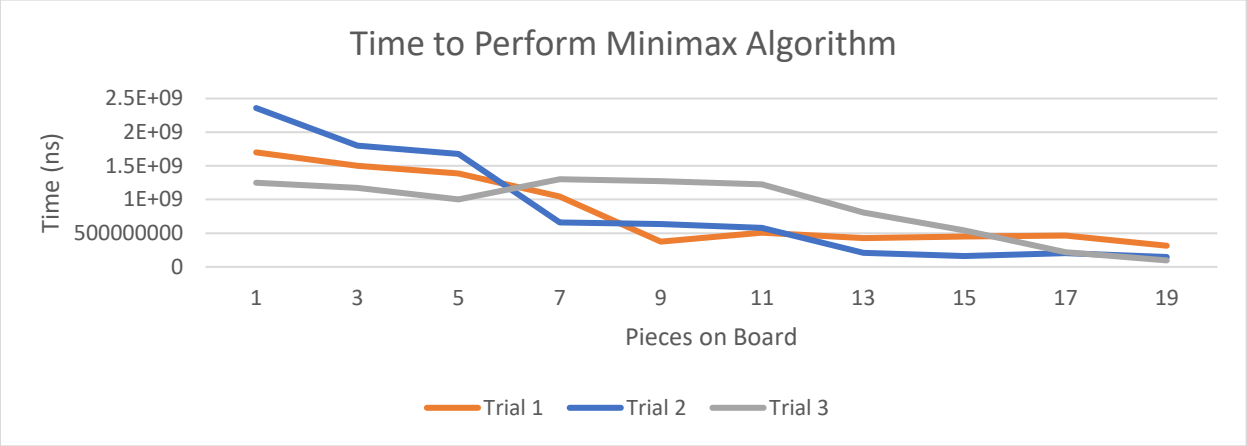
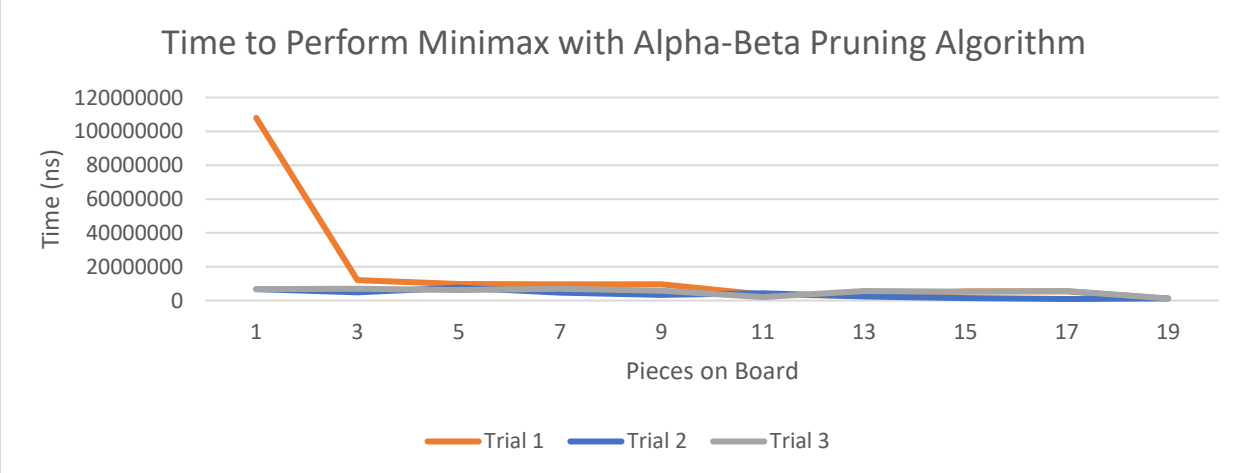
Minimax Search vs Minimax Search with Alpha-Beta Pruning

