



Trinity College Dublin

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CS7IS2 Artificial Intelligence

2048 AI Agent

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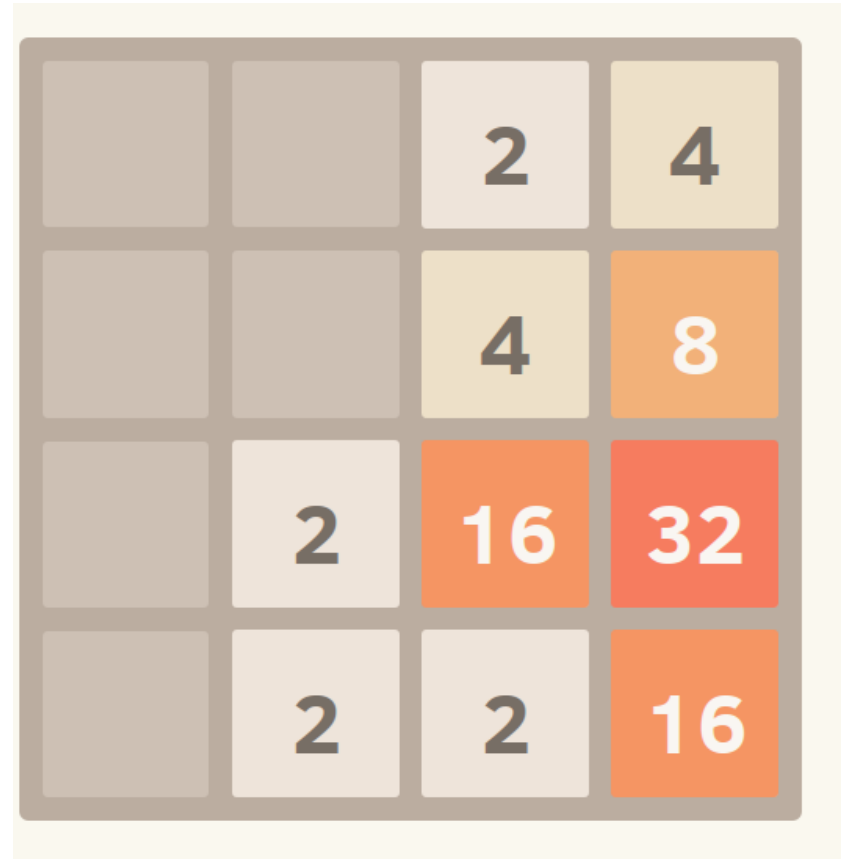
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2048

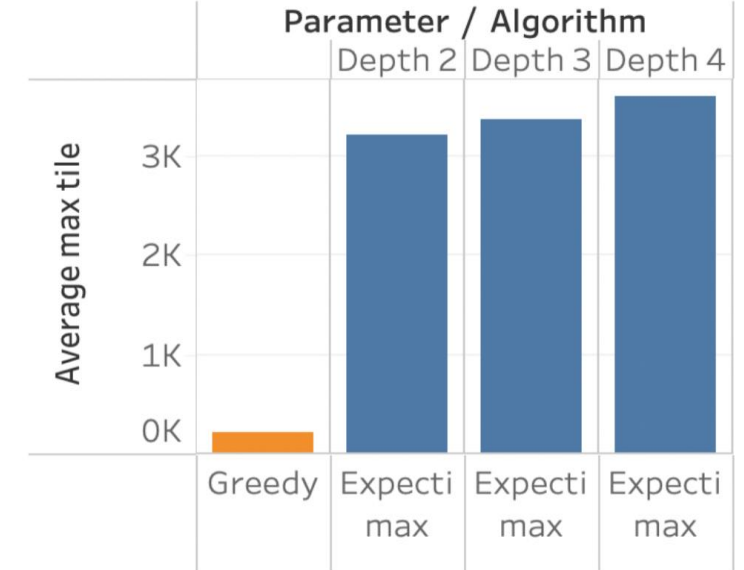
- **Objective** – combine numbered cells on grid to achieve 2048.
- 4x4 grid where tiles are a power of 2.
- 4 actions – LEFT, RIGHT, UP, DOWN
- Two tiles of same value merge and scores get added.
- New tile gets 2 with a 90% probability or 4 with 10% probability.
- Game ends - no more moves can be made / no tiles can be merged.



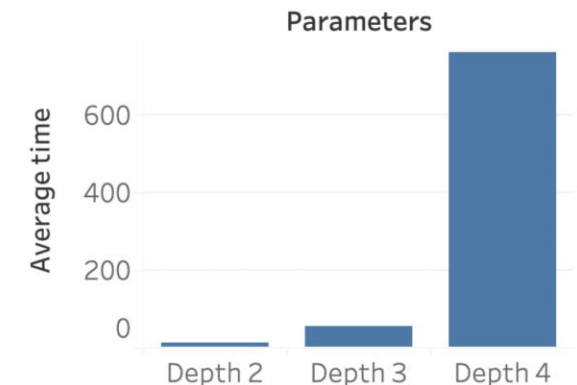
Expectimax

- Variation of MiniMax – maximizes the expected utility.
- **Best** for stochastic problem like 2048.
- Expectimax game tree has max nodes (max value of child nodes) and chance nodes (expected utility of random states).
- Snake Heuristic - numbers arranged descendingly in snake format.
- **Results:** Max Score=8192 with depth=4.

Expectimax Average Max Scores



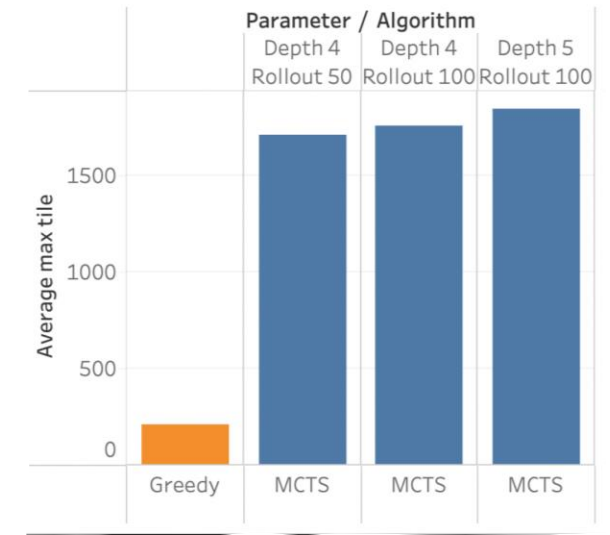
Expectimax Time For Different Depths



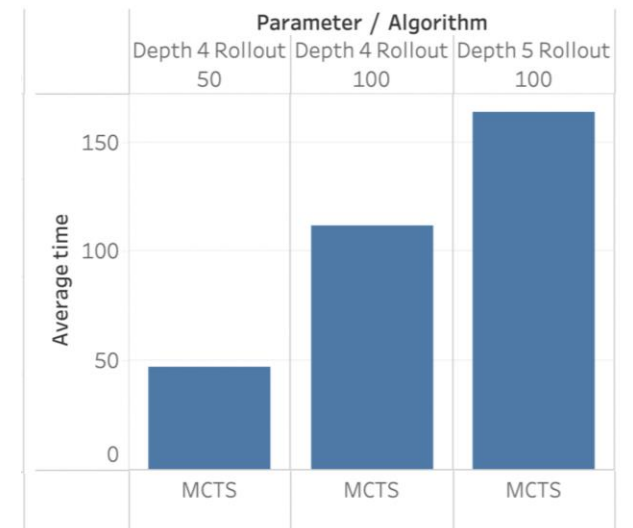
MCTS

- Random simulations run multiple times to determine optimal course of actions.
- 4 steps - Selection, Expansion, Simulation and Backpropagation.
- Asymmetrical trees - poor paths pruned which allows potential paths to be searched deeper.
- **Results:** Max Score=2048 with depth=5 and rollout=100.

MCTS Max Average Tiles

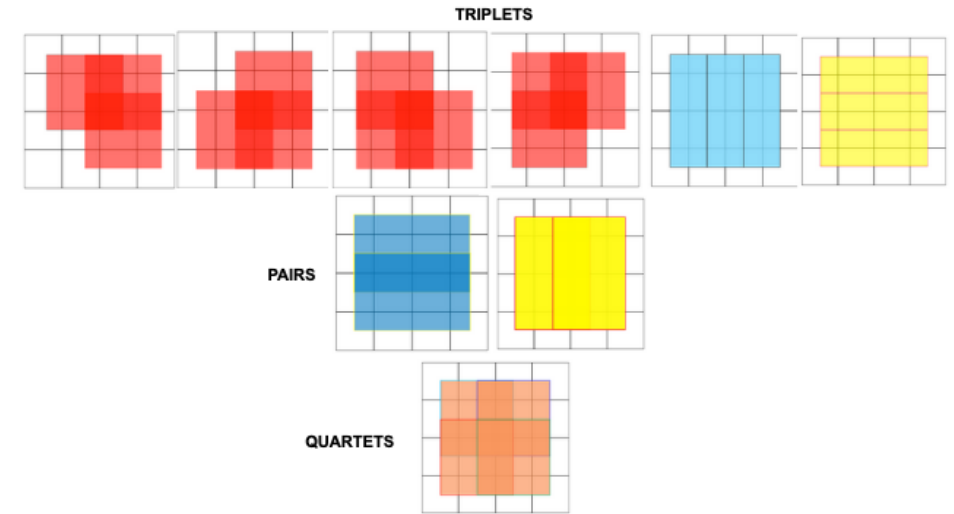


MCTS Timings for different parameters



Tuple based Q learning

- The Tuple based Q-learning agent learns similarities between various parts of the board (collaborative learning) instead of separate disjointed portions.
- Heuristic - sum of the weighted features for the pairs, triplet and quartet tuples.
- At each step, we check which possible actions (evaluation of heuristic) leads to a state with the highest Q-value. We then move to that state, and use the Bellman Equation to make a back-propagation update for the previous state.
- **Results:** Max Score=4096 with 5000 episodes



Average Max Tile Achieved

