2048 - Project

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Version 1 : MinMax with Heuristic

The first part I focussed on is the heuristic. I wanted to see what parts like corners etc need to have what kind of weights to get a good score. So in this version, I tried to keep the highest tile at the bottom left corner and also to measure the monotonicity of the bottom row and left most column. The resulting scores were low but I understood what's happening and what needs to be improved. Empty tiles are weighted x2.7 and corner with x2.

Version 2: Alpha Beta with a better heuristic

This version uses AlphaBeta because within the time for every move to get a better depth pruning is needed. It uses the last best move if the time runs out. Rather than having move order randomly, I ordered them in UP, LEFT, RIGHT and DOWN since it's better than having it random. Rewarded with x1000 when the highest occupies any corner and only rewarded monotonicity by x10 only when the rows/columns are non increasing. I also included the base score and increased the weight for the empty tile bonus to 270. This got me a better score than my previous one. The scores were on average around 7000. It tested all the versions with just 0.1sec.

Version 3: Alpha Beta with move ordering and best move memory

Added penalty when the max tile is not in the corner and also changed the weights for empty tiles to 250 and corner score is calculated by 1000*max_tile and penalty is 500*max_tile. I preferred it to stay in the corner in the later half of the game. Penalty and reward for monotonicity. The move ordering is also just static. The scores were on average around 8500.

Version 4: Alpha Beta with rotation and heuristic

This version kept AlphaBeta but improved the heuristic further by trying all 4 rotations of the board (0°, 90°, 180°, 270°) and choosing the maximum score across all rotations. This allowed the agent to evaluate symmetrical board configurations and favor ones that maintain corner control and better merge paths.

The corner bonus logic stayed similar to Version 3 (1000×max_tile if in a corner, else −500×max_tile), and I also continued rewarding empty tiles (270×count) and monotonicity (positive for decreasing sequences, negative otherwise).

The key addition was the heuristic function checking each board rotation and picking the best-scoring one, encouraging the agent to keep good board structure even if the tile orientations varied.

Version 5:

This version refines the rotational approach from Version 4 by strongly encouraging the maximum tile to stay in the bottom-left corner (instead of any corner). I explicitly added a much stronger bonus when the highest tile is in that fixed corner and a significant penalty otherwise.

The board is still rotated 4 ways like in Version 4, but now the heuristic places more weight on anchoring the max tile in a single fixed corner, helping with long-term planning and smoother merges. The same monotonicity and empty tile bonuses were preserved, and the overall structure of AlphaBeta remained unchanged.

Version 6:
This version has some revisions over version 5 in the weights. Corner bonus with 1500*max_tile and penalty with 800*max_tile, empty tiles 300*count. I did 29 runs with this version with 0.5 seconds per move using python and got an average of 14000 score. The highest score is around 33000.

Version 7: Expectimax with Heuristics, best move memory and move ordering
Uses depth 4 when enough empty tiles are available, else 3 for speed under tight limits. Improved heuristic with Empty tile count,Max tile in a corner bonus,Snake pattern weighting,Monotonicity (rows & columns),Smoothness penalty (adjacent tile difference),Merge potential bonus. In this version I used 500×empty tiles, +2500/−1000 for corner max tile, weighted snake pattern, +1200 for monotonic rows/cols, −50×log-diff for smoothness, and +400×merge potential as heuristic to get the best result.

Version 7 is my best version.