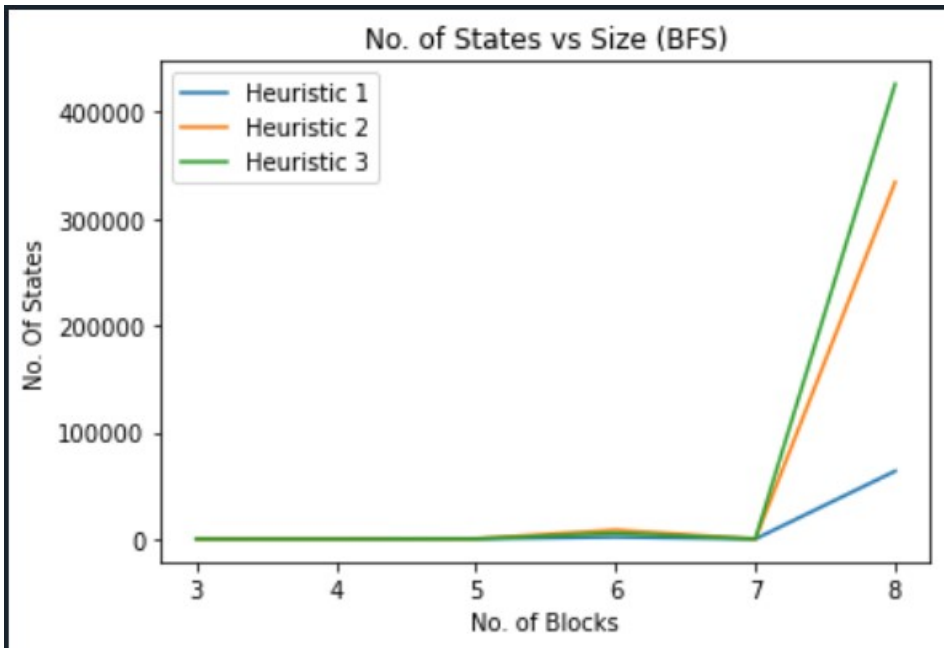
3.3 Heuristic 3

- This function turns the Block problem into a maximization problem for the Best First Search Algorithm .
- A block is in its correct position iff it is present in the correct stack with appropriate height .
- The sum of the Manhattan distances of each of the blocks in a state gives us the heuristic value for that state .
- The higher the heuristic value of a given state, the more priority is given to it during the BFS search .

4 Analysis & Observations

Based on observation , we have plotted the following graphs for Best First Search Algorithm :





From the above graphs , we have analysed that the best first search algorithm always finds the best and optimal solution but at the cost of time consumed is high as BFS has a time complexity of O(b^d) .

5 Results

The following conclusions have been made after evaluation of our program :

States Explored : The Hill-Climbing algorithm in general will have lesser no. of states explored than that of BFS . In the worst scenario, the best first search algorithm will explore all the states but Hill-Climbing algorithm will explore uptill $O(bd)$,
where b = the maximum beam width
d = the depth of the search graph from the start state.

Time Complexity : The time complexity for the Best First Search Algorithm is $O(b^d)$ and for Hill-Climbing algorithm it is $O(bd)$.

Optimal Solution : For reaching to the optimal solution , the Best First Search Algorithm is the better algorithm as it explores all the nodes/states but in the case of Hill-Climbing algorithm it doesn't explore all the states and it may get stuck in the local extremum while finding the goal state .

Conclusion

The Best First Search Algorithm is the more optimal choice as it helps to solve the given problem efficiently .

Although it takes more time than the Hill-Climbing algorithm, it ensures that the best solution has been found to reach the goal state by exploring all the nodes/states in $O(b^d)$, whereas in Hill-Climbing algorithm not all the nodes/states are visited as sometimes the algorithm gets stuck at a local extremum while finding the optimal path to the goal state.

6 References

- http://geeksforgeeks.com
- https://wikipedia.org
- https://stackoverflow.com