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CS 482

Homework # 2

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1.) I choose Scrabble. Rules used here are adapted from <http://iml.jou.ufl.edu/projects/spring10/henderson_s/rules.html> , <https://scrabble.hasbro.com/en-us/rules> ,

and <https://www.youtube.com/watch?v=swlg3vQXboE>

There seems to be a fair bit of latitude concerning what exactly the rules are depending on who you ask, so I did my best to cover what was common.

State Descriptions: For normal play, a state consists of a board, a player’s tray of tiles, a tally of each player’s score, a list of tiles in the draw bag, and some marker of whose turn it is.

The initial state, however, is an exception to this: it requires an empty board, each player with 1 tile and a score of 0, and a bag containing n - p tiles, where n is the total number of tiles and p is the number of players (between 2 and 4 inclusive). This state is used to resolve who will go first. Afterwards all states follow the original description.

Terminal states are those that occur when the tile bag has been exhausted such that a player attempting to draw tiles cannot replenish their tray up to 7 tiles total.

Since information about the bag and the trays of other players should not be available to a player, a simulation would need to obscure complete information about the state from the players.

Move generators: For the initial state, players compare their singleton tiles, and the player with the tile closest to ‘a’ alphabetically goes first. All players then draw 6 additional tiles from the bag so that each player has 7 tiles. The first player must use her first turn to play a word on the board where one of the letters is on the central star grid position. Afterwards normal play begins and turns transition in counterclockwise order. On a player’s turn, the player can choose between three options: play a word on the board, redraw tiles, or pass. The player’s actions during these turns cause changes in state. Since this game is stochastic, we can also consider the bag’s “actions” during tile draws to change the state.

When a player plays a word, which must be horizontal or vertical on the grid and intersect with a word already placed on the board, another player can opt to challenge them. If the word is challenged, it is checked for existence in the Scrabble dictionary. If it exists, the person who challenged the word forfeits their next turn. If it does not exist, the person who played the word returns the tiles to her tray and forfeits her turn. If there is no challenge or the challenge fails, the value of the word is calculated according to tile letter values and the values of special spaces on the board and added to the player’s score. After a player plays a word, they draw tiles from the bag back up to 7.

When a player redraws tiles, they choose between 1 and 7 tiles to return to the bag, redrawing the same number of tiles back into their tray. This ends their turn.

A player can also choose to pass, retaining their tiles and ending their turn. (Some variants of Scrabble seem to include provisions for a game to end if everyone passes, or a player passes twice; I have not included these rules as they don’t appear to be standard.)

The game continues in this fashion, with each player taking a turn in a counterclockwise fashion until a final state is reached.

Terminal test: Check a player’s tray after her turn. The test succeeds if the player could not draw from the bag back up to a tray of 7 tiles and fails otherwise.

Utility functions: To evaluate a state’s utility for a given player, add in the tally of that player’s score which has been maintained throughout the game. Additionally, quantify the value of the tiles in the player’s tray (i.e. the score given for that letter versus the frequency of that letter in the dictionary) and add that in to the utility. Since the values in the other player’s trays are unknown, these cannot be used in the utility function. This method can be used to evaluate a given state for a given player.

Evaluation functions: Comprehensive tree search is likely to be extremely prohibitive due to the large branching factor of the bag as a stochastic player in the game, among other issues, so a heuristic is probably necessary. A potential heuristic for a naive Scrabble move is to search all combinations of existing characters on the board vertically and horizontally together with tiles in the tray for a valid move that rewards the most points possible. (I note that this is a greedy strategy and, the text claims, not difficult to implement and not optimal, but adequate for “good” play.) Then make that move, and repeat the process on each turn until the game ends. If no move can be made, i.e. for a heuristic of 0, the function should instead opt to redraw tiles- we can naively say to redraw all 7, or define some more complex evaluation strategy where tiles are given values relating to e.g. frequency in the dictionary vs. tile point values, such that more valuable ones are kept and less valuable ones are discarded.