DS & AI

Artificial Intelligence

Informed and Uninformed Search

Lecture -03

By - Siddharth Sabharwal Sir

Topic : Informed Search

#Q. Consider a graph having nodes $v1, v2, v3, v4, v5$, 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 ___12___.

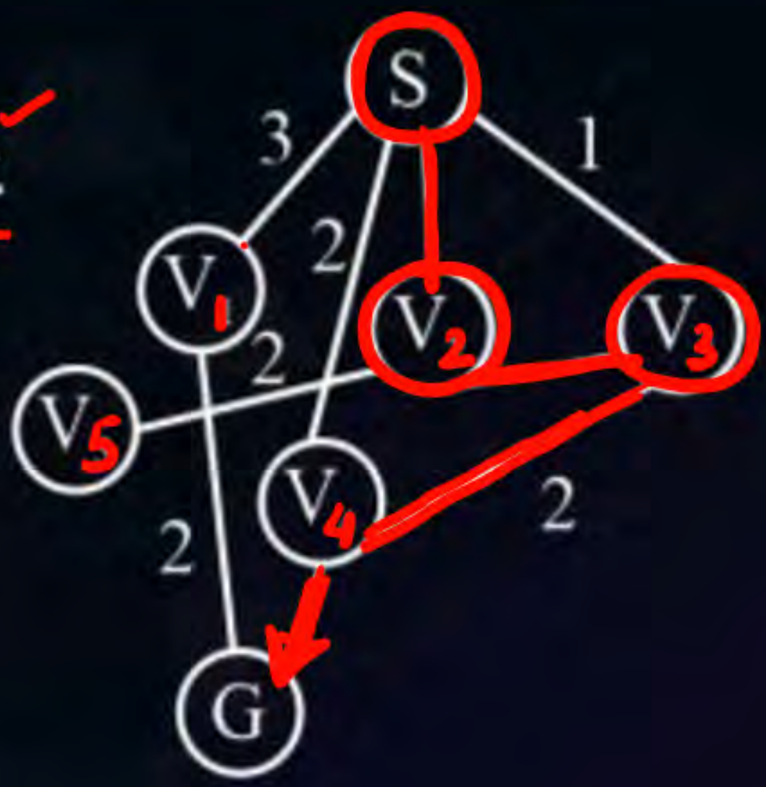
Node: the tie breaker will be the vertex with highest order.

expanded → visited

GBFS → only heuristics

i	
1	2
2	2
3	6
4	14
5	10

V_1, V_5 not visited

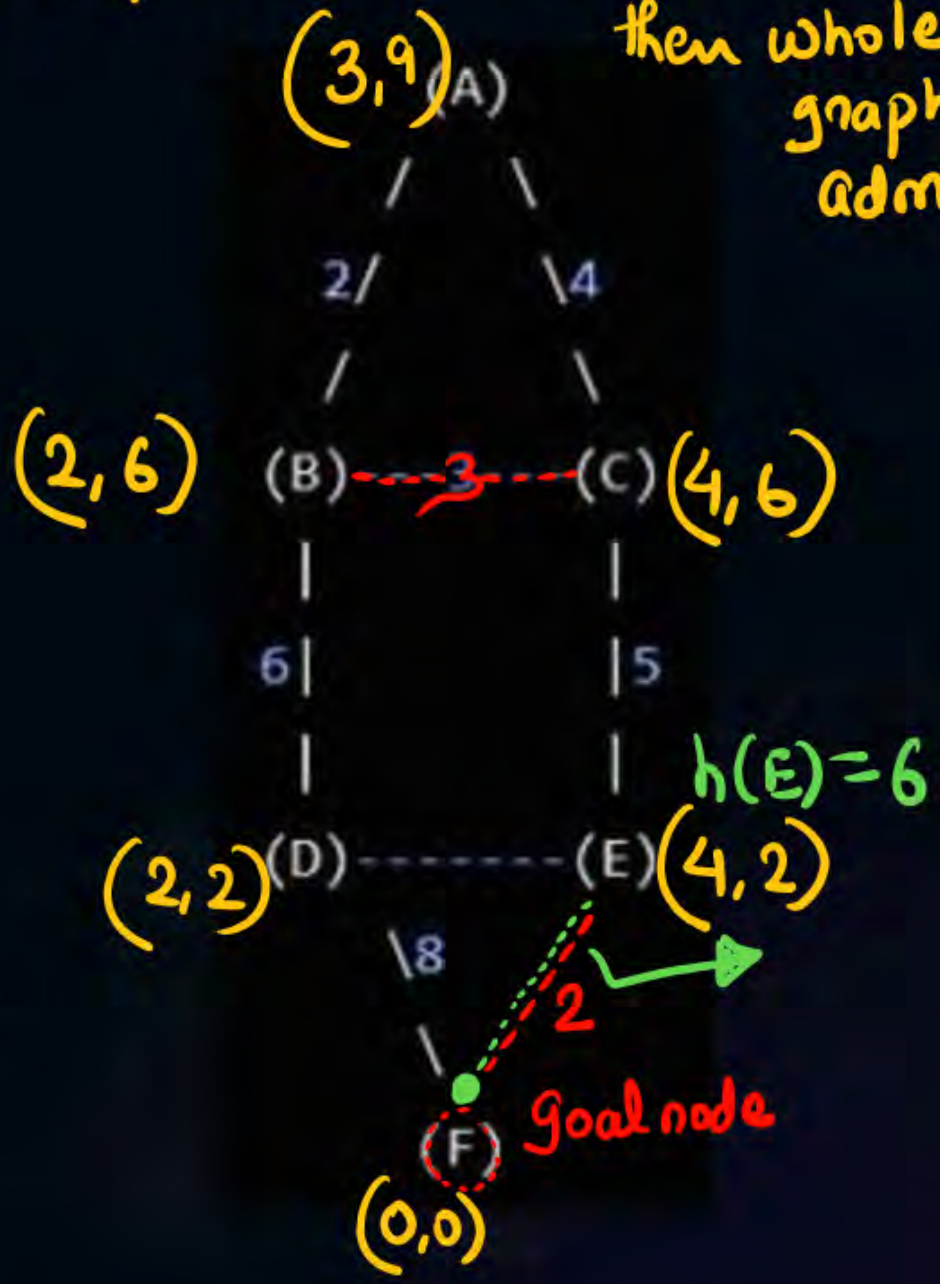


#Q. Consider two heuristics $\boxed{h_1 \text{ and } h_2}$ for the A* algorithm applied to the graph in

• even if one path is not admissible then whole graph = not admissible

1. ~~✗~~ $\boxed{h_1(n) = \text{Manhattan distance to F.}}$ ✗
2. * $\boxed{h_2(n) = 2 \times \text{actual cost to F.}}$ ← (not admissible) ✓

Which of the following is correct?



A Both h_1 and h_2 are admissible.

B h_1 is admissible, but h_2 is not.

C $\boxed{\text{Both } h_1 \text{ and } h_2 \text{ are inadmissible.}}$ ✓

D Neither h_1 nor h_2 can be used for A∗.

#Q. DFS is applied starting from node 1, exploring the leftmost child first. How many times is a node pushed onto the stack during the DFS traversal of this graph?

(one time only)

```
            (1)
           /   \
          /     \
       (2)       (3)
      / | \     / | \
   (4)(5)(6)(7)(8)(9)
```

Close

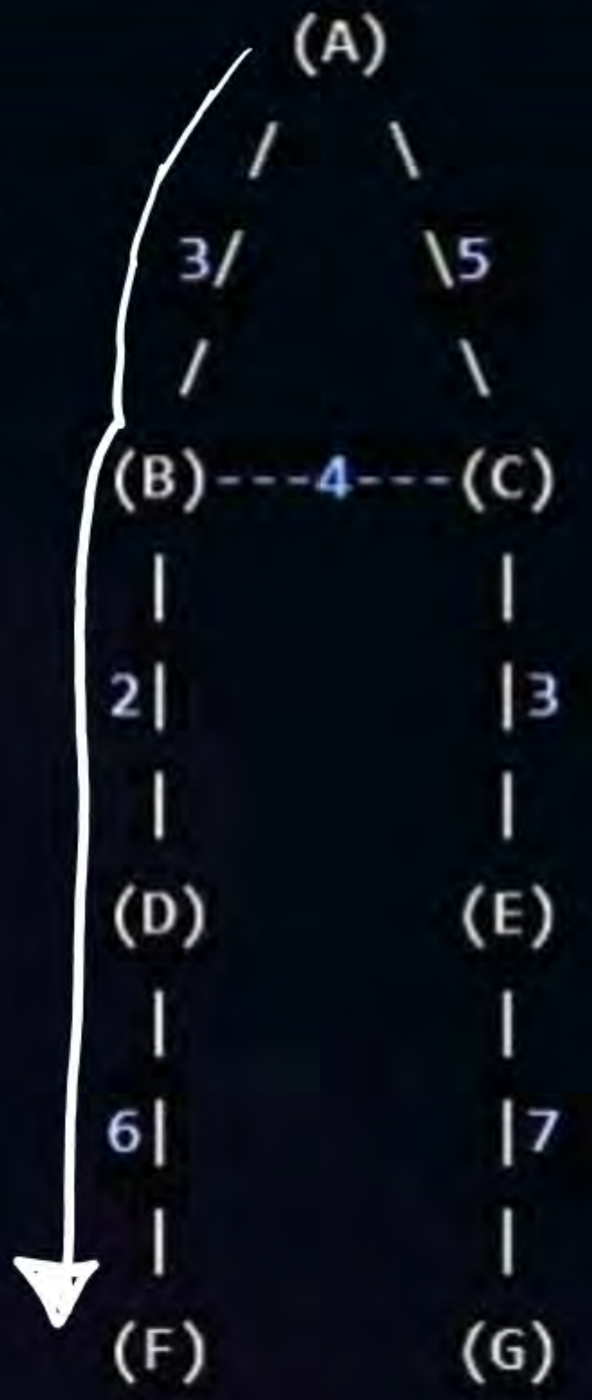
1, 2, 4, 5, 6, 3, 7, 8, 9,

open (Stack)

~~1~~ ~~3~~, ~~2~~ ~~6~~ ~~5~~ ~~4~~ 9 8 7

#Q. You need to find the shortest path from A to any of the goal nodes {F, G} using UCS.

F goal node ✓



	A	B	C	D	E	F
A	0	0	0	0	0	
B	3	3	3	3	3	
C	5	5	5	5	5	
D	-	5	5	5	5	
E	-	-	8	8	8	
F	-	-	-	11	11	
G	-	-	-	-	15	

#Q. For any binary classification dataset, let $S_B \in \mathbb{R}^{d\times d}$ be the between-class and within-class scatter (covariance) matrices, respectively. The $\boxed{\text{Fisher linear discriminant}}$ is defined by $u^* \in \mathbb{R}^d$, that maximizes

$$\boxed{J(u)} = \boxed{\frac{u^T S_B u}{u^T S_W u}}$$

If $\lambda = J(u^*)$, S_w is non-singular and $S_B \neq 0$, then (u^*, λ) must satisfy which ONE of the following equations?