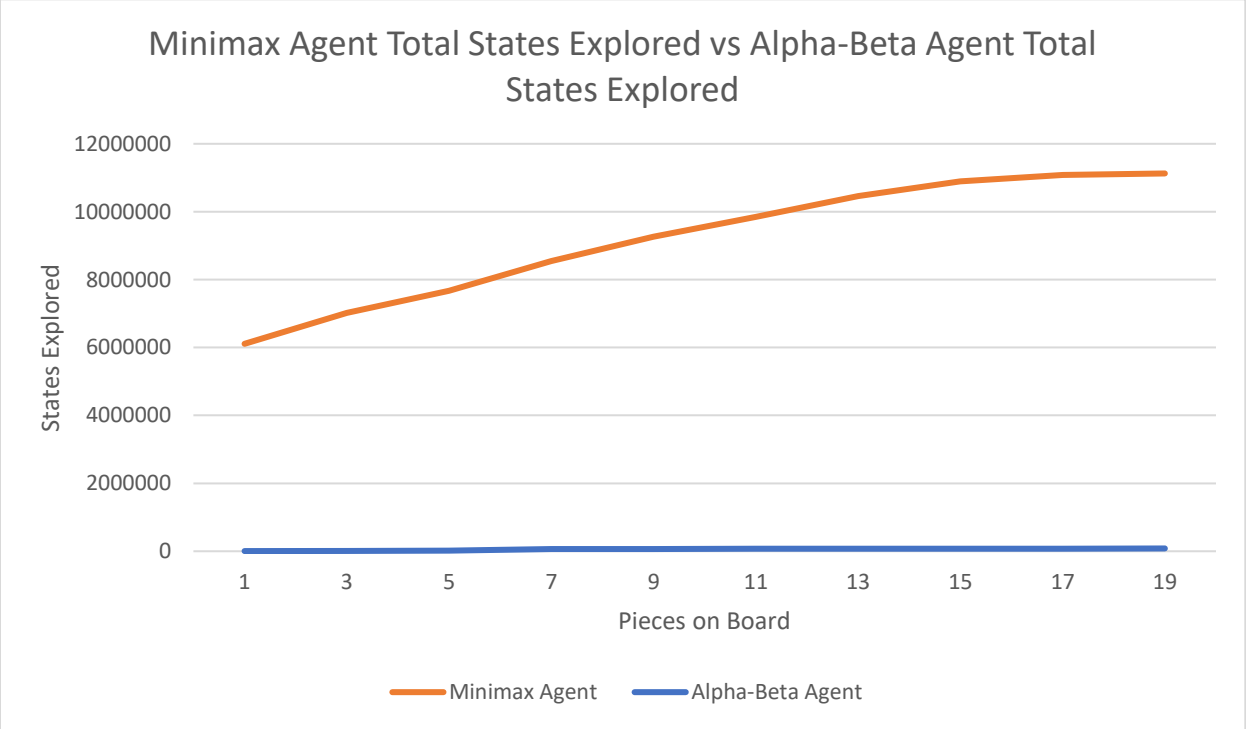
Upon completion of the code needed to run this experiment, it became clear that there is a stark and unmissable difference in performance between an adversarial agent using the Minimax algorithm, and one that uses Minimax with alpha-beta pruning. The agent that took advantage of alpha-beta pruning is much faster, but how much faster and why?

In order to quantify the difference in speed between these two search algorithms, the code was augmented slightly to sample the system time in nanoseconds immediately before and after the search algorithms were run. The game was then played 3 times and the agents were allowed 10 turns each per game. The results below indicate that the Minimax Agent without Alpha-Beta pruning ran between 50 to 170 times slower than the Minimax Agent with Alpha-Beta pruning.





Additionally, the code was augmented to track the number of states explored when searching the state space. The game was played and the agents were allowed 10 turns each. The results show that the Agent that did not use Alpha-Beta pruning explored 11043546 more states.



In conclusion, it is painfully obvious that the Minimax Agent with Alpha-Beta pruning is a much less resource intensive and far more responsive adversary when playing Connect 4. Use it instead of simple Minimax.