DS & AI ENGINEERING

Artificial Intelligence

Informed search

Lecture No.- 05

By- Aditya sir

Recap of Previous Lecture

- Topic
- Topic
- Topic
- Topic

Questions

Topics to be Covered

- Topic — Questions
- Topic — IDA*
- Topic

About Aditya Jain sir

1. Appeared for GATE during BTech and secured AIR 60 in GATE in very first attempt - City topper
2. Represented college as the first Google DSC Ambassador.
3. The only student from the batch to secure an internship at Amazon. (9+ CGPA)
4. Had offer from IIT Bombay and IISc Bangalore to join the Masters program
5. Joined IIT Bombay for my 2 year Masters program, specialization in Data Science
6. Published multiple research papers in well known conferences along with the team
7. Received the prestigious excellence in Research award from IIT Bombay for my Masters thesis in ML
8. Completed my Masters with an overall GPA of 9.36/10
9. Joined Dream11 as a Data Scientist
10. Have mentored 15,000+ students & working professions in field of Data Science and Analytics
11. Have been mentoring & teaching GATE aspirants to secure a great rank in limited time
12. Have got around 27.5K followers on Linkedin where I share my insights and guide students and professionals.

Telegram Link for Aditya Jain sir:

https://t.me/AdityaSir_PW

Topic : Artificial Intelligence

$n \rightarrow n+1$, $n+2$

33%

#Q. Consider a state space where the start state is number 1. The successor function for the state numbered a returns two states numbered n+1 and n+2. Assume that the states in the unexpanded state list are expanded in the ascending order of numbers and the previously expanded states are not added to the unexpanded state list.

Which ONE of the following statements about breadth-first search (BFS) and depth-first search (DFS) is true, when reaching the goal state number 6?

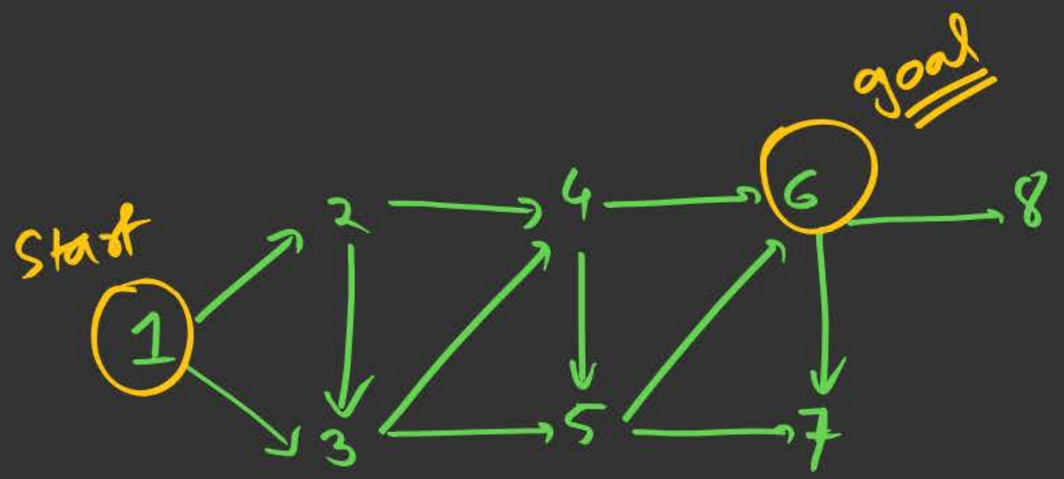
A BFS expands more states than DFS. ✗

B DFS expands more states than BFS. ✗

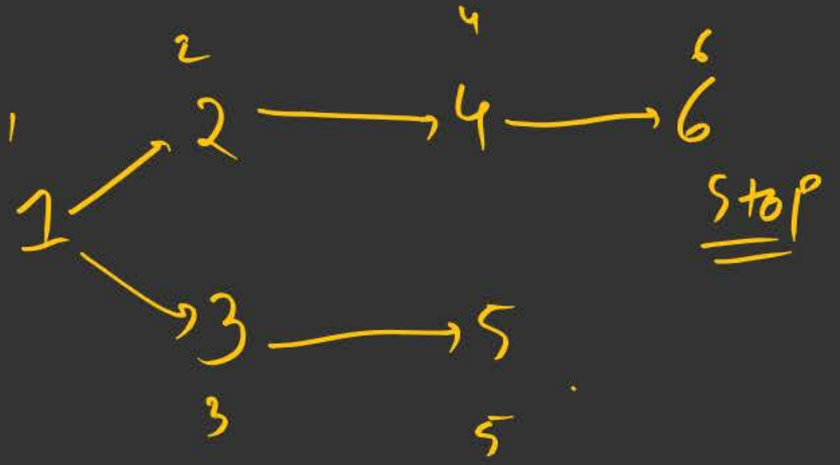
C Both BFS and DFS expand equal number of states. ✓