Note: 1R denotes the set of real numbers.

(PYQ)

A $\boxed{S_W^{-1} S_B u^* = \lambda u^*}$ ✓

$(S_W^{-1} S_B w^* = \lambda w^*)$

B $S_W u^* = \lambda S_B u^*$

C $S_B S_W u^* = \lambda u^*$

D $u^{*T} u^* = \lambda^2$

#Q. Consider the table below, where the $(i, j)^{th}$ element of the table is the distance between points x_i and x_j. Single linkage clustering is performed on data points. x_1 x_2, x_3, x_4, x_5.

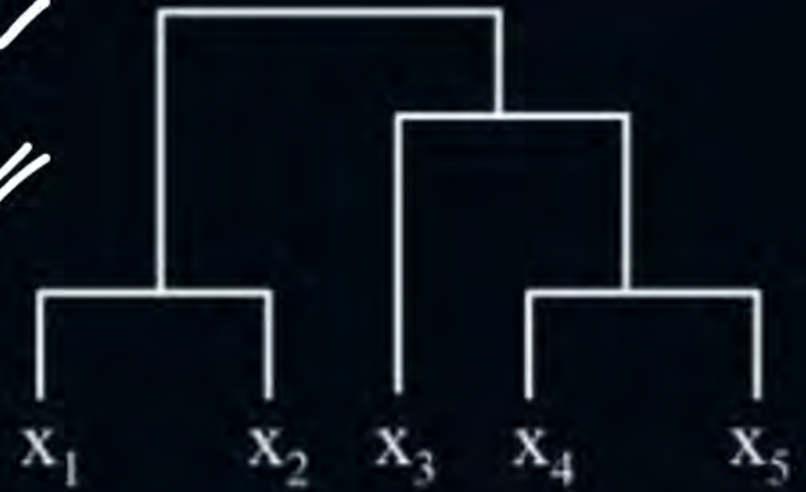
	x_1	x_2	x_3	x_4	x_5
x_1	0	1	4	3	6
x_2	1	0	3	5	3
x_3	4	3	0	2	5
X_4	3	5	2	0	1
x_5	6	3	5	1	0

Which ONE of the following is the correct representation of the clusters produced?

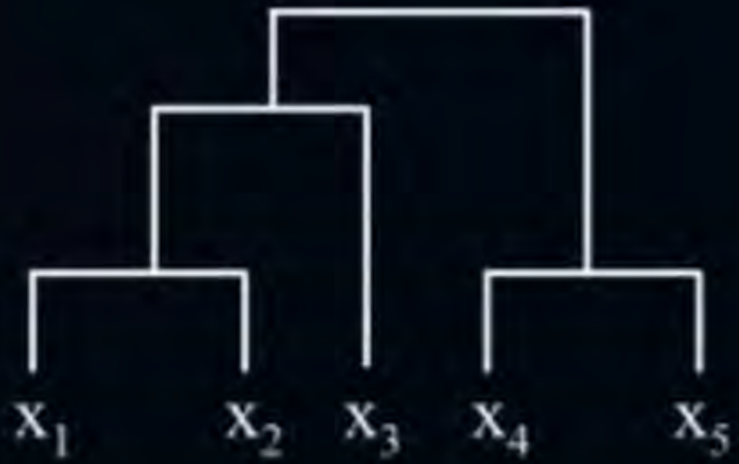
Continue...

a ✓

A



B

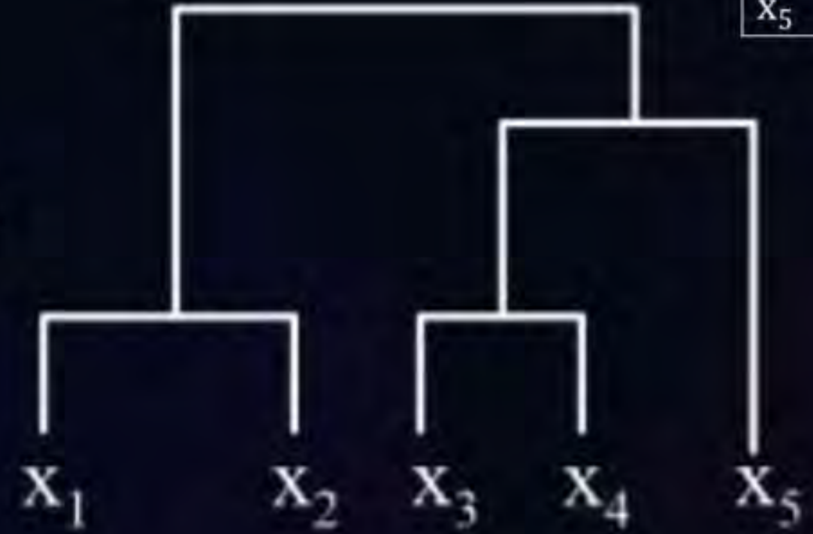


	x_1	x_2	x_3	x_4	x_5
x_1	0	1	4	3	6
x_2	1	0	3	5	3
x_3	4	3	0	2	5
X_4	3	5	2	0	1
x_5	6	3	5	1	0

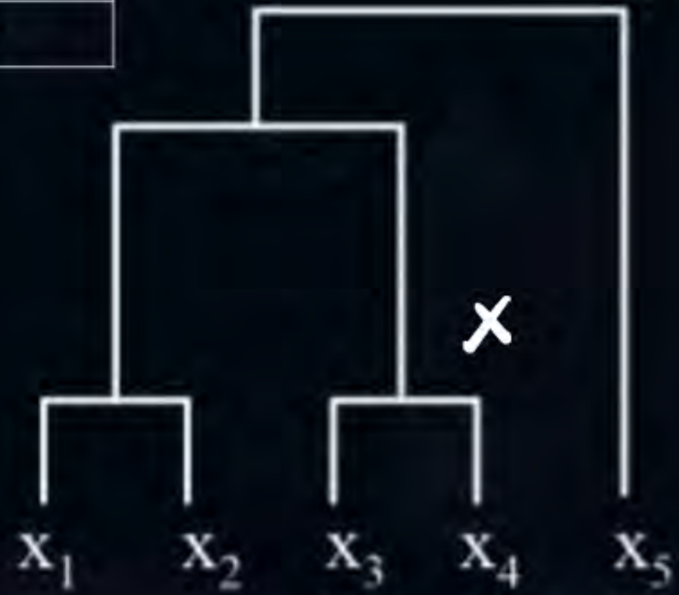
	x_1x_2	x_3	x_4x_5
x_1x_2	0	3	3
x_3	3	0	2
x_4x_5	3	2	0

C

X



D

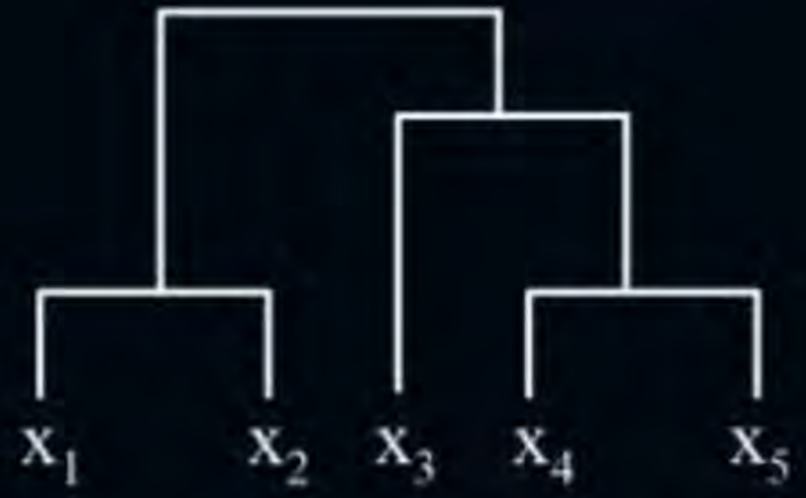


X

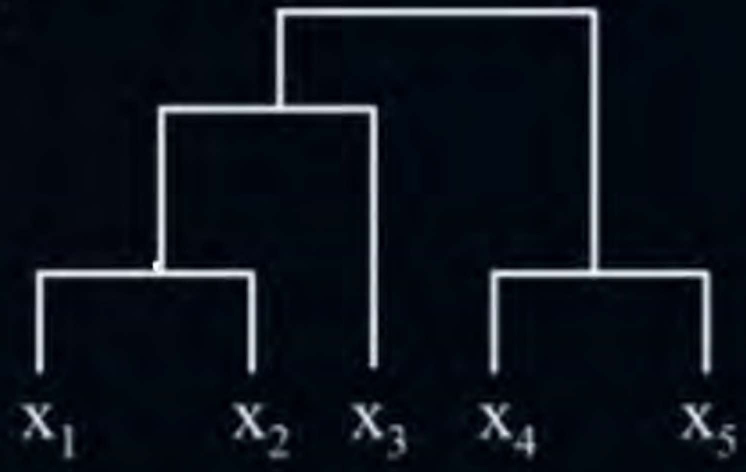
Complete linkage

(b)

A



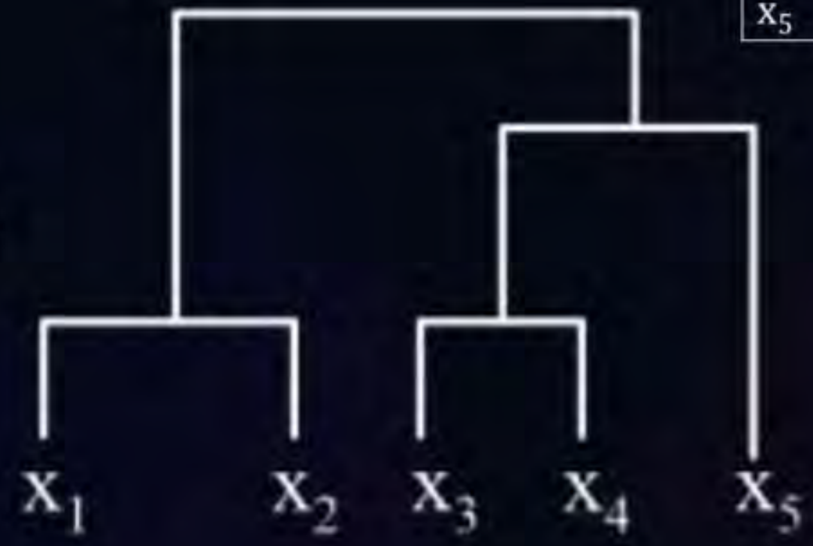
B



	x_1	x_2	x_3	x_4	x_5
x_1	0	1	4	3	6
x_2	1	0	3	5	3
x_3	4	3	0	2	5
x_4	3	5	2	0	1
x_5	6	3	5	1	0

	x_1x_2	x_3	x_4x_5
x_1x_2	0	4	6
x_3	4	0	5
x_4x_5	6	5	0

C



D

#Q. Consider the grid world shown in the figure below. An agent is planning to move from the starting location (x_s, y_s) to the final location (x_f, y_f). The obstacles along the path are triangular in form.

