UNIT III

# Adeversarial Search and Games

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| Unit III | Adversarial Search and Games | 07 Hours |
|---|---|---|
| Game Theory, Optimal Decisions in Games, Heuristic Alpha–Beta Tree Search, Monte Carlo Tree Search, Stochastic Games, Partially Observable Games, Limitations of Game Search Algorithms, Constraint Satisfaction Problems (CSP), Constraint Propagation: Inference in CSPs, Backtracking Search for CSPs. | | |
| **#Exemplar/Case Studies** | Machine Learning At Google: The Amazing Use Case Of Becoming A Fully Sustainable Business | |
| ***Mapping of Course Outcomes for Unit III** | CO3, CO4 | |

# Alpha-beta Pruning

- Alpha: Alpha is the best choice or the highest value that we have found at any instance along the path of Maximizer. The initial value for alpha is – ∞.
- Beta: Beta is the best choice or the lowest value that we have found at any instance along the path of Minimizer. The initial value for alpha is + ∞.
- The condition for Alpha-beta Pruning is that α >= β.
- Each node has to keep track of its alpha and beta values. Alpha can be updated only when it's MAX's turn and, similarly, beta can be updated only when it's MIN's chance.
- MAX will update only alpha values and MIN player will update only beta values.
- The node values will be passed to upper nodes instead of values of alpha and beta during go into reverse of tree.
- Alpha and Beta values only be passed to child nodes.

# Alpha-beta Pruning

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# Alpha-beta Pruning

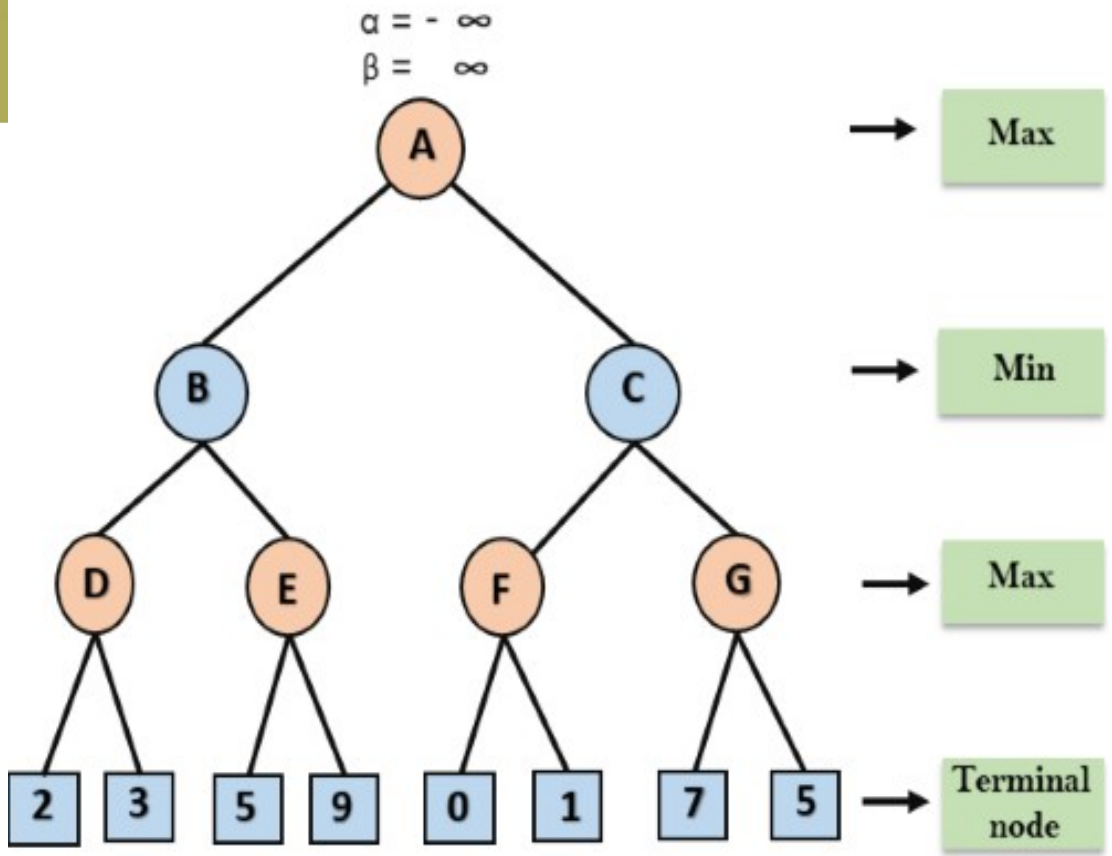
- Move Ordering in Alpha-Beta pruning:
- The effectiveness of alpha-beta pruning is highly dependent on the order in which each node is examined. Move order is an important aspect of alpha-beta pruning.
- It can be of two types:

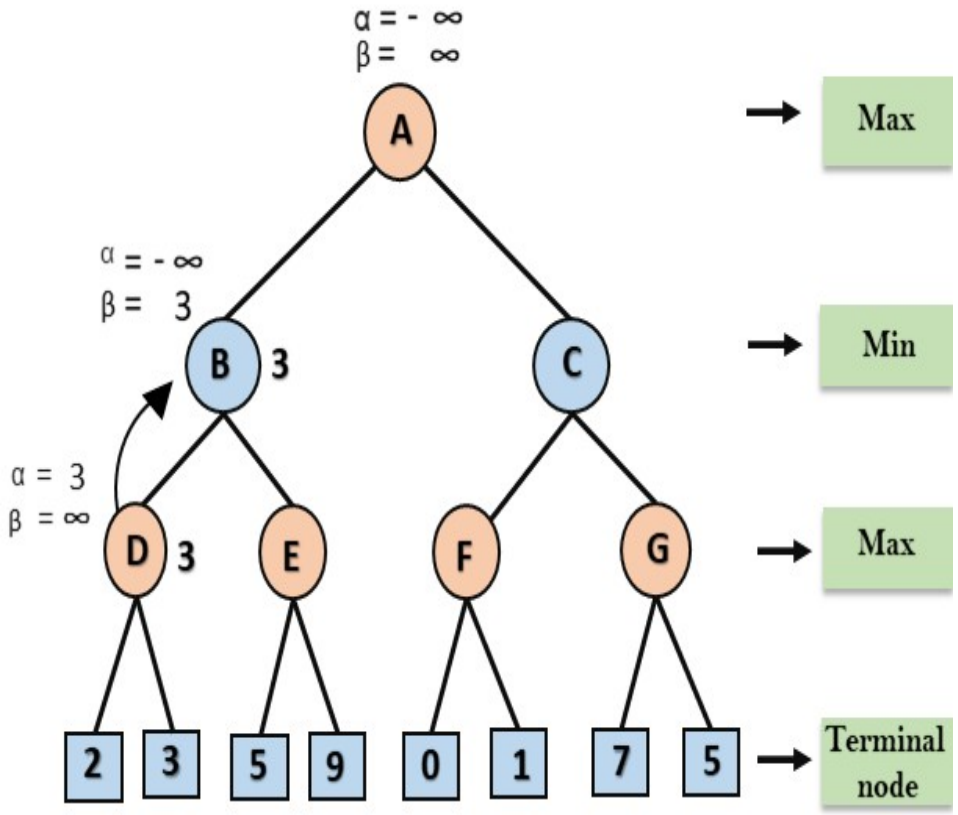
  **Worst ordering:** In some cases, alpha-beta pruning algorithm does not prune any of the leaves of the tree, and works exactly as minimax algorithm. In this case, it also consumes more time because of alpha-beta factors, such a move of pruning is called worst ordering. In this case, the best move occurs on the right side of the tree. The time complexity for such an order is $O(b^m)$.

  **Ideal ordering:** The ideal ordering for alpha-beta pruning occurs when lots of pruning happens in the tree, and best moves occur at the left side of the tree. We apply DFS hence it first search left of the tree and go deep twice as minimax algorithm in the same amount of time. Complexity in ideal ordering is $O(b^{m/2})$.

