

hw3_games_q8_shallow_search

Question 8: Shallow Search

0.0/8.0 points (graded)

In this question, we will investigate shallow search, also known as depth-limited search. Depth-limited search is not guaranteed to find the optimal solution to the original problem. The point of this question is to explore some of the (potentially undesirable) behavior of depth-limited search, and to illustrate that the quality of the evaluation function can play a big role in how well depth-limited search performs.

Consider the following Pacman configuration, in the board below. At each time step, Pacman can move either West (left) or East (right) and is using limited-depth minimax search (where the minimizing agent does not really do anything) to choose his next move. Pacman is 3 East moves away from the food, and chooses from the following state evaluation functions:

- $F1(\text{state}) = -\text{Number of food pellets left}$
- $F2(\text{state}) = -\text{Number of food pellets left} + 0.5/(\text{distance to closest food pellet} + 1)$; distance to closest food pellet is taken as 0 when no food remains.

The search depth referred to in this question corresponds to the depth in a search tree that only considers the maximizer's actions. For example, if the search considers sequences of up to 2 actions by the maximizer, it'd have a search depth of 2.

In the questions below, optimality means that the action is an optimal **first** action according to the search tree with the specified depth and the specified evaluation function. In each of these questions, there are 5 different search trees under consideration: one of depth 1, one of depth 2, ... , and one of depth 5.

Note that there can be more than one optimal action for a given search tree (this can happen whenever there are ties). Also, note that a search does not finish when the dots are eaten.



Using F1 as the state evaluation function, for what search depths will East be an optimal action?

☒ 1 ✓

☒ 2 ✓

☒ 3 ✓

☒ 4 ✓

☒ 5 ✓

Using F1 as the state evaluation function, for what search depths will West be an optimal action?

☒ 1 ✓

☒ 2 ✓

☐ 3

☐ 4

☒ 5 ✓

Using F2 as the state evaluation function, for what search depths will East be an optimal action?

☒ 1 ✓

☒ 2 ✓

☒ 3 ✓

☒ 4 ✓

☒ 5 ✓

Using F2 as the state evaluation function, for what search depths will West be an optimal action?

☐ 1

☐ 2

☐ 3

☐ 4

☒ 5 ✓

Part 1:

Depths 1 and 2: All actions result in the same score in the search tree because no sequence of 1 or 2 actions will eat the food, so both actions optimal.

Depths 3 and 4: East is the only optimal action, because the only way to eat the food with 3 or 4 moves is to move East until it is eaten.

Depth 5: It is possible to eat the food by either going West, then East four times, or by going East three times followed by any action. Thus, either action is optimal

Part 2:

See the solution for Part 1.

Part 3:

Depths 1-4: The optimal policy is to move East until pacman has eaten the pellet, because any state without the pellet has a higher score than any state in which the pellet hasn't been eaten.

Depth 5: The optimal policy is either to move West once, then East 4 times, or to move East three times followed by anything, because all states have the same score once there is no food left. Both policies have the same score because both end up with no food left.

Part 4:

As mentioned above, for depths 1-4, the optimal action is only to go East, but for depth 5 the optimal action is either to move East or West.

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i Answers are displayed within the problem

Note this is a challenging question, so we have provided an optional hint. It will benefit you most if you first think about this problem on your own, and then if stuck, use the hint to guide you. To read the hint click on the hint button. [Hint](#)