

Name : Ruchita Suresh Rasal

Roll No : 53

Sub : Is lab

Class : B.E.I.T.

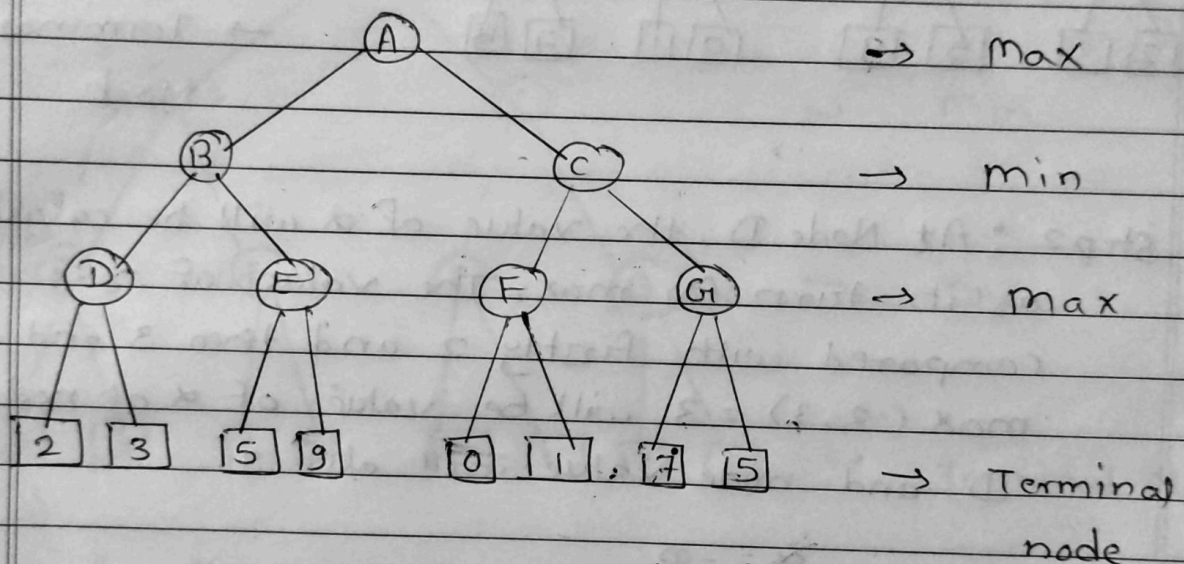
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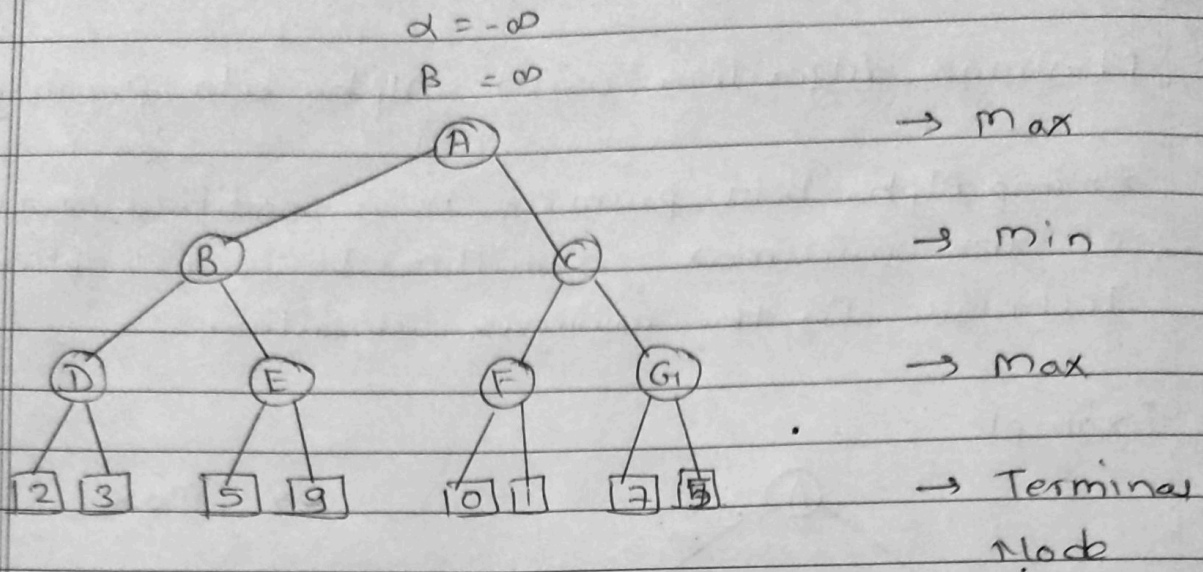
## \* Minimax Algorithm with Alpha-beta pruning

