# DS & AI

# Artificial Intelligence

## Informed Search
## 1500+ Series

Lecture_01


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# Topic : Uninformed Search

#Q. Consider the state space with the branching factor of 4 and assume that goal occurs somewhere at depth 6.
How many maximum numbers of nodes will be inspected if we used BFS search algorithm?

$$\sum_{N_1}^{N_2} r^n$$

$$\left(\frac{r^{(N_2-N_1)+1}-1}{r-1}\right)$$

$4^0$

$4^1$

$4^2$

$4^3$

$4^4$

$4^5$

$4^6$

$4^0 + - - - 4^6$

$$\sum_{n=0}^{6} 4^n = (5461)$$

# Topic : Uninformed Search

#Q. Which of the following statements is/are correct about Iterative deepening depth-first search?

DLS ✓

**A** In terms of node generation, it is asymptotically similar to breadth-first search (BFS)

**B** ✗ IDS is preferred for large search spaces when the depth of the solution is known.

**C** It combines benefits of depth-first and breadth-first search, offering modest memory requirements and completeness ✓

**D** In IDS, the predefined limit is used to start the search. ✗ IDDFS

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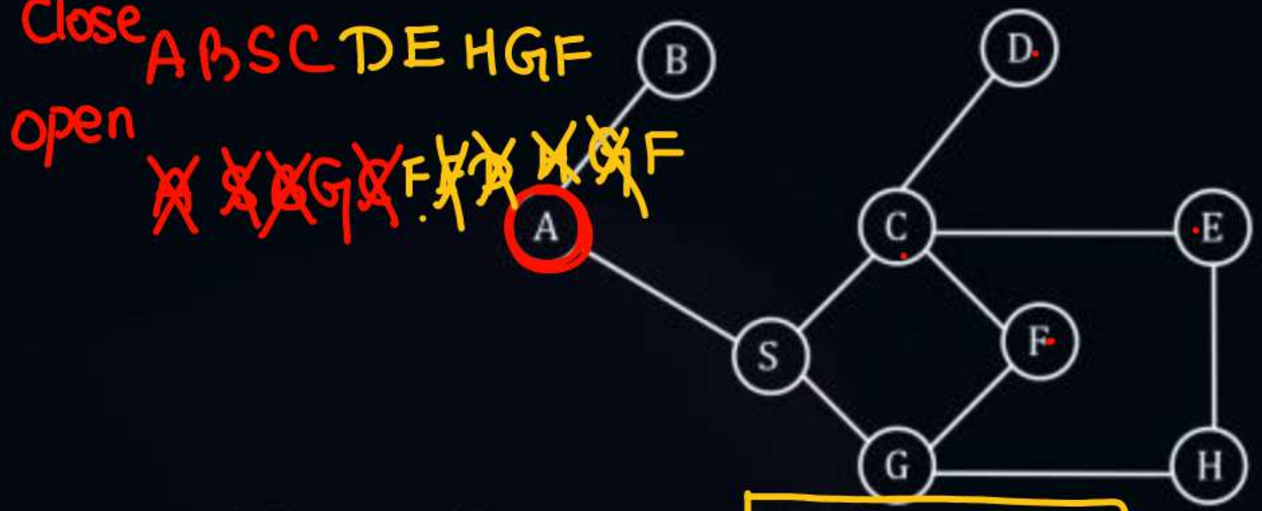
#Q. Consider the following graph:




What is the correct DFS traversal starting from node A ?
Assume that you visit alphabetically smaller nodes first.

**A** {A B S C D E H G F}

**B** {A B S C D E G F H}

**C** {A B S C H E D G F}

**D** {A B C S D E H G F}

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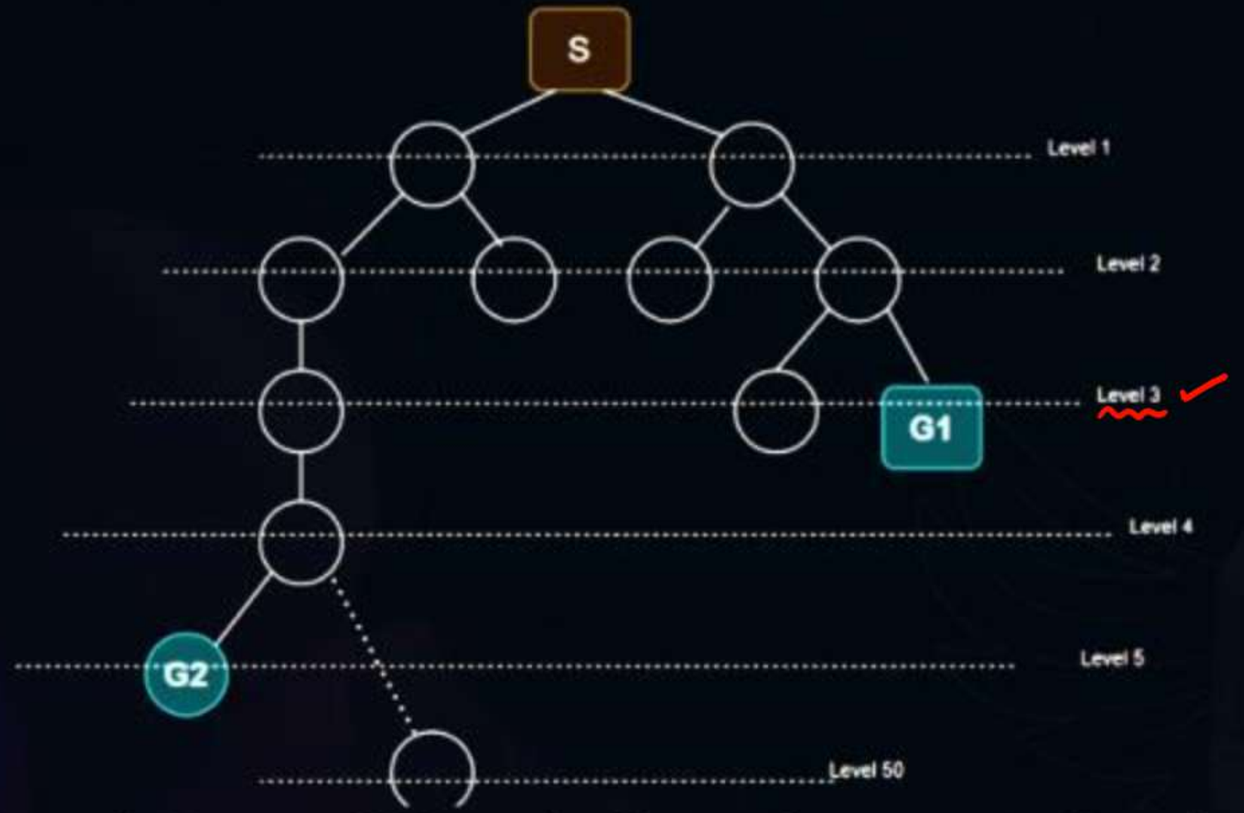
#Q. Consider the below infinite search space, S is start state and G is the Goal State.




