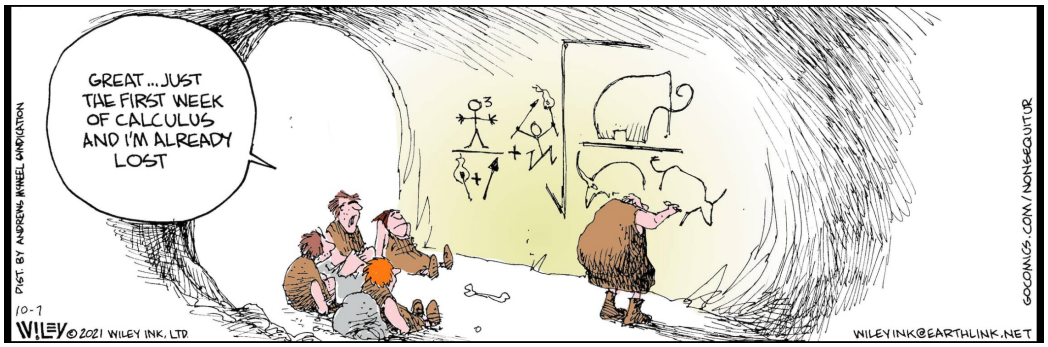
CSCI 3202

Lecture 22

October 17, 2025



Non Sequitur by Wiley Miller: https://www.gocomics.com/nonsequitur

Announcements

- Homework 6 available today
  - Due in 1 Week on Friday, 10/24 by 11:59 pm
- Quiz 7 Today
  - Game Trees
  - Minimax
  - Alpha Beta pruning
- Project Description Today
  - Make a choice on which project to do and submit by Wednesday, October 22 at 11:59 pm

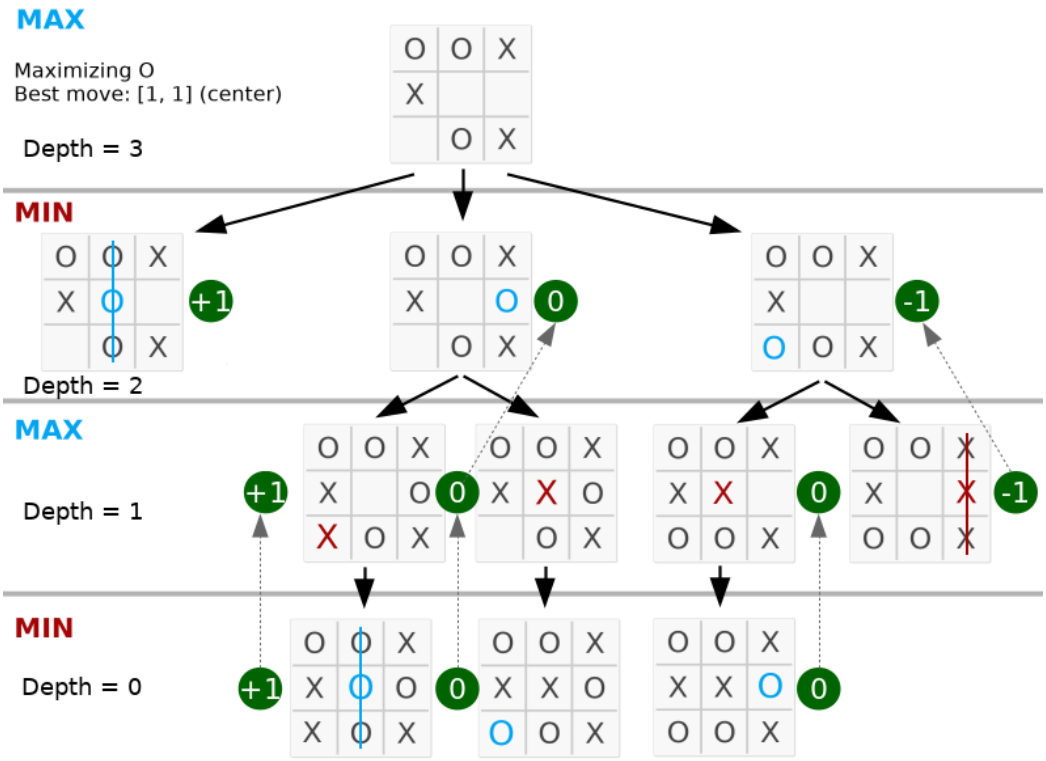
$\alpha\beta$ Pruning

- An alternative summary of $\alpha\beta$ is in: https://www.geeksforgeeks.org/minimax-algorithm-in-game-theory-set-4-alpha-beta-pruning/
- For an average breadth of b with a depth of d, the game tree has $O(b^d)$ nodes to search
  - The depth, d, can be terminal nodes for a game (nodes at the end of the game) or they can be *plies*
  - *Plies* are a limit on the number of moves usually based on time to reach a solution
  - Plies are the number of turns ahead (from the current turn) that each player

makes in a game
    - 4 plies is 2 turns for each player
- By using the $\alpha\beta$ cutoff, *best case* we can reduce the number of nodes to search in half to $O(b^{d/2})$
- We are applying the $\alpha\beta$ Cutoff in some particular order, usually left to right. This order determines how effective the cutoff actually is for a particular tree
- Because order matters (determines how effective the cutoff is), on averages, we expect the cutoff to give is $O(b^{3d/4})$ nodes to search
- This is still a reduction. For large problems the reduction can be very large
- Detailed Alpha Beta Pruning.pdf

How We Use minimax to play tic-tac-toe

- Tic-tac-toe is a 2 player, zero-sum games
- Each board position is a state
- We create a tree of all possible moves beginning at the start of the game
- We use an evaluation function to rate the strength of the terminal states, positive means that we are winning and negative means we are losing
- We use a function from game theory called minmax() to maximize the value of our move and minimize the value of our opponent's move
- Then we search through the tree looking for the best value of the minmax() function, as far out as possible into the game
- Ideally, we would search to the end of the game, but we rarely can afford to search that far (or we don't have the patience)
- How far we can search into the game depends mainly on the amount of memory and the speed of our CPU



Readings

- AIMA Section 5.1-5.3

Alpha Beta pruning

- Minimax is a backtracking algorithm therefore we have to go through the entire tree
- The size of the tree grows exponentially with each layer
- There are some nodes or entire branches of the tree that will never be the result of minimax. We can stop evaluating these nodes or branches to save time
- Alpha Beta is recursive. It follows a similar evaluation path to DFS search
- Remember that the algorithm descends to the bottom of the tree then works back up. This means that alpha beta is doing its primary work as it climbs back up the tree
  - You don't get the utility function values until you get to the bottom of the tree
- Each time the a player moves, we reevaluate the tree with either minimax or alpha beta
- Detailed Alpha Beta Pruning.pdf

Questions

- How do the result of Minimax differ from the results of Alpha Beta pruning?
- Why does the order of evaluation affect Alpha Beta pruning?
- How can we determine the sequence of best moves from a particular position?
- What happens if your opponent makes a non-optimal move?

Project

- CSCI 3202 Course Project 2025.pdf
- Make a choice on which project to do and submit by Wednesday, October 22 at 11:59 pm

Upcoming

- Markov decision processes next week