- ~~Examp~~ Alpha-beta pruning is a modified version of the minimax algorithm. It is an optimization technique for the minimax algorithm.

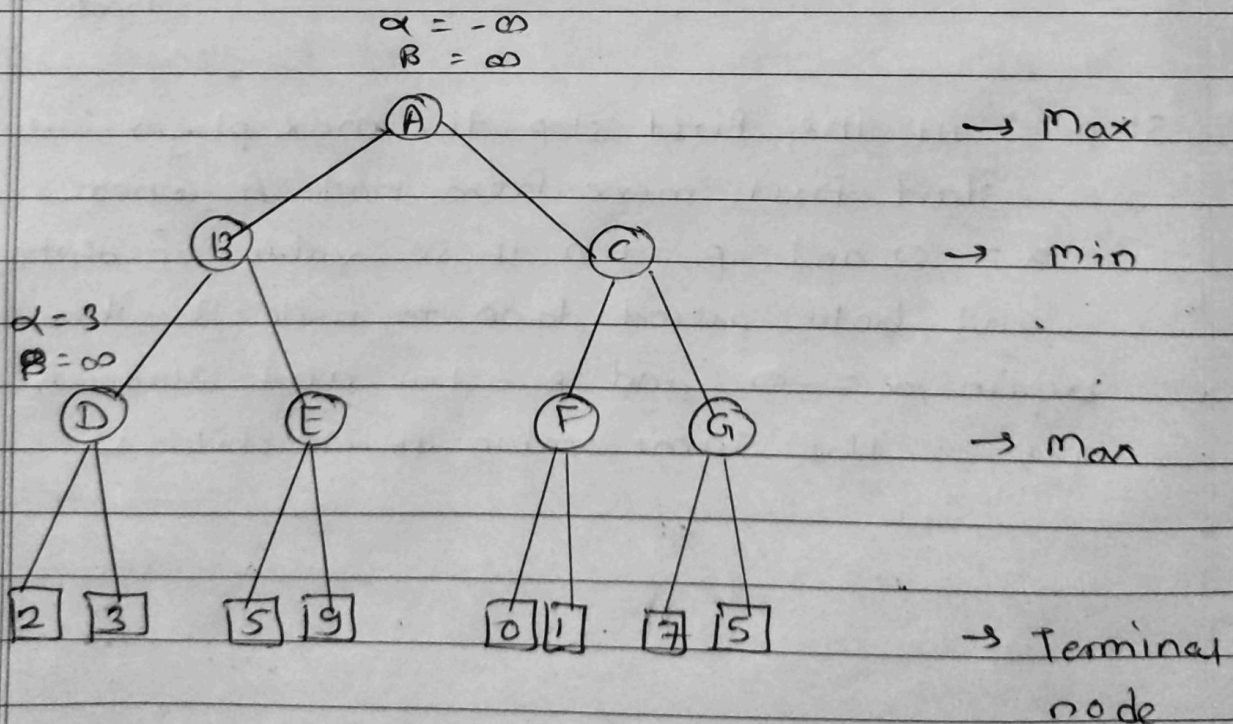
\* Example :-



Step 1 : At the first step, the max player will start first move from node A where  $\alpha = -\infty$  and  $\beta = +\infty$  these value of alpha and beta passed down to node B where again  $\alpha = -\infty$  and  $\beta = +\infty$  and Node B passes the same value to its child D.