Suppose Depth Limited Search Algorithm is used to find the Goal Node G2 with the predefined search limit of level 3. Based on the performance of DLS DLS algorithm, choose the correct option.

A Search will be Complete

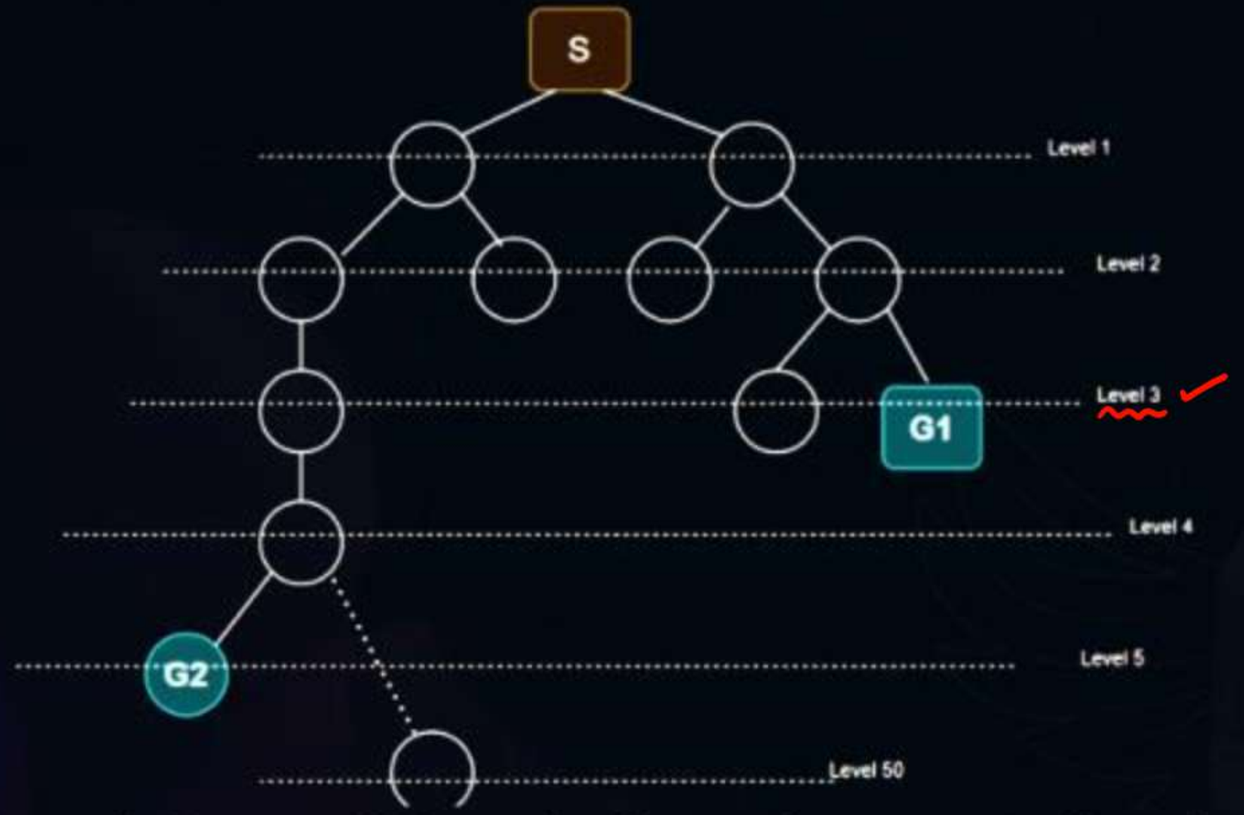
B Search will be Incomplete

C Search will provide optimal solution

D Search will provide a solution but may not be optimal

# Topic : Uninformed Search

#Q. Consider the below infinite search space, S is start state and G is the Goal State.




Suppose Depth Limited Search Algorithm is used to find the Goal Node G2 with the predefined search limit of level 3. Based on the performance of DLS algorithm, choose the correct option.

