A* search

BFS, DFS ⇒ uninformed search
↓
No idea how far the goal/destination node is from current node

A* search ⇒ informed search. Estimation of goal distance from current node

A* search ⇓ An algorithm to reach from source S to goal D in optimal cost, given all heuristic values(h) are admissible

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

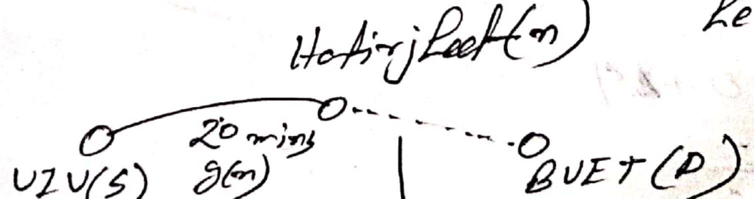
$g(n)$ → Actual cost so far to arrive at node n from source node S

$h(n)$ → Admissible heuristic cost to reach destination node D from node n

optimal cost ⇒ smallest possible cost (least time/least expense...)
largest possible profit (max production/max earning...)

heuristic value ⇒ approximate cost (assumption)

Admissible heuristic ⇒ h(n) is admissible if:
for all node n:
actual cost of reaching D >= heuristic cost of reaching D
⇓
An underestimation

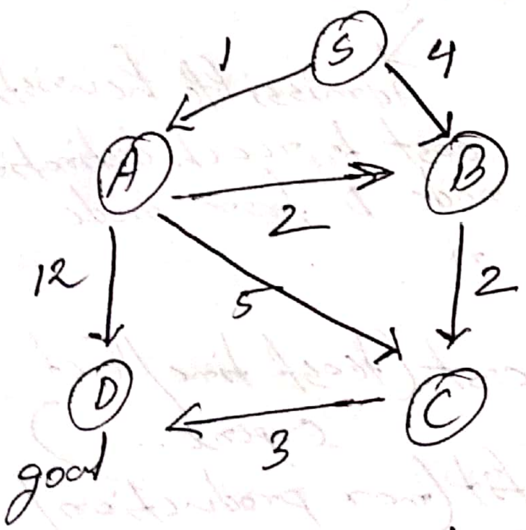


may take 20/30/40/45 mins depending on traffic
so, h(n) <= 20, if h(n) is to be admissible.

* A^* search expands most promising node first
⇓
node with least $f(n)$ value

The closer $h(n)$ is to actual min cost ⇒ quality of $h(n)$
the more efficient A^* search will become.

Demonstration



$h(n)$
$S \Rightarrow 7$
$A \Rightarrow 6$
$B \Rightarrow 2$
$C \Rightarrow 1$
$D \Rightarrow 0$

* Use min-priority queue Q

Initially: $Q \Rightarrow S \rightarrow g(n)=0$ ⇒ $f(n)=7$
$\searrow h(n)=7$

(1) Q extract-min $\rightarrow S \rightarrow S == D??$ = No

$S \rightarrow A$ ⇓
$g(n) = 0+1$
$h(n) = 6$
$f(n) = 7$

$S \rightarrow B$ → (insert into Q)
⇓
$g(n) = 0+4$
$h(n) = 2$
$f(n) = 6$

$\xrightarrow{}$ $S \to B \Rightarrow B == D$?? (No)
(extract_min)

(2) Q

$S \to A$
$g(n) = 1$
$h(n) = 6$
$f(n) = 7$

$S \to B \to C$ → (insert into Q)
$g(n) = 4 + 2$
$h(n) = 1$
$f(n) = 7$

(3) Q → $S \to A \Rightarrow A == D$?? (No)
(extract_min) → (Insert into Q)

$S \to A \to B$
$g(n) = 1 + 2$
$h(n) = 2$
$f(n) = 5$

$S \to A \to C$
$g(n) = 1 + 5$
$h(n) = 2$
$f(n) = 7$

$S \to A \to D$
$g(n) = 1 + 12$
$h(n) = 0$
$f(n) = 13$

$S \to B \to C$
$g(n) = 6$
$h(n) = 1$
$f(n) = 7$

(4) Q → $S \to A \to B \Rightarrow B == D$?? (No)
(extract_min) → (Insert into Q)

$S \to A \to B \to C$
$g(n) = 3 + 2$
$h(n) = 1$
$f(n) = 6$

$S \to A \to C$
$g(n) = 6$
$h(n) = 1$
$f(n) = 7$

$S \to A \to D$
$g(n) = 13$
$h(n) = 0$
$f(n) = 13$

$S \to B \to C$
$g(n) = 6$
$h(n) = 1$
$f(n) = 7$

(5) Q → $S \to A \to B \to C \Rightarrow C == D$?? (No)
(extract_min) → (Insert into Q)

$S \to A \to B \to C \to D$
$g(n) = 5 + 3$
$h(n) = 0$
$f(n) = 8$

$S \to A \to C$
$g(n) = 6$
$h(n) = 1$
$f(n) = 7$

$S \to A \to D$
$g(n) = 13$
$h(n) = 0$
$f(n) = 13$

$S \to B \to C$
$g(n) = 6$
$h(n) = 1$
$f(n) = 7$

Scanned with CamScanner

$S \to B \to C \Rightarrow C == D$?? (No)

(6) $\underline{Q}$ (extract min) (insert into Q)

$S \to B \to C \to D$	$S \to A \to B \to C \to D$	$S \to A \to C$	$S \to A \to D$
$g(n) = 6 + 3$	$g(n) = 8$	$g(n) = 6$	$g(n) = 13$
$h(n) = 0$	$h(n) = 0$	$h(n) = 1$	$h(n) = 0$
$f(n) = 9$	$f(n) = 8$	$f(n) = 7$	$f(n) = 13$

$S \to A \to C \Rightarrow C == D$?? (No)

(7) $\underline{Q}$ (insert into Q)

$S \to A \to C \to D$	$S \to B \to C \to D$	$S \to A \to B \to C \to D$	$S \to A \to D$
$g(n) = 6 + 3$	$g(n) = 9$	$g(n) = 8$	$g(n) = 13$
$h(n) = 0$	$h(n) = 0$	$h(n) = 0$	$h(n) = 0$
$f(n) = 9$	$f(n) = 9$	$f(n) = 8$	$f(n) = 13$

(8) Q $\to$ $S \to A \to B \to C \to D \Rightarrow D == D$?? (~~No~~) yes

goal reached

optimal path : $S \to A \to B \to C \to D$

optimal cost : 8