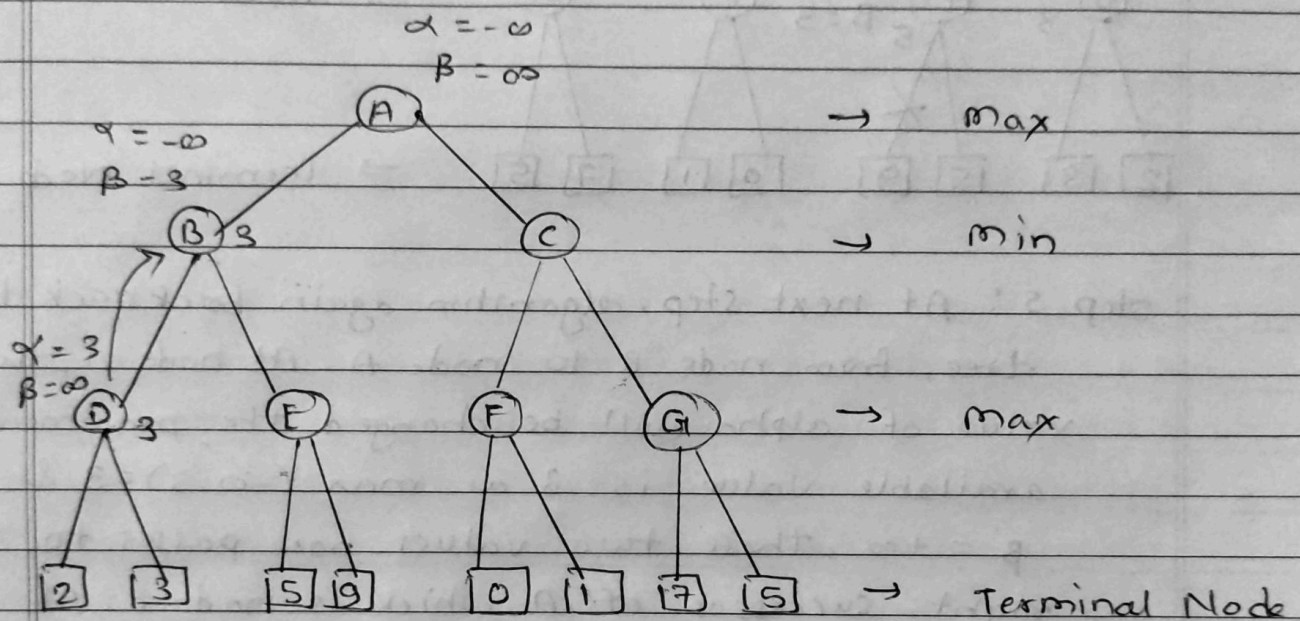


Step 2 : At Node D, the value of  $\alpha$  will be calculated as its turn for max. The value of  $\alpha$  is compared with firstly 2 and then 3 and the  $\max(2, 3) = 3$  will be value of  $\alpha$  at node D and node value will also 3.