A. Search will be Complete

B. Search will be Incomplete

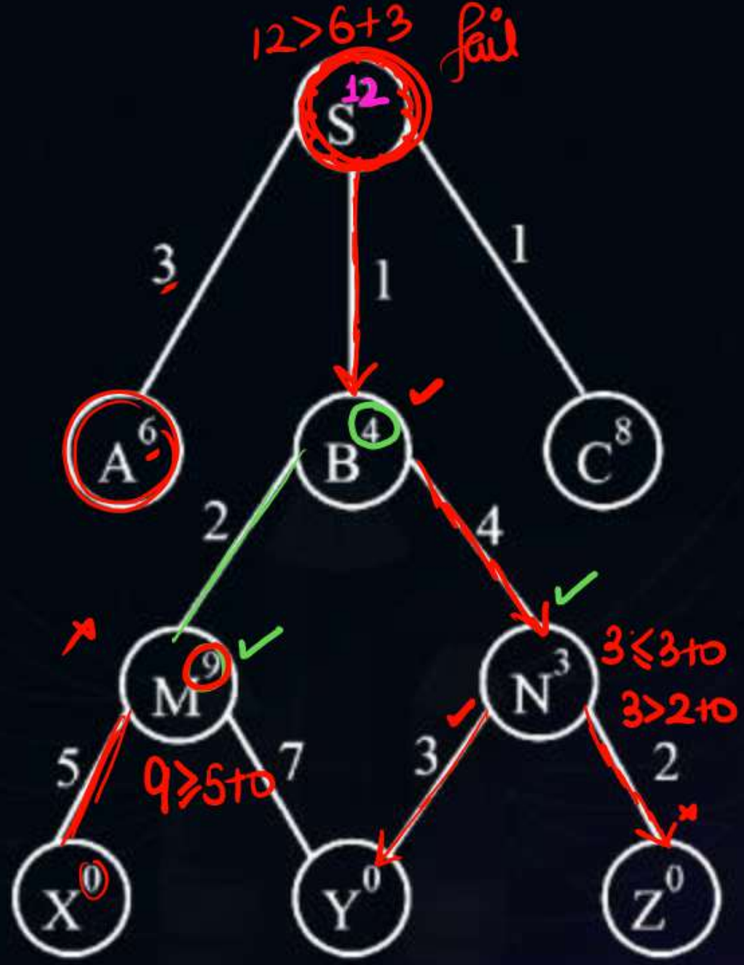
C. Search will provide optimal solution

D. Search will provide a solution but may not be optimal

# Topic : Informed

#Q. Consider the search space depicted in the Figure below. S is the initial state. X, Y, an Z are the states that satisfy the goal test. Use alphabetical order of nodes to break ties. Let P denote the set of states present in the optimal path using A* algorithm and Q represent the set of states present in the optimal path using GBFS. The cardinality of P ∩ Q is _____.

GBFS → min heuristic
SBNY, SBNZ




- Heuristic Consistent ⇒ $h(n) \leq h(\text{neighbour}) + C_n\text{-neighbour}$

# Topic : Informed

A* P (S,B,N,Z) → 7

P ∩ Q ⇒ S, B, N

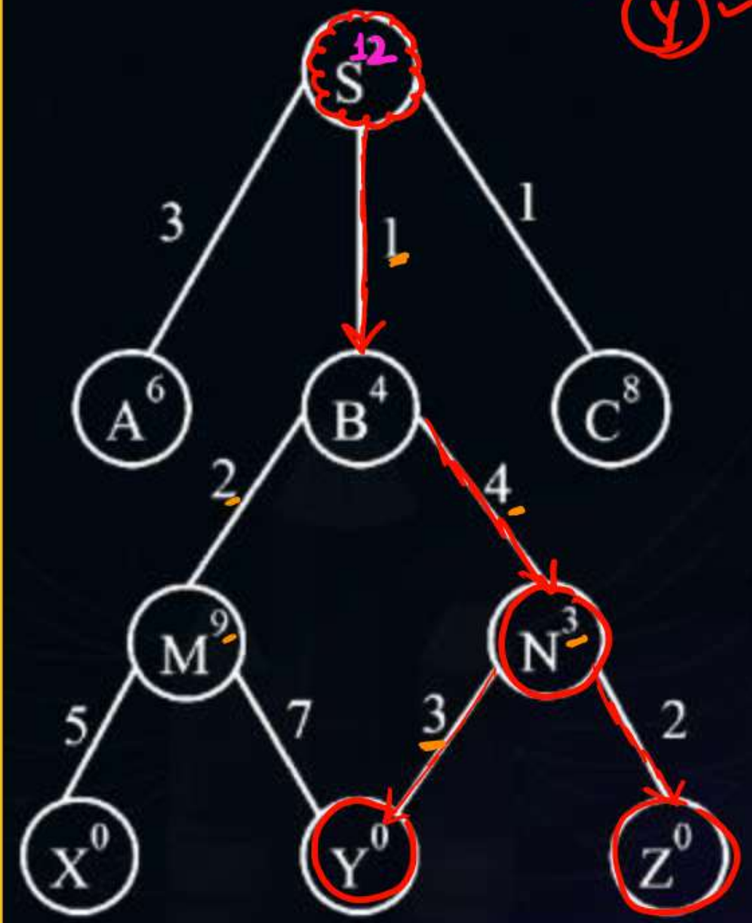
Common 3

GBFS → min heuristic

Q ⇒ SBNY → 8

Tie Break Y

| | S | B | N | Z |
|---|---|---|---|---|
| S | 0 | 0 | 0 | 0 |
| A | 9 | 9 | 9 | 9 |
| B | 5 | 5 | 5 | 5 |
| C | 9 | 9 | 9 | 9 |
| M | - | 12 | 12 | 12 |
| N | - | 8 | 8 | 8 |
| X | - | - | - | - |
| Y | - | - | 8 | 8 |
| Z | - | - | 7 | 7 |