Consider the following heuristic functions to conduct A* search.

(a) h_c assumes the obstacles are the smallest circles circumscribing the triangles.

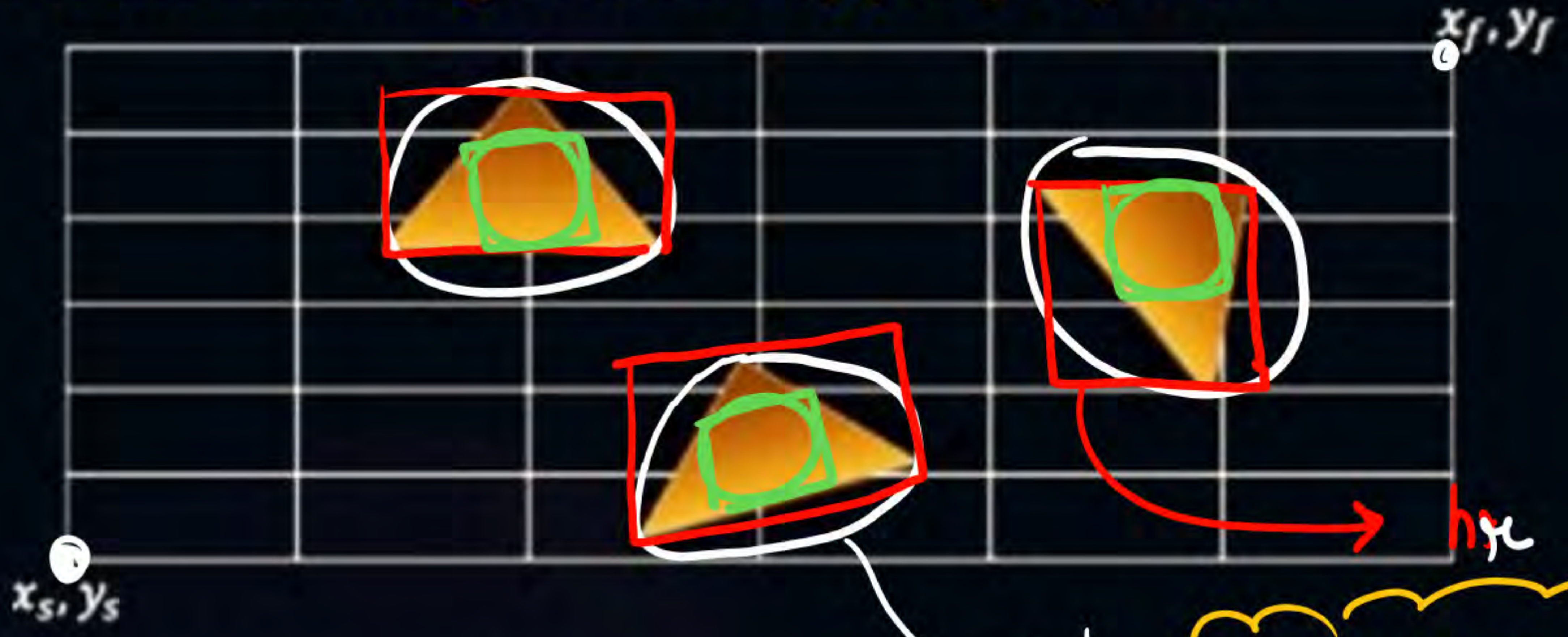
(b) h_r assumes the obstacles are smallest rectangles circumscribing the triangles.

(c) h_c' assumes the obstacles are largest circles inscribed in the triangles.

(d) h_r' assumes the obstacles are largest rectangles inscribed the triangles.

Continue...

Which of the following statement(s) is (are) true?



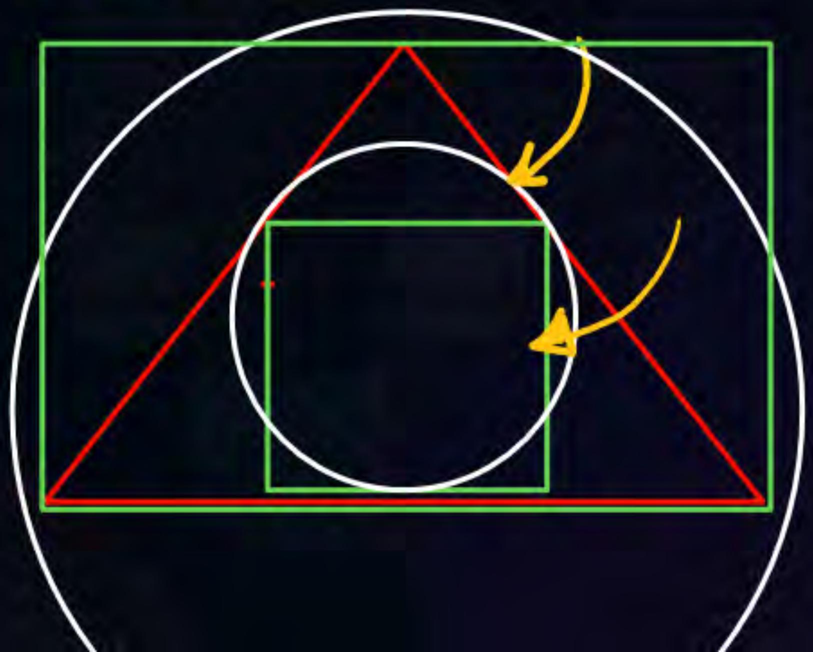
h_c $h(x) <$ actual cost

A h_c is an admissible heuristic ✗

B h_r is an admissible heuristic ✗

C h_c' is an admissible heuristic ✓

D h_r' is an admissible heuristic ✓



#Q. Consider the search space depicted in the figure below. S is the initial state.

H.W

Continue...

#Q. Consider the search space depicted in the figure below. S is the initial state.

	S	A	F	B	G1
S	0	0	0	0	
A	9	9	9	9	
B	10	10	10	10	
C	–	–	–	14	
D	–	–	–	12	
E	–	–	–	–	
F	9	9	9	9	
H	–	–	13	13	
G1	–	10	10	10	
G2	–			–	

$S \to A \to G_1$

Ans G_1, Cost = 10

#Q. 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 an A* (graph) search? What is the largest value that the heuristic function can take for node B while still being admissible?

- A G1 [redacted]
- B G1 [redacted]
- C G2 [redacted]
- D G2 [redacted]