# Alpha-beta Pruning

- Example

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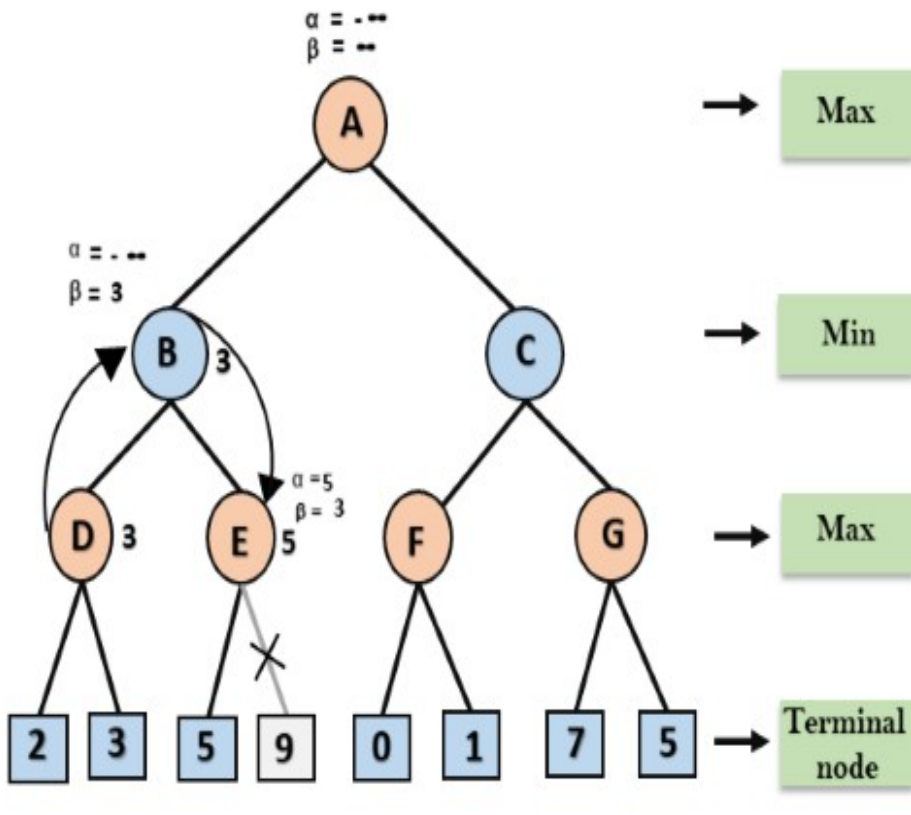
Max
α = - ∞
β = 3
B 3
C
Min
α = 3
β = ∞
D 3
E
F
G
Max
2
3
5
9
0
1
7
5
Terminal node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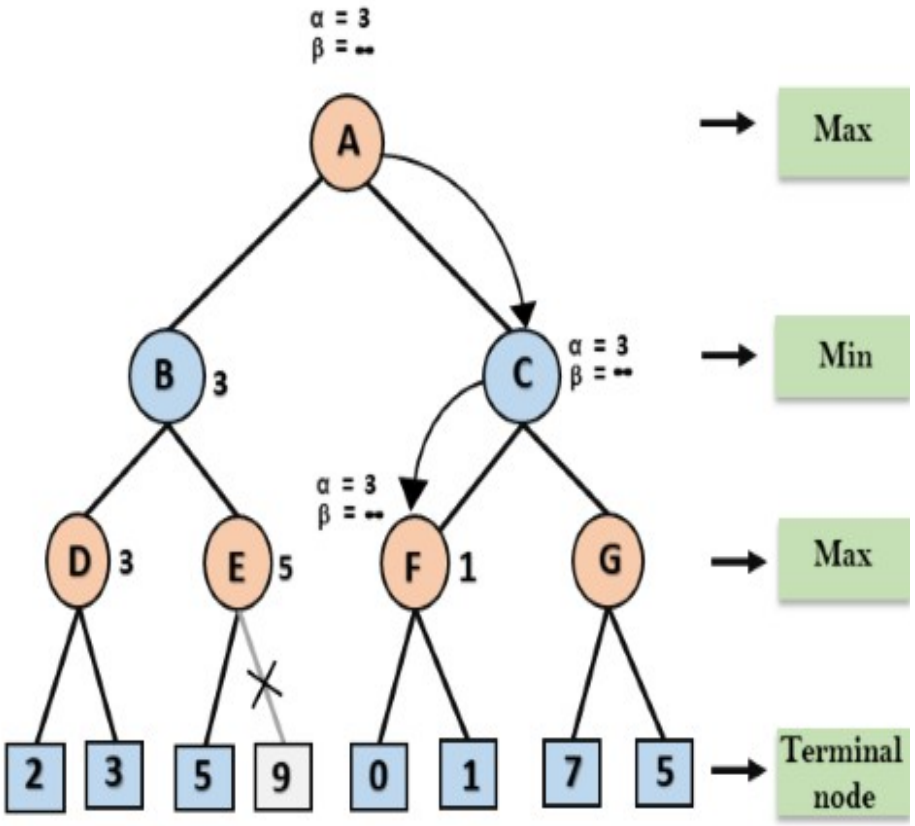
α = -∞
β = 3
B 3
C
Min
D 3
E 5
α =5
β = 3
F
G
Max
2
3
5
9
0
1
7
5
Terminal node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B