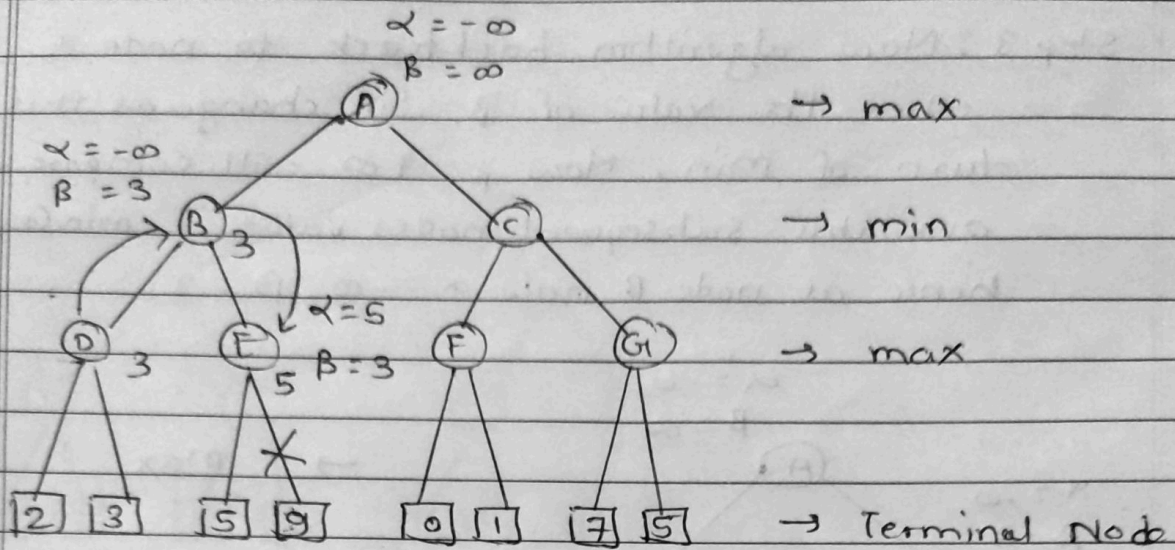


Step 3: Now algorithm backtrack to node B, where the value of  $\beta$  will change as this is turn of min. Now  $\beta = +\infty$ , will compare with available subsequent nodes value, i.e.  $\min(\infty, 3) = 3$ , hence at node B now  $\alpha = -\infty$ ,  $\beta = 3$

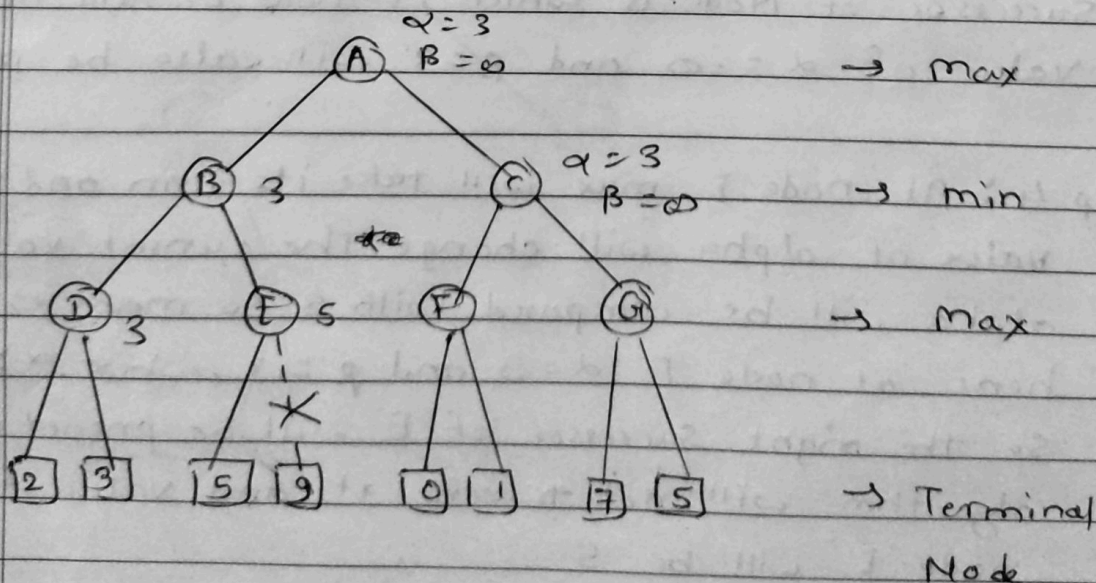


In the next step, algorithm traverse the next Successor of Node B which is node E, and the value of  $\alpha = -\infty$  and  $\beta = 3$  will also be passed

