ROB 538
Multiagent Systems
Fall 2022
Homework 4: Game Theory
Due Nov 1, 2022 at 11:59 PM

1. Consider the bar problem from Homework 3 with 42 agents, b=5, and k=6.

   (a) Find the Nash Equilibrium when each agent uses the local reward:

   $$L(z) = x_k(z)e^{\frac{-x_k(z)}{b}} \tag{1}$$

   where z is the system state and $x_k(z)$ is the number of agents that attend on night k.

   (b) Find the Nash Equilibrium for the global reward, given by:

   $$G(z) = \sum_{k=1}^{K} x_k(z)e^{\frac{-x_k(z)}{b}} \tag{2}$$

   (c) Are the Nash Equilibria in a) and b) the same? What does the answer imply about the expected performance of the local reward?

   (d) Find the Nash Equilibrium for the Difference Reward with a zero counterfactual:

   $$D_i(z) = x_i(z)e^{\frac{-x_i(z)}{b}} - (x_i(z)-1)e^{\frac{-(x_i(z)-1)}{b}} \tag{3}$$

   where z is the system state, and $x_i(z)$ is the attendance of the night agent i selected.

   (e) Is this the same as the local or global reward's Nash Equilibria? What does the answer imply about the expected performance of the local reward?

2. Now consider a new problem where two players are deciding which bar to attend. Player 1 prefers McMenamin's, and Player 2 prefers Clod's. However, neither player wants to drink alone. This is reflected in the payoff matrix, where the first entry is Player 1's payoff:

		Player 2	
		Clod's	McMenamin's
Player 1	Clod's	2,5	0,0
	McMenamin's	0,0	5,2

   (a) Assume that Player 1 will choose McMenamin's with probability 1/2 and Clod's with probability 1/2. Use a simple action-value learner to learn a strategy to optimize Player 2's payoff given that Player 1 has this mixed strategy. To what policy does your learner converge? Does that policy maximize Player 2's payoff? Is this a Nash Equilibrium? Explain your answer.

   (b) What is the mixed strategy equilibrium for this game? If one exists, how do the payoffs compare to the pure strategy equilibria payoffs?

Your report should be in research paper format, and clearly describe your algorithms, results and analysis. You may use IEEE, AAMAS, or other similar conference standards as a template. Please submit your report as a PDF. **Please also submit the code for your assignment in a SEPARATE zip file or a link to a repository**.