3
C
α = 3
β = ∞
Min
α = 3
β = ∞
D
3
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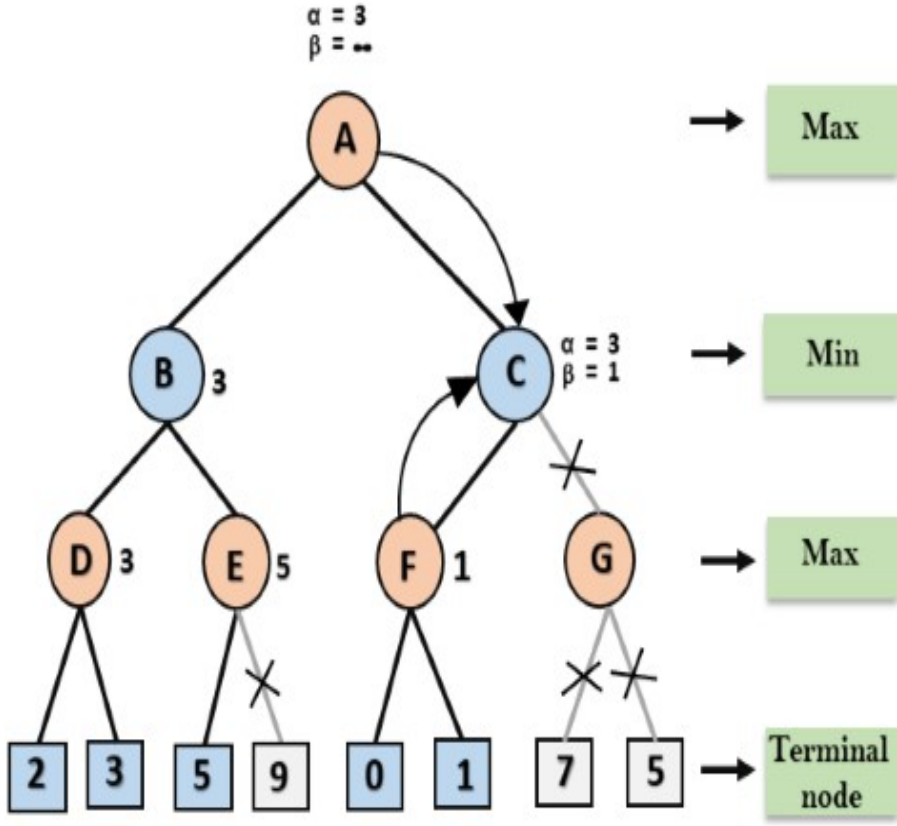
F
1
G
Max
2
3
5
9
0
1
7
5
Terminal node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β = ∞
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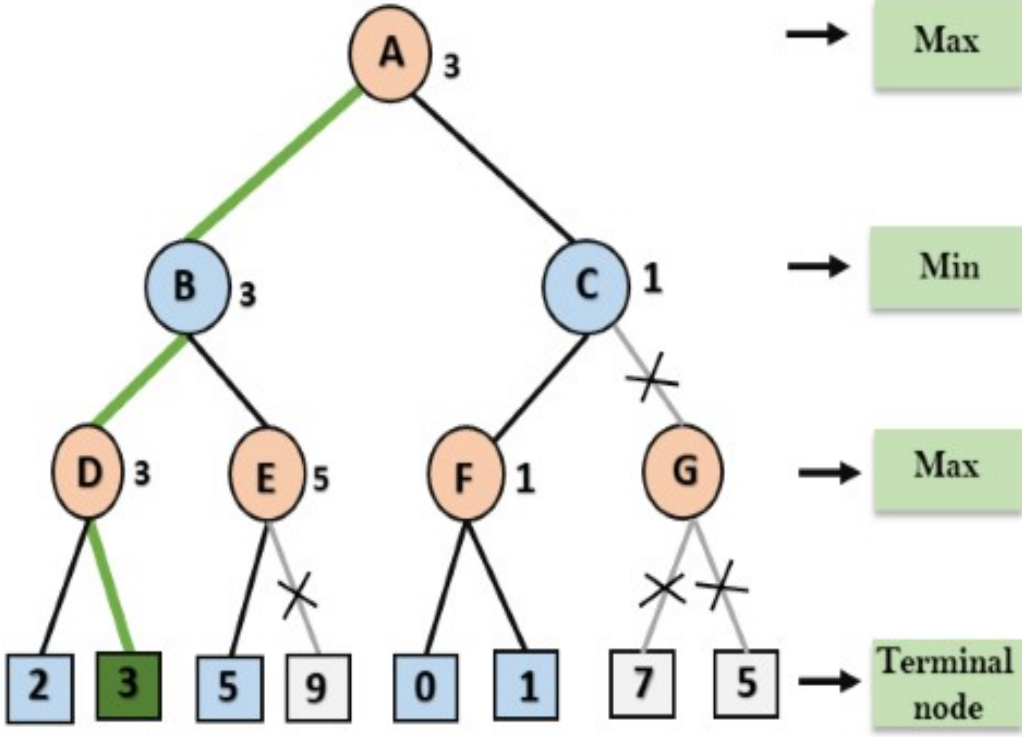
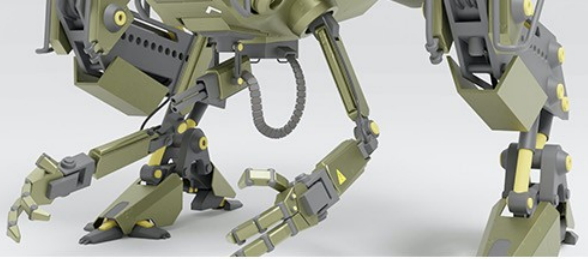
B
3
C
α = 3
β = 1
Min
D
3
E
5
F
1
G
Max
2
3
5
9
0
1
7
5
Terminal node