(done) ✓

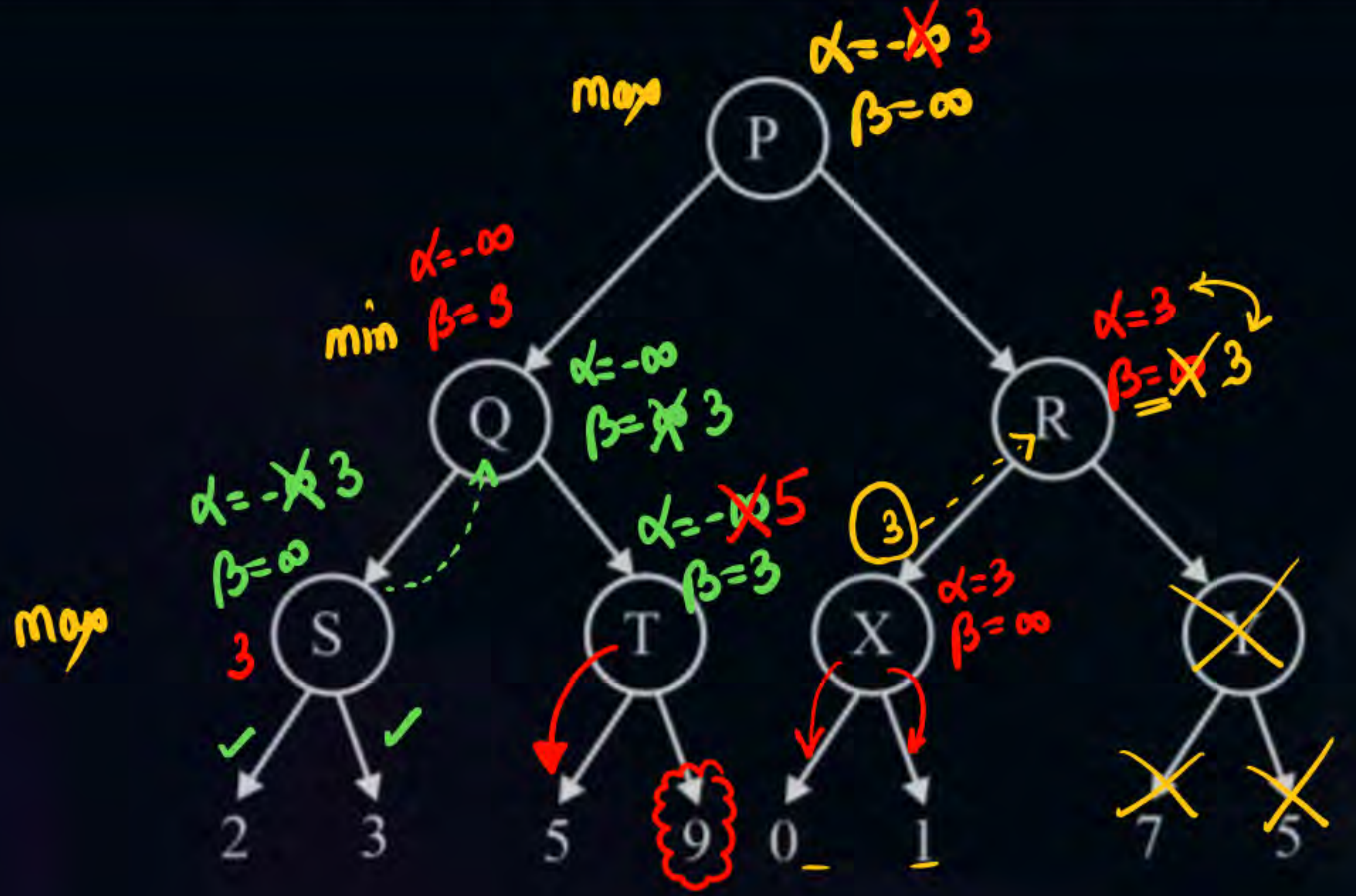
• $h(B) \leq$ actual cost to goal node

actual cost $(5+7) = 12$

$h(B) \leq 12$

Topic : Adversarial Search

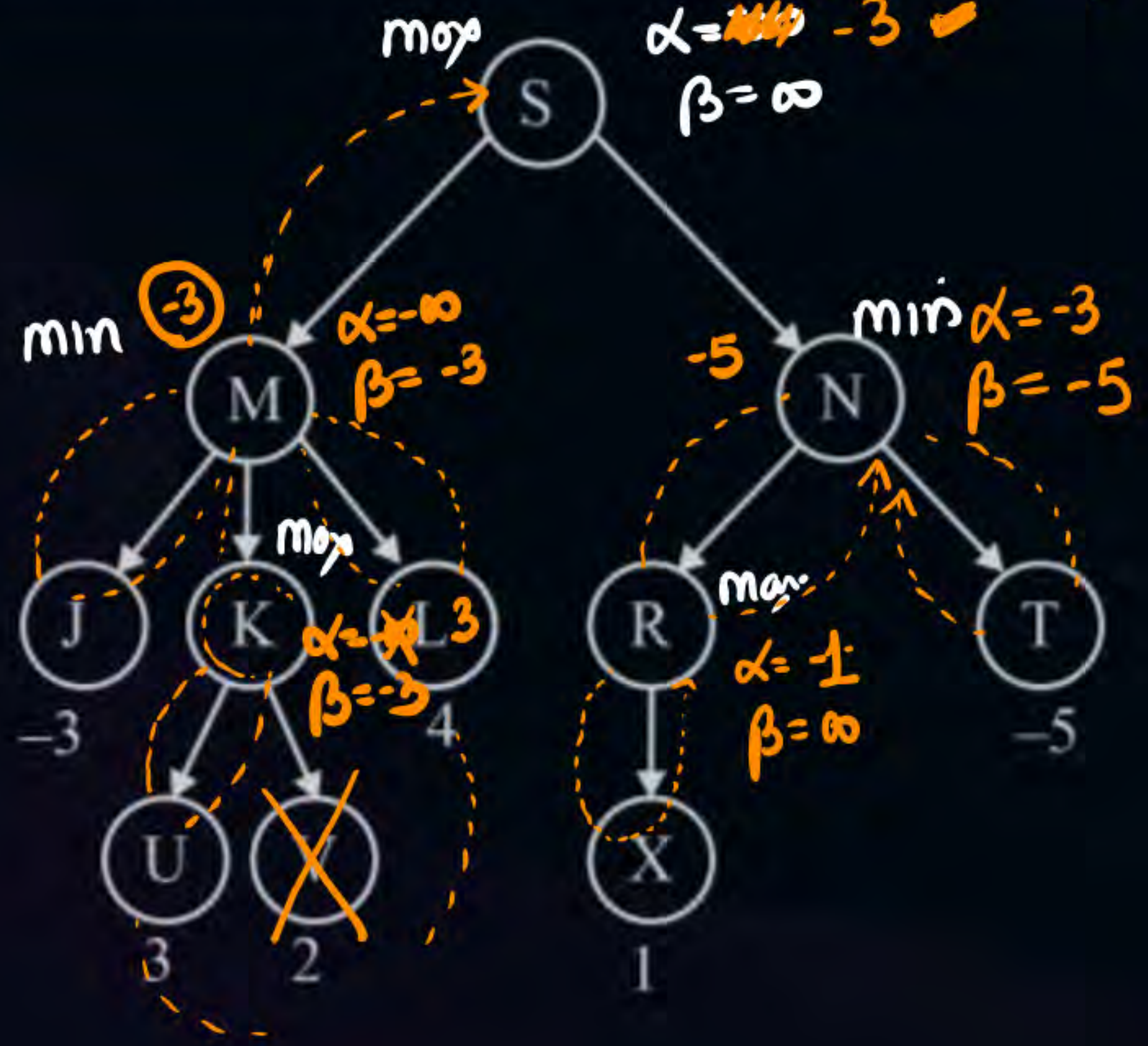
#Q. Count the number of nodes that will be pruned using a –b pruning



4 node Prune

Topic : Adversarial Search

#Q. Consider the tree green below. The root node S is the max player. What will be the best score for this root node S. No of node prune

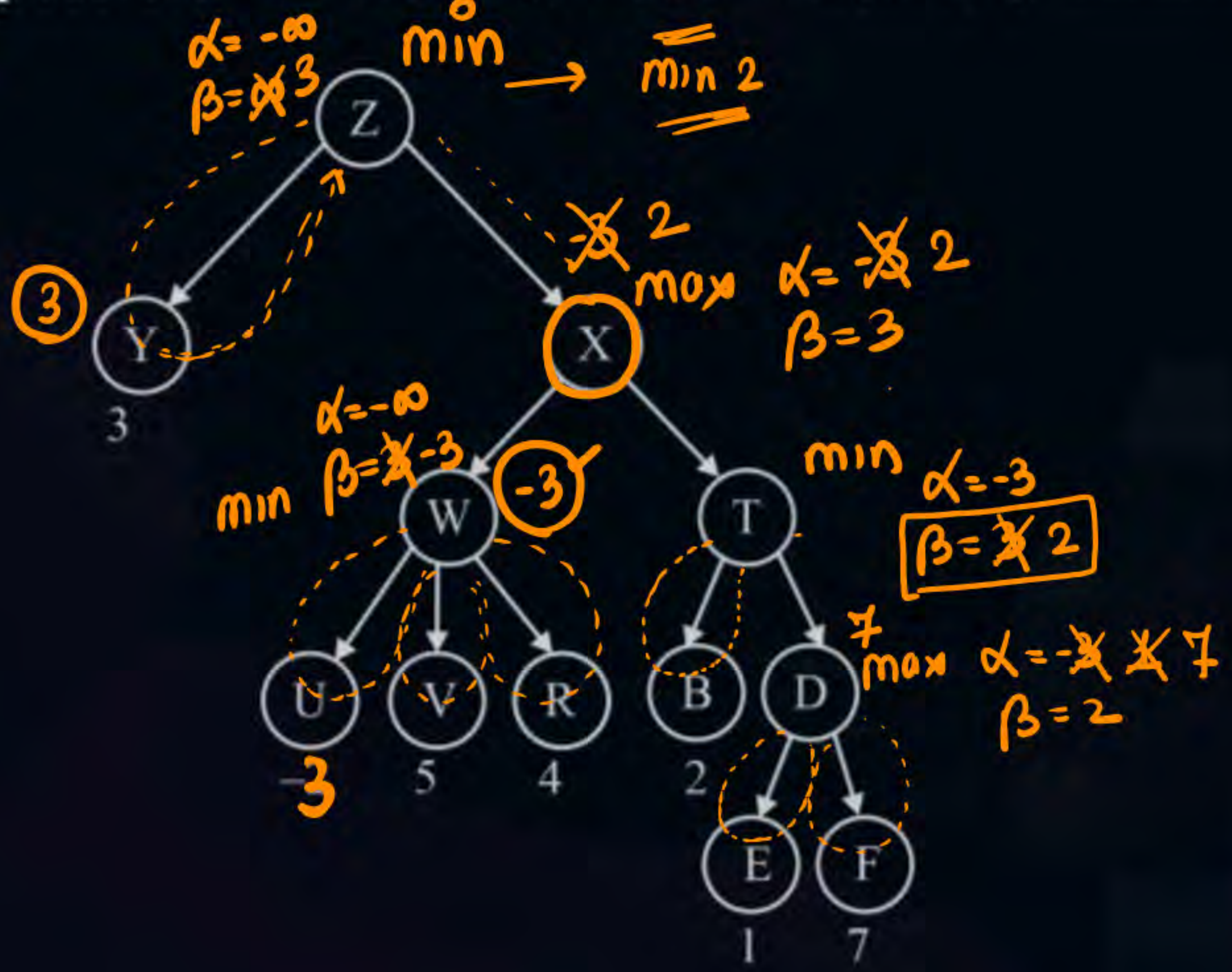


Only one node prune ✓

Topic : Adversarial Search

#Q. The best score possible for the root node which is a minimum player is ________.

Node prune ??

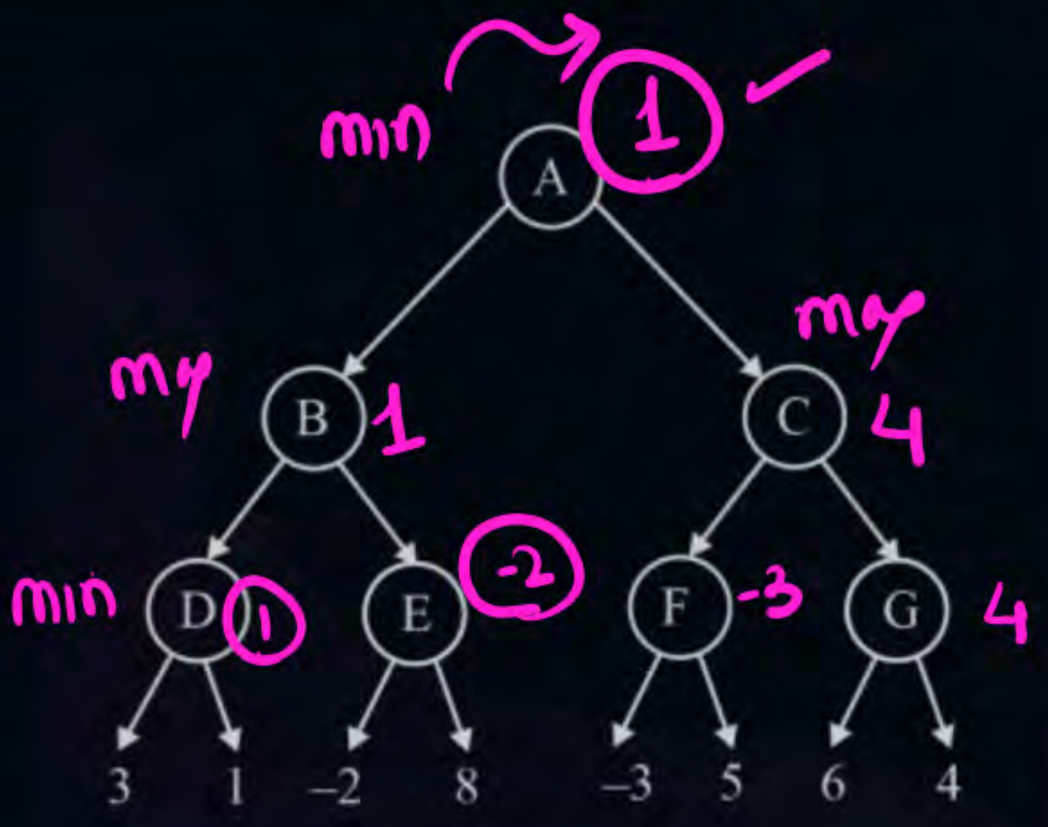


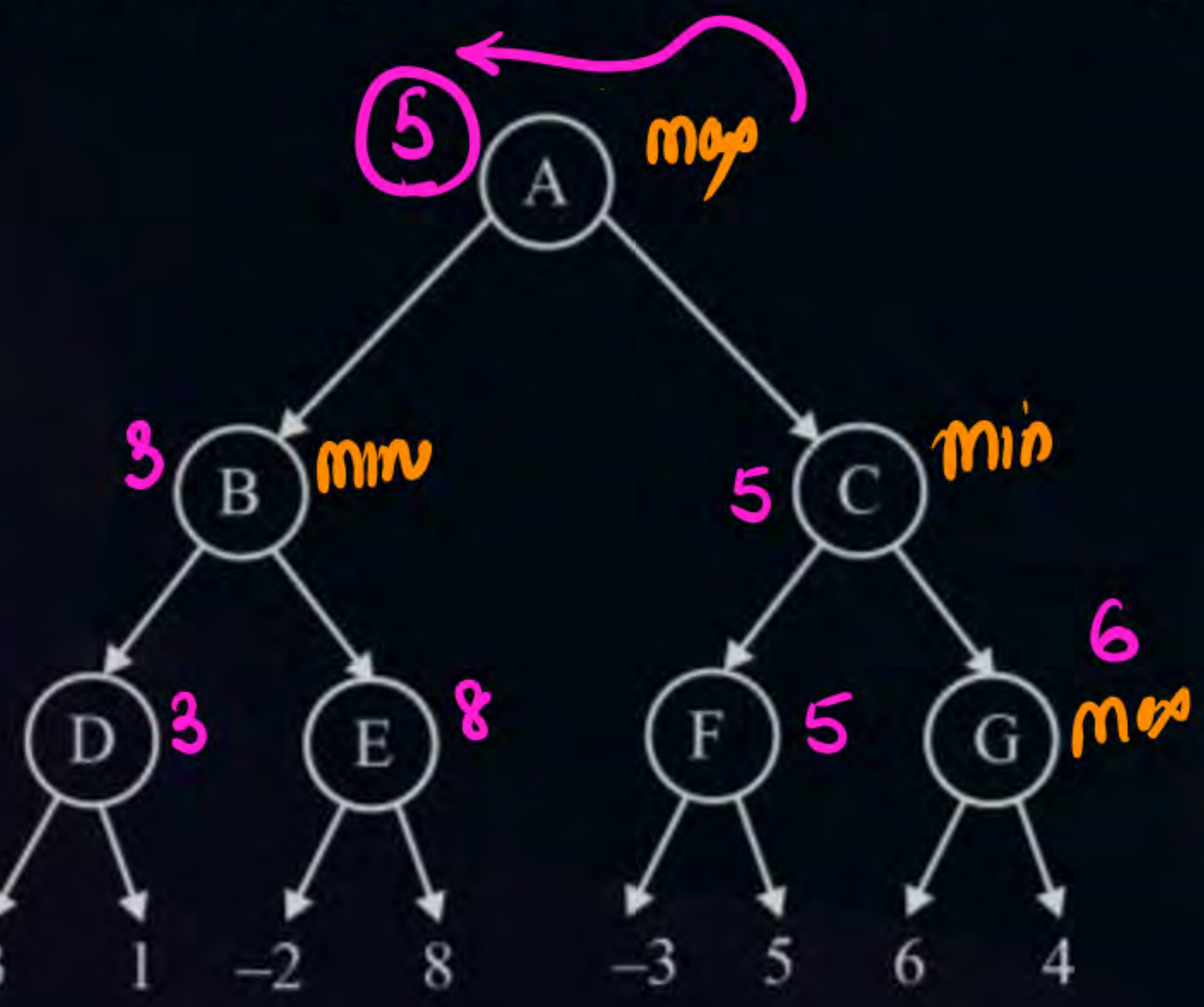
* No pruning

Ans 2

Topic : Adversarial Search

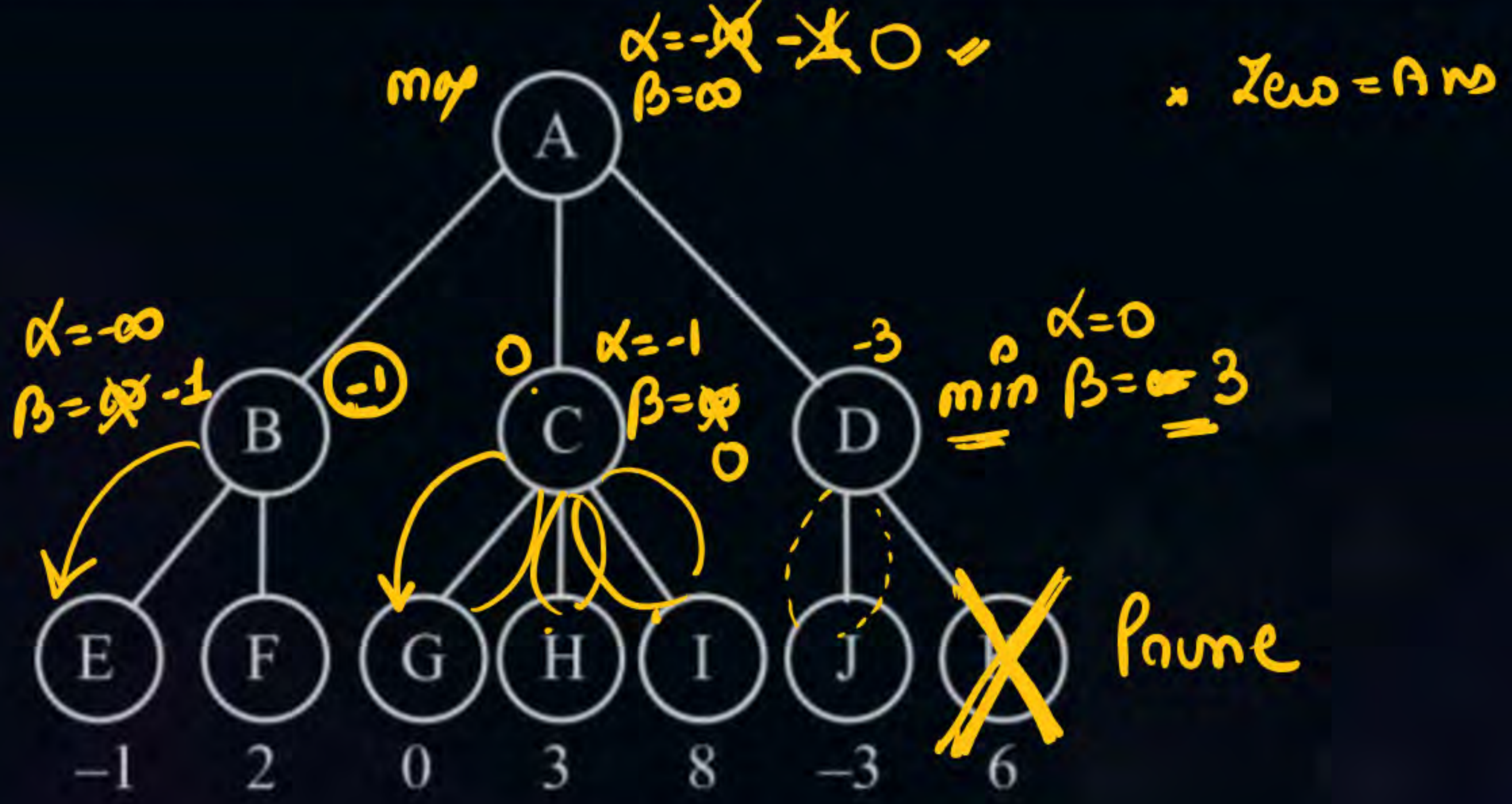
#Q. Consider the following tree. Let X denote the best score of the root node when it acts as the 'max' player. Let Y denote the best score of the root-node when if acts as the 'min' player. The value of x + y is 6 ______.





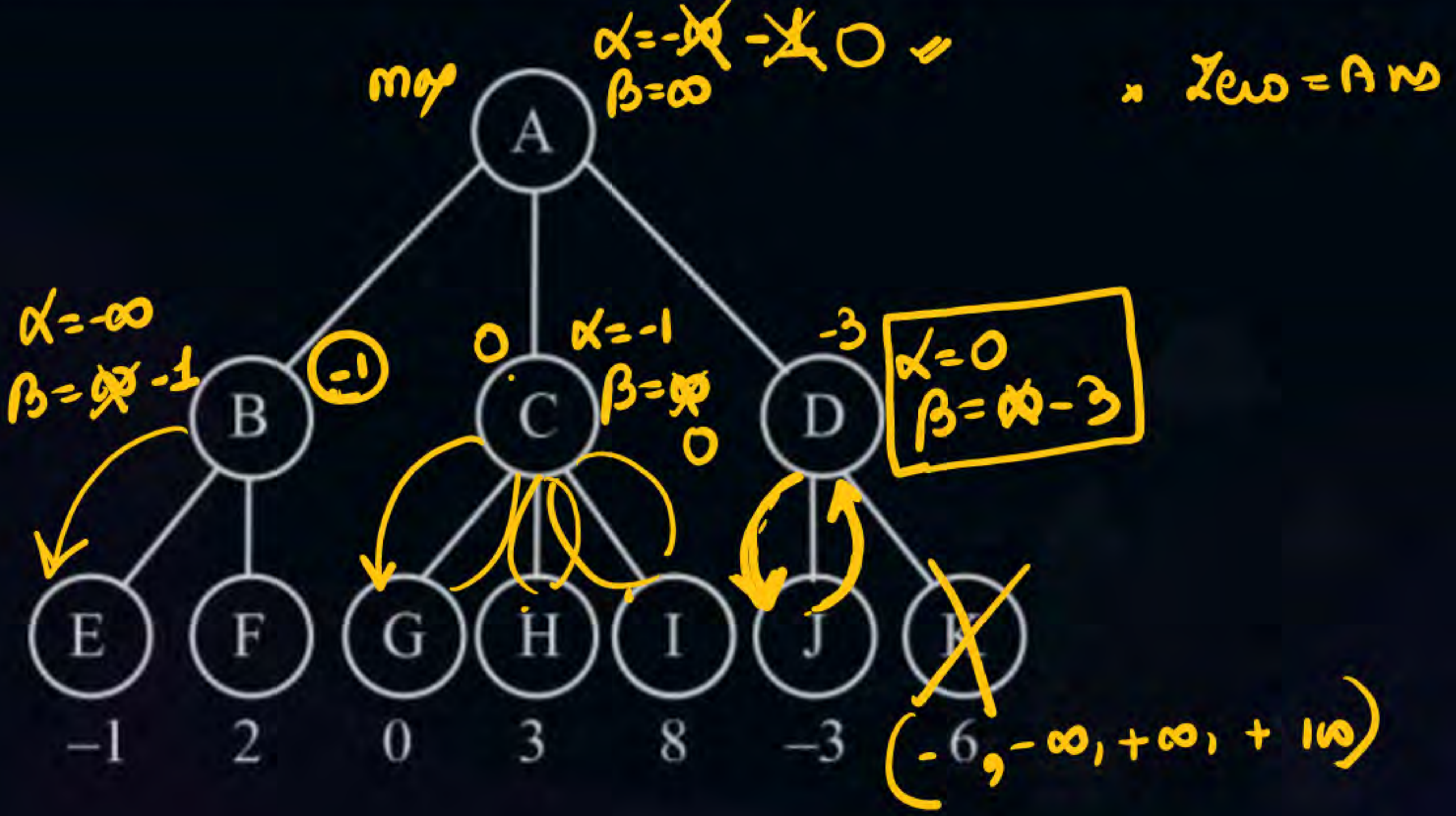
Topic : Adversarial Search

#Q. Find the best result for the root where root acts as the max player:



Topic : Adversarial Search

#Q. Find the best result for the root where root acts as the max player:

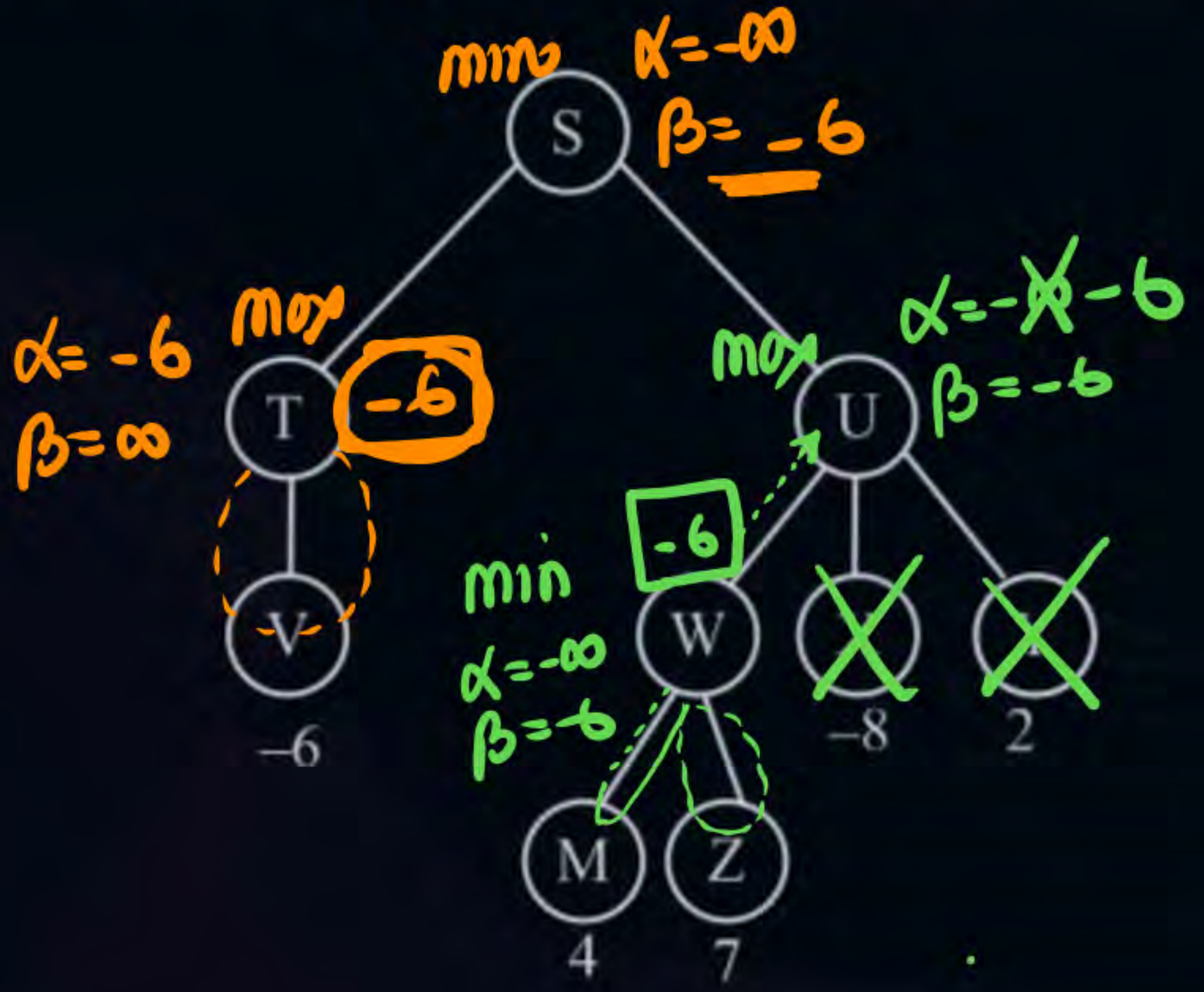


Topic : Adversarial Search

#Q. Find the best result for min player:

Topic : Adversarial Search

#Q. Find the best score for S (min player) in the following graph:

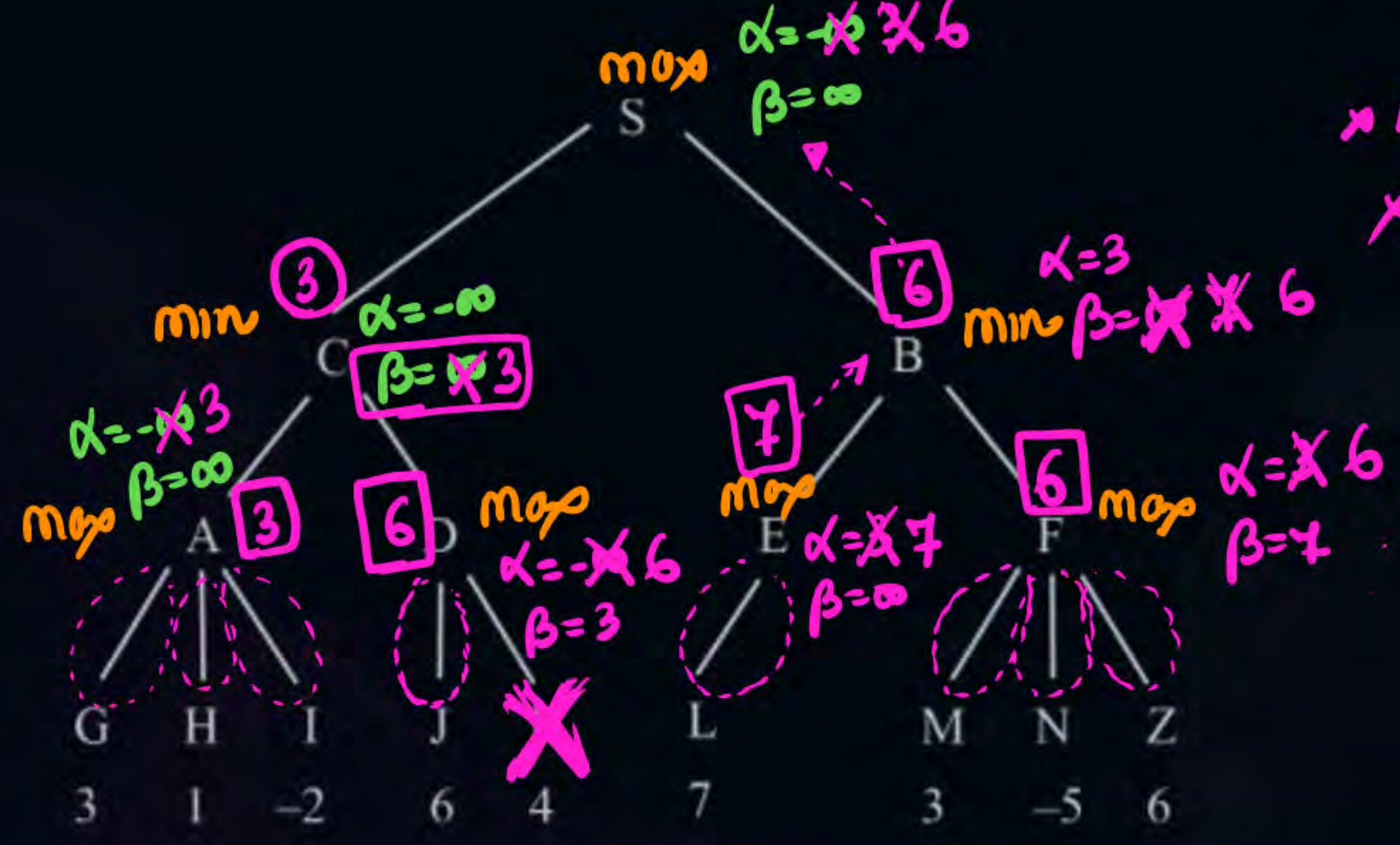


Ans -6

2 prune

Topic : Adversarial Search

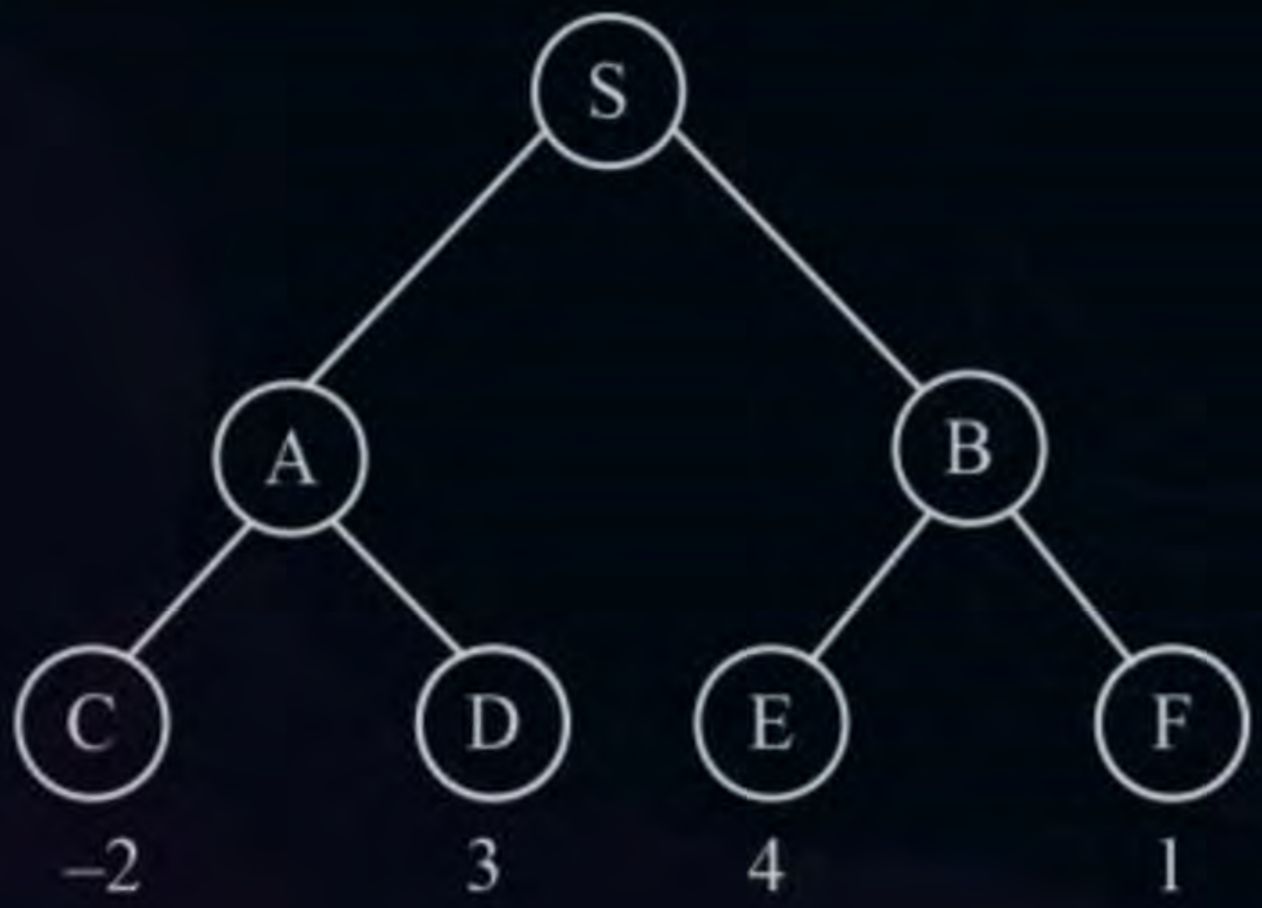
#Q. What is the best result for node C if the root node is a max player?



* Ans 6
* (one pruned node)

#Q. The number of nodes that will be pruned using alpha-beta pruning in the following graph is _______.

H.w



Topic : Adversarial Search

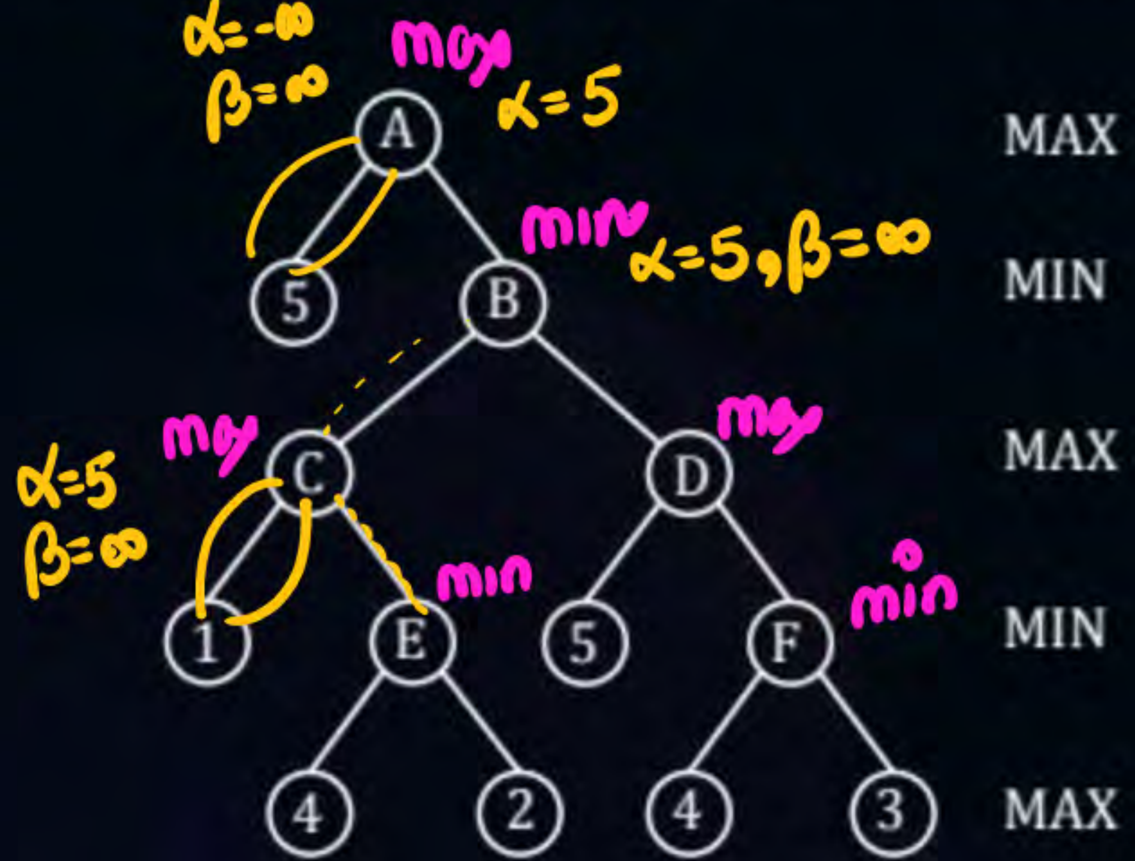
#Q. What is the minimax value of the root node for the game tree below?

H.W

Assuming that it performs a depth-first search that always generates the leftmost child node first and a loss (and win) of MAX (and MIN) corresponds to a value of $-\infty$ (and ∞, respectively).

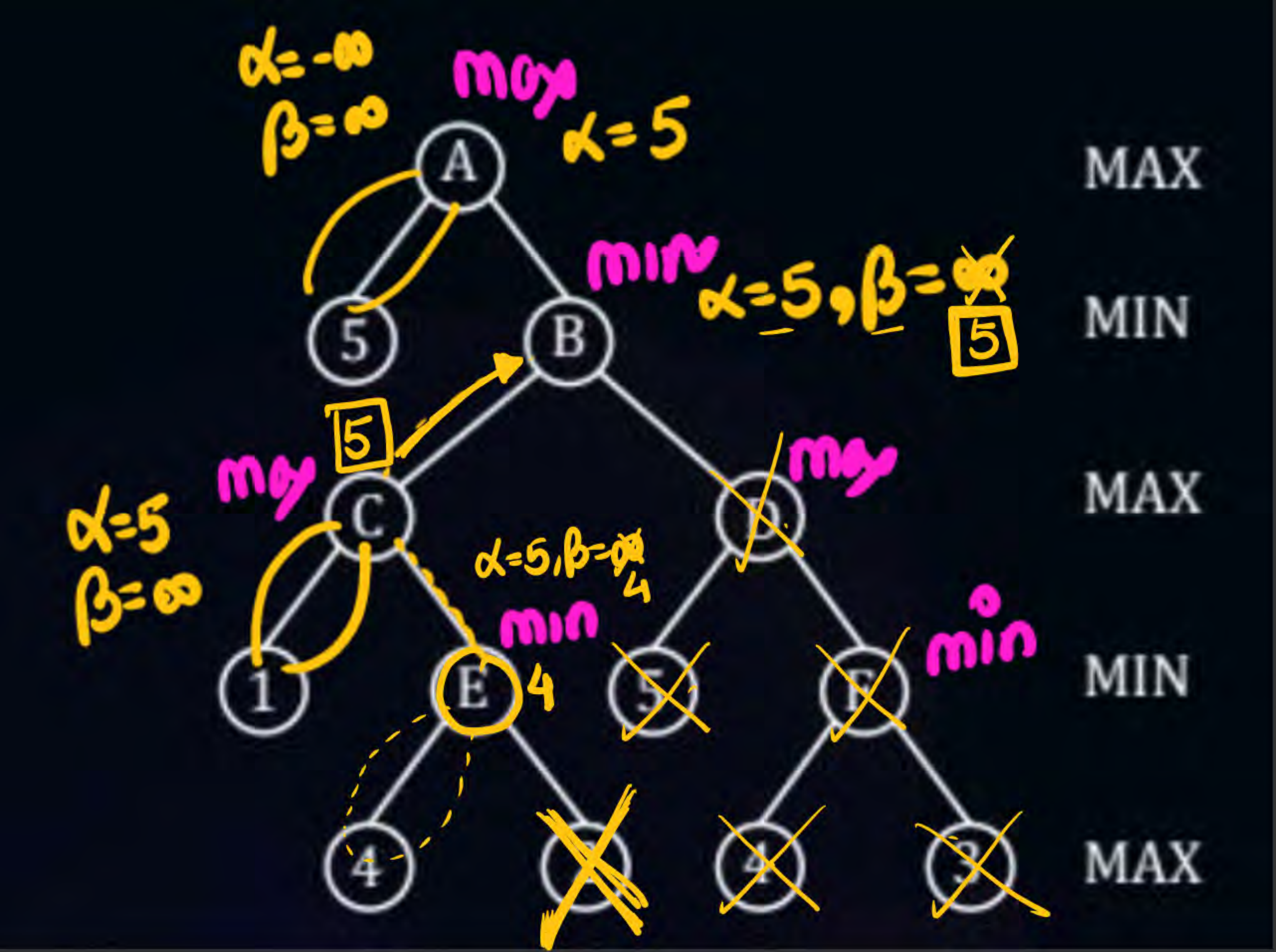
Topic : Adversarial Search

#Q. Consider the below search tree.



If we apply alpha-beta pruning method to above tree, then which of the node(s) will get pruned?

Assuming that it performs a depth-first search that always generates the leftmost child node first and a loss (and win) of MAX (and MIN) corresponds to a value of $-\infty$.



α=-∞
β=∞
max
α=5
A
MAX
min
α=5, β=5
5
B
MIN
5
max
max
α=5
β=∞
C
D
MAX
α=5, β=4
min
min
1
E
4
5
F
MIN
4
4
3
MAX

6 Node

A. F

B. D

C. $\boxed{\text{D, F}}$ ✓

D. E, F

Topic : Adversarial Search

#Q. What type of games is the $\boxed{\text{Minimax algorithm}}$ well-suited for?

A Single-player games

B Cooperative games

C $\boxed{\text{Two-player, zero-sum games}}$ ✓

D Games with random elements

Topic : Adversarial Search

#Q. How does alpha-beta pruning impact the time complexity of the minimax algorithm?

A. It increases time complexity.

B. It decreases time complexity.

C. It has no effect on time complexity.

D. It depends on the game being played.

Topic : Adversarial Search

#Q. What branch is expanded further.

incomplete

A The branch is expanded further.

B The branch is evaluated immediately.

C The branch is eliminated from consideration

D The branch is assigned a utility value of 0

Topic : Adversarial Search

#Q. In alpha-beta pruning, what is the initial value of alpha at maximizing nodes?

A. It varies based on the game

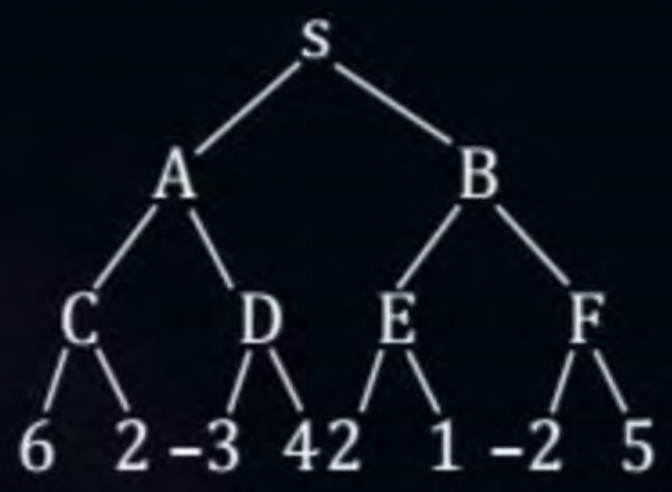
B. $\boxed{-\infty\text{(negative infinity)}}$

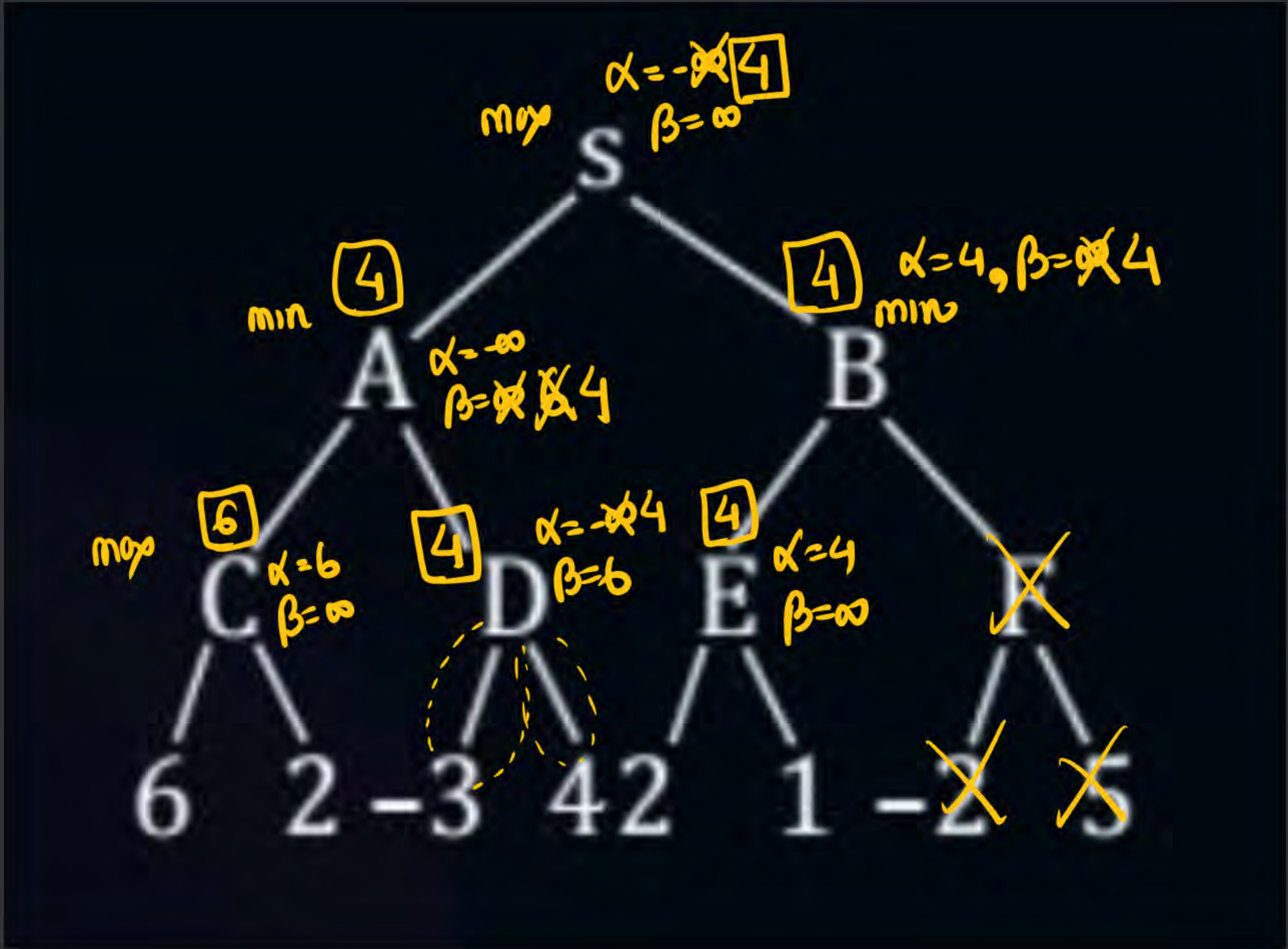
C. ∞(negative infinity)

D. 0

Topic : Adversarial Search

#Q. The value of $\alpha + \beta$ of node B(min player) is ________.

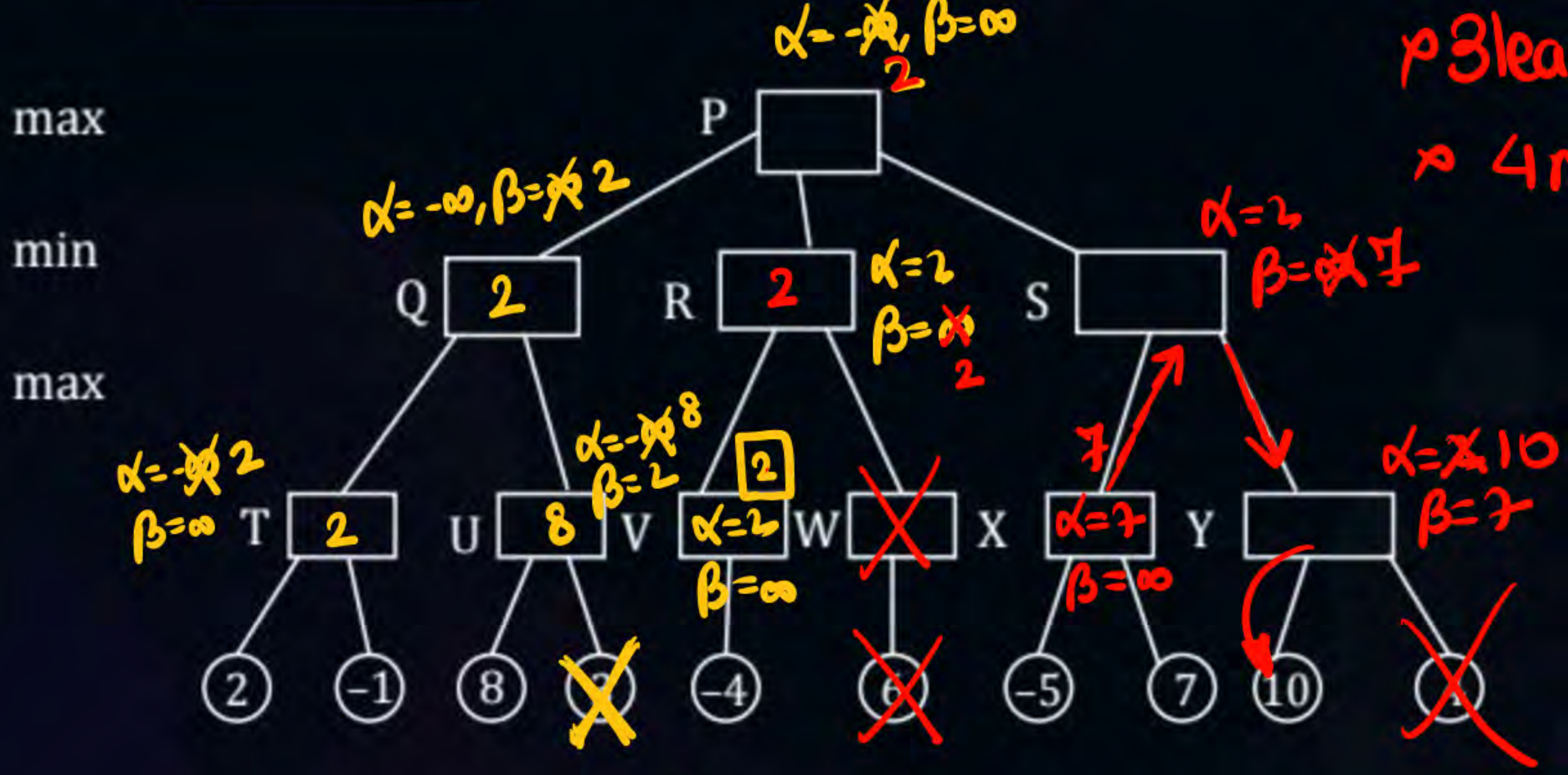



max
$\alpha = -\cancel{\infty}\ \boxed{4}$
$\beta = \infty$
S
min
$\boxed{4}$
A
$\alpha = -\infty$
$\beta = \cancel{\infty}\ \cancel{6}\ 4$
$\boxed{4}$
$\alpha = 4, \beta = \cancel{\infty}\ 4$
min
B
max
$\boxed{6}$
C
$\alpha = 6$
$\beta = \infty$
$\boxed{4}$
D
$\alpha = -\cancel{\infty}\ 4$
$\beta = 6$
$\boxed{4}$
E
$\alpha = 4$
$\beta = \infty$
F
6 2 −3 4 2 1 −2 5

* 3 node Prune

Topic : Adversarial Search

#Q. How many leaf nodes will be pruned in the following tree?



→ 3 leaf node

→ 4 node

Topic : Propositional logic

#Q. The $\boxed{\text{number of different possible logical connectives on n variables is}}$ 2^{2^n} ____.

logical function

digital elec

n var → Truth table 2^n rows

A $\boxed{2^n}$

B n^2

C $\cancel{2^{2n}}$ $\left(2^{2^n}\right)$

D $\cancel{2^{n2}}$ 2^{n^2}

n var → 2^n rows

each Row has 2 option

$2 \times \cdots$ 2^n times

4 Row $\boxed{2 \times 2 \times 2 \times 2}$ 16

	$f=0$	$f=1$	$(\sim A \wedge \sim B)$	$(\sim A \wedge B)$	$(A \wedge \sim B)$		$A \vee B$
A B	f_1	f_2	f_3	f_4	f_5	f_6	f_7
0 0	0	1	1	0	0	0	0
0 1	0	1	0	1	0	0	1
1 0	0	1	0	0	1	0	1
1 1	0	1	0	0	0	1	1

2 var $\rightarrow$ 4 Rows $\rightarrow$ $2\times2\times2\times2 \rightarrow 2^4$

3 var $\rightarrow$ 8 Row $\rightarrow$ $2\times \text{----} \; 2$ (8 times) $= 2^8$

4 n $\rightarrow$ 16 Rows $\rightarrow$ $2 \text{----} \; 2$ (16 times) $= 2^{16}$

$\left(2^{2^n}\right)$ ✓

Topic : Propositional logic

#Q. Consider the following statements:

S_1: AI stands for Artificial Intelligence.

S_2: $2 + 1 = 5$

A. S_1 is a proposition but S_2 is not a proposition

B. S_1 is not proposition but S_2 is a proposition

C. Both S_1 and S_2 are propositions.

D. Neither S_1 nor S_2 is a propositions.

Topic : Propositional logic

#Q. The negation of the statement "We have those students who have applied for CS paper or DA paper" is

A. We do not have those students who have applied for CS paper or DA paper

B. We have students who have not applied for CS paper and not applied for DA paper.

C. We have those students who have applied for CS paper and DA paper.

D. None of the above

Topic : Propositional logic

#Q. "If I am selected, then I will get the job" is equivalent to saying

A "If I am not selected, then I will not get the job"

B "If will not get the job, then I am not selected".

C "If I will get the job then I am selected.."

D None of the above

Topic : Propositional logic

#Q. The expression $P \leftrightarrow q$ can also be stated as

A "p is necessary and sufficient for q"

B "if p then q, and conversely"

C "p exactly when q".

D $(p \rightarrow q) \wedge (q \rightarrow p)$

Topic : Propositional logic

#Q. Simplify the expression $(p \vee \neg q) \rightarrow (p \wedge q)$

A p

B q

C T

D F

THANK - YOU