Parallel Functional Programming Project Proposal

Using Parallel Alpha-Beta Pruning to Solve 2048

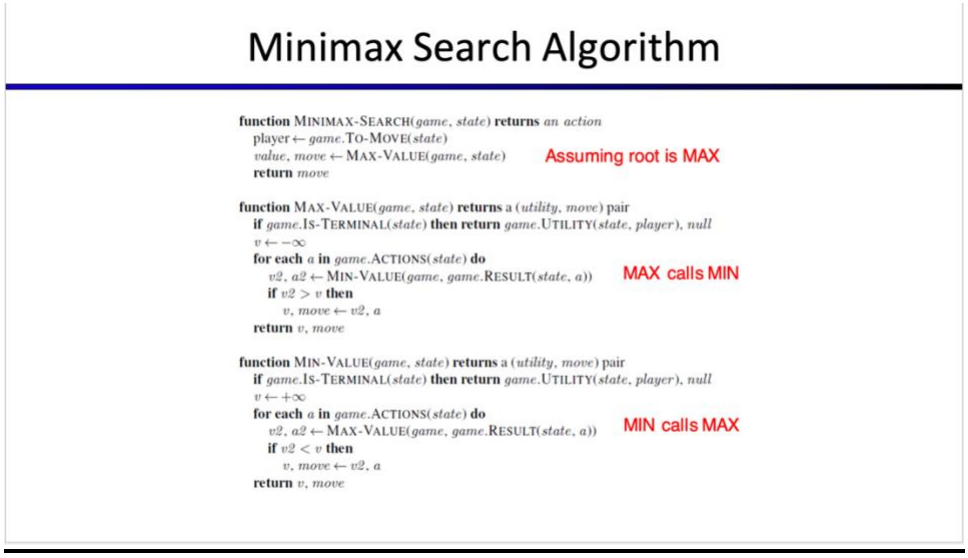
Unal Yigit Ozulku (UNI: uyo2000)

2048:

"2048 is played on a plain 4×4 grid, with numbered tiles that slide when a player moves them using the four arrow keys. Every turn, a new tile randomly appears in an empty spot on the board with a value of either 2 or 4. Tiles slide as far as possible in the chosen direction until they are stopped by either another tile or the edge of the grid. If two tiles of the same number collide while moving, they will merge into a tile with the total value of the two tiles that collided. The resulting tile cannot merge with another tile again in the same move." (Wikipedia)

Minimax:

"Minimax is a recursive algorithm which is used to choose an optimal move for a player assuming that the adversary is also playing optimally" (Medium). This project will focus on parallelizing the minimax algorithm in Haskell and analyzing metrics to understand the difference in performance from a sequential implementation to a parallel one.



Picture from COMS 4701 lecture slides

Alpha-beta pruning:

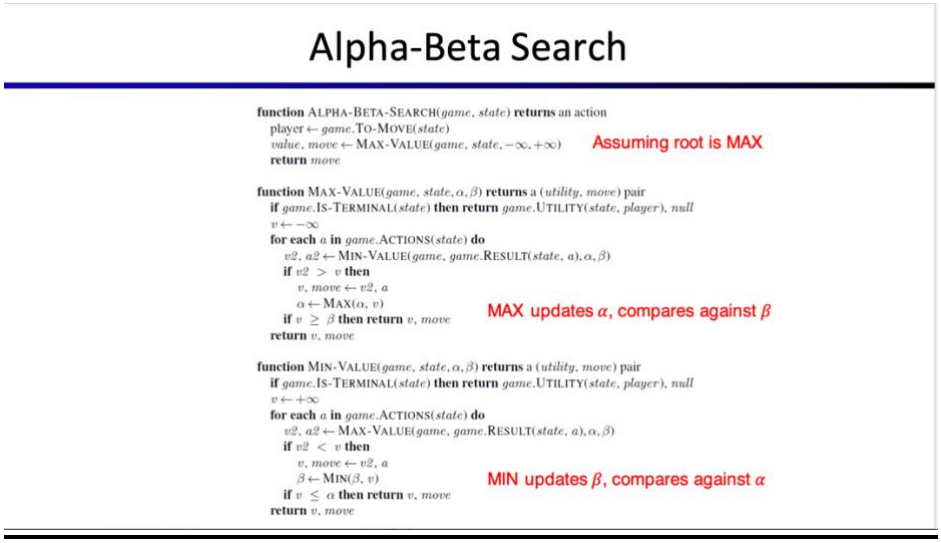
"Alpha–beta pruning is a search algorithm that seeks to decrease the number of nodes that are evaluated by the minimax algorithm in its search tree. It stops evaluating a move when at least one possibility has been found that proves the move to be worse than a previously examined move. Such moves need not be evaluated further. When applied to a standard minimax tree, it returns the same move as minimax would, but prunes away branches that cannot possibly influence the final decision." (Wikipedia)

General idea: Keep track of highest (α) and lowest (β) values seen so far by MAX and MIN nodes, respectively

▪ Skip remaining children (prune) if:

▪ MAX sees value higher than β

▪ MIN sees value lower than α



Picture from COMS 4701 lecture slides

Sources:

- https://en.wikipedia.org/wiki/2048_(video_game)
- COMS 4701 – Artificial Intelligence (Columbia University, Prof. Tony Dear, Summer 2021)

- https://medium.com/@bartoszzadrony/beginners-guide-to-ai-and-writing-your-own-bot-for-the-2048-game-4b8083faaf53
- https://en.wikipedia.org/wiki/Alpha–beta_pruning