6.034: Game Search For Non-Games

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We've discussed game theory in the context of playing games, but game theory also plays an important role in other domains as well, particulary in economics. (The Nobel Prize in economics has gone more than a few times to academics working on game theory!)

The idea is still one of adversarial search, but the nodes in the game tree represent decision points rather than board configurations, and the links represent decision choices.

Consider the following example.

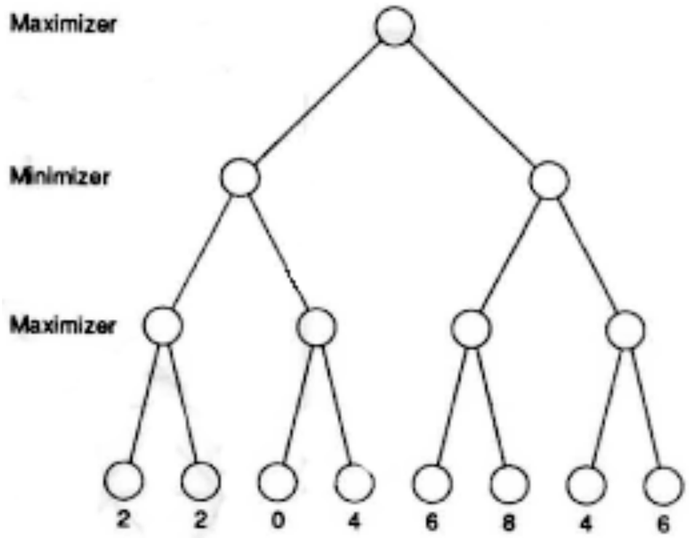
You want to park your food truck in downtown Boston where you'll get lots of business during the morning and evening rush hours. Your competitor wants to do the same thing and is determined to take as much business away from you as possible. There's another location that you're considering that doesn't really have rush hours, but instead has a steady stream of customers throughout the day. If your competitor puts his truck in that location too, you think you wouldn't lose as much business. Where should you park your truck?

Here's your assessment of the situation. The numbers below represent an estimate of your total sales in hundreds of dollars at the rush hour (R) location and the non-rush hour (N) location.

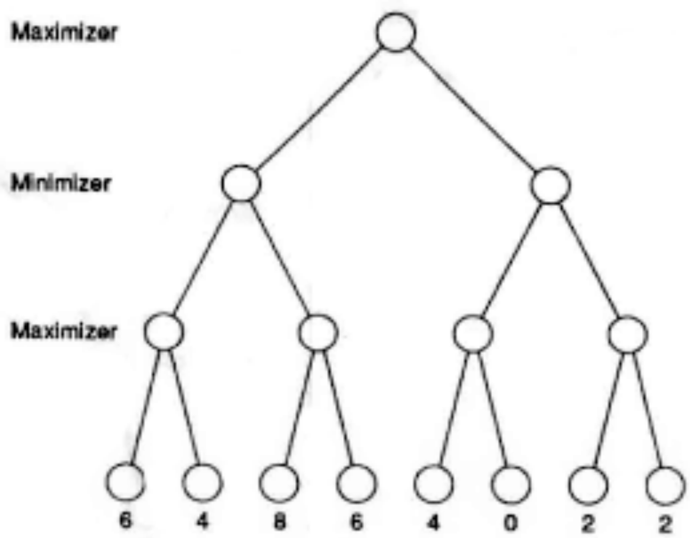
	Him at R	Him at N
You at R	1	5
You at N	4	3