D Both BFS and DFS do not reach the goal state number 6. ✗

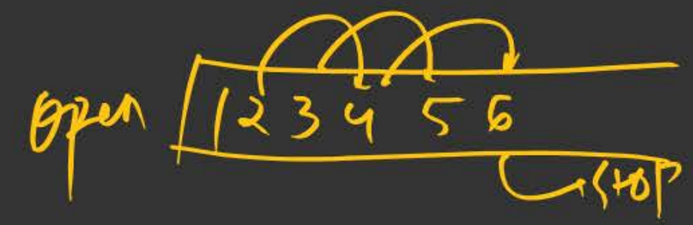
expand → visited



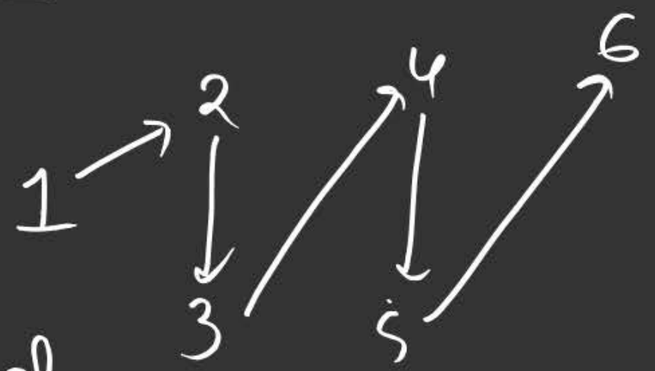
1) BFS



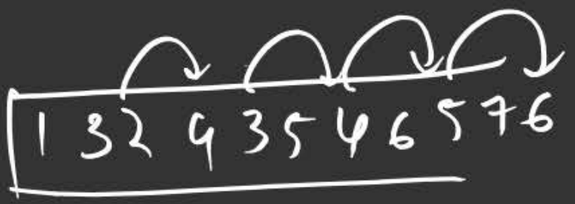
6 visited



2) DFS



6 visited



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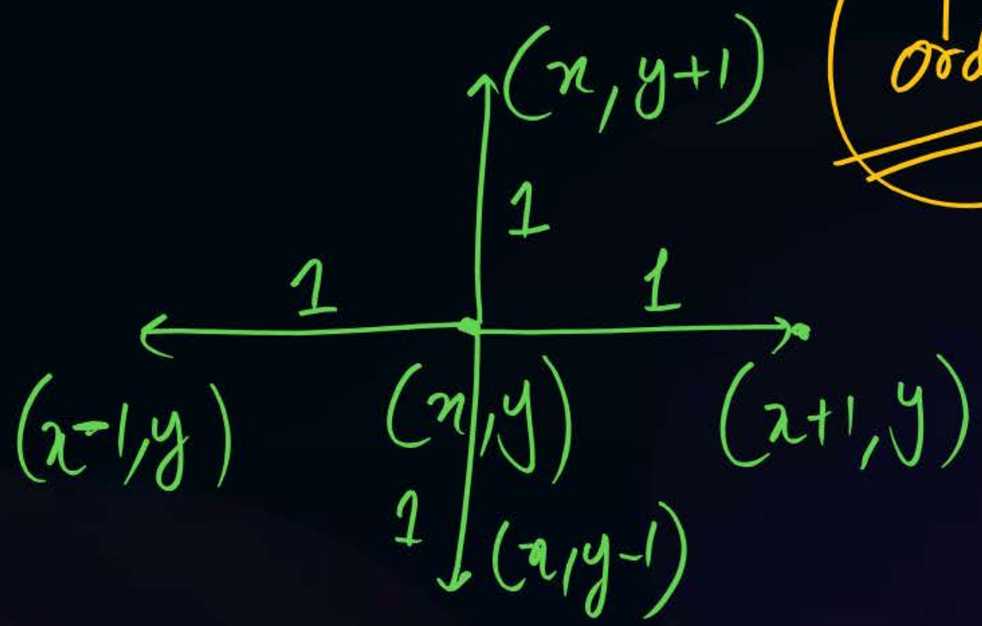
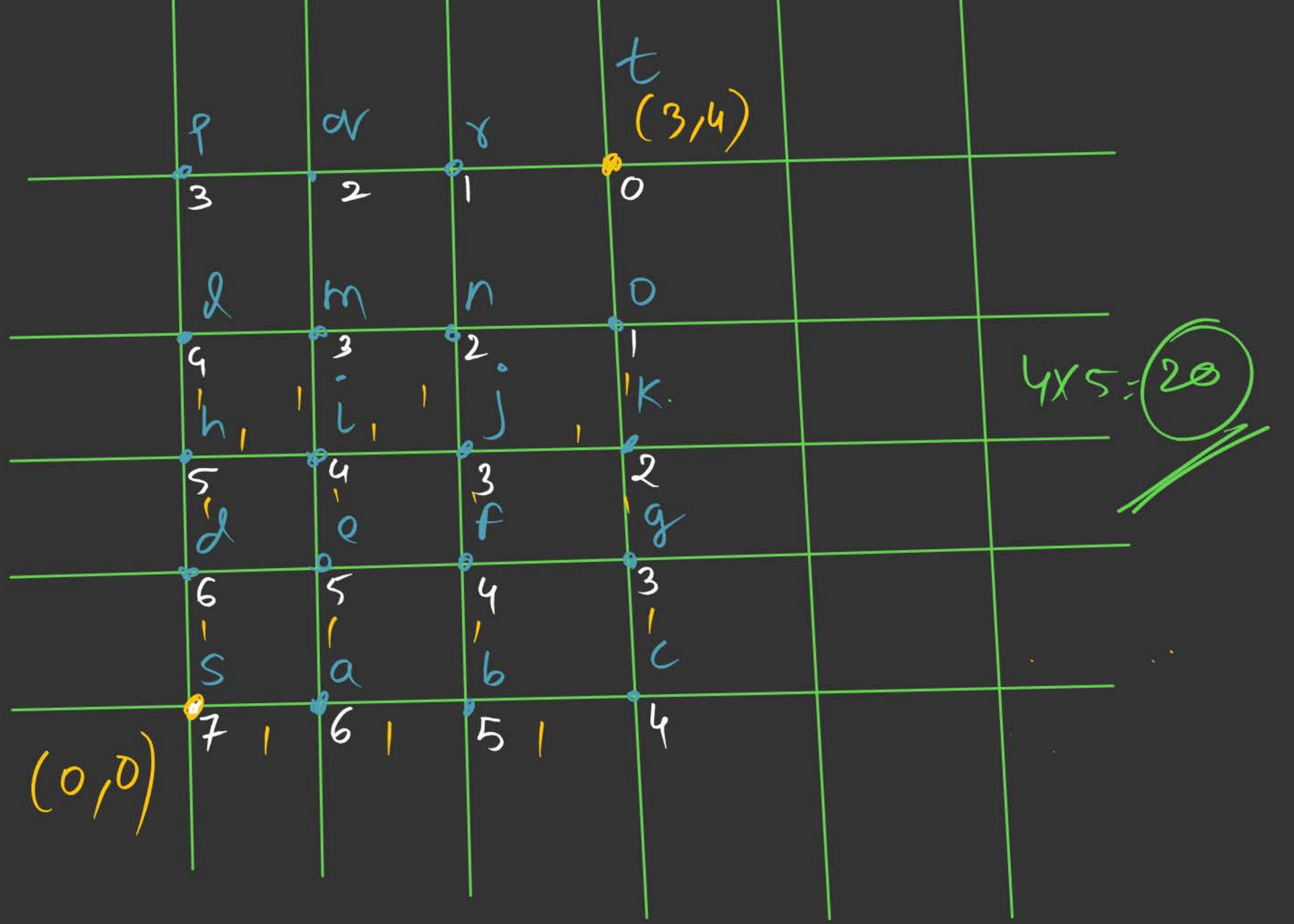
Adv

