**CS 221: Pacman**

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**Problem 1**

(a) Write the recurrence for a multi-agent vopt with stopping depth Vmax.

$$V = \begin{cases} \text{Utility(s)} & \text{IsEnd(s)} \\ \text{Eval(s)} & d = 0 \\ \text{Max}_{a \in actions} \text{ Vopt(Succ(s, a), d)} & \text{Player(s)} = \text{agent} \\ \text{Min}_{a \in actions} \text{ Vopt(Succ(s, a), d)} & \text{Player(s)} = \text{opp}_1 \ldots \text{opp}_{n-1} \\ \text{Min}_{a \in actions} \text{ Vopt(Succ(s, a), d -1)} & \text{Player(s)} = \text{opp}_n \end{cases}$$

(b) (in code)

**Problem 2** (Code)

**Problem 3**

(a) $$V = \begin{cases} \text{Utility(s)} & \text{IsEnd(s)} \\ \text{Eval(s)} & d = 0 \\ \text{Max}_{a \in actions} \text{ Vopt(Succ(s, a), d)} & \text{Player(s)} = \text{agent} \\ \frac{1}{|actions|} \sum_{a \in actions} \text{ Vopt(Succ(s, a), d)} & \text{Player(s)} = \text{opp}_1 \ldots \text{opp}_{n-1} \\ \frac{1}{|actions|} \sum_{a \in actions} \text{ Vopt(Succ(s, a), d -1)} & \text{Player(s)} = \text{opp}_n \end{cases}$$

**Problem 4** (in code)