AI - Exercice 3 - 2048

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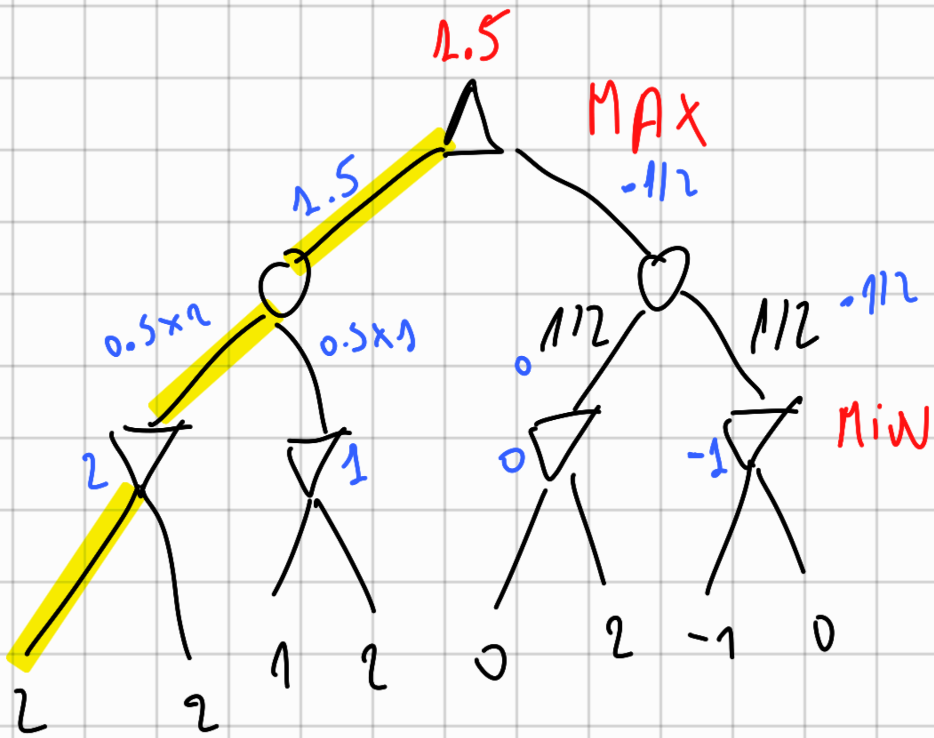
Question 4

①



② • If we know 6 first leaves, we need to do better than 1.5 from the left-hand chance node.
The fact is that we can do better, that's why we need to evaluate the 7^{th} and 8^{th} node.
The 5^{th} and 6^{th} nodes will give $\min(0,2) = 0 \Rightarrow 1/2 \cdot 0 = 0$
So we have for 7^{th} and 8^{th} to be higher:

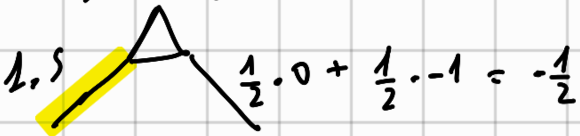
$$0 + \frac{1}{2} \cdot \min(7^{th}, 8^{th}) > \frac{3}{2}$$

$$\frac{1}{2} \cdot X > \frac{3}{2}$$

$$X > \frac{5}{2}$$

That's why we need to know the value of 7^{th} and 8^{th}

- If we know the 7th first nodes, we don't need to know the 8th because the 4th ▽ will take the min(-1, x) when x is the value of 8th nodes.
  - If it's -1 the minimum the root that chooses the maximum will go through left-hand node:



  - If the 8th is lower than -1, the node will take it but the max will again go through left-hand.

that's why the 8th node is so important.