#Q. Consider an infinite search space Z × Z. The start state is at (0, 0) and the goal state is at (g_x, g_y). Given that the agent can move from a state (x, y) to either of {(x+1, y), (x–1, y), (x, y+1), (x, y–1)} with a unit step cost, find the number of nodes explored using A* tree search with Manhattan distance heuristic for $(g_x, g_y) = (3, 4)$. Assume no duplicate detection. (graph Search)

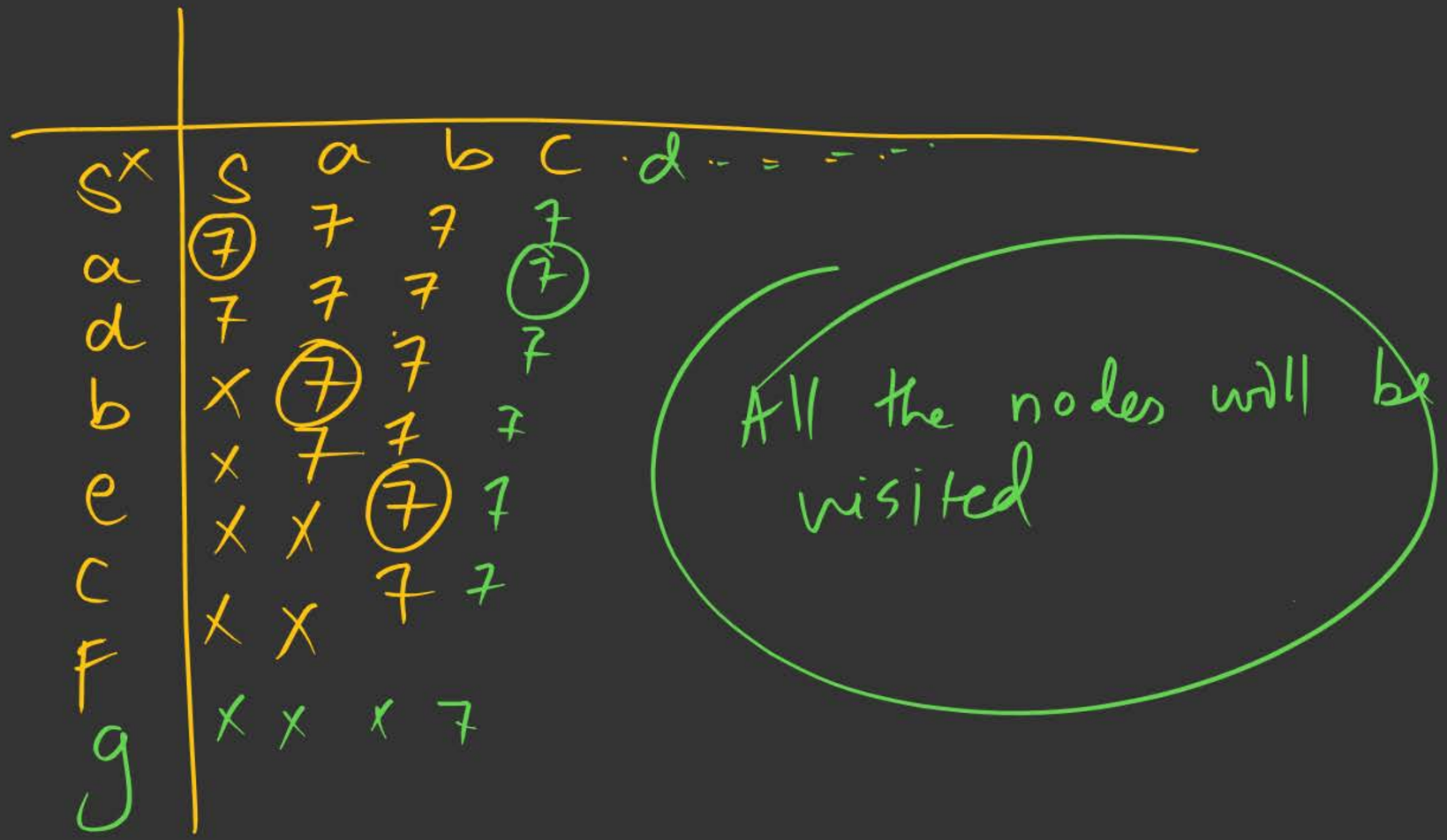
alpha order

$$\left(|x_1 - x_2| + |y_1 - y_2|\right)$$




t
(3,4)
p
q
r
3
2
1
0
l
m
n
o
4
3
2
1
h
i
j
k
5
4
3
2
d
e
f
g
6
5
4
3
s
a
b
c
7
6
5
4
(0,0)
4X5 = 20

A* Graph Search



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#Q. We define an evaluation function for a heuristic search problem as:

$f(n) = (w * g(n)) + ((1 - w)\ h(n))$

where g(n) is the cost of the best path found from the start state to state n, h(n) is an admissible heuristic function that estimates the cost of a path from n to a goal state, and $0.0 \leq w \leq 1.0$.