# Topic : Informed Search

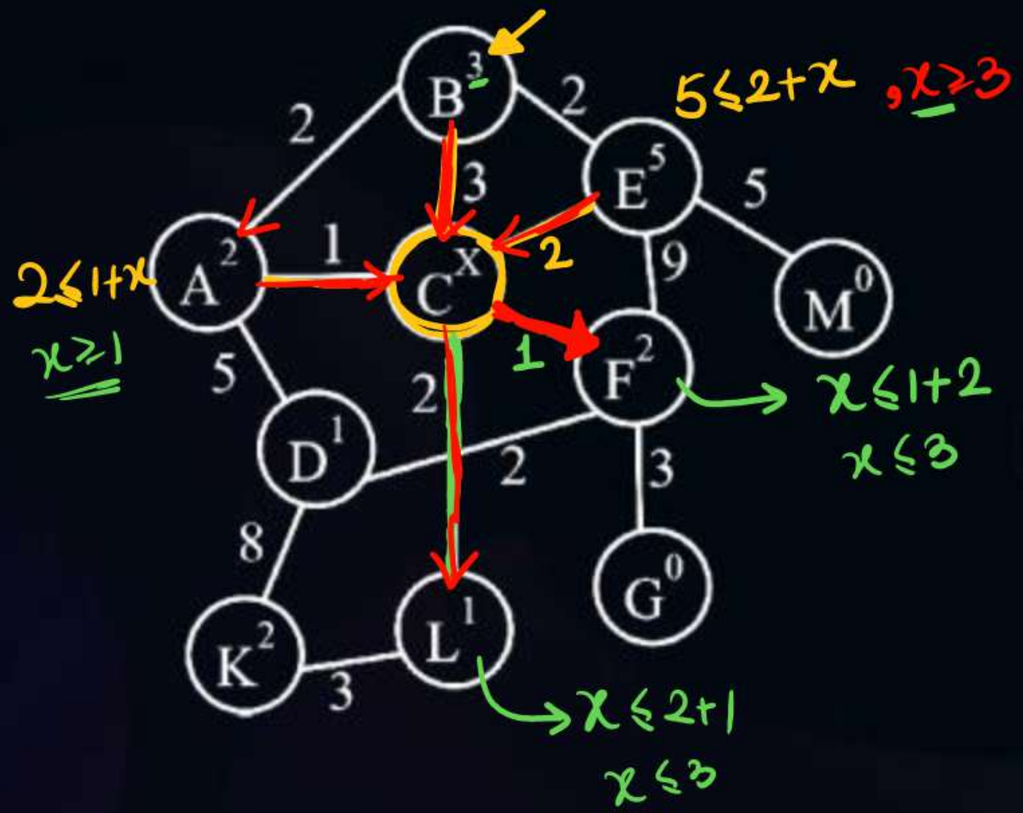
#Q. What can be the minimum value of 'x' possible to keep the graph consistent?

$3 \leq 3+x \Rightarrow (x \geq 0)$

$(x \geq 0), (x = 3)$ ✓

× min =

× max =




$2 \leq 1+x$

$x \geq 1$

$5 \leq 2+x, x \geq 3$

$x \leq 1+2$

$x \leq 3$

$x \leq 2+1$

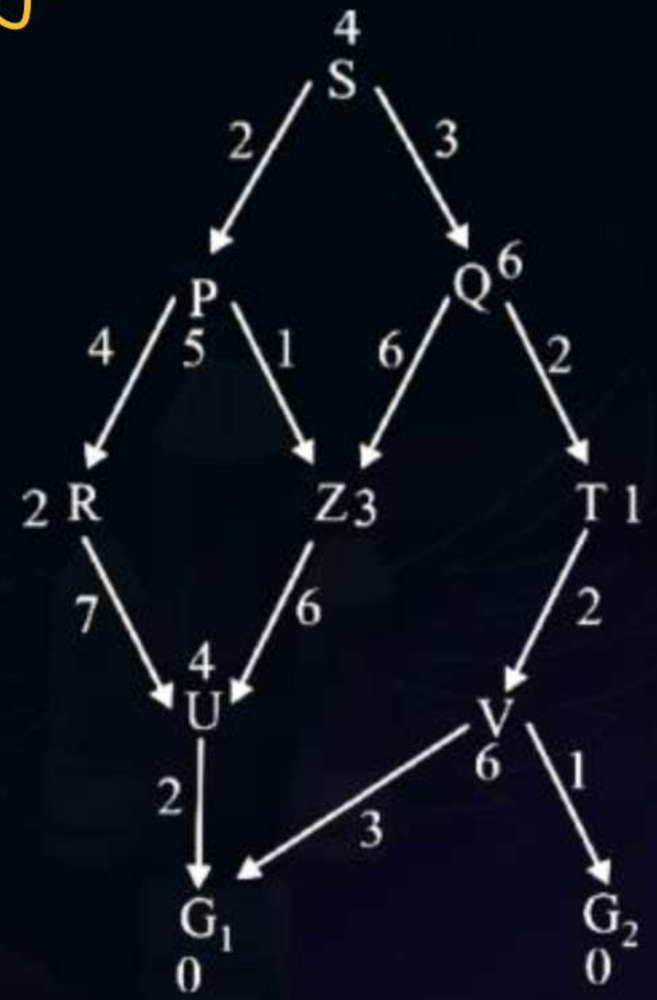
$x \leq 3$

# Topic : Informed Search

(weighted A*)

goal G1, Cost=11 ✓

#Q. You are performing Weighted A* search on the following graph where the start node is S, and the goal nodes are G1 and G2. The f-value is calculated using the formula: $f(n)=g(n)+w\times h(n)$ where the weight w for the heuristic is set to 3. Calculate the size of the Open list after the completion of the entire process. 1 ✓



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$f = g + 3h$

alphabetical order

(Path cost 11, goal $G_1$)

| | S | P | R | Z | Q | T | U | $G_1$ |
|---|---|---|---|---|---|---|---|---|
| S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| P | 17 | 17 | 17 | 17 | 17 | 17 | 17 | |
| Q | 21 | 21 | 21 | 21 ← | 21 | 21 | 21 | |
| R | – | 12 | 12 | 12 | 12 | 12 | 12 | |
| Z | – | 12 | 12 | 12 | 12 | 12 | 12 | |
| T | – | – | – | – | 8 ← | 8 | 8 | |
| U | – | – | 25 | 21 ← | 21 | 21 ← | 21 | |
| V | – | – | – | – | – | 25 | 25 | |
| $G_1$ | – | – | – | – | – | – | 11 ← | |
| $G_2$ | – | – | – | – | – | – | – | |

8

Close: S P R Z Q T U $G_1$

Open: ~~S P Q R Z Q T~~ V ~~$G_2$~~ → 1

# Topic : Informed Search

#Q. The branch factor for a graph is 5 and the depth threshold is 3. The difference between the worst case time and space complexity if Iterative Deepening A* search is used will be _____.

IDA*

- Time C → $O(b^d)$
- Space C → $O(b \times d)$

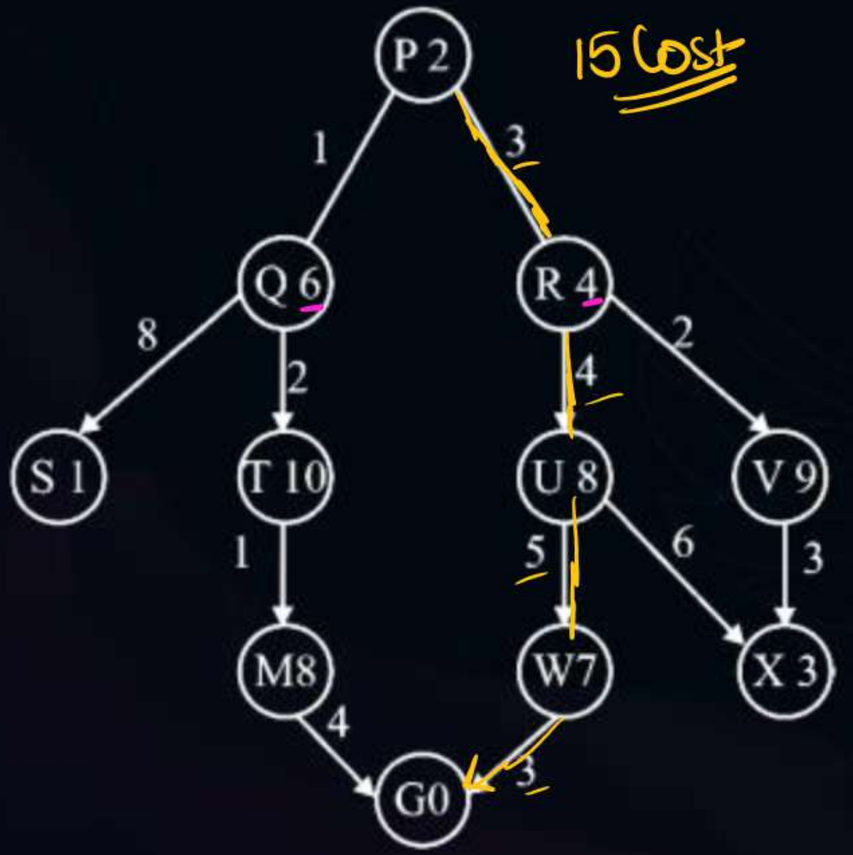
DFS

$\Rightarrow (5^3 - 5 \times 3)$

# Topic : Informed Search

A*,

#Q. What will be the path cost in reaching the goal node G starting from node P, when Breadth First Heuristic Search algorithm is applied on the following graph? Note: Use alphabetical order of nodes to break ties.




15 Cost

Close
P R Q S U X W G0

open
6 8 9 1 10 7 3

G6

open (2)

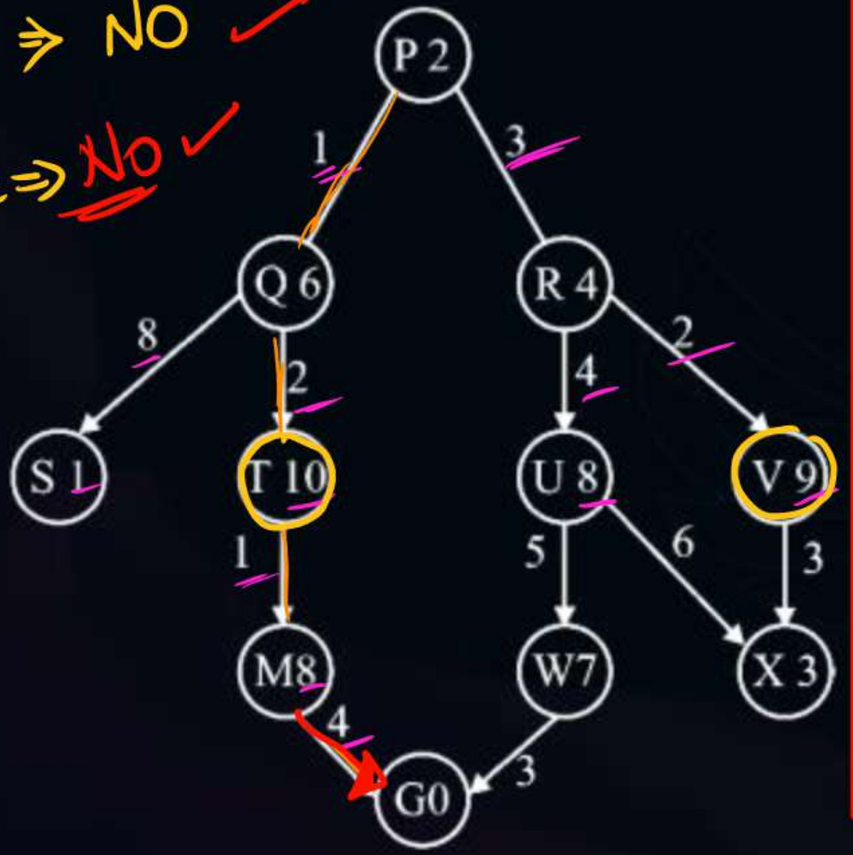
Close (8)