1. Draw the game tree, assuming that you choose your location first.

2. Where do you park your truck? Where does your competitor park his truck?

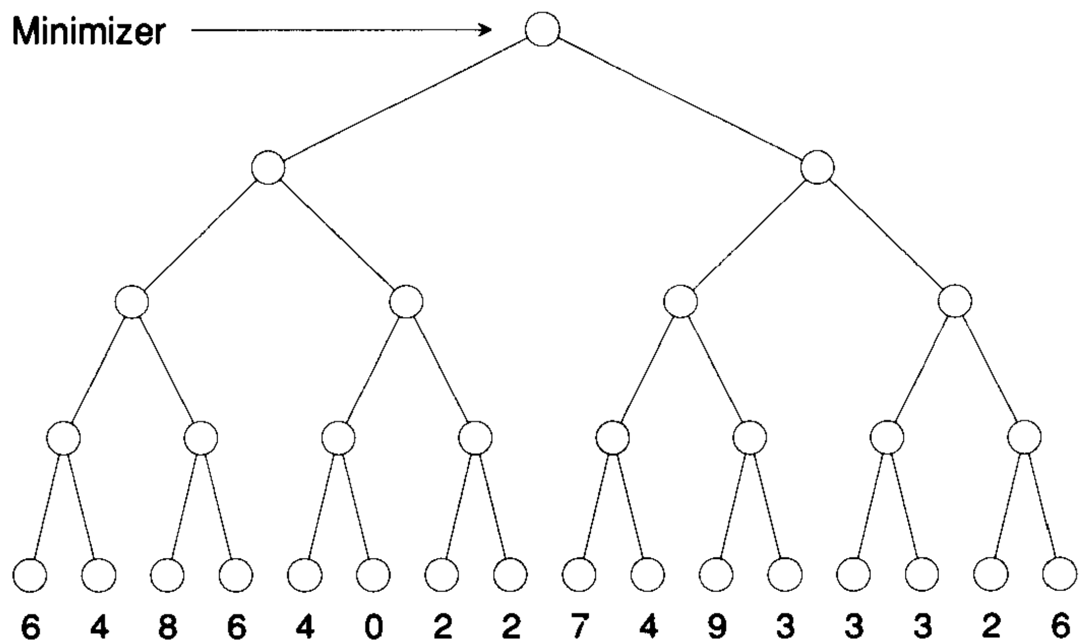


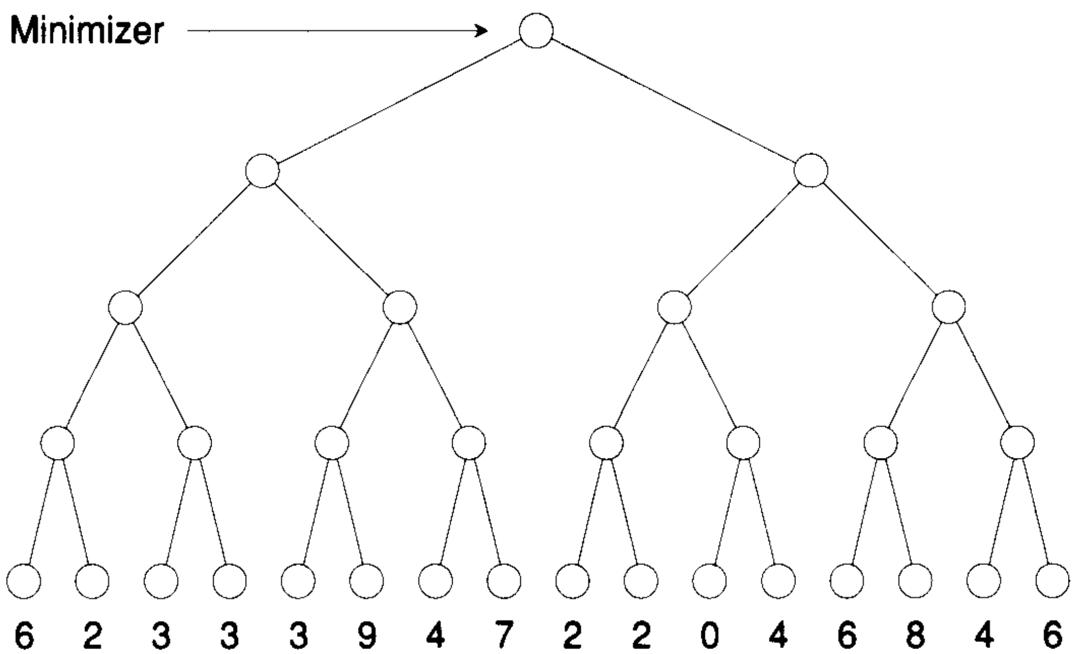
2. Now consider the tree shown below. which is a mirror image of the tree shown above. Explore the tree using the alpha-beta procedure. Indicate all parts of the tree that are cut off. Indicate the winning path or paths. Strike out all static evaluation values that do not need to be computed.