What search algorithm do you get when w = 0?

(A) Breadth-First search

(B) Uniform-Cost search

(C) Greedy Best-First search

(D) Algorithm A* Search

$$f = w * g + ((1-w) * h)$$

$w = 0$, $f = 0 * g + ((1-0) * h)$

$= 0 + h$

$f = h$

Topic : Artificial Intelligence

#Q. We define an evaluation function for a heuristic search problem as:

$f(n) = (w * g(n)) + ((1 - w)\ h(n))$

where g(n) is the cost of the best path found from the start state to state n, h(n) is an admissible heuristic function that estimates the cost of a path from n to a goal state, and $0.0 \leq w \leq 1.0$.

What search algorithm do you get when w = 1.0?

A. Breadth-First search

B. Uniform-Cost search

C. Greedy Best-First search

D. Algorithm A* Search

IDS

or

IDDFS

d=0
d=1
d=2

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Iterative Deepening A* algorithm (IDA*) - Artificial intelligence

- The Iterative Deepening A* (IDA*) algorithm is an extension of the A* search algorithm designed to use less memory, making it more suitable for large search spaces where A* would require too much memory to store all nodes in the open and closed lists.
- IDA* combines the space efficiency of Iterative Deepening Depth-First Search (IDDFS) with the optimality of A*. Instead of maintaining a priority queue like A*, IDA* performs a series of depth-limited searches, where the depth limit is determined by a threshold that is increased iteratively. Each iteration explores paths that do not exceed the current threshold, and the threshold is based on the f-cost (sum of g-cost and h-cost).

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Algo/ Idea

Iterative Deepening A* algorithm (IDA*) - Artificial intelligence

- Step 1: Initialization
  Set the root node as the current node, and find the f-score.
- Sep 2: Set threshold
  Set the cost limit as a threshold for a node i.e the maximum f-score allowed for that node for further explorations.
- Step 3: Node Expansion
  Expand the current node to its children and find f-scores.
- Step 4: Pruning
  If for any node the f-score > threshold, prune that node because it's considered too expensive for that node, and store it in the visited node list.
- Step 5: Return Path
  If the Goal node is found then return the path from the start node Goal node.

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Iterative Deepening A* algorithm (IDA*) - Artificial intelligence

- Step 6: Update the Threshold

  If the Goal node is not found then repeat from step 2 by changing the threshold with the minimum pruned value from the visited node list. And Continue it until you reach the goal node.

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It 1: fth =2, AB pruned node

