Informed Search

INFORMED SEARCH

- All the previous searches have been blind searches .They make no use of any knowledge of the problem

- When more information than the initial state , the operator , and the goal test is available, the size of the search space can usually be constrained.

- HEURISTIC INFORMATION:

  Information about the problem (the nature of the states, the cost of transforming from one state to another , the promise of taking a certain path, and the characteristics of the goals).can sometimes be used to help guide the search more efficiently.

  Information in form of heuristic evaluation function=f(n,g),a function of the nodes n, and/or the goals g.

- They help to reduce the number of alternatives from an exponential number to a polynomial number and , thereby , obtain a solution in a tolerable amount of time.

Heuristics

- A heuristic is a rule of thumb for deciding which choice might be best
- There is no general theory for finding heuristics, because every problem is different
- Choice of heuristics depends on knowledge of the problem space
- An informed guess of the next step to be taken in solving a problem would prune the search space
- A heuristic may find a sub-optimal solution or fail to find a solution since it uses limited information
- In search algorithms, heuristic refers to a function that provides an estimate of solution cost

The notion of Heuristics

- Heuristics use domain specific knowledge to estimate the quality or potential of partial solutions.
- Example:
- Manhattan distance heuristic for 8 puzzle.
- Minimum Spanning Tree heuristic for TSP.

The 8-puzzle

2	8	3
1	6	4
	7	5

Initial State

1	2	3
8		4
7	6	5

Goal state

- **Heuristic Fn-1 :** Misplaced Tiles Heuristics is the number of tiles out of place.
- The first picture shows the current state *n, and the second picture the goal state.*
- $h(n) = 5$ because the tiles 2, 8, 1, 6 and 7 are out of place.
- **Heuristic Fn-2:** Manhattan Distance Heuristic: Another heuristic for 8-puzzle is the Manhattan distance heuristic. This heuristic sums the distance that the tiles are out of place. The distance of a tile is measured by the sum of the differences in the x-positions and the y-positions.
- For the above example, using the Manhattan distance heuristic,
- $h(n) = 1 + 1 + 0 + 0 + 0 + 1 + 1 + 2 = 6$
- This piece will have to be moved *at least* that many times to get it to where it belongs
- Suppose, from a given position, we try every possible single move (there can be up to four of them), and pick the move with the smallest sum

The Informed Search Problem

- Given [S,s,O,G,h] where
  - S is the (implicitly specified) set of states.
  - s is the start state.
  - O is the set of state transition operators each having some cost.
  - G is the set of goal states.
  - h() is a heuristic function estimating the distance to a goal.
- To find :
  - A min cost seq. of transition to a goal state .

Hill Climbing

- Hill climbing is a variant of Generate and test in which feedback from test procedure is used to help the generator decide which direction to move in search space.
- Feedback is provided in terms of heuristic function