# Topic : Informed Search

Alphabetical

#Q. What will be the path cost in reaching the goal nod
when Breadth First Heuristic Search algorithm is a
graph? Note: Use alphabetical order of nodes to bre

- Consistent ⇒ NO ✓
- admissible ⇒ No ✓




P Q R S T M G

| | | | | | |
|---|---|---|---|---|---|
| P | 0 | 0 | 0 | 0 | |
| Q | 7 | 7 | 7 | 7 | |
| R | 7 | 7 | 7 | 7 | |
| S | – | 10 | 10 | 10 | |
| T | – | 13 | 13 | 13 | |
| u | – | – | 15 | 15 | } open |
| v | – | – | 14 | 14 | |
| w | – | – | – | | |
| x | – | – | – | | |
| M | – | – | – | 12 | |
| G | – | – | – | 8 | |

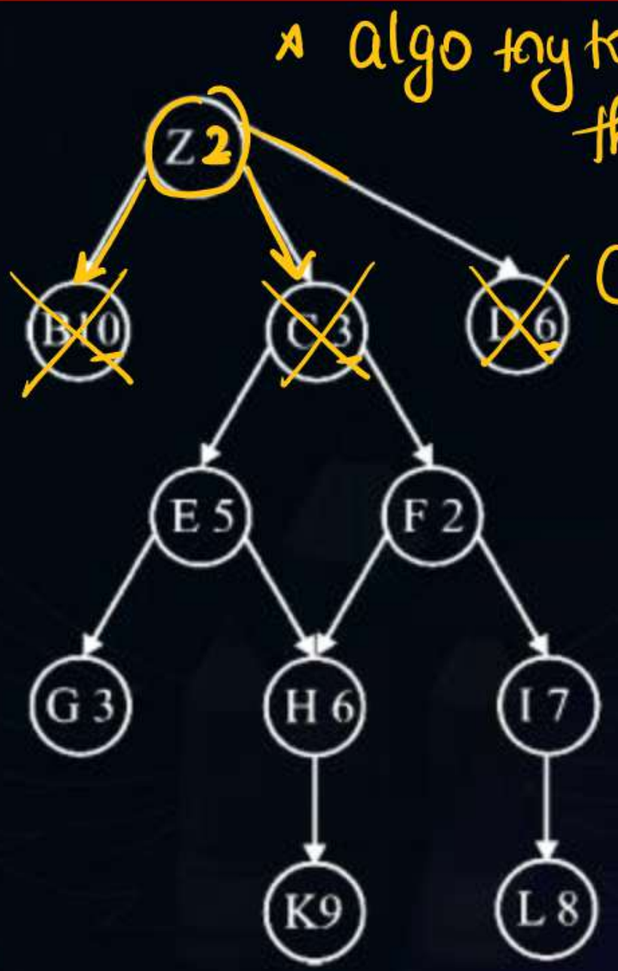
* { Close 7, open 2 } Cost 8

# Topic : Informed Search

Hill climbing

#Q. In a Hill Climbing problem, we have a graph where the nodes are represented by letters, and each letter is associated with a number based on its position in the alphabet. Z is the start node and G,K, and L are the goal nodes. Determine the code (number) corresponding to the letter on which the Hill Climbing algorithm will stop.

26.




* algo try to find the min value

Cannot move further

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#Q. What will be the threshold value for second iteration when IDA* algorithm is used?


Close P Q R S

Open

- IDA* ⇒
- First It → 5
- Second It → 7
- Third It → 8

# Topic : Informed Search

#Q. Let b denote the branching factor and d denote the maximum depth of a graph. The difference between the worst case time complexity and worst case space complexity on this graph using BFHS is ____0____.

$$\begin{cases} TC = O(b^d) \\ SC = O(b^d) \end{cases}$$

# Topic : Informed Search

#Q. Consider the following weighted graph where the heuristic values h(n) are provided for each node:

h(A) = 6 h(B) = 4 h(C) = 2 h(D) = 6 h(E) = 1

h(F) = 0

Using the A search algorithm, what is the path from A to F?


**A** $A \rightarrow B \rightarrow D \rightarrow E \rightarrow F$

**B** $A \rightarrow C \rightarrow E \rightarrow F$

**C** $A \rightarrow B \rightarrow C \rightarrow F$

**D** $A \rightarrow C \rightarrow F$

# Topic : Informed Search

#Q. Consider the following weighted graph where the heuristic values h(n) are provided for each node. There are three possible goal state G1, G2, and G3.

h(A) = 10 h(B) = 8 h(C) = 5 h(D) = 7 h(E) = 6

h(F) = 3 h(G1) = 0 h(G2) = 0 h(G3) = 0

Using the A* search algorithm, what is the path from A to Goal node?