Closed list S

Prune list A,B

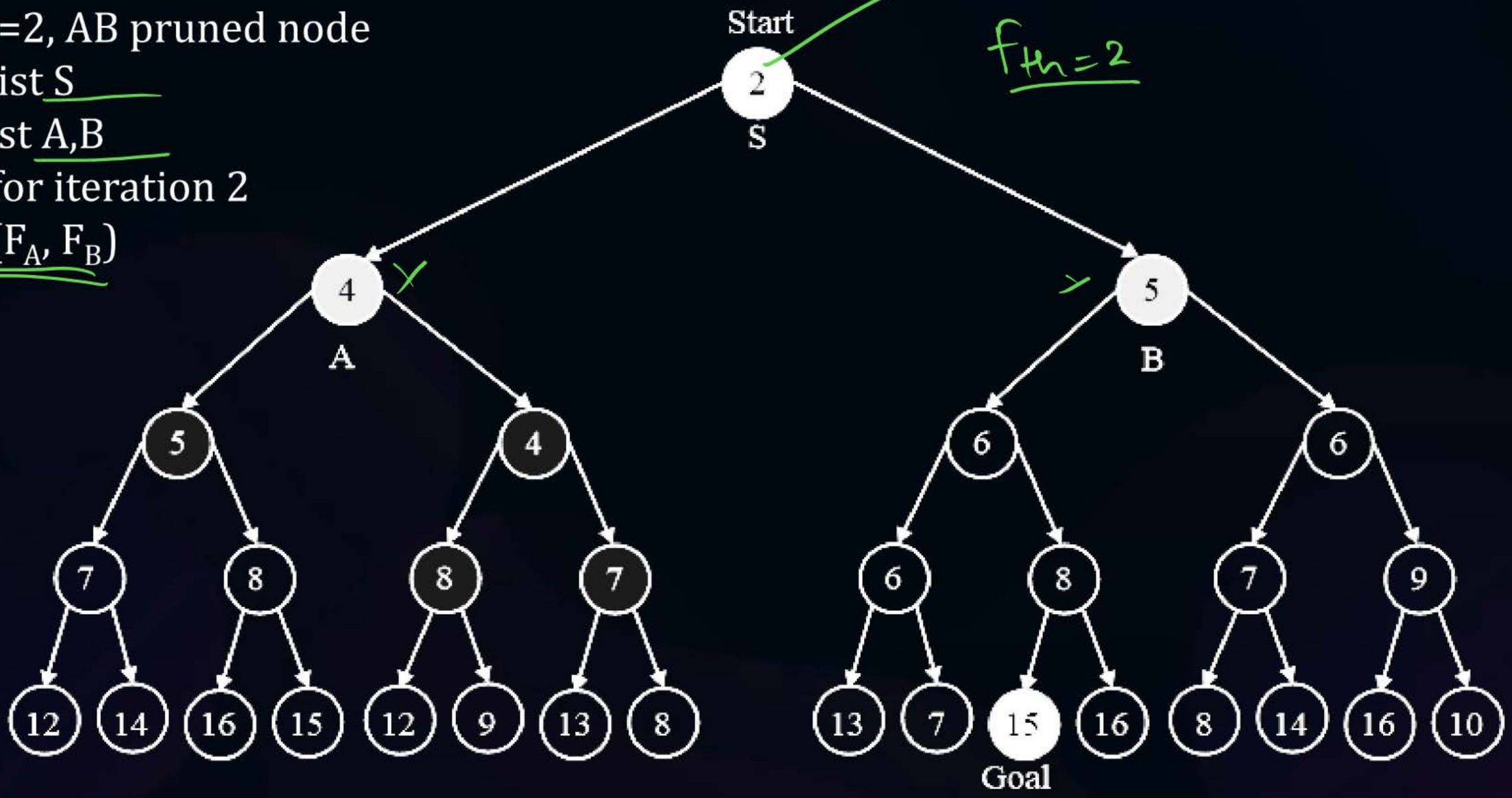
- Fth for iteration 2

⇒ Min (F_A, F_B)

⇒ 4

f - values

$f_{th} = 2$



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It 1: f_{th} =2, AB pruned node

