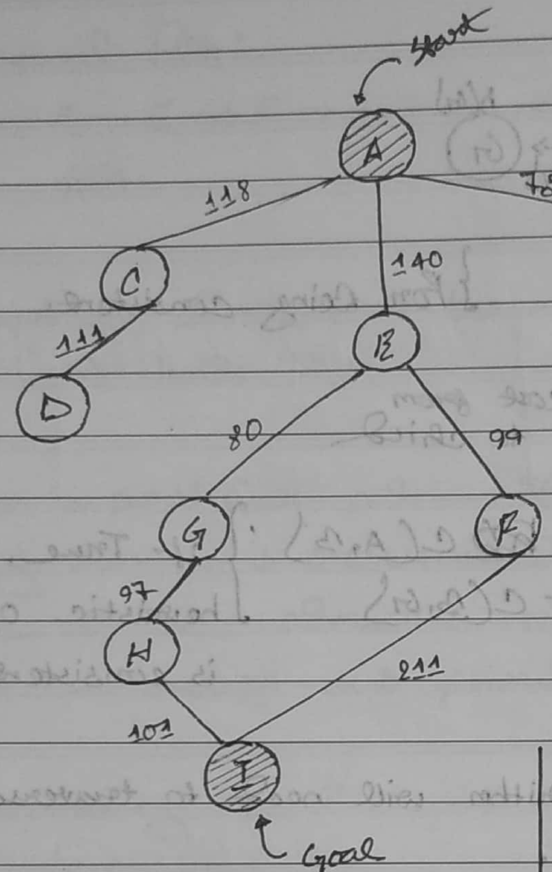
Subject :

Date :



State	Heuristic : h(n)
A	366
B	374
C	329
D	244
E	253
F	178
G	193
H	98
I	0

```
adj_graph = {
'A': {'C': 118, 'B': 75, 'E': 140}
'B': { }
'C': {'D': 111}
'D': { }
'E': {'G': 80, 'F': 99}
'F': {'I': 211}
'G': {'H': 97}
'H': { I: 101}
'I': { }
}
```

f(n) = h(n) = straight-line distance heuristic

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$h(n) \leftarrow$ heuristic

$g(n) \leftarrow$ path cost from start node to node n.

$$f(n) = h(n) + g(n)$$

$f(A) = h(A) + g(A)$	$f(C) = h(C) + g(C)$	$f(G) = h(G) + g(G)$
$= 366 + 0$	$= 329 + 118$	$= 193 + \underbrace{140 + 80}_{g(G)}$
$= 366$	$= 447$	$= 413$

$A^{366+0=366}$

A^{366} | $C^{329+118=447}$ $E^{253+140=393}$ $B^{374+75=449}$

Among these three nodes in the fringe, we will be expanding the node with the lowest cost.

E^{393} | C^{447} B^{449} $G^{193+140+80=413}$ $F^{178+140+99=417}$

G^{413} | C^{447} B^{449} F^{417} $H^{98+140+80+97=415}$

H^{415} | C^{447} B^{449} F^{417} $I^{0+140+80+97+101=418}$

F^{417} | C^{447} B^{449} I^{418} $I_{P=F}^{0+140+99+211=450}$ $I_{P\to H}^{418}$

$I_{P\to H}^{418}$ | C^{447} B^{449} I^{450}

Path:

$A \longrightarrow E \longrightarrow G \longrightarrow H \longrightarrow I$

Cost - 418

This is a optimal path because it's cost is lower.

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Sub Optimal Path:

$A \rightarrow E \rightarrow F \rightarrow I$

Cost - 450

This graph is admissible because for all the nodes $h(n) \leq g(n)$ holds TRUE.

if for a particular node ~~h(n) ≤ g(n)~~ $h(n) \geq g(n)$: then we can say than h is overestimated. Thus, we can not say the heuristic to be admissible any more. In this case, A* algorithm can return sub-optimal root.

The optimality of A* algorithm, depends on the admisibility of the heuristic.

Optimal ?
- └> h admisible → Optimal
- └> h not admisible → not optimal

Time and space complexity is exponential: $O(b^{\epsilon d})$.
Depending upon the quality of the heuristics in practical implementations actual time and memory requirements can decrease significantly.
The epsilone factor is based upon the quality of the heuristics.

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Heuristic Consistency:

$$\overset{h(A)}{A} \xrightarrow[C(A,B)]{} \overset{h(B)}{B} \xrightarrow[C(B,G)]{} \overset{h(G)}{G}$$

$h(n) \leq h(n') + h(n,n')$ } For being consistent.

$h(n')$ ↑ child

$h(n,n')$ ↑ Actual cost from parent to child

$$h(A) \leq h(B) + \cancel{h}\, C(A,B)$$
$$h(B) \leq h(G) + C(B,G)$$

} if True, then the heuristic of the graph is consistent.

As a result, the algorithm will need to traverse less to find the optimal path.

~~For a graph, the heuristic can be consistent while it may not be admissible.~~

For a graph, the heuristic can be admissible while it may not be consistent.

$$\overset{h=4}{A} \xrightarrow[C(A,B)]{1} \overset{h=1}{B} \xrightarrow[C(B,G)]{3} \overset{h=0}{G}$$

} So, This graph is admissible but NOT consistent.

$h(A) \leq C(A,B) + h(B)$	$h(B) \leq C(B,G) + h(G)$	$\hat{h}(n) \leq \hat{g}(n)$
$\Rightarrow h(A) \leq 1 + 1$	$\Rightarrow h(B) \leq 3 + 0$	$\Rightarrow 4 \leq 4$
$\therefore h(A) \leq 2$	$\therefore h(B) \leq 3$	~~Thus~~, $h(B) \leq g(B)$
$\Rightarrow 4 \leq 2$ NOT true	$\Rightarrow 1 \leq 3$ NOT true	$\Rightarrow 1 \leq 3$ TRUE; Thus admissible

Thus, not consistent.

If NOT consistent, in practical implementation time and complexity will be needed more. Because, it may expand the irrelevant branch before than expanding the relevent branch.

* Like all searching algorithm's, A* has two versions:
  (i) Graph search versions.
  (ii) Tree search versions.

In Graph search versions, the nodes that have been visited and expanded are kept track of.
But, in tree search versions, no such tracking is kept.

In Graph search versions, if heuristic is admissible then its Complete. Meanwhile, in tree search versions the informations that are needed for back tracking are not kept. In tree search versions, ~~the heuristic has to be~~ the heuristic has to be both admissible and consistent for the A* algorithm to be complete.