Algorithmic Game Theory
Assignment 4

Palash Dey
Indian Institute of Technology, Kharagpur

1. What is the computational complexity of finding a PSNE of an arbitrary two player finite strategic form game where each player has n strategies each?

   (a) $\mathcal{O}(2^n)$
   (b) $\mathcal{O}(2^{n^2})$
   (c) $\Theta(n)$
   (d) $\mathcal{O}(n^4)$

   The correct answer is (d). I think it should be $\mathcal{O}(n^2)$
   Justification: For PSNE, we fix the strategy of first player and select the best response of second player (out of n possible strategy). Further, this has to be repeated for remaining $(n-1)$ strategies of first player. Finally we find the intersection of the players' best responses.

2. How many numbers are needed to describe an n-player graphical zero-sum (that is, the sum of utilities of all the players are zero in every strategy profile) game where the underlying graph is regular, the in-degree of each vertex is 10 and each player has 3 strategies? Assume $n \geqslant 200$.

   (a) $n11^3$
   (b) $(n-1)11^3$
   (c) $n3^{11}$
   (d) $(n-1)3^{11}$

   The correct answer is (c).
   Justification: Refer to week-4 lecture-1

3. Consider a arbitrary network congestion game with n vertices, m edges, and N players. How many numbers are there in the most succinct representation this game? Consider the name of the vertices as label and not numbers.

   (a) $(N+1)mn$
   (b) $(N+1)m$
   (c) Nm
   (d) $Nm(n+1)$

   The correct answer is (b).

4. In a symmetric game, suppose we have 20 players and each player has 5 strategies each. How many numbers are needed in the most succinct representation of this game?

   (a) $5\binom{24}{4}$
   (b) $5\binom{20}{4}$
   (c) $5\binom{24}{5}$
   (d) $20\binom{20}{5}$

   The correct answer is (a).

5. In an anonymous game, suppose we have 20 players and each player has 5 strategies each. How many numbers are needed in the most succinct representation of this game?

   (a) $100\binom{25}{4}$
   (b) $100\binom{24}{4}$
   (c) $25\binom{23}{4}$
   (d) $100\binom{23}{4}$

   The correct answer is (a).
   Justification: Refer to week-4 lecture-1

6. Which of the following statements is wrong?

   (a) every network congestion game is also a strategic form game.
   (b) every network congestion game has an MSNE.
   (c) every congestion game is also a network congestion game.
   (d) every congestion game has an MSNE.

   The correct answer is (c).

7. Which of the following games always have a PSNE?

   (a) Finite strategic form game.
   (b) Finite symmetric game.
   (c) Finite zero-sum game.
   (d) Finite congestion game.

   The correct answer is (d).

8. For which of the following games, an ε-PSNE can be computed efficiently?

   (a) symmetric games
   (b) congestion games where cost functions have bounded jump
   (c) network congestion games where cost functions have bounded jump
   (d) multi-matrix games

   The correct answer is (c).

9. For which of the following problems, no efficient algorithm is known?

   (a) finding an ε-PSNE in an arbitrary finite strategic form game
   (b) finding an ε-PSNE in a bounded-jump network congestion game
   (c) finding an ε-PSNE in a bounded-jump congestion game
   (d) finding an ε-PSNE in a zero-sum game

   The correct answer is (c).
   Justification: Refer to week-4 lecture-4

10. Which of the following problems is not a local search problem?

   (a) minimum-cut in an unweighted undirected graph
   (b) PSNE in a network congestion game
   (c) PSNE in a congestion game
   (d) local-minimum-cut in a weighted undirected graph

   The correct answer is (a).