It 2: f_{th} = 4

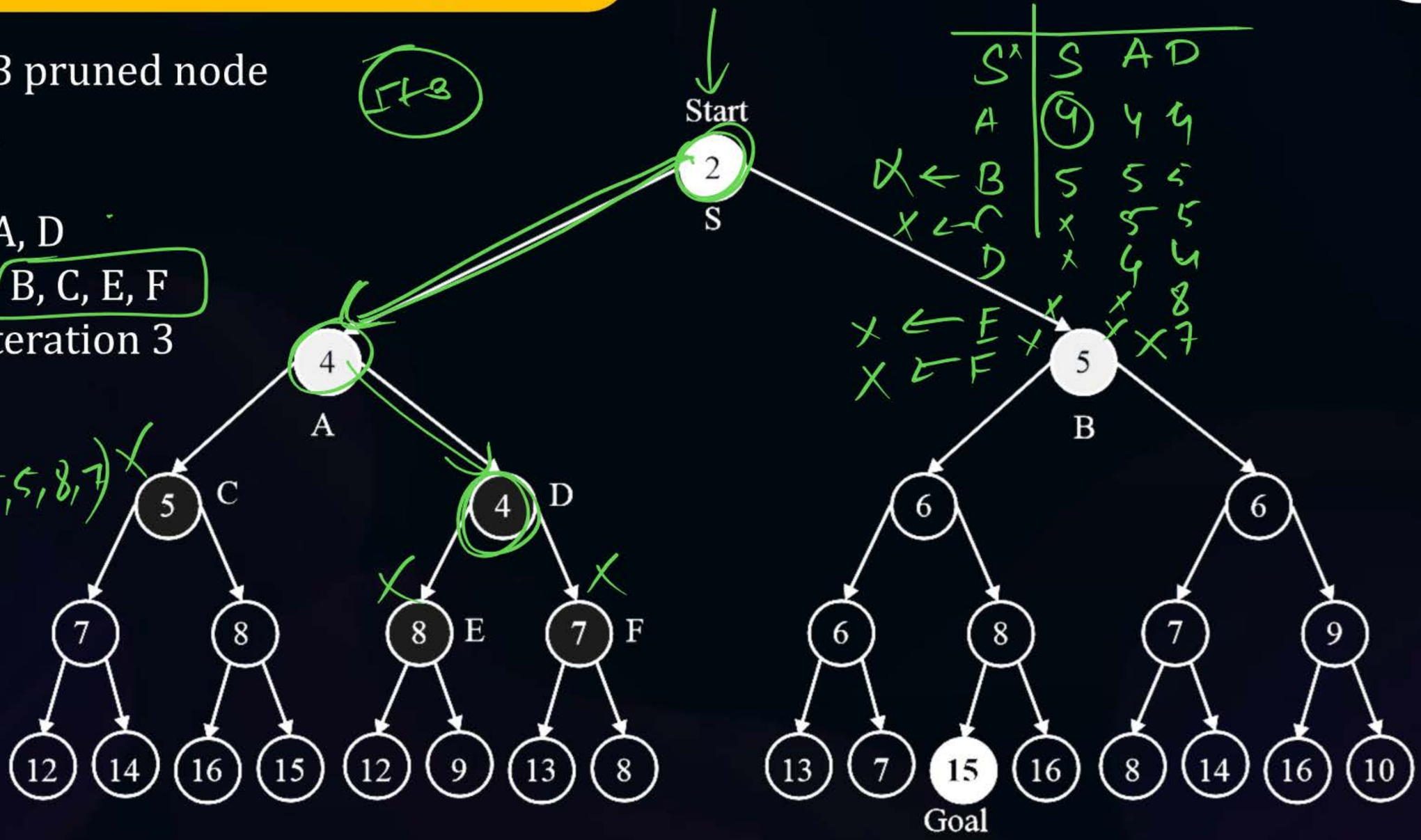
Closed list S

Prune list S, A, D

Pruned node B, C, E, F

New F_{th} for iteration 3

$\Rightarrow$ 3



S'	S	A	D
A	9	4	4
B	5	5	5
C	x	5	5
D	x	4	4
E	x	x	8
F	x	x	7

$F_{th} = \min(5,5,8,7)$

$= 5$

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It: 3

Fth = 5

Close list: S,A,B,C, D

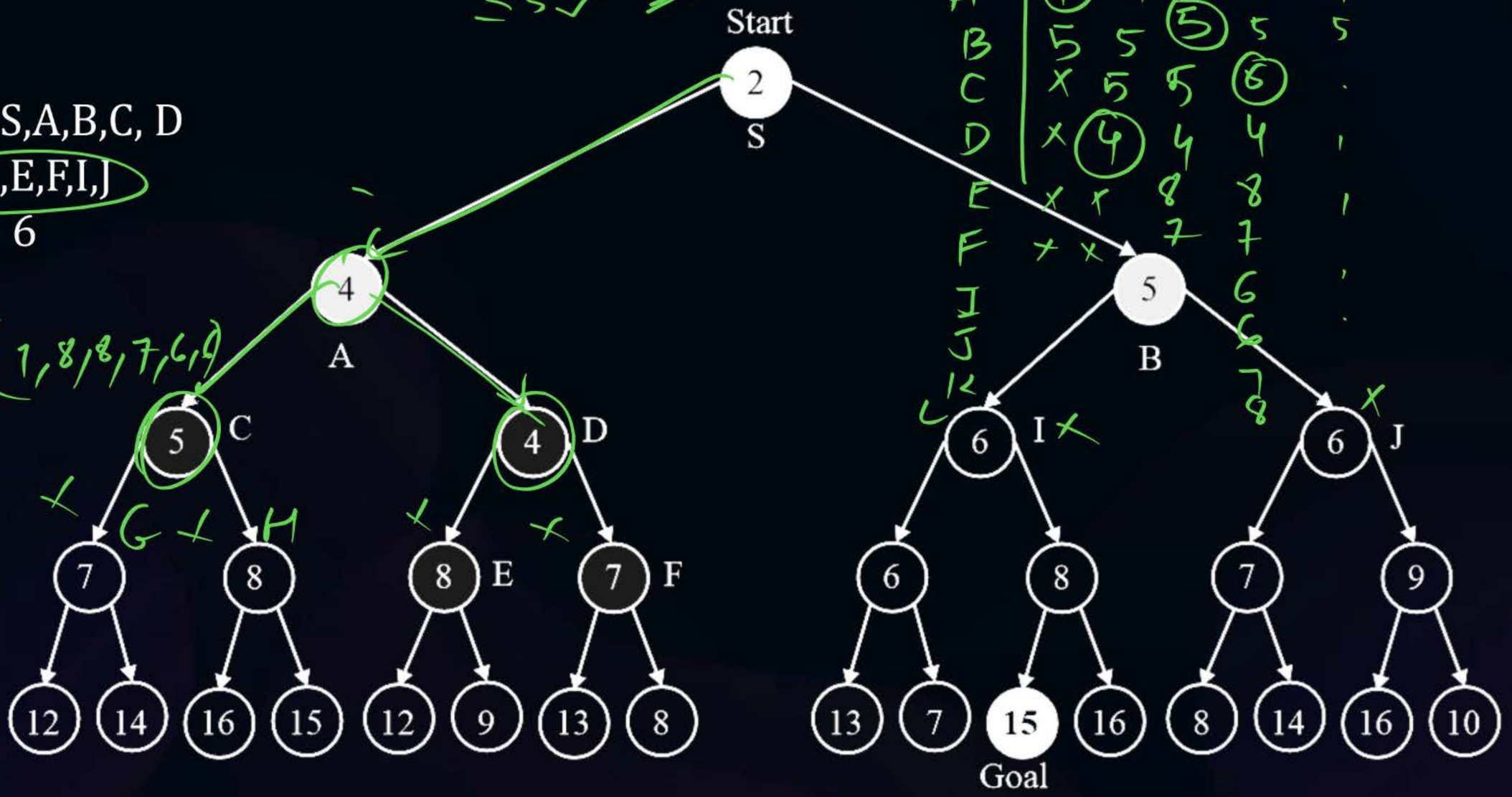
