Game Agents for 2048

OK, but some questions about algorithms

Problem description:

2048 is a single player puzzle game invented by Italian developer Gabriele Cirulli inspired by 'Threes'. The standard 2048 is played on a 4 x 4 grid with numbered tiles. The player can move the tiles in four directions (Left, Right, Up or Down). When two tiles of the same number slide on each other, they combine to form a tile whose number is the sum of the two numbers. The player wins the game when he forms the 2048 tile and loses if there are no possible moves to make. The problem deals with the creation of an agent which can play and win the game.

The game starts with a few tiles available initially. After each move, a new tile is randomly placed on an empty location with probability of 0.9 for it being a 2 and 0.1 for it being a 4. For every move the player makes, score will be calculated based on the cumulative value of the tiles present on the board. Hence, higher valued tiles will result in higher score. The agent should be rewarded for the moves which maximizes the score when the game terminates.

The input for the agent is the current state of the board. The output will be the direction in which the agent wants to move the tiles.

I have played the 2048 game and found it to be addictive. The game has a lot of mathematical background which can be used as heuristics when creating the agent. This intrigued me, and I aspire to create an agent that can play and win the game.

but what is the data? will you use a simulator?

Data:

This machine learning problem comes under unsupervised learning and hence the agent will learn and adjust its parameters as it plays the game. The current state of the game (location of the tiles in the board along with their value) will be the input parameters and maximizing the score will be the goal of the agent. The AI will provide with a move on the given board which maximizes the score.

Algorithms:

I plan on using Expectimax algorithm and Reinforcement Learning and compare the results of these algorithms. Both the algorithms aim to maximize the score (which will be a direct reflection of the highest tile in the board) obtained while playing the game and will use that as the reward for decision making.

Expectimax Algorithm:

This is a variation of the minmax algorithm. The minmax algorithm is suited for a two-player environment which aims to minimize the loss for a worst-case scenario. The Expectimax algorithm includes the expectancy of a random event when making a decision. This algorithm is commonly used to create game agents that make decisions considering a random event (E.g. Throw of a dice).

look at value iteration

The Expectimax algorithm introduces the element of chance (the placement of a 2 or 4 tile at a free location) into the minmax tree. At each stage the agent tries to maximize the score taking into consideration the expectancy of the placement of the random tile.

Projects using Expectimax to solve 2048:

1. http://informatika.stei.itb.ac.id/~rinaldi.munir/Stmik/2013-2014-genap/Makalah2014/MakalahIF2211-2014-037.pdf
2. https://home.cse.ust.hk/~yqsong/teaching/comp3211/projects/2017Fall/G11.pdf
3. http://www.cs.uml.edu/ecg/uploads/AIfall14/vignesh_gayas_2048_project.pdf

Reinforcement Learning:

The goal of reinforcement learning is learning a sequence of actions that lead to a long-term reward. They are commonly used to build agents for computer games, robot control, advertising, etc.

For the current problem, the agent learns the sequence by interacting with the environment (Board) and observing the reward (Score). The agent must aim to maximize the probability of forming a 2048 tile, thus maximizing the score, rather than combining tiles to score points at the current step. Hence, reinforcement learning is suitable for training the agent.

Projects involving variants of Reinforcement Learning to solve 2048:

1. http://www.cs.put.poznan.pl/wjaskowski/pub/papers/Szubert2014_2048.pdf
2. https://pdfs.semanticscholar.org/e11f/23691ca8f6dabbf701c367d9c09882e1690f.pdf
3. http://www.mit.edu/~amarj/files/2048.pdf

A project which compares the Expectimax algorithm and the Reinforcement Learning algorithm for 2048 game is http://cs229.stanford.edu/proj2016/report/NieHouAn-AIPlays2048-report.pdf

Results:

There are online websites that allow us to play the 2048 game. By letting the agent play the game, it is possible to view the decisions made by the agent. The game terminates when the agent forms the 2048 tile or when there is no valid move which can be made.

The results are analyzed by comparing the performance of Expectimax and Reinforcement Learning algorithms towards solving the 2048 puzzle game in terms of the time taken to train the model, the winning rate and the number of steps taken to win each game.