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Assignment -2

using Alpha-Beta Pursuning to optimize AI in a Real-time logistics strategy Game by Amazon:

Introduction of the Game AI needs:

Amazon is developing a real-time of strategy (RTS) game to educate users of logistics, supply chain, and delivery The management. The game combines enterai-nment with practical learning objectives, placing players in control of logistics hubs, delivery routes.

AI Role in The game:

The game includes AI-driven opponents that simulate realistic competitor of behavior. These AI agents make strategic.

* Adjusting delivery routes.
* managing stock levels across The warehouses
* the changing pricing is based on the supply-demand.
* Responding to competitor strategies.

The need of optimization:

Decision trees naturally grow exponentially with each layer of complexity added. Without optimization, the AI's decision-making time would exceed acceptable limits. Therefore, optimization methods like Alpha-Beta pruning are essential.

Understanding Alpha-Beta Pruning:

Before diving into Alpha-Beta pruning, it's important to understand the minimax algorithm.

* Generating a tree of all possible moves.
* Simulating possible responses from the opponent.
* Choosing the move that maximizes the AI's minimum guaranteed outcome.

What is Alpha-Beta pruning?

Alpha-Beta pruning is an enhancement to the minimax algorithm that significantly reduces the number of nodes evaluated:

* Alpha (α): The best (highest) value That the maximizer currently can guarantee.

* Beta (β): The best (lowest) value that The minimizer currently can guarantee.

If the current branch cannot produce a better outcome than a previously examined branch, it can be skipped.

Decision trees in the game

Each AI opponent builds a decision tree based on various parameters:

* Route efficiency and delivery times.
* Inventory costs and stock shortages.
* pricing strategies and customer demand.
* competitor movements (player strategies).

Each node in the decision tree represent a game state, and each branch represen possible decision.

Benefits of Alpha-Beta pruning in this scenario:

Implementing Alpha-Beta pruning within this context allows:

* **Faster AI response**: The AI can evalute only promising branches of decision tree, ensuring it responds.

* **Resource optimization**: Reduces memory and CPU usage, making it suitable for mobile for mobile and wep.

Real-Time Application example:

Suppose the AI must choose b/w:

* Increasing inventor in a low-supply warehouse.

* Diverting a truck to reduce the delivery time.

* lowering prices to undercut the player.

Each move has consequences several turns into the future.

Heuristics for evaluation:

Since the game involves complex logistics data, heuristic evaluation functions must be domain-specific.

* Average delivery time.
* stockout risk.
* customer satisfaction.
* competitor pricing differences.

Depth limiting and iterative deepening:

To meet the 1-sec response constraint the AI can:

* use iterative deepening: start with depth = 1 and increase until time runs out.
* use move ordering: evaluate promising moves (e.g: reduce delivery time) first, increasing chance.

Using Alpha-Beta pruning allows Amazon's educational RTS game to:

Summary of Benefits:

* Provide intelligent and challenging AI opponents.
* Maintain real-time performance with sub-second decision-making.
* Simulate realistic logistics strategies under the constraints.