Prune G,H,E,F,I,J

It 4: Fth = 6

$Fth = \min(7, 8, 8, 7, 6, 9)$

$= 6$

HW



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It: 4

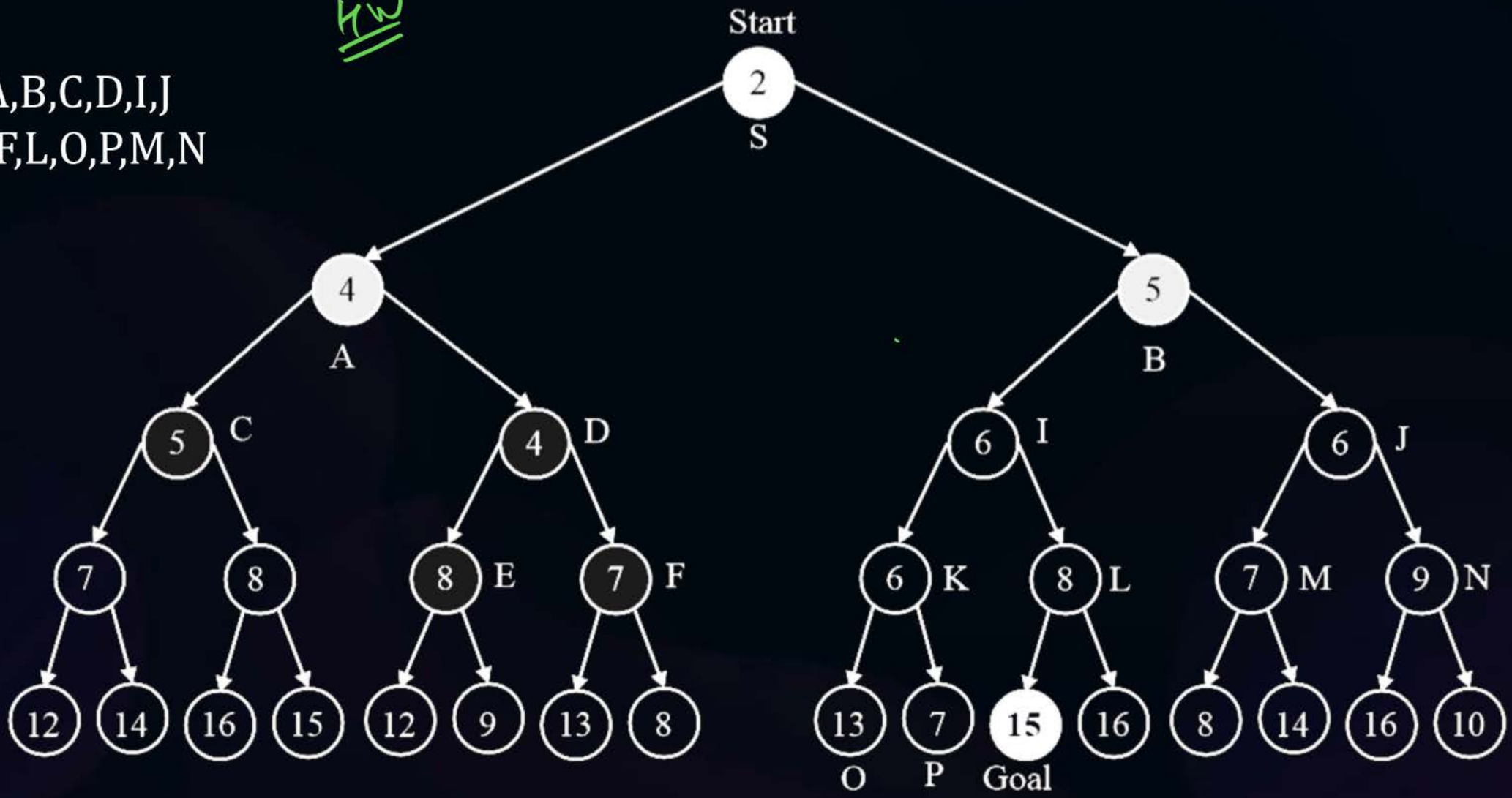
F_{th} = 6

Close list: S,A,B,C,D,I,J

Prune G,H,E,F,L,O,P,M,N

Fth = 7

HW



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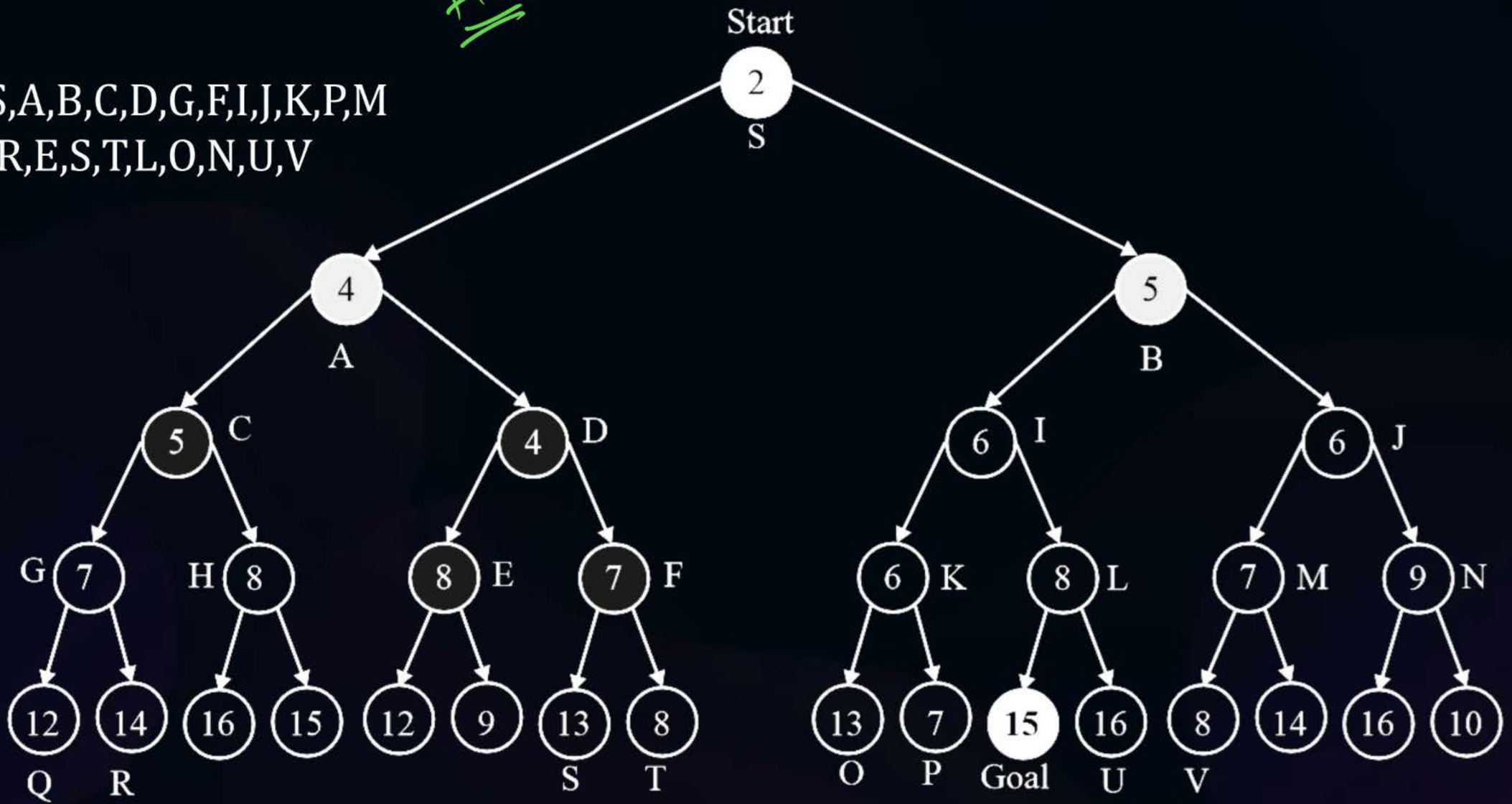
It: 5

F_{th} = 7

Close list: S,A,B,C,D,G,F,I,J,K,P,M

Prune H,Q,R,E,S,T,L,O,N,U,V

Fth = 8



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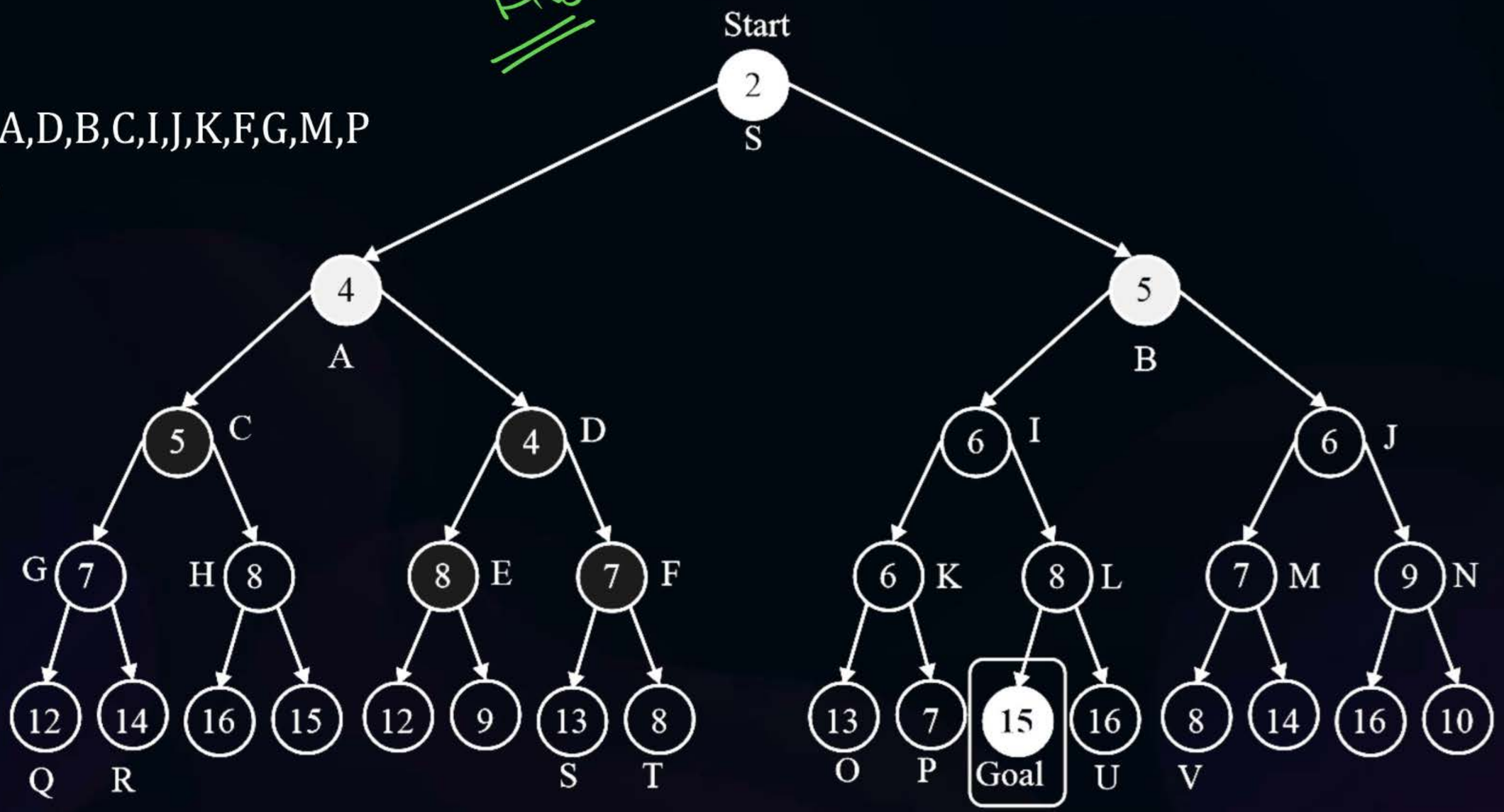
It: 6

F_{th} = 8

Close list: S,A,D,B,C,I,J,K,F,G,M,P

Prune E,H,L



IDA* Search

Algo is moving like DFS

But we are apply A* Search in each iteration

A^*	IDA*
1) SC : $O(b^d)$	1) SC : $O(b*d)$
2) TC : $O(b^d)$	2) TC : $O(b^d)$
3) Optimal	3) Optimal
4) Complete	4) Complete
5) Priority Queue.	5) No priority Queue
6) BFS version of A^*	6) DFS version of A^*

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IDA*

⇒ Iterative deepening A*

A* ⇒ Space O(b^d)

Time O(b^d)

IDA* ⇒ Space O(b*d)

Time O(b^d)

⇒ Iterative A*

⇒ Iterative Run on the f core

IDDFS

Depth = 0,1,2,3....

IDFS

Space comp. O(b.d)

Time comp. O(b^d)

THANK - YOU