# Topic : Informed Search

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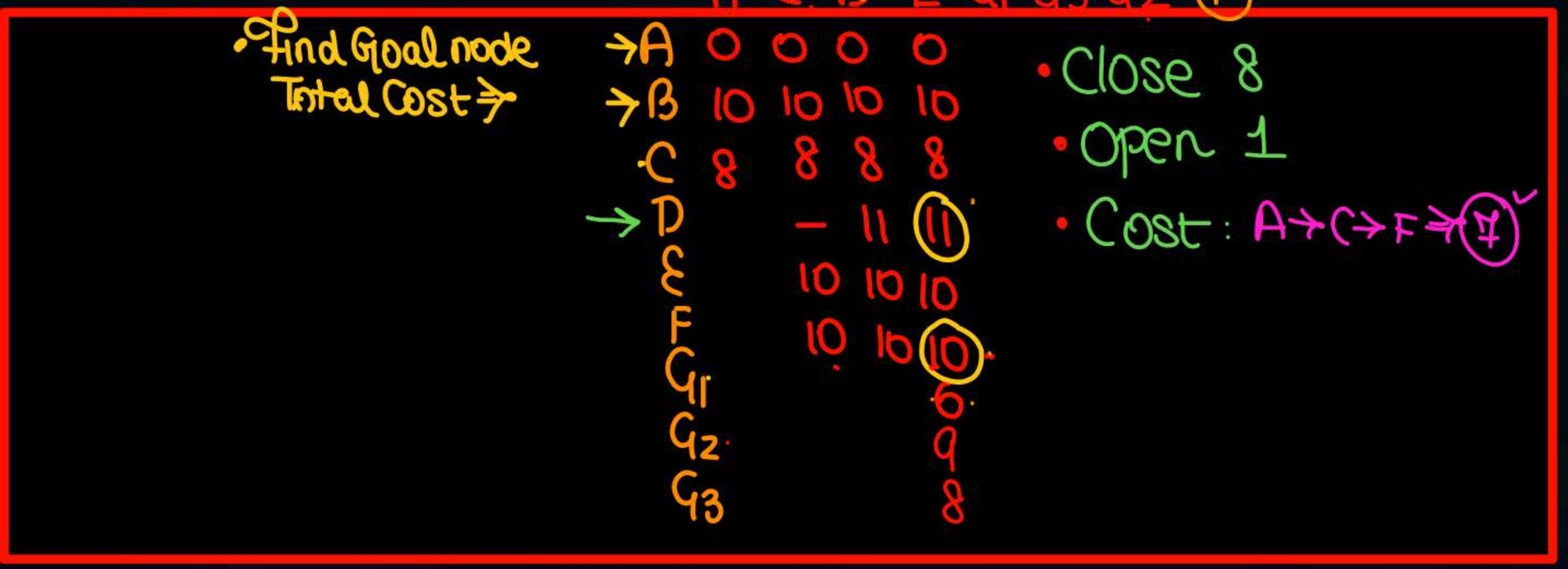
h(A) = 10 h(B) = 8 h(C) = 5 h(D) = 7 h(E) = 6

h(F) = 3 h(G1) = 0 h(G2) = 0 h(G3) = 0

Using the A* search algorithm, what is the path from A to F?




# Topic : Informed Search

#Q. Consider the following graph where the start node is S, the goal node is G, and the edge costs are given. The heuristic values (h(n)) for each node are as follows:

The edge costs (g(n)) are:

- S → A = 2
- S → B = 3
- A → D = 4
- B → D = 2
- D → G = 3
- A → C = 5
- C → G = 7

| Node | Heuristic (h(n)) |
|---|---|
| A | 5 |
| B | 4 |
| C | 6 |
| D | 3 |
| G | 0 |

Using the A* algorithm, what is the total cost of the optimal path from S to G?

# Topic : Informed Search

#Q. You are given a graph with the following heuristic values for nodes and edge costs. Using Greedy Best-First Search, what will be the total path cost from starting node S to goal node G?

The edge costs (g(n)) are:

- S → A = 1
- S → B = 4
- A → C = 2
- A → D = 4
- B → D = 3
- C → G = 5
- D → G = 2

| Node | Heuristic (h(n)) |
|---|---|
| A | 3 |
| B | 6 |
| C | 2 |
| D | 1 |
| G | 0 |

# Topic : Informed Search

#Q. Consider a graph with the following nodes and their respective heuristic value:

| Node | Heuristic (h(n)) |
|---|---|
| A | 10 |
| B | 8 |
| C | 7 |
| D | 5 |
| E | 3 |
| G | 0 |

The edges are as follows:

- S → A = 2
- S → B = 4
- A → C = 3
- B → D = 2
- D → G = 5
- C → G = 4

The number nodes (including the start node and the goal node) that will be visited while reaching the goal using the Hill Climbing algorithm is _____.

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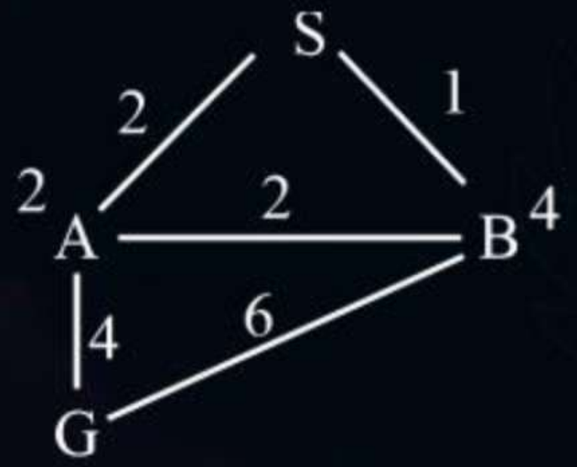
#Q. Use the A* algorithm to find the optimal path cost from node S to G using the following graph:

