Università degli Studi dell'Aquila

Non-Cooperative Networks: Mid-term Evaluation

Wednesday, November 6th, 2019 – Prof. Guido Proietti

[redacted]	Last name: .... First name: .... ID number:	Points
EXERCISE 1		
EXERCISE 2		
TOTAL		

EXERCISE 1: Multiple-choice questions (20 points)

Remark: Only one choice is correct. Use the enclosed grid to select your choice. A correct answer scores 3 points, while a wrong answer receives a -1 penalization. You are allowed to omit an answer. If you wrongly select an answer, just make a circle around the wrong $\times$ (i.e., in the following way $\otimes$) and select through a $\times$ the newly selected answer. A question collecting more than one answer will be considered as omitted. The final score will be given by summing up all the obtained points (0 for a missing answer), and then normalizing to 20.

1. What does the Nash Theorem state?
   *a) Any game with a finite set of players and a finite set of strategies has a NE of mixed strategies
   b) Any game with a finite set of players and a finite set of strategies has a NE of pure strategies c) Any game with a finite set of players and a finite set of strategies has at least a NE of mixed strategies d) Any game with any number of players each with a finite set of strategies has a NE of mixed strategies

2. Which of the following claim is true for the Battle of the Sexes game:
   a) It admits a single Nash equilibrium b) It admits two dominant strategy equlibria
   *c) It has a Price of Anarchy equal to 1 d) It does not admit any Nash equilibrium

3. Which of the following claim is false for the Prisoner's Dilemma game:
   a) It admits a Nash equilibrium b) It admits a dominant strategy equlibrium
   c) It has a Price of Anarchy equal to 5 *d) It has a Price of Stability equal to 1

4. How the Price of Stability is defined for a game in which the social-choice function C has to be maximized (S is the set of Nash equilibria)?
   *a) $\text{PoS} = \sup_{s\in S} \frac{C(s)}{C(\text{OPT})}$ b) $\text{PoS} = \inf_{s\in S} \frac{C(s)}{C(\text{OPT})}$ c) $\text{PoS} = \sup_{s\in S} \frac{C(\text{OPT})}{C(s)}$ d) $\text{PoS} = \inf_{s\in S} \frac{C(\text{OPT})}{C(s)}$

5. How the Price of Anarchy is defined for a game in which the social choice function C has to be minimized (S is the set of Nash equilibria)?
   *a) $\text{PoA} = \sup_{s\in S} \frac{C(s)}{C(\text{OPT})}$ b) $\text{PoA} = \inf_{s\in S} \frac{C(s)}{C(\text{OPT})}$ c) $\text{PoA} = \sup_{s\in S} \frac{C(\text{OPT})}{C(s)}$ d) $\text{PoA} = \inf_{s\in S} \frac{C(\text{OPT})}{C(s)}$

6. In the global connection game on a graph $G = (V, E, c)$, if we denote by c_e (resp., k_e) the cost (resp., the load) of an edge $e \in E$, and by $N(S)$ the network induced by a given strategy profile S, which of the following is a potential function?
   *a) $\Psi(S) = \sum_{e\in N(S)} c_e \cdot (1 + 1/2 + \ldots 1/k_e)$ b) $\Psi(S) = \sum_{e\in N(S)} c_e/k_e$
   c) $\Psi(S) = \sum_{e\in N(S)} c_e$ d) $\Psi(S) = \sum_{e\in N(S)} c_e \cdot (1 + 2 + \ldots + k_e)$

7. In a local connection game with k players and building cost $\alpha \geq 0$, which of the following claim is true?
   a) for $\alpha = 3/2, \text{PoS} = 1$ b) for $\alpha = 1$, the clique is the only stable graph c) $\text{PoA} = O(1)$ *d) $\text{PoS} \leq 4/3$

8. In the Malik, Mittal and Gupta algorithm on a graph with n nodes and m edges, which of the following set of operations are performed on the Fibonacci heap?
   a) A single make-heap, $O(n)$ insert, n find-min, $O(n)$ delete and $O(m)$ decrease-key
   b) A single make-heap, n insert, $O(n)$ find-min, n delete and $O(m)$ decrease-key
   *c) A single make-heap, n insert, $O(n)$ find-min, $O(n)$ delete and $O(m)$ decrease-key
   d) A single make-heap, n insert, $O(n)$ find-min, $O(n)$ delete and m decrease-key

9. In the selfish-edge single-source shortest-path tree problem, which of the following corresponds to the threshold value for an edge $e = (u, v)$ belonging to the solution?
   *a) $\Theta_e = \min_{f=(x,y)\in C(e)}\{d_G(s, x) + r(e) + d_G(y, v)\} - d_G(s, u)$ b) $\Theta_e = \min_{f=(x,y)\in C(e)}\{d_G(s, x) + r(e) + d_G(y, v)\} - d_G(s, v)$
   c) $\Theta_e = \min_{f=(x,y)\in C(e)}\{d_{G-e}(s, x) + r(e) + d_{G-e}(y, v)\} - d_G(s, u)$ d) $\Theta_e = \min_{f=(x,y)\in C(e)}\{d_{G-e}(s, x) + r(e) + d_{G-e}(y, v)\} - d_G(s, v)$

10. In the one-parameter mechanism for the single-source shortest path tree problem, which payment will receive an edge e belonging to the solution?
    *a) $p_e = r_e w_e(r) + \int_{r_e}^{\infty} w_e(r_{-e}, z)\, dz$ b) $p_e = r_e w_e(r) + \int_{0}^{\infty} w_e(r_{-e}, z)\, dz$
    c) $p_e = -r_e w_e(r) + \int_{r_e}^{\infty} w_e(r_{-e}, z)\, dz$ d) $p_e = r_e w_e(r) + \int_{0}^{r_e} w_e(r_{-e}, z)\, dz$

Answer Grid

	Question									
Choice	1	2	3	4	5	6	7	8	9	10
a										
b										
c										
d										

EXERCISE 2: Open question (10 points)

Remark: Select at your choice one out of the following two questions, and address it exhaustively.

1. Describe and analyze the global connection game.
2. Describe and analyze the one-parameter mechanism for the private-edge SPT problem.