# Artificial Intelligence - Lab

## Assignment Solution - 9

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## 1. Simple Connect-four game

The simple Connect-four game is implemented using Minimax algorithm and Alpha-beta pruning.

**Minimax algorithm:**The Minimax algorithm is a kind of backtracking search algorithm that is mainly implemented in game theory to find optimal move by the player. It is popularly used in two-player games such as Chess, Connect4, Tic-tac-toe etc.

**Alpha-beta pruning:** The Alpha-beta pruning is not a new algorithm, instead its a optimization of the minimax algorithm, which decides the optimal moves for a player in lesser steps, reducing the execution time.
**Alpha-** The best value for maximizer.
**Beta-** The best value for minimizer.

**Negamax search:** Negamax is a variant of minimax algorithm that considers, max(a, b) = -min(a, b). It reduces code complexity.

Currently the Connect4 game is played against human player and computer.

## 2. Comparison of approaches

1. Time Complexity: $O(b^d)$
   where, b - branching factor and d - depth of game tree
For the Connect4 game,
b = 7, d = 5
Time complexity = 16807

2. Space complexity: $O(bd)$
   Space complexity = 7*5 = 35

Conclusion: The Alpha-beta pruning is a optimization technique, that results in a better execution of Minimax algorithm. The technique is much faster and also explores the nodes into deeper levels in game tree. As the method cuts off the branching of the nodes when it already has its best node/move. Therefore, there is a reduced space complexity and computation time.
Below table displays the average computation time for the AI/computer to make its best move, in both the techniques.

| Technique | Execution time (in seconds) |
|---|---|
| Minimax algorithm | 0.6 |
| Alpha-beta pruning | 0.07 |

*Citation:*

1. http://www.geeksforgeeks.org/minimax-algorithm-in-game-theory-set-4-alpha-beta-pruni

2. https://github.com/LouisBarranqueiro/ia-connect-four-game