Costs: S → A = 2, S → B = 1, A → G = 4, B → G = 6, A → B = 2

Heuristic values: S = 5, A = 2, B = 4, G = 0



# Topic : Informed Search

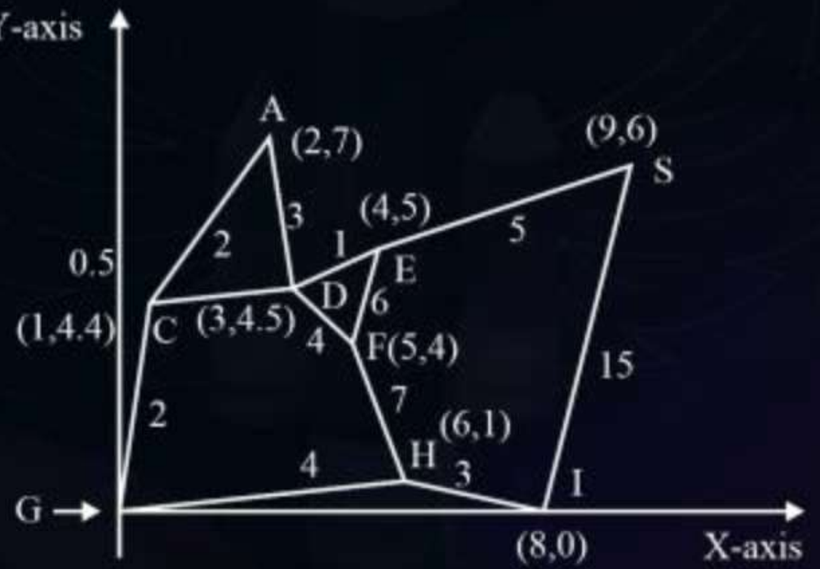
#Q. In an A* search problem, if the cost to move from node A to B is 6, and the heuristic from B to the goal is 4, what is the evaluation function f(B) for node B if g(A) = 3?

# Topic : Informed Search

#Q. In a GBFS search, the heuristic from node X to the goal is 6, and from node Y to the goal is 4. Which node will GBFS prioritize for expansion, and what is the heuristic value of the prioritized node?

# Topic : Informed Search

#Q. Consider the below undirected graph with cartesian coordinate in which G is the "Goal" node with coordinate (0,0) and S is the starting node with coordinate (9,6). Apply the A* algorithm on the below graph and find the node that is not generated as neighbor (except S) in searching for the shortest path from S to G with Euclidean distance from G node as heuristic value and edge cost is given on the edge. Note – If two nodes have same cost then for tie-breaker use alphabetical order.




**A** C

**B** D

**C** E

**D** F

# Topic : Informed Search

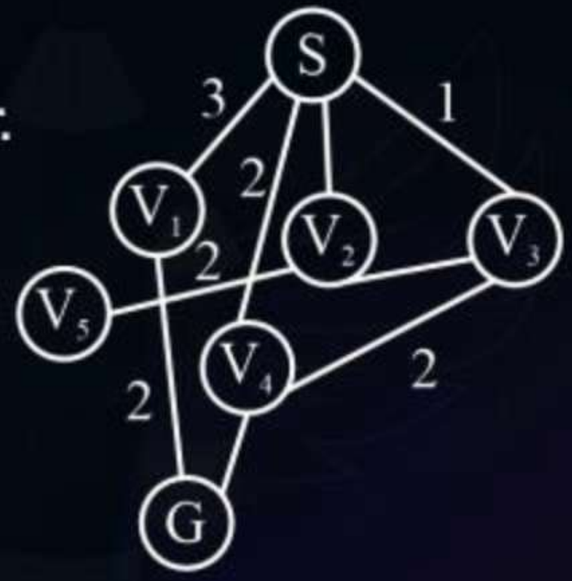
#Q. Consider a graph having nodes y1, y2, y3, y4, y5, S (starting node) and G (goal node). It uses GBFS algorithm.

The heuristic function h(n) is defined as follows:

$$h(v_i) = \begin{cases} i^2 - 2, & i \text{ is even} \\ 2i, & i \text{ is odd} \end{cases}$$

The value of $\Sigma h(v_i)$ where $v_i$ is not expanded is _____.

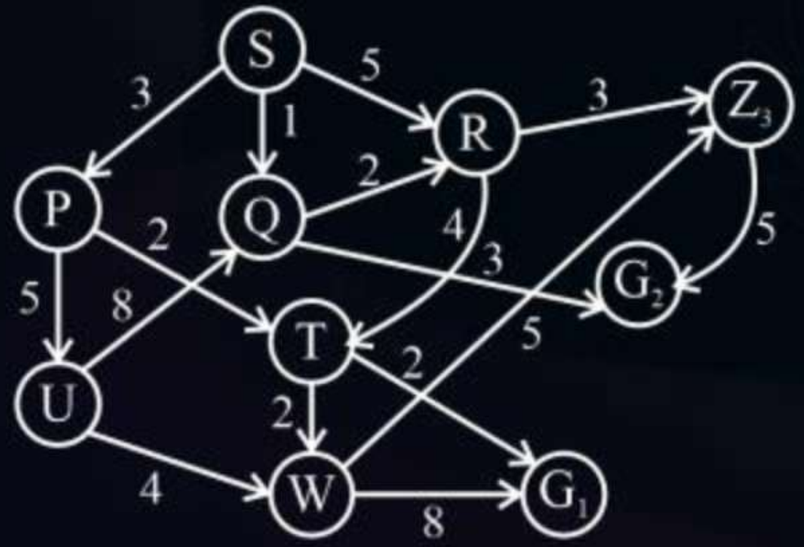
Node: the tie breaker will be the vertex with highest order.



# Topic : Informed Search

#Q. Consider the search space depicted in the figure below. S is the initial state. G1 and G2 are two states that satisfy the goal test. The cost of traversing from one state to another is depicted by the numerical value close to the edge connecting the two states. The estimated cost to the goal is reported inside the states. Use alphabetical order of nodes to break ties. Which goal state is reached if you perform A* (graph) search?

What is the number of nodes failing the admissibility condition?



# THANK - YOU