CS221, Spring 2019, PS5 Pacman

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Problem 1: Minimax

a. Recurrence of $V_{minmax}(s,d)$.

$$V_{minmax}(s,d) = \begin{cases} \text{Utility}(s) & , \quad \text{IsEnd}(s) \\ \text{Eval}(s) & , \quad d = 0 \\ \max_{a \in \text{Actions}(s)} V_{minmax}(Succ(s,a),d) & , \quad \text{Player}(s) = a_0 \\ \min_{a \in \text{Actions}(s)} V_{minmax}(Succ(s,a),d) & , \quad \text{Player}(s) = a_{1 \ldots n-1} \\ \min_{a \in \text{Actions}(s)} V_{minmax}(Succ(s,a),d-1) & , \quad \text{Player}(s) = a_n \end{cases}$$

Problem 3: Expectimax

a. Recurrence of $V_{expectimax}(s,d)$.

$$V_{expectimax}(s,d) = \begin{cases} \text{Utility}(s) & , \quad \text{IsEnd}(s) \\ \text{Eval}(s) & , \quad d = 0 \\ \max_{a \in \text{Actions}(s)} V_{expectimax}(Succ(s,a),d) & , \quad \text{Player}(s) = a_0 \\ \sum_{a \in \text{Actions}(s)} \pi_(s,a) V_{expectimax}(Succ(s,a),d) & , \quad \text{Player}(s) = a_{1 \ldots n-1} \\ \sum_{a \in \text{Actions}(s)} \pi_(s,a) V_{expectimax}(Succ(s,a),d-1) & , \quad \text{Player}(s) = a_n \end{cases}$$

Note the above $\pi_(s,a) = \frac{1}{|\text{Actions}(s)|}$

Problem 4: Evaluation function

b. Thoughts on pacman evaluation function

Generally the features I can access are:

1. distance to food: should have higher reward going towards positions close to more food. Firstly I use number of food in square $\text{foodgrid}_{p_0-\text{offset}\ldots p_0+\text{offset},p_1-\text{offset}\ldots p_1+\text{offset}}$, then used $\sum \frac{1.0}{\text{distance}(p,(x,y))}$ but neither achieve good results. Then changed to $\frac{c1}{2^{\text{distance}}}$ incorporated with the following ghost related feature makes things work.
2. distance to ghost, should avoid going too close to ghost. Feature extracted is $-\frac{c2}{\text{distance}}$. Here need to redeem a positive fraction when the ghost is in scary state. The redeemed number is $\frac{10\times c2}{\text{distance}}$
3. distance to capsule, trying to make higher reward when close to capsules, but doesn't seem to help much. The reason I guess should be related to movement flexibility: When pacman is cornered, it is very easy to be eaten by ghost.
4. number of actions, Tried to use number of actions as a feature, but doesn't get much result.
5. scared timer, it is used in above item 2 for redeeming ghost cost.

Result: the average winning score on my windows 10:
Scores: 53, 650, 1667, 175, -61, 1556, 416, 1322, 1519, 1442, 424, -42, 1266, -152, 1619, 127, 1659, 1308, 1591, 1582
Win Rate: 11/20 (0.55)
Record: Loss, Loss, Win, Loss, Loss, Win, Loss, Win, Win, Win, Loss, Loss, Win, Loss, Win, Loss, Win, Win, Win, Win
Average score of winning games: 1502