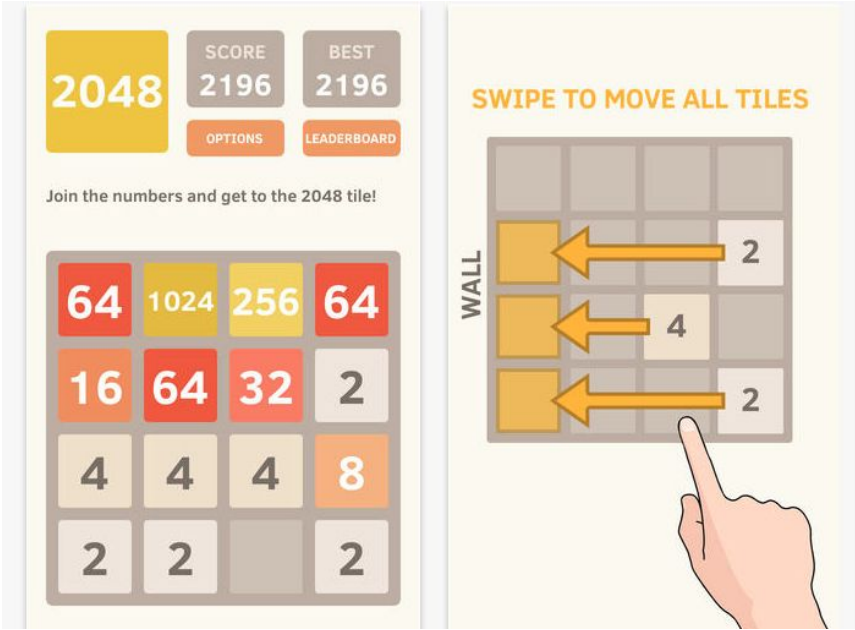




Beyond 2048: AI Models for Extended 2048 Problems

Han Jiang, Peter Ly, Ron Nafshi

2048: How to Play

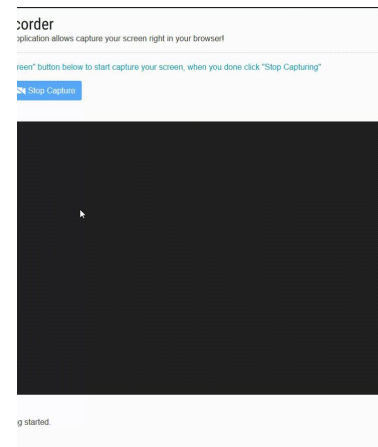


Main Mechanic: Merging



Beyond 2048: Challenges

- # of Game States: $(N \times N+1)^{(N \times N)}$
- Stochastic element with new tiles
- On larger boards, even random agents seem to perform well
 - It takes thousands of moves for an agent to lose
 - Simply total score or large tiles are insufficient heuristics

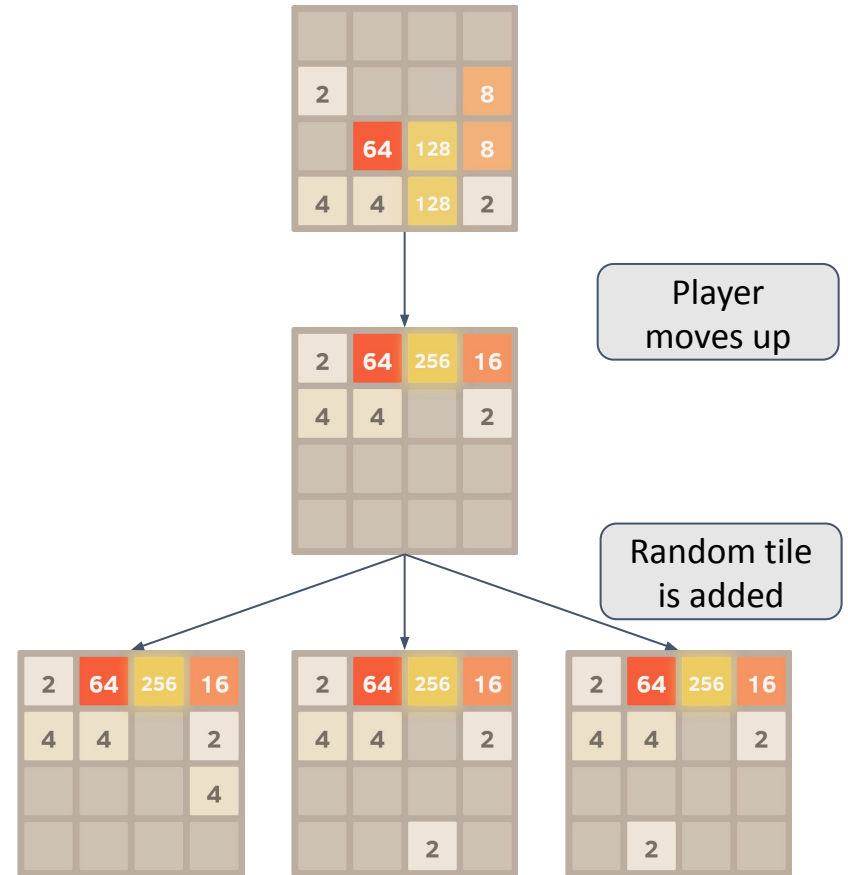


Project Set-up

- We explore two algorithms, Expectimax and Temporal Difference Learning on board sizes 4 x 4 to 6 x 6
- We use two scoring metrics, percentage of the time the 2048 tile is achieved (win rate) and total score
- We then explore heuristics for each model as the board size changes.

Expectimax pt.1

- Model game states as a tree
- Process tree via iterative deepening
- Construct heuristics (offline)
 - # of empty spaces
 - How close similar tiles are together
 - Where large tiles are placed
- Decide value of actions+randomness with heuristics
- Weight each value by probability of occurrence
- Do the action with max weighted value



Expectimax pt.2

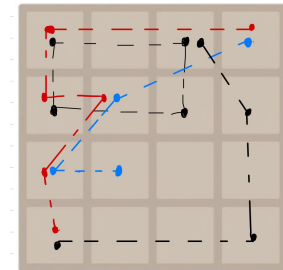
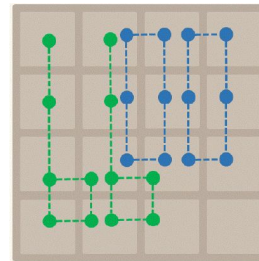
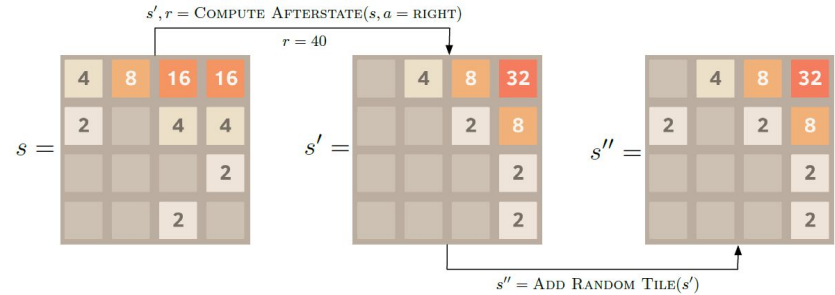
- Problems
 - Need to be semi-good at 2048 to generate heuristics
 - Expectimax slows down greatly when we increase search depth
- Results for 4x4 boards
 - Win rate: 88.3%
 - Max score: 79224
 - Avg. number of moves: 2163.954

			4
		4	8
4	4	8	16
4	8	16	32

TD Learning pt.1

- Evaluating Afterstates
 - State after a move and before tile generation
 - Evaluate the afterstates (higher accuracy)

- Problem: Too many states
 - Use tuples to represent the board
 - Select most “representative” tuples
 - Sum of tuple values -> board value



Results

Dimension 4x4 board summary

	Random	Expectimax	TD
Win Rate (%)	0	88.3	94.9
Max Score	2808	79224	150,896

Results for other dimensions

4x4 boards	Random	Expectimax
Win Rate	0	88.3
Max Score	2808	79224
Avg # of moves	113.757	2163.954

5x5 boards	Random	Expectimax
Win Rate	0	100
Max Score	19336	1267828
Avg # of moves	451.989	18678.01

6x6 boards	Random	Expectimax
Win Rate	92.6	100
Max Score	178008	14745584
Avg # of moves	3184.35	204785.909

Takeaways + Next Steps

- Takeaways
 - Both methods outperform random, with TD edging out on the base game board
- Next Steps
 - TD against Expectimax
 - Even Larger Boards! Currently collecting results for 6x6, 7x7 and 8x8
 - More critically, examine how heuristic performance changes as board size changes, and developing new ones
- If you want to try playing (or procrastinating), someone made a PhD version!