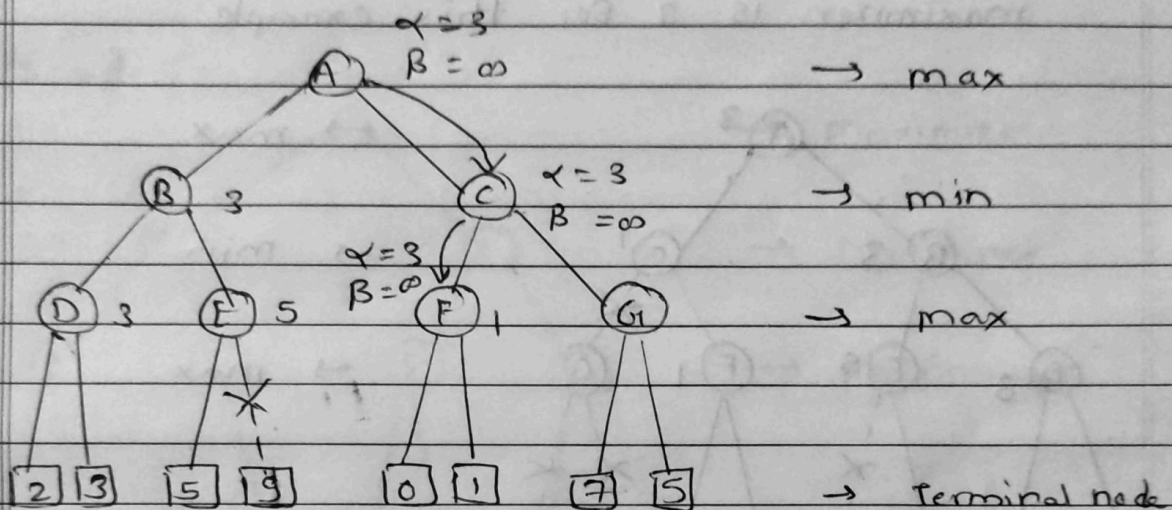
Step 4: At node E, max will take its turn and the value of alpha will change. The current value of alpha will be compared with 5, so  $\max(-\infty, 5) = 5$ , hence at node E  $\alpha = 5$  and  $\beta = 3$ , where  $\alpha \geq \beta$ , So the right Successor of E will be pruned and algorithm will not traverse it and value at node E will be 5.



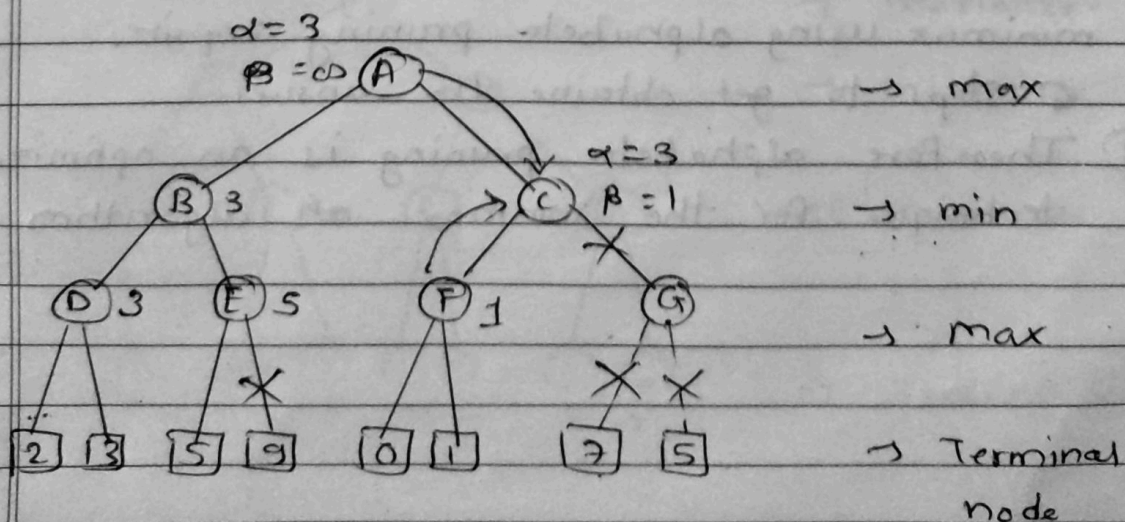
step 5: At next step, algorithm again backtrack the tree, from node B to node A. At node A, the value of alpha will be changed the maximum available value is 3 as  $\max(-\infty, 3) = 3$  &  $\beta = +\infty$ , these two values now passes to right successor of A which is node C. At node C,  $\alpha = 3$ , &  $\beta = +\infty$ , and the same value will be passed on to node F.