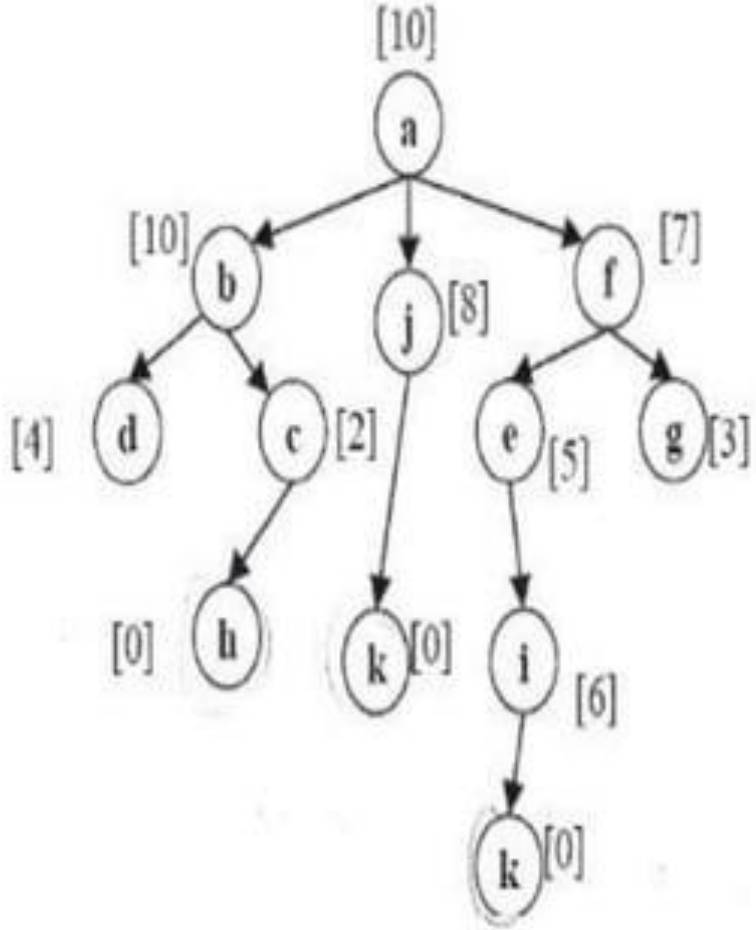
HILL CLIMBING SEARCH

1. Evaluate the initial state. If it is a goal state then return it and quit. Otherwise, continue with initial state as current state.
2. Loop until a solution is found or there are no new operators left to be applied in current state:
   - Select an operator that has not yet been applied to the current state and apply it to produce a new state
   - Evaluate the new state:
     * if it is a goal state, then return it and quit
     * if it is not a goal state but better than current state then make new state as current state
     * if it is not better than current state then continue in the loop

- It is a simply a loop that continually moves in the direction of increasing value.
- The algorithm does not maintain a search tree, so the node structures need only record the state and its elevation which denote by VALUE.
- It terminates when it reaches a “peak” where no neighbor has a higher value.
- When there is more than one best successor choose from, the algorithm can select them at random.

Hill Climbing Example

- Goal state : h and k
- Local minimum: A-> F -> G
- Solution:
  - A, J, K
  - A, F, E, I, K



Steepest-Ascent Hill Climbing (Gradient Search)

- Considers all the moves from the current state.
- Selects the best one as the next state.

Steepest-Ascent Hill Climbing (Gradient Search)

1. Evaluate the initial state. If it is a goal state then return it and quit. Otherwise, continue with initial state as current state.
2. Loop until a solution is found or a complete iteration produces no change to current state:

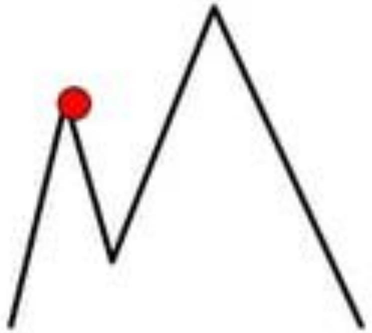
   - let SUCC be a state such that any possible successor of the current state will be better than SUCC (the worst state).
   - For each operator that applies to the current state do:
     * Apply any operator and generate new state
     * evaluate the new state:
       * if it is a goal state, then return it and quit
       * if it is not a goal state, compare it to SUCC.

         If it is better than set SUCC to this state

         If it is not better than leave SUCC alone
     * if SUCC is better than the current state then set the current state to SUCC.

DRAWBACK

- Local maxima: A local maximum is a peak that is higher than each of its neighboring states, but lower than the global maximum. Once a local maximum peak the algorithm is halt even though the solution may be far from satisfactory.



- Plateau: A plateau is an area of the state space landscape where the evaluation function is flat. It can be a flat local maximum , from which no uphill exit exists .The search will conduct a random walk.

- Ridges: A ridge is a special kind of local maximum. It is an area of the search space that is higher than surrounding areas and that itself has a slope (which one would like to climb). But the orientation of the high region, compared to the set of available moves

Hill Climbing: Disadvantages

Ways Out

- **Local maximum :**Backtrack to some earlier node and try going in a different direction.
- **Plateau:** Here make a big jump to some direction and try to get to new section of the search space.
- **Ridge:** Here apply two or more rules before doing the test i.e., moving in several directions at once.
- Hill climbing is a local method:
  Decides what to do next by looking only at the “immediate” consequences of its choices.
- Global information might be encoded in heuristic functions.