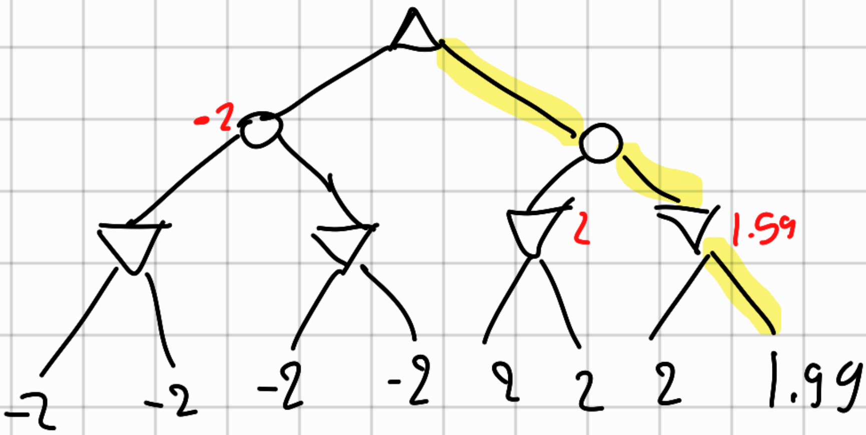
③ The range value is between [-2, 2].

If - 1/2 nodes are 2 } left-hand is 1/2 . 2 = 1
 - 3/4 ——— 2

If - 1/2 nodes are -2] left-hand is $\frac{1}{2} \cdot -2 = -1$
 - 3/4 nodes are -2

So the range is [-1, 1] for the left-hand chance node

④ In many cases, just 6 nodes are enough but we will give without loss of generality, we will take an example that we need all leaves to return an answer.



Here the left hand don't need the node 2/3/4 because it's already the minimum of the range but the root takes the maximum so all the left hand node is uncessary.
The node 5/6/7 are the maximum of the range and we are in the minimum that's why we need to check node 8 that is the answer.

Question 6

(1) The Expectimax algorithm is theoretically more suitable for the game 2048

- It's a single player game with random elements.
- Expectimax can handle probabilistic outcomes which aligns with 2048 game.
- It doesn't assume a rational opponent, fitting 2048's nature.

(2)

Metric	Minimax	AlphaBeta	Expectimax
Average Score	6,592	6,190	10,010
Average Highest Tile	512	486	768
Average Game Duration (seconds)	148.87	28.84	236.35
Lowest Score	3,064	3,064	5,584
Highest Score	10,464	12,240	14,468
Lowest Highest Tile	256	256	512
Highest Highest Tile	1,024	1,024	1,024

Expectimax is more successfull in averay score but it is less efficient in time

(3) Yes, they are consistent because this game has no adversary and the tiles appears randomness.

(4)

Metric	Minimax Agent	AlphaBeta Agent	Expectimax Agent
Scores Std Dev	2385.7	2822.5	3067.6
Highest Tiles Std Dev	227.2	132.0	256.0
Game Durations Std Dev	41.66	12.07	56.65

- Expectiax has the longest mean duration that explains the std deviation because it takes time to take decisions due to more

complex / deeper evaluation. Alpha beta is the fastest agent because it takes decision fast possibly due to pruning.
Minimax is between them.

- Expectimax has the highest mean score and tiles, indicating it generally performs better in achieving higher tiles. std is high also showing its strategy depth.
- Minimax is consistent but is not reaching high score like Expectimax.
- Alphabeta shows lower consistency reflecting more variability.

Alternative games

① • Expectimax: impact of the algorithm's performance and decision making would be minimal in most practical scenarios due to the extremely low probability.
The algo will still primarly focus on optimizing the normal game outcomes, with only a very slight tendency towards more immediate scoring opportunities in extremely long games.

• Minimax / Alpha-beta: not designed to handle probabilistic events especially ones with such extreme probabilities (1 in a billion).

② Simple game: - choose between 2 actions A or B
- each action leads to a change node, where the outcome depends on a probabilistic event.

A → A_1 : 80% and score 10
↘ A_2 : 20% and score 0

B → B_1 : 50% and score 5
↘ B_2 : 50% and score 5

- Minimax: He will chose the action that maximizes the minimum score

  A has min 0

  B has min 5

  $\max(\min(A,B)) = 5$

So, the minimax player will choose B.

- Not exacly expectimax player
  - $A = \frac{10+0}{2} = 5$
  - $B = \frac{5+5}{2} = 5$

Since both actions have the same expected score, the player might choose any of them but the wrong assumption makes the player indifferent to the probabilistic differences.

He can check A or B due to the assumption wrong of equal probabilities and potentially take A which could lead to score 0.