step 6: At node F, again the value of  $\alpha$  will be compared with left child which is 0,  $\max(3, 0) = 3$ , then compared with right child which is 1, and  $\max(3, 1) = 3$  still  $\alpha$  remains 3, but the node value of F will become 1.

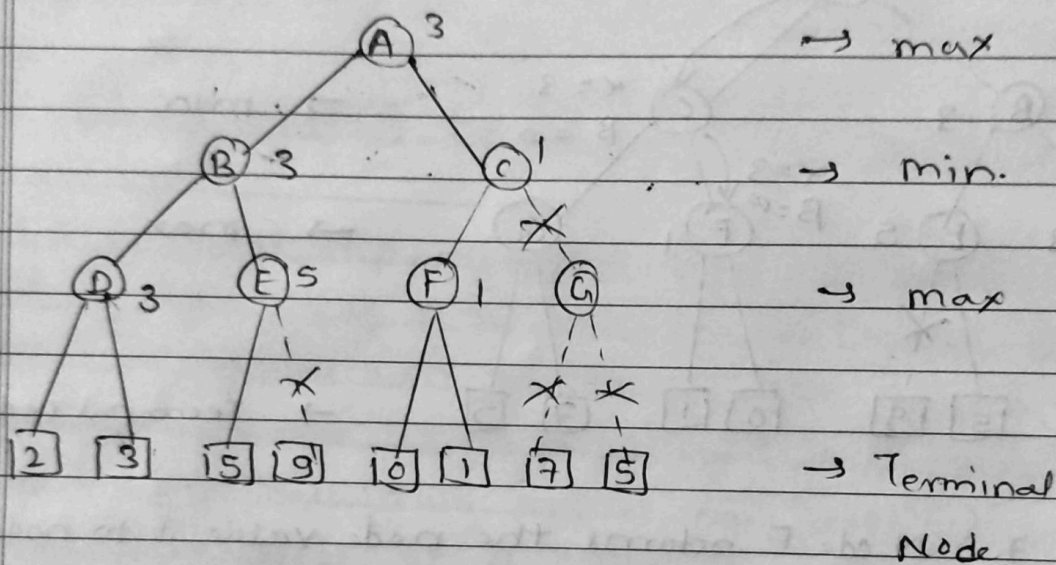


Step 7: Node F returns the node value 1 to node C, at  $C$   $\alpha=3$ ,  $\beta=\infty$ , there the value of beta will be changed, it will compare with 1 so  $\min(\infty, 1) = 1$ . Now at  $C$ ,  $\alpha=3$  and  $\beta=1$  and again it satisfies the condition  $\alpha \geq \beta$ , so next child of  $C$  which is  $G$  will be pruned and algorithm will not compute the entire sub-tree  $G$ .





Step 8: C, Now return value of 1 to A here the best value for A is  $\max(3, 1) = 3$ . Following is the final game tree which is showing nodes which are computed and nodes which has never computed. Hence the optimal value for the maximizer is 3 for this example



Conclusion: Minimax algorithm using alpha-beta pruning is an optimization technique for the minimax algorithm.

- ① In this example min-max algorithm requires 8 steps to obtain the final answer whereas minimax using alpha-beta pruning requires 6 steps to get the answer.
- ② Therefore alpha-beta pruning is an optimization technique for the minimax algorithm.