3. Compare the amount of cutoff in the above two trees. What do you notice about how the order of static evaluation nodes affects the amount of alpha-beta cutoff?

4. Below are two game trees (as above, they are mirror images of one another). Perform alpha-beta search on both trees and comment on the effectiveness in each case.



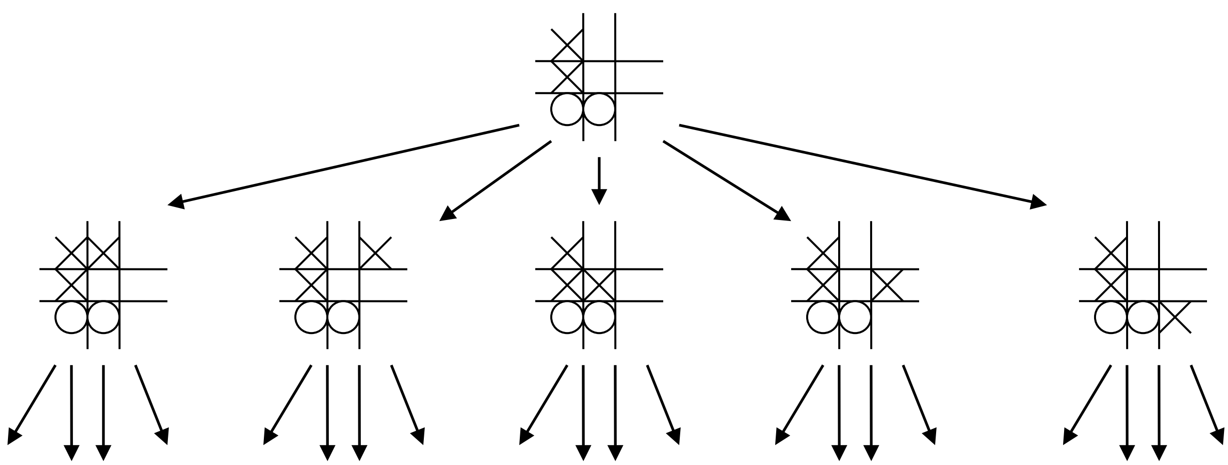


5. Tic-Tac-Toe

You are the X player, looking at the board shown below, with five possible moves. You want to look ahead to find your best move and decide to use the following evaluation function for rating board configurations:

```
value V = 0
do over all rows, columns, diagonals R:
    if R contains three Xs, V = 1000
    else if R contains three Os, V = -1000
        else when R contains only two Xs, V = V + 100
        else when R contains only one X, V = V + 10
        else when R contains only two Os, V = V – 100
        else when R contains only one O, V = V – 10
  end do
return V
```

Draw the four configurations possible from the leftmost and rightmost board configurations below. Use the above static evaluation function to rate the 8 board configurations and choose X's best move. (A reminder: The board configurations that you draw will show possibilities for O's next move.)



6. Consider the game GO. The game is played on a grid with white and black stones placed at the grid intersections. White and black alternate moves, each placing one stone per move. The actual GO board is 19 x 19. Let's consider mini-GO played on a simpler board that is 9 x 9 (81 positions). Estimate the size of the game tree for mini-GO (ignoring the rules for capturing opponent stones). How deep is the search tree?