# Alpha-beta Pruning

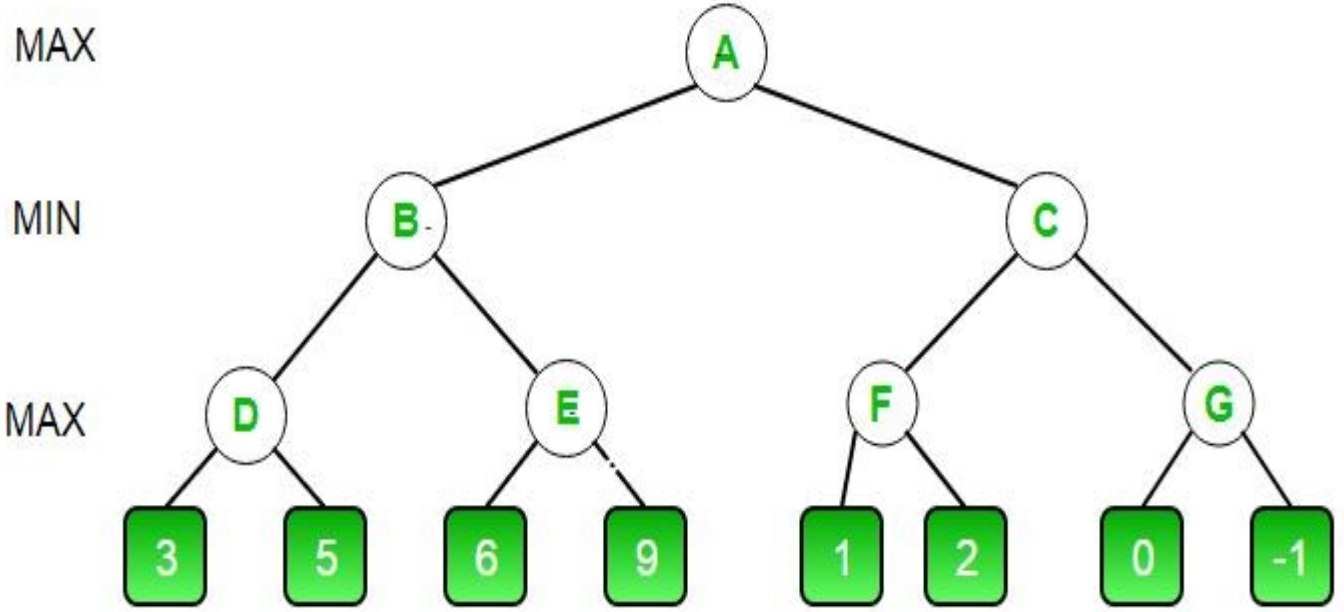
- Example:
  Following is the final game tree which is the showing the nodes which are computed and nodes which has never computed.
- Hence the optimal value for the maximizer is 3 for this example.



