DA221: Introduction to AI
Lab Assignment 2: TIC TAC TOE SOLVER

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ALGORITHMS USED

1. MINIMAX without alpha beta Pruning

2. MINIMAX with alpha beta Pruning or NORMAL

METRICES FOR EVALUATION:

1. Number of Nodes Visited

2. Time taken

ANALYSIS:

NUMBER OF NODES VISITED:

When both algorithms were placed to fight each other in Tic Tac Toe game with randomly selecting which algorithm starts first, these are the number of nodes both algorithms visited in their respective MINIMAX functions.

Seed	Number of Instances	Nodes Visited(Pruning)	Nodes Visted (Normal)
100	100	1204572	3182202
101	100	1129965	3292784
102	100	1122548	3411420
103	100	1037970	3628846
104	100	1098933	3431190
105	100	1055091	3739324
106	100	1155328	3301470
107	100	1086190	3570246
108	100	1076105	3674104
109	100	1129463	3263240
110	100	1087462	3410414

Hence, on an average:

Number of Instances	Average Nodes Visited(Pruning)	Average Nodes Visited(Normal)
100	1107602	3445930

It can be seen clearly from the above average number of nodes visited in 100 matches that MINI-MAX algorithm with alpha-beta pruning is about 3 times efficient (visits $\approx 67\%$ less nodes).

TIME TAKEN:

To measure speed of solving the problem , i.e Time Taken to finish a match(either win/draw) , we measured the time taken by 100 matches between algorithms when:
1.Both were not using alpha beta pruning (Normal vs Normal)
2.One of them was using alpha beta pruining (Normal vs Pruning)

VALIDITY: This measurement metric is valid becuase during comaparing the performance between 2 types of matches, we have kept the seed value to same hence in both kind of matches *Normal Algorithm* plays the same against Pruning Algorithm and another Normal Algorithm.

Seed	Number of Instances	Normal vs Normal	Normal vs Pruning
100	100	323353	216902
101	100	303439	196324
102	100	311305	202262
103	100	288173	215007
104	100	297898	196959
105	100	282935	212311
106	100	295513	204645
107	100	287634	208778
108	100	290621	220713
109	100	290771	202619
110	100	295253	214375

Hence, on an average:

Number of Instances	Average Time Taken(Normal)	Average Time taken(Pruning)
100	296990	208263

It can be seen clearly from the above average time taken for 100 matches that MINIMAX algorithm with alpha-beta pruning is about 1.5 times efficient (takes $\approx 33\%$ less time).

CONCLUSION:

Using both the metrices, we have shown that MINIMAX Algorithm with α β Pruning is almost 1.5x better in terms of time taken and almost 3x better in terms of space complexity.
Thereotically as well, we can easily deduce that by comparing values of α and β at each node, MINIMAX with Pruning should visit lesser nodes and hence should have lesser time and space complexity.
Hence, it can be concluded that MINIMAX with Pruning is far better than without pruning in case of **Two-Player, Zero-Sum game**.