2048 AI Report

CS 4300 - Artificial Intelligence

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December 4, 2023

What is 2048?

- Introduced in March 2014 by Itailin web developer Gabriele Cirulli.
- Consists of a 4x4 grid, with numbered tiles.
- The goal of the game is to combine the tiles and reach the score of 2048.

PEAS Assessment:

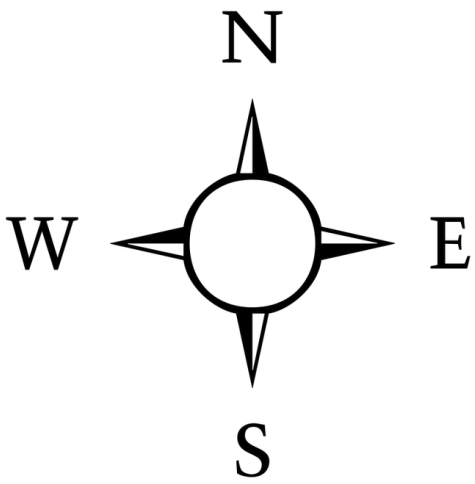
- Environment
  - Fully observable: Each point in time the state is completely observable.
  - Single Agent: The only agent is the player.
  - Deterministic: Every action on the environment has a deterministic effect on the environment and new blocks spawn in a deterministic manner.
  - Sequential: An action taken effects future actions.
  - Static: The environment waits for the agent to take an action before changing.
  - Discrete: The environment is discrete because there are finite states and the percepts and actions are discrete.
  - Known: Every action in the environment has a deterministic outcome so the agent knows what will happen given an action.

PEAS Assessment (Continued):

- Performance Measure
  - The highest achievable block.
  - High numbered blocks that could lead to higher numbered blocks.
- My Agents Performance Measure
  - Add up the value of each block when raised to the power of $\frac{5}{4}$.
  - Add one point for each block with a zero in it to incentivice the agent to keep the board clear.
  - Return an evaluation of zero if the board is full.

PEAS Assessment (Continued):

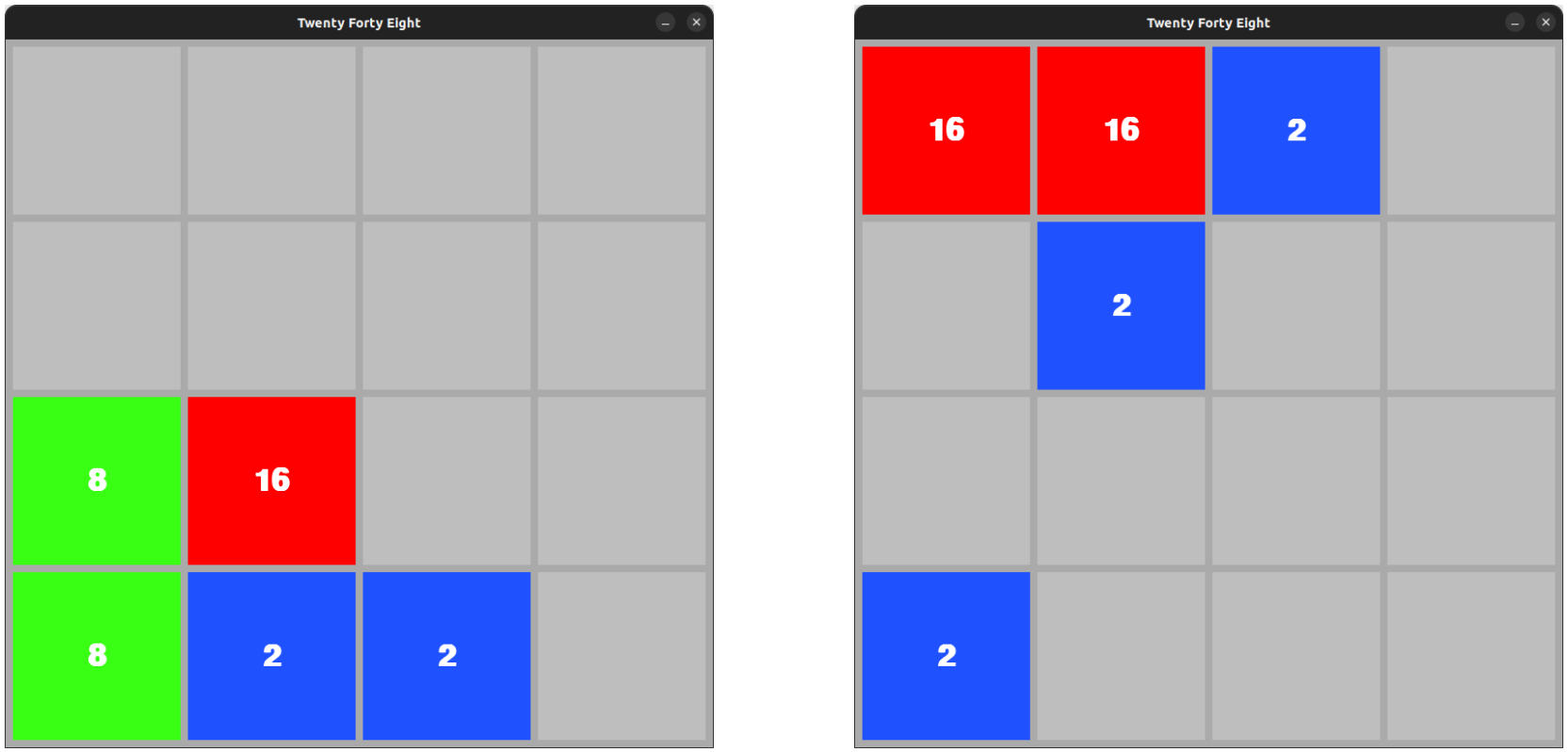
- Actuators
  - The game works by the player choosing one of the cardinal directions to shift the board in.
  - The available actions are therefore the cardinal directions (North, South, East, West).
- Sensors or Percepts
  - The current state of the board and the evaluation of it.
  - The set of states derived from the current state.



The Agent

- Uses a MAXMAX algorithm to caculate the max evaluation from taking an action.
- The depth of the lookup is adjustable, on my computer 6 seems to be a good compromise between performance and time to compute.
- Has an action space of 4 and therefore has 4^d possible spaces to check, where d is the depth.

Problem Instances

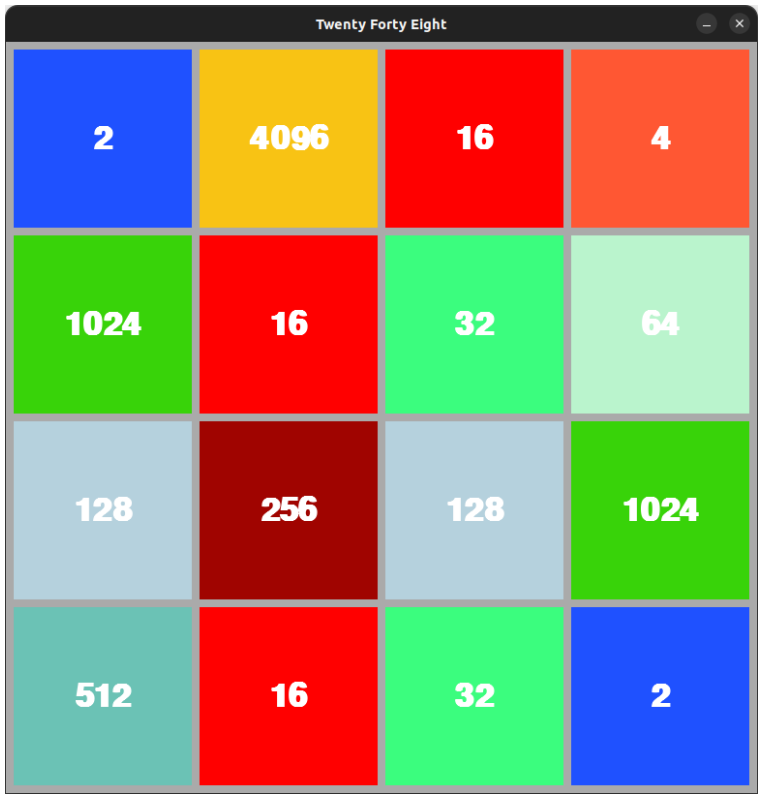


(a) Before Combining.

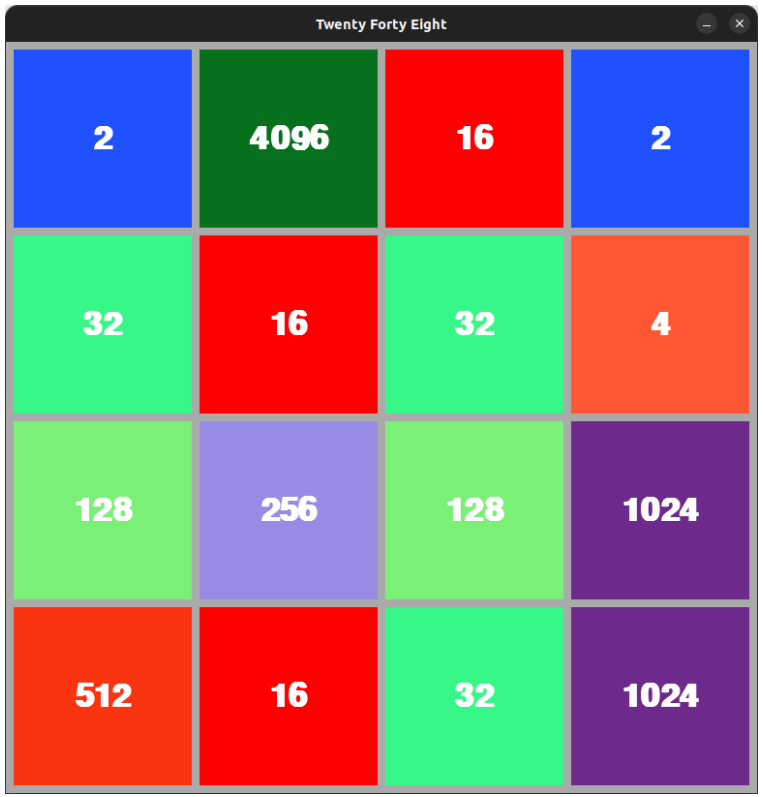
(b) After Combining.

Figure: The game mechanic of combining two blocks of equal value.

Problem Instances (continued)



(a) Game Over.



(b) Game is not over.

Figure: The game is not over until there are no moves.

Agent Performance

Agent Score:

- Highest score on a block achieved was 4096.
- Depending on depth level the agent achieved at least 2048 on average. Compare that to the random agent getting a score of 256 on average.

View my agent play

Future improvements

Future Ideas:

- Implement winning and game over screens.
- Implement more randomization in the environment like block spawn in locations.
- Build an agent that uses some form of machine learning to hopefully get a better score.

Conclusion

What I have done:

- Created a deterministic environment for the game 2048 in gymnasium.
- Created a model for the environment.
- Built a human render mode for the environment using pygame.
- Built an agent that plays the environment using a MAXMAX algorithm.

Questions?