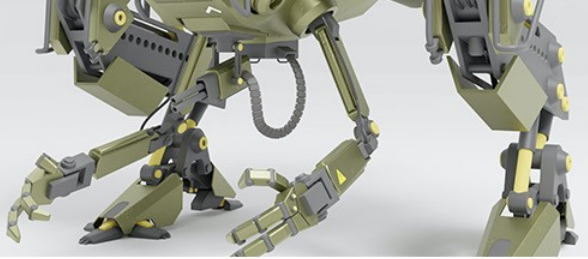
# Alpha-beta Pruning



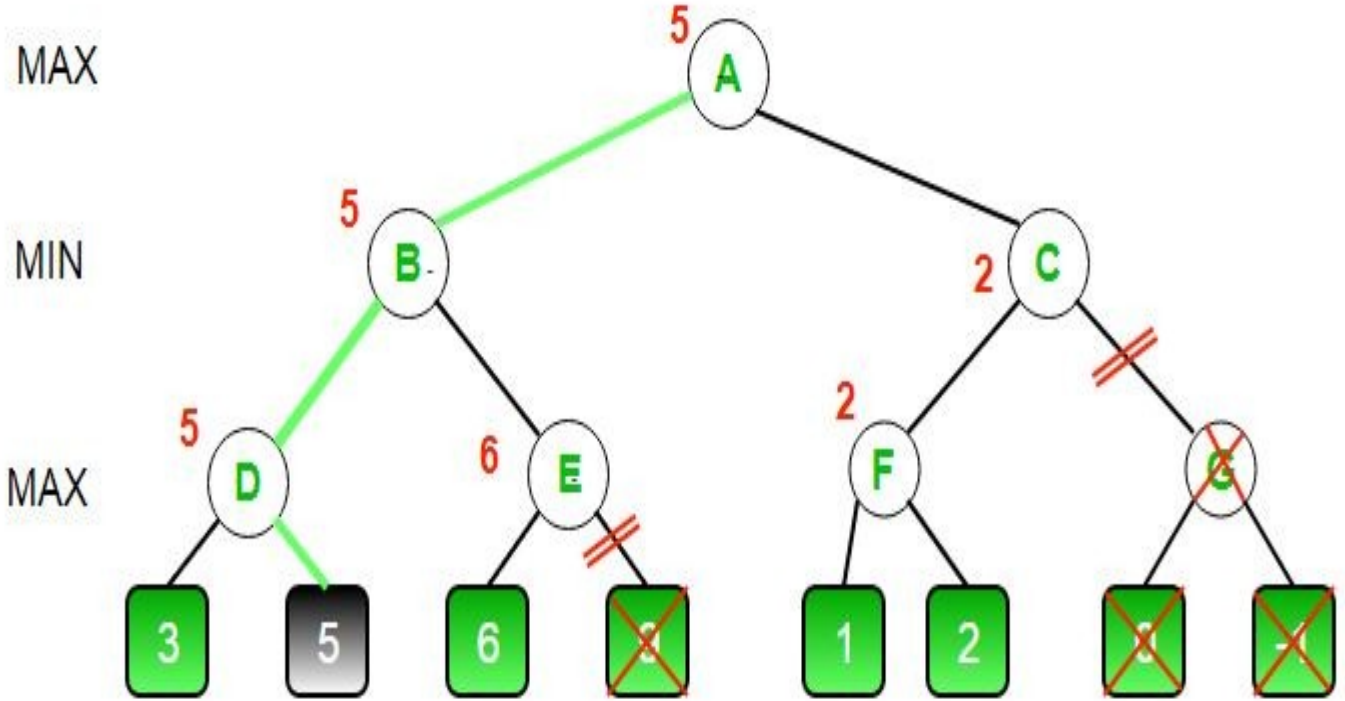
- Examples:



# Alpha-beta Pruning

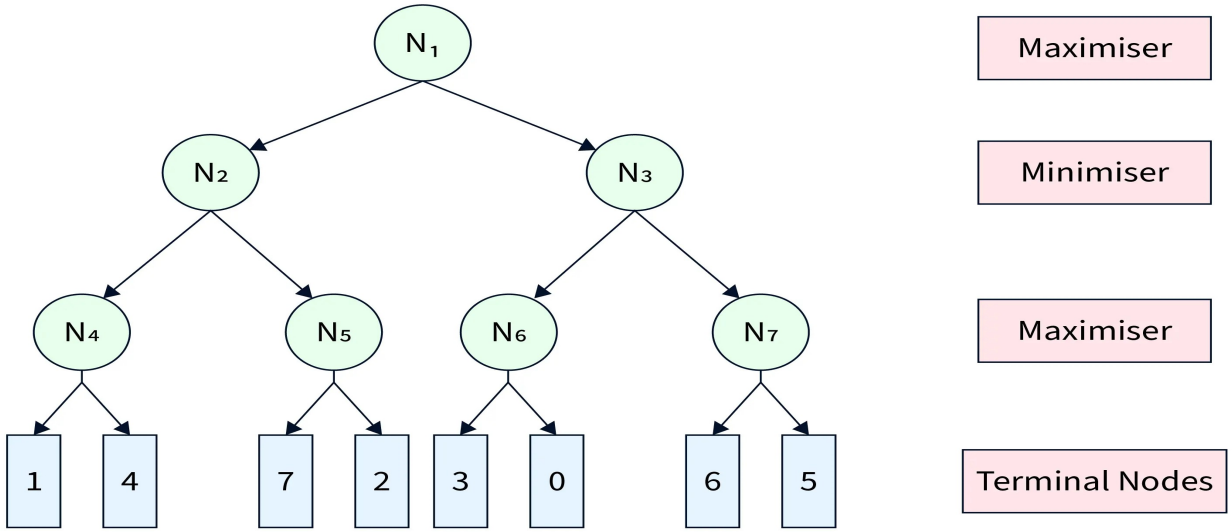


- Examples:
  Solution



# Alpha-beta Pruning

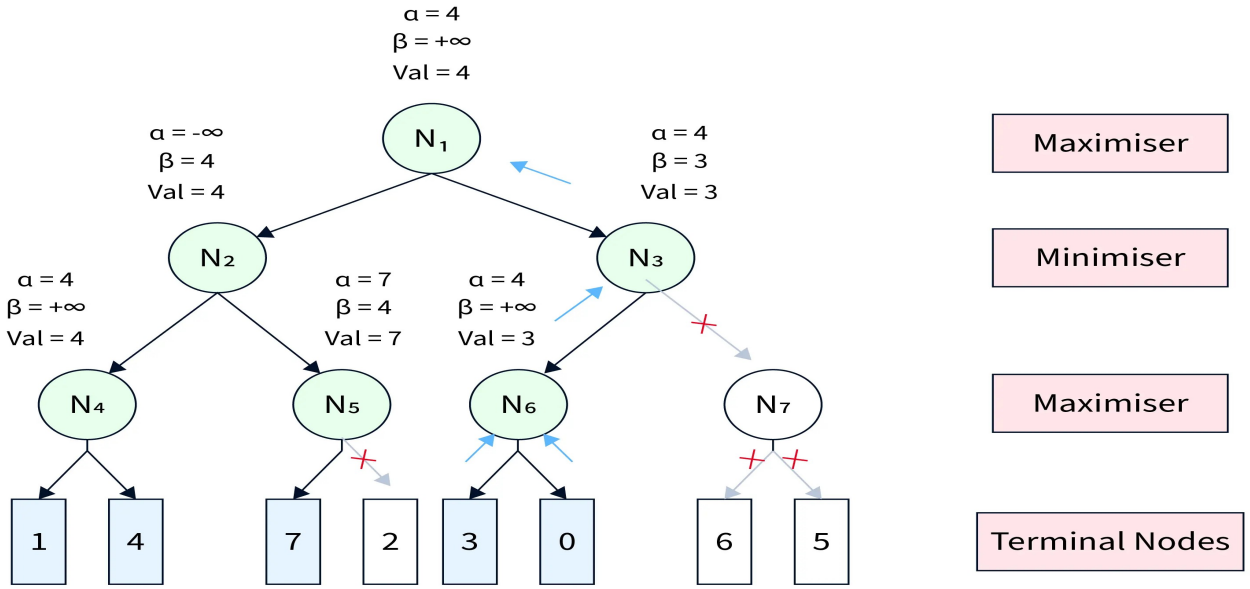
- Examples:




SCALER Topics

# Alpha-beta Pruning

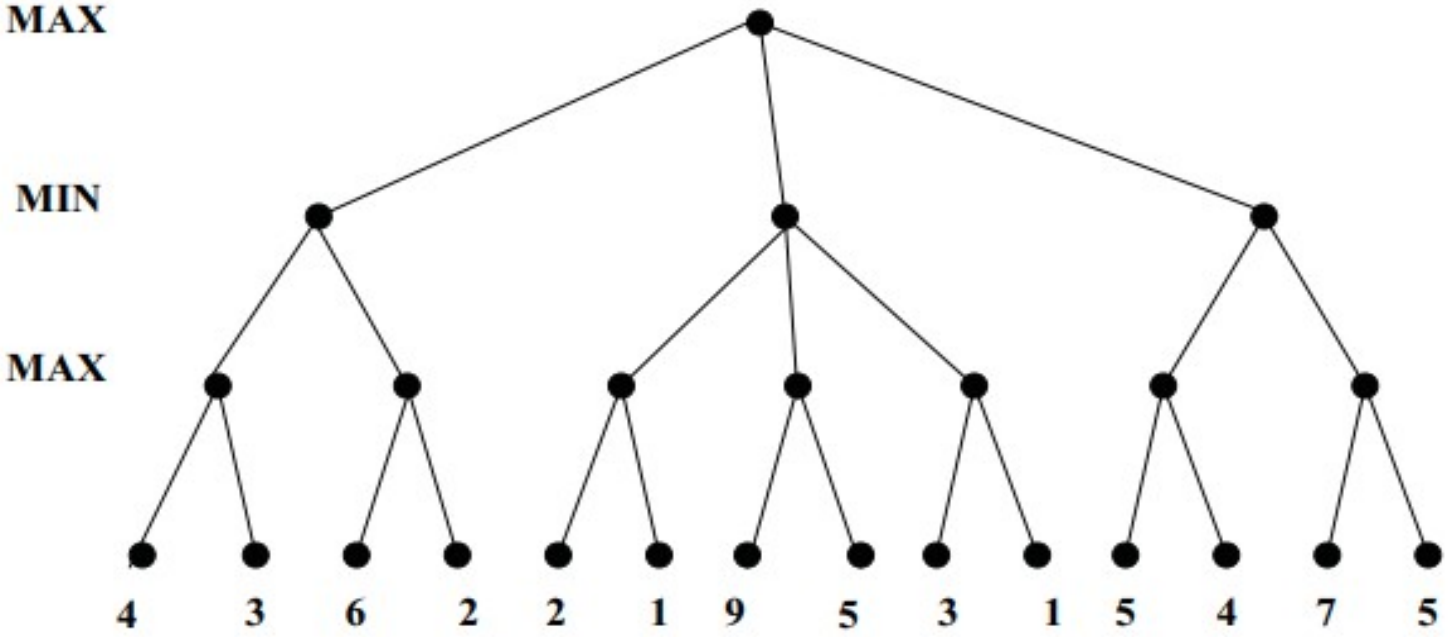
- Examples: Solution




SCALER Topics

# Alpha-beta Pruning

- Examples: Solution



# Alpha-